Obstetric Sonography in Fiji

A Review of the Current Practice at an Urban Public Hospital

Sanjalesh Kumar

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Health Science (Hons) (Medical Radiation Technology), Unitec New Zealand, 2008
ABSTRACT

This research employed a case study approach positioned in an interpretive paradigm to investigate the current obstetric sonography practice at an urban public hospital in Fiji. The primary aims of this research were firstly, to evaluate the current practices and procedures used for the mid-trimester obstetric sonography examinations at an urban public hospital in Fiji; and secondly, to examine the potential need for the development of a standard protocol for the mid-trimester obstetric sonography examinations at the hospital where this research was located.

Multiple data collection methods were employed to collect predominantly qualitative data through observations, questionnaires and interviews. The participants, who were purposively selected, comprised six ‘on-the-job’ trained radiographers performing obstetric sonography and four sonography specialists (two radiologists and two obstetricians). While the quantitative data was obtained from the observations made on the scanning criteria used by the radiographers, most of the qualitative data was obtained from the radiographers’ questionnaires and the specialists’ interviews.

The findings of this study revealed that there are obvious omissions in the current practice of obstetric sonography in Fiji. The evaluation of the radiographers’ guidelines for the mid-trimester obstetric sonography examinations at the host hospital showed inconsistencies in their current practice. Absence of a standard written protocol, insufficient expertise, training and supervision, excessive workload and lack of resources, have been identified as some of the major factors influencing the radiographers’ sonography practice at the host hospital.

It is surmised that due to the identified limitations and constraints, the current obstetric sonography practice at the host hospital neither meets the international standards nor the expectations of the sonography specialists in their entirety. Hence, there is a genuine need for the implementation of standard obstetric sonography examination protocols at the host hospital and continuing professional development in medical sonography in Fiji.
DECLARATION

Name of Candidate: Sanjalesh Kumar

This thesis entitled *Obstetric Sonography in Fiji: A review of the current practice at an urban public hospital* is submitted in partial fulfilment for the requirements for the Unitec degree of Master of Health Science (Medical Radiation Technology).

Candidate’s Declaration

I confirm that:

- This thesis represents my own work;
- The contribution of supervisors and others to this work was consistent with the Unitec Regulations and Policies; and
- Research for this work has been conducted in accordance with the policy and procedures of the Unitec Research Ethics Committee (UREC) and the Fiji National Research Ethics Review Committee (FNRERC). This research has fulfilled any requirements set for this project by the UREC and FNRERC.

UREC Approval Number: 2007.768
FNRERC Approval Number: 019-2007

Candidate’s Signature: …………………………………………….Date: …………………

Student number: 1246857
ACKNOWLEDGEMENTS

There are a number of people who have contributed to my research. I would like to express my thanks to all the research participants who gave me their valuable time to freely share their experiences in obstetric sonography practice in Fiji.

I am particularly grateful to my supervisors, Andrea Thompson and Dr. Jennie Billot, for their splendid role in guiding me throughout my research. They provided continuous support and motivation. Their availability and enthusiasm with regard to my research topic have been extremely encouraging.

I must thank Jenny Mitchell, for sharing her sonography expertise and providing technical assistance in this research, and Rob Moron for offering initial assistance in the analysis of the research data. I would also like to show my appreciation to my medical imaging colleagues in Fiji and New Zealand who always provided the needed support.

Lastly, I would like to express my heartfelt thanks to my wife, Shalini, for her endless encouragement and support during my studies at Unitec. I dedicate this work to our son, Giriraj, who was born at the completion of this research and was a great inspiration throughout this exciting journey.
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<td>3-D</td>
<td>3-Dimensional</td>
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<tr>
<td>4CH</td>
<td>4-Chambered Heart</td>
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<tr>
<td>AC</td>
<td>Abdominal Circumference</td>
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<tr>
<td>ACR</td>
<td>American College of Radiology</td>
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<tr>
<td>AFI</td>
<td>Amniotic Fluid Index</td>
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<tr>
<td>AIUM</td>
<td>American Institute of Ultrasound in Medicine</td>
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<tr>
<td>ASUM</td>
<td>Australasian Society for Ultrasound in Medicine</td>
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<tr>
<td>BMI</td>
<td>Body Mass Index</td>
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<tr>
<td>BPD</td>
<td>Bi-parietal Diameter</td>
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<td>CM</td>
<td>Cisterna Magna</td>
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<td>CPD</td>
<td>Continuing Professional Development</td>
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<tr>
<td>CRL</td>
<td>Crown Rump Length</td>
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<tr>
<td>CSF</td>
<td>Cerebrospinal Fluid</td>
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<td>CSP</td>
<td>Corpus Septum Pellucidum</td>
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<td>CT</td>
<td>Computed Tomography</td>
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<tr>
<td>CWMH</td>
<td>Colonial War Memorial Hospital</td>
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<td>DMU</td>
<td>Diploma of Medical Ultrasonography</td>
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<td>EDD</td>
<td>Estimated Date of Delivery</td>
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<td>FH</td>
<td>Fetal Heart</td>
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<td>FL</td>
<td>Femur Length</td>
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<td>FNRERC</td>
<td>Fiji National Research Ethics Review Committee</td>
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<td>FSMed</td>
<td>Fiji School of Medicine</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>HC</td>
<td>Head Circumference</td>
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<td>HL</td>
<td>Humerus Length</td>
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<td>IUGR</td>
<td>Intra-uterine Growth Restriction</td>
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<td>JICA</td>
<td>Japanese International Cooperation Agency</td>
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<td>LVOT</td>
<td>Left Ventricular Outflow Tract</td>
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<tr>
<td>MHz</td>
<td>Mega Hertz</td>
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<tr>
<td>MRI</td>
<td>Magnetic Resonance Imaging</td>
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<td>Acronym</td>
<td>Description</td>
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<td>MRT</td>
<td>Medical Radiation Technologist</td>
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<td>NHRC</td>
<td>National Health Research Committee (Fiji)</td>
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<td>OHS</td>
<td>Occupational Health and Safety</td>
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<tr>
<td>P/P</td>
<td>Placenta Previa</td>
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<tr>
<td>PACS</td>
<td>Picture Archiving and Communication System</td>
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<td>RADIUS</td>
<td>Routine Antenatal Diagnostic Imaging with Ultrasound</td>
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<td>RCOG</td>
<td>Royal College of Obstetricians and Gynaecologists</td>
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<td>RVOT</td>
<td>Right Ventricular Outflow Tract</td>
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<td>ToP</td>
<td>Termination of Pregnancy</td>
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<td>U/S</td>
<td>Ultrasound</td>
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<td>UREC</td>
<td>Unitec Research Ethics Committee</td>
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<td>WFUMB</td>
<td>World Federation for Ultrasound in Medicine and Biology</td>
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CHAPTER 1

THE RESEARCH CONTEXT

OVERVIEW

This research is focused on the mid-trimester obstetric sonography practice at an urban public hospital in Fiji. This chapter addresses the reasons and significance of this research. The main aim is to evaluate the procedures currently used for sonography scans of 18 to 23 week pregnant women in Fiji and to identify the guidelines that are followed during the mid-trimester sonography examinations. Furthermore, this chapter identifies the research question, discusses the outline of the study and the researcher’s positioning, and provides a brief overview of the structure of the thesis. The meaning of the terms used in this thesis can be found in the Glossary.
RATIONALE AND SIGNIFICANCE OF THE STUDY

Obstetric sonography refers to the method of acquisition and interpretation of fetal and maternal anatomical images in pregnancy, using appropriate ultrasound equipment, for the assessment of the baby and the mother’s health (Collin, 2000). The issues of concern that drew my attention and developed my curiosity to pursue research in relation to obstetric sonography practice at an urban public hospital in Fiji, can be summarised as follows:

- Obstetric sonography has been practised for almost three decades by ‘on-the-job’ trained radiographers.
- In the absence of a formal standard sonography protocol, scans are performed according to unwritten departmental criteria.
- A significant number of obstetric patients are scanned each day by the radiographers, who also interpret and write the final diagnostic reports on behalf of the radiologists.
- Obstetric scans are performed using a decade old ultrasound machine which lacks Doppler capabilities. Additionally, this obstetric ultrasound machine does not have Picture Archiving and Communication System (PACS) capabilities that can enable transmission of images from the ultrasound equipment to the radiologist’s workstation for consultations and diagnostic report writing.
- Currently, no ultrasound programmes are facilitated by the Ministry of Health, the Fiji School of Medicine or the hospitals in Fiji, for education of the radiographers performing sonography or their professional development.

As a consequence of the above issues, the current obstetric sonography practice at the selected urban public hospital in Fiji has been investigated through this research. It was anticipated that this research would identify the gaps in the current obstetric sonography practice and make suitable recommendations for optimisation of the sonography services at the host hospital. Hence, the rationale for conducting this study was to:

- Establish the importance of performing detailed and optimal standard obstetric sonography examinations on 18 to 23 week pregnant women;
- Identify the practice standards at the host hospital in the absence of an established documented obstetric sonography protocol and qualified sonographers in Fiji; and
- Identify the professional needs of the radiographers and the specialists closely affiliated to obstetric sonography practice at the host hospital.
From the above statements it can be ascertained that the focus of this research was on the mid-trimester obstetric sonography examinations at an urban public hospital. Mid-trimester obstetric sonography (also known as 2nd trimester sonography) refers to the acquisition and interpretation of fetal and maternal images using ultrasound during the mid-trimester period, more specifically between 18 to 23 weeks of pregnancy (Sanders, 1998b). The majority of the fetal organs continue to develop and mature during the 2nd and 3rd trimester. Hence, it is important to have a full anatomical scan of the fetus during the mid-trimester period for more accurate determination of gestational age, reassurance of a normal pregnancy (Johnson, 2005), detection of major fetal defects, identification of early fetal intrauterine growth restriction, early detection of placental abnormalities and assessment for cervical incompetence (Scorza & Vintzilios, 1996).

It is a common practice to conduct obstetric sonography in both the 1st and 2nd trimesters (Johnson, 2005). The 1st trimester sonography mainly involves nuchal translucency measurements and early fetal evaluation. On the other hand, the mid-trimester sonography is highly recommended for a thorough anatomical survey and anomaly detection, if any, because visualisation of much of the fetal anatomy becomes easier as the pregnancy progresses (Johnson, 2005). Occasionally scans are performed as late as the 3rd trimester for practical reasons, such as fetal and maternal complications and on patients who present for scans late in their pregnancies. However, mid-trimester scans allow early diagnosis of fetal structural anomalies that may require intrauterine therapy and where feasible, an option for the termination of pregnancy (ToP) (Haak, 2005).

ToP is not a legal choice for women in Fiji. In Fiji, pregnancies can only be terminated on medical grounds, for instance if there is a lethal fetal anomaly or a severe maternal disease that may pose a risk to the mother’s life. Dr. Swati Mahajan (personal communication, August 30, 2007) confirmed that the obstetricians may decide to perform ToPs due to severe maternal conditions up to 20 weeks of pregnancy, whereas ToPs as a result of fetal anomalies may be performed at any gestation in Fiji. Nevertheless, the legal restrictions of ToPs should not minimise the benefits of performing a thorough mid-trimester sonography. The significance of mid-trimester sonography is discussed more comprehensively through the review of the published literature in Chapter 3.

Another reason for placing the emphasis of this research only on the mid-trimester obstetric
sonography was to limit the scope of this research. That is, sonography of the entire pregnancy period could not be included in this study since it would have required a longer period of time. Therefore, considering the significance of the mid-trimester sonography practice mentioned earlier (as well as later in Chapter 3), this research was conducted with the emphasis on the current mid-trimester sonography practice at an urban public hospital in Fiji. The rationale for conducting this study at an urban public hospital was that the majority of the radiographers in Fiji begin their professional career in medical imaging at the major public hospitals. Their initial exposure to sonography occurs during their clinical placements as radiography students at these hospitals. When qualified, some of the radiographers move into the area of ultrasound and learn to perform scans ‘on-the-job’. Hence, considering the size of this research, it was deemed appropriate to conduct it at an institute that provides the hub for exposure and practice in sonography.

**PURPOSE OF THE STUDY**

The main aims of this research were to:

- Evaluate the current practices and procedures used for the mid-trimester obstetric sonography examinations at an urban public hospital in Fiji; and
- Examine the potential need for the development of a standard protocol for the mid-trimester obstetric sonography examinations at the hospital where this research was located.

Thus, the research question that this study addressed was: *How does the current mid-trimester sonography practice in Fiji meet the professional expectations of the obstetricians and the radiologists, and the international standards?*

**SCOPE OF THE STUDY**

This research was essentially based on the obstetric sonography practice at an urban public hospital in Fiji, with two main aims: first, to collect data on the current practices and procedures used for the mid-trimester obstetric sonography examinations; and second, to examine the potential need for the development of a standardised protocol for the mid-trimester obstetric examinations. Positioning the research in the interpretive paradigm, a case study approach was taken to address the research question. Multiple data collection methods
were employed which predominantly entailed qualitative data supported by quantitative data. The nature of the research topic, which included some sensitive issues (such as practising of obstetric sonography in the absence of a documented standard protocol, and acquisition, interpretation and reporting of sonographic images by the radiographers lacking sonography specific qualifications), rendered the use of multiple methods of data collection. The multiplicity of the data collection methods, namely, the in-field observations, questionnaires and in-depth interviews, enabled the triangulation of data and contributed to the overall reliability and validity of the research. Further details of the research design are discussed in Chapter 4.

The participants comprised a cohort of ‘on-the-job’ trained radiographers performing obstetric sonography and the specialists affiliated to obstetric sonography, the radiologists and the obstetricians. All the participants were purposively selected using a “critical case sampling scheme” to obtain detailed descriptive data, based on the participants’ professional characteristics (Collins, Onwuegbuzie & Jiao, 2007, p. 272). While the quantitative data was obtained from the observations made in relation to the scanning guidelines used by the radiographers, they also provided qualitative responses by completing open-ended questions within the questionnaire. A significant amount of qualitative data was also obtained from the interviews conducted with the sonography specialists, which provided valuable insights about the current obstetric sonography practice at the host hospital and the challenges faced by the specialists during the delivery of this service. The participants were assured confidentiality at all times and the issue of anonymity and non-traceability were addressed by concealing the participants’ and patients’ identities.

**RESEARCHER’S POSITIONING**

From 1997 until mid 2001, I worked as a qualified radiographer at the public hospital where this research was conducted. Apart from the routine radiography work, I was occasionally scheduled to work in the Ultrasound Department (which is part of the Radiology Department) to perform both obstetric and non-obstetric sonography examinations under supervision of the more experienced radiographers at the hospital. In the beginning I found it very difficult to comprehend what I was seeing on the ultrasound monitor since I did not have adequate knowledge of the sonographic anatomy and the ultrasound principles. There was no written
examination protocol for guidance. Later, I preferred not to perform sonography scans at the host hospital as I felt that it was not appropriate to make diagnostic decisions for patients without having adequate knowledge and skills.

Prior to joining the Fiji School of Medicine as a full-time tutor, I had worked at one of the private hospitals in Fiji. Again at the private practice, due to staff shortages, I was asked to perform sonography scans. However, this was a better learning experience since the Radiology Department followed a documented protocol and each examination was discussed with the radiologist in detail, who made the final diagnostic reports. This experience at the private hospital inspired me to pursue a career in sonography and, ultimately, conduct research on the current practice of obstetric sonography at the urban public hospital in Fiji, where I was previously employed. Despite my preconceptions about the sonography services at the host hospital, I have strived to be open-minded and as objective as possible during this research so that I can address the insights of the research participants. Similarly, despite the researcher-participant familiarity, the research participants did not hesitate to express themselves on the subject of this study. As a researcher, my limited clinical experience in sonography was a restricting factor, therefore, frequent consultations and guidance were sought from an obstetrics and gynaecology sonography expert based in a clinical facility in Auckland. Chapter 4 further discusses the ethical issues relevant to this research.

**THESIS STRUCTURE**

Including this introductory chapter, this thesis entails nine chapters. Chapter 2 provides an overview of the development of obstetric sonography both in Fiji and globally. It discusses the current set-up at the hospital where this research was located and presents a comprehensive discussion on the contents of a standard mid-trimester anatomical survey. Chapter 3 presents a review and critical appraisal of the current literature pertaining to the practice of obstetric sonography. Chapter 4 explains the research process, namely, the research paradigm used, the selection of research participants, the methods of data collection and analysis, and the ethical considerations of this research. Chapter 5 illustrates the research findings, accompanied by brief descriptions. Chapters 6 to 8 entail a discussion of the central findings. Chapter 9 discusses the findings, limitations and implications of this study, and suggests suitable recommendations for enhancement of obstetric sonography practice in Fiji.
CHAPTER 2

AN OVERVIEW OF OBSTETRIC SONOGRAPHY

OVERVIEW

Sonography is a diagnostic medical procedure that uses ultrasound, which involves mechanical sound vibrations, normally ranged between 3 to 15 MHz (beyond human audibility), to produce dynamic visual images of organs, tissues and blood flow within the vessels (Chudleigh & Thilaganathan, 2004). Obstetric sonography refers to the method of acquisition and interpretation of fetal and maternal anatomical images in pregnancy, using appropriate ultrasound equipment, for the assessment of the baby and the mother’s health (Collin, 2000). This chapter provides an overview of the development of obstetric sonography, both in Fiji and globally. Further, it presents a comprehensive discussion on the standard criteria for a mid-trimester sonography examination.
DEVELOPMENT OF OBSTETRIC SONOGRAPHY

The medical terminology *obstetric* pertains to pregnancy (Collin, 2000). Full duration of an approximate 40 weeks human pregnancy is categorised as the 1st trimester (first 14 weeks), 2nd or mid-trimester (approximately 15 to 27 weeks) and the 3rd trimester (approximately 27 weeks until birth). While there are other imaging modalities available for diagnostic purposes such as conventional x-ray imaging, computed tomography (CT) and magnetic resonance imaging (MRI), ultrasound is considered to be the most suitable and safe modality for obtaining the pregnancy information through imaging (Johnson, 2005). This process of acquisition and interpretation of fetal and maternal anatomical images in pregnancy using appropriate ultrasound equipment for the assessment of the baby and mother’s health is referred to as obstetric sonography (Collin, 2000).

The introduction of obstetric sonography in 1958 by Ian Donald and colleagues (Johnson, 2005) was considered to be a major breakthrough in the practice of medicine. For the first time it was possible to acquire fetal images using ultrasound, a safe and non-invasive procedure (Johnson, 2005), compared to ionizing radiation such as x-rays which are known for their detrimental effects on the fetus during pregnancy (Park, 2001). In the early days of its discovery, sonography was only used as a relatively reliable means to determine fetal number, position and age. However, over the years its benefits have been maximised with the development of its cutting-edge technology.

In the last 10 years, sonography has made tremendous advancement, both in general and obstetric applications. In obstetric sonography, developments such as high frequency transducers for improved image resolution, colour and power Doppler for imaging of fetal and maternal blood circulation, three- and four-dimensional images that allow the clinicians to view the images in multiple orientations, improved user interfaces and digital archiving, have made ultrasound the modality of choice for prenatal imaging (Johnson, 2005; Roberts & Thilaganathan, 2007).

As for any sonography examination, obstetric studies also need an appropriate combination of ultrasound equipment and the operator’s expertise to provide optimal standard images and interpretations. Three basic components are common to all obstetric equipment, namely, transducers, a control panel enabling measurements, freezing of images and Doppler
applications, and the image archiving system. While high frequency transducers are useful for high image resolution, low frequency transducers are needed when increased penetration of ultrasound in the tissue is required, for instance in obese patients (Johnson, 2005). When sonography examinations are performed from the surface of the patient’s abdomen, it is referred to as transabdominal approach. On the other hand, the transvaginal approach involves scanning via the patient’s vaginal cavity using an appropriate transducer, whenever there is a need for greater sonographic detail, especially during early pregnancy (Sanders, 1998a).

As mentioned earlier, advanced equipment alone cannot guarantee optimal quality diagnostic images in sonography. Expertise is needed to identify and differentiate between the normal and abnormal anatomical appearances. Therefore, pattern recognition and the knowledge of causes and effects of abnormal ultrasound appearances are essential (Ola-Ojo, 2005). Unlike other imaging modalities such as CT, MRI and conventional x-ray, which have fixed imaging planes and technique to acquire the necessary views, sonography is very much dependent on the ultrasound operator’s ability to adapt to the patient’s medical condition while adhering to the departmental standard guidelines (Ola-Ojo, 2005). On the other hand, there are certain limitations in the practice of obstetric sonography as well that may affect the quality of diagnoses made, such as fetal movement, unfavourable fetal position, maternal obesity, uterine abnormalities, volume of amniotic fluid and the quality of the ultrasound equipment in use (Johnson, 2005).

**USES AND BENEFITS**

Obstetric sonography plays an important role in the evaluation of fetal and maternal health during pregnancy. Some of the most acknowledged benefits of sonography in pregnancy are:

- Detection of presence of fetal life
- Accurate assessment of gestational age
- Detection of multiple pregnancies
- Diagnosis of fetal anomalies
- Assessment of fetal growth and wellbeing
- Prevention, diagnosis and treatment of pregnancy complications (for example, fetal death, maternal death from placenta previa)
• Prevention and management of premature delivery
• Guiding obstetricians and physicians in planning deliveries and postnatal care
• Where feasible in terms of expertise, facilities and technology, providing diagnostic guidance for prenatal and postnatal surgical therapies for correcting malformations before irreversible organ damage can occur. For example, some hospitals have successfully performed fetal surgeries for urinary tract obstruction, congenital diaphragmatic hernia and cystic adenomatoid malformation (Antsaklis, 2004)
• Reduction in maternal anxiety by providing images of normal pregnancy status (Johnson, 2005; Royal Australian & New Zealand College of Radiologists, 1998)

Johnson (2005) further stated that, “it is, in fact, difficult to think of an obstetric problem in which diagnostic ultrasound does not contribute to the solution” (p. 1039). Today, routine obstetric sonographic examination has become more of a social experience than merely a diagnostic medical procedure. Ola-Ojo (2005) claimed that many women in the modern society see imaging of their fetus in utero as a positive experience; the real-time sonographic images of the living fetus provide an opportunity for the mother to develop a bond with her unborn child. However, a true- or mis-diagnosis of an abnormal fetus can be devastating for the mother and the relatives (Johnson, 2005). Therefore, it is important for the ultrasound operator to make the best use of time, expertise and equipment to provide prenatal information to the clinicians and the patients, to enable them to make timely decisions about the pregnancy.

SONOGRAPHY PRACTICE IN FIJI

THE HISTORICAL PERSPECTIVE

Sonography was introduced as a diagnostic tool in Fiji in 1982 at the Colonial War Memorial Hospital (CWMH) in Suva (Singh, 1999). The first Toshiba ultrasound machine, which was donated by the Fiji Medical Association, did not last more than four years and had to be replaced by a Shimadzu SDL300 table top machine. This table top machine was mostly used for obstetric examinations until 1994. In 1998 two more ultrasound machines (Toshiba) with Doppler and transvaginal capabilities were donated by a radiologist in Australia (Singh, 1999). With the donation of the Toshiba ultrasound machines at CWMH, older machines were moved to other major hospitals in Fiji. For the first 18 months following the
introduction of ultrasound in Fiji, the sonography examinations were initially performed by the radiologists and then also by two radiographers who had six months of training in Australia (Singh, 1999). As the workload increased, these radiographers provided ‘on-the-job’ training for other radiographers, under the supervision of the radiologists.

Statistics reveal that the appealing features of ultrasound, such as real-time images of the cardiac activity and fetal mobility, attracted a significant number of patients for sonography. Over the last 40 years, hospitals in Fiji have seen a rapid increase in the number of patients being referred for sonography services. For instance, at CWMH the total number of patients referred for sonography in 1982 was approximately 2,000 and by 1998 the patient number increased to approximately 14,000 per year (Singh, 1999). Since then the demand for sonography has increased significantly at all of the major public hospitals in Fiji. Consequently today, there are several public health care facilities and private practices offering sonography services in Fiji. While sonography examinations at the public and private hospitals are performed by radiographers, the general practitioners (private physicians) who have ultrasound facilities in their clinics also perform sonography (Singh, 1999). The sonography qualifications and expertise of the general practitioners are not known.

**The Current Set-up at An Urban Public Hospital**

The urban public hospital where my research was located (also referred to as the ‘host hospital’ in this research) has two sonography examination rooms, namely an obstetric and a general examination room. The examination room that is dedicated for obstetric sonography is located adjacent to the antenatal maternity department, but more than a kilometre away from the main Radiology Department where all the hospital radiologists are based. Currently, obstetric examinations at this hospital are performed using the Toshiba JustVision-400 machine (2000 model), which was donated by the Japanese International Cooperation Agency (JICA) in 2003. All the obstetric sonography referrals are made by the hospital obstetricians (physicians specialising in maternal and fetal medicine (Stoppard, 2002)). On some occasions the obstetric sonography room also accommodates general and gynaecology in-patients admitted at the ‘old wing’ of the hospital.

The second sonography room based at the main Radiology Department, which is designated
for general sonography, also receives referrals for gynaecological cases, umbilical Doppler cases and private obstetric patients for the diagnosis of pregnancy. Since the obstetric ultrasound machine does not have Doppler capabilities, all the obstetric patients who are clinically indicated for umbilical artery Doppler examinations by the obstetricians, are sent to the main Radiology Department. The ultrasound machine (Toshiba Nemio; 2002-2004 model) based at the main Radiology Department is a much newer model compared to the machine used for obstetric scans. There are two ultrasound machines at the Obstetrics and Gynaecology Department which are occasionally used by the obstetricians for critically ill patients. With a further ultrasound machine based at the paediatric section of the hospital, the host hospital has five ultrasound machines.

Ideally, sonography examinations are performed by the sonographers (Society of Diagnostic Medical Sonography, 2007) and reported by the radiologists. The Australasian Society for Ultrasound in Medicine (2007) describes a sonographer as “a health care professional who has undertaken an appropriate postgraduate course of practical and theoretical study specific to the practice of diagnostic ultrasound and is practising that speciality” (¶ 2). Further, according to Chudleigh and Thilaganathan (2004), a sonographer may only make a provisional diagnosis to provide necessary information of what was observed during the examination to the radiologist. “Legally” it is the radiologist’s responsibility to conclude the final diagnosis from the sonographic images and prepare the diagnostic report (Gurley & Callaway, 2002, p. 230).

At the hospital where my research was located, there are currently only two radiologists and they are based remote from the obstetric sonography examination room. Since the current obstetric equipment does not have PACS capabilities, allowing transmission of images from the ultrasound equipment to the remotely located radiologist’s workstation, it is not possible for the radiologists to review, provide consultations and write sonography reports. Consequently, the obstetric sonography examinations are performed, interpreted and reported by the ‘on-the-job’ trained radiographers at the host hospital.

Anecdotally, it is known that most or all the radiographers in Fiji who perform sonography do not have a qualification in ultrasound. The radiographers who perform obstetric sonography either hold undergraduate certificates or diploma qualifications in radiography from the Fiji School of Medicine. A few of the radiographers have had overseas ultrasound clinical
placements for a few months, but unfortunately their learning was based mostly on observation rather than ‘hands-on’ clinical training. It is believed that experiential learning promotes better understanding of a phenomenon than observations alone (Steele & Yielder, 2004). In more recent years, obstetric sonography specialists from Australia have visited the major public hospitals in Fiji once a year to conduct week-long sonography workshops for the radiographers and the obstetricians. However, these workshops came to a halt in 2006 after the political coup d’état in Fiji.

Despite the above constraints of sonography practice at the host hospital, the number of patients referred for obstetric examinations is overwhelming. The 2007 sonography records at the host hospital show that at least 70 obstetric patients are scanned per day, which may rise to 80-100 patients on a very busy day. One of the major drawbacks of the Radiology and the Obstetrics and Gynaecology Departments’ policies is that the patients referred for obstetric sonography are not pre-booked. Hence, currently the public hospitals in Fiji are facing a major crisis with regard to the significant number of patients referred for sonography, compared to the total number of patients who were scanned in the previous decade. Singh reported that,

On average about 30-40 patients are scanned daily and this can go up to 60-70 on busy clinic days. Most include obstetrics, gynaecology and general cases. Ideally about 10-15 patients should be scanned daily for a proper and thorough diagnostic work-up. (1999, p. 512)

Comprehensive statistics of obstetric patients scanned at the host hospital are shown in Table 1. These statistics, provided by the radiology manager for August, September and October of 2007, are an indication of patient referrals at the host hospital. Anecdotally and through my personal experience, it has been noted that although a significant number of patients are scanned at the host hospital, no formal documented obstetric sonography protocol is followed during the examinations by the radiographers. Radiographers at the host hospital have been performing scans using unwritten departmental guidelines and hence, the scanning patterns are assumed to vary amongst the radiographers as are the examinations performed by the individual radiographers. Dudley and Chapman (2002) have emphasised that practising without standard protocols can lead to inappropriate interventions, perinatal compromises and
legal implications. Even in countries where high standards of sonography protocols are established and qualification in sonography is mandatory for practice, sonographers have been implicated in malpractice suits (Chudleigh & Thilaganathan, 2004). Practising obstetric sonography without access to an effective protocol by the ‘on-the-job’ trained radiographers at the host hospital is a contentious issue.

Table 1  
Statistics of various obstetric sonography examinations at the host hospital

<table>
<thead>
<tr>
<th>Examination Types</th>
<th>August ‘07</th>
<th>September ‘07</th>
<th>October ‘07</th>
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<tbody>
<tr>
<td>Gestational Dating</td>
<td>781</td>
<td>663</td>
<td>876</td>
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<td>Amniotic Fluid Index</td>
<td>482</td>
<td>358</td>
<td>338</td>
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<tr>
<td>Umbilical Artery Doppler</td>
<td>47</td>
<td>74</td>
<td>87</td>
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<tr>
<td>Fetal Anomaly</td>
<td>31</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>Estimated Fetal Weight</td>
<td>12</td>
<td>5</td>
<td>8</td>
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<tr>
<td>Placenta</td>
<td>11</td>
<td>11</td>
<td>11</td>
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<tr>
<td>Fetal Presentation</td>
<td>7</td>
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<td>8</td>
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<tr>
<td>Serial</td>
<td>0</td>
<td>1</td>
<td>5</td>
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<td><strong>TOTAL</strong></td>
<td><strong>1371</strong></td>
<td><strong>1154</strong></td>
<td><strong>1370</strong></td>
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</table>

Prior to employing a sonography examination protocol, it is essential to understand its contents so that it can effectively be used to achieve the expected outcomes. Since the importance of a sonography protocol has been repeatedly emphasised in this thesis, the following section presents a discussion on the standard criteria for a mid-trimester sonography examination based on the Australasian Society for Ultrasound in Medicine (ASUM) guidelines (an international sonography protocol, considered to be the ‘gold-standard’ for this research). The scanning criteria, described in the ensuing section, have been used to develop the observation protocol for this research. This issue has been further discussed in Chapter 4.
STANDARD CRITERIA FOR A MID-TRIMESTER SONOGRAPHY EXAMINATION

With the progress of pregnancy, mid-trimester sonography offers an opportunity to thoroughly assess the fetal anatomy and hence structural normality (Chudleigh & Thilaganathan, 2004). An anatomical survey encompasses systematic examination of the fetus “literally from the head to toe” (Johnson, 2005, p. 1047), as well as scanning of the entire maternal uterine cavity. Prior to discussing the contents of an anatomical survey, it is imperative to briefly discuss fetal development to recognise and appreciate the sonographic assessment of the fetal anatomy that will be discussed subsequently in this chapter.

FETAL DEVELOPMENT

The embryonic period (4 to 8 weeks’ gestation) involves early development of all the major external and internal structures, including the heart, brain, liver, limbs, ears, eyes and nose (Moore & Persaud, 2003). The embryonic period is most critical since any disturbances, such as those from drugs and viruses may cause congenital anomalies of the embryo (Moore & Persaud, 2003). From the 9th week until birth the unborn child is referred to as a fetus and by this time all the organs are in place, as in a fully grown human, waiting to be fully developed. The fetus develops rapidly with differentiation of tissues, organs and systems. By the 11th week the intestines are present in the abdomen and by the 14th week the external genitalia can be recognised sonographically (Moore & Persaud, 2003). The limbs reach their relative proportions between 17 and 20 weeks (Moore & Persaud, 2003). By the 24th week the fetal heart is large enough to be visualised in detail, sonographically (Moore & Persaud, 2003). Sufficient development of the lungs takes place between 26 and 29 weeks so the baby is capable of surviving if born prematurely (Moore & Persaud, 2003). By the 30th week the fetus begins to respond to the external light perceived from the mother’s abdomen. Around 37 to 38 weeks “the nervous system is sufficiently mature to carry out some integrative functions” (Moore & Persaud, 2003, p. 83).

SONOGRAPHIC ASSESSMENT OF THE FETAL AND MATERNAL ANATOMY

The majority of the literature that was reviewed, pertaining to obstetric sonography protocols, presented a comprehensive list of fetal and maternal anatomical structures to be assessed
during an anatomical survey. It was noted that the contents of the ASUM mid-trimester
guidelines (see Appendix 3) were analogous to the guidelines of other international institutes,
such as the American Institute of Ultrasound in Medicine (AIUM), the American College of
Radiology (ACR) and the Royal College of Obstetricians and Gynaecologists (RCOG). Table
2 presents the basic fetal and maternal anatomical checklist of the ASUM mid-trimester
sonography guidelines, followed by the discussion of each scanning parameter.

Table 2  Standard mid-trimester obstetric sonography anatomical checklist

<table>
<thead>
<tr>
<th>Fetal Life and Position</th>
<th>Spine</th>
<th>Biometry Measurements</th>
<th>Extremities</th>
<th>Head</th>
<th>Abdomen</th>
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<tbody>
<tr>
<td>Fetal number</td>
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<td>Bi-parietal diameter (BPD)</td>
<td>12 long bones</td>
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<td>Initial fetal cardiac activity</td>
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<td>Head circumference (HC)</td>
<td>Hands / fingers</td>
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<tr>
<td>Fetal position</td>
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<td>Abdominal circumference (AC)</td>
<td>Feet / toes</td>
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<td>Femur length (FL)</td>
<td>Position of the joints</td>
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<td>Coronal, sagittal &amp; axial planes</td>
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<td>Diaphragm (left &amp; right)</td>
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<td>Stomach / situs</td>
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<td>Fetal heart in M-mode or colour Doppler</td>
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<td>Face</td>
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<td>Position &amp; Axis</td>
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<td>Face</td>
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<td>Interventricular septum &amp; Foramen ovale</td>
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<td>Face</td>
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<td>Cardiac valves &amp; Outflow tracts</td>
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Assessment of Fetal Life and Position

The first sonographic view should demonstrate the uterine cavity (see Figure 1) so that the
number of fetuses is confirmed or determined, if this had not been diagnosed in the 1st
trimester scan. Once the fetal number is determined, cardiac activity should be assessed to
confirm fetal life (Australasian Society for Ultrasound in Medicine, 2005). In the initial mid-
trimester assessment, the fetal heart is visualised sonographically by its blood pumping action
which is later assessed using the M-mode, colour and/or pulsed Doppler (Saylor & Cordier,
If for some reason the fetal heart motion is undetected during the initial assessment, the sonographer should not assert fetal death unless confirmed through specific tests. One of the tests is the biophysical profile, whereby fetal breathing, movements and tones are observed for 30 minutes to meet certain scoring criteria (Ling, 1998). The test also involves a non-stress test and measuring a pocket of amniotic fluid which should be at least 2cm in both vertical and horizontal planes, in order to obtain a satisfactory score (Ling, 1998). However, if all the tests fail, the examination can be concluded because there is no point continuing to scan unless otherwise clinically indicated (Ling, 1998). Hence, it is essential to conduct an initial assessment of the cardiac activity to confirm fetal life before proceeding with the fetal scan.

**Figure 1**  
Sonographic assessment of the fetal number, cardiac activity and position in the uterus

![Diagram of fetal and uterine anatomy](image1)

(Johnson, 2005, p. 1051)

Once fetal cardiac activity is noted (Figure 1), the fetal position should be determined. Commonly, the presentation or lie of the fetus in the uterus is determined by identifying the relationship of the fetal head to the lower segment of the uterus (Johnson, 2005). The fetal position often changes during the early mid-trimester due to the fetal movements and is more permanent towards the end of pregnancy either in vertex, breech or transverse position. In spite of the vigorous fetal movements during the mid-trimester period, locating the fetal position still has importance as it helps to obtain accurate biometry measurements and identify the fetal situs, that is, the correct anatomical position of the fetal structures (Chudleigh & Thilaganathan, 2004). The correct situs of the thoracic and abdominal contents in the fetus must show the stomach, cardiac apex and aortic arch on the left side of the body and the inferior vena cava on the right. A situs is considered abnormal when either the heart or the stomach, or both are located on the right side of the body (Saylor & Cordier, 1998).
With the latter condition structural abnormalities are unlikely (Saylor & Cordier, 1998), however, if the stomach remains on the left and the heart is located on the right of the body, “there is an increased incidence (95%) of congenital heart disease” (DeVore & McGahan, 2003, p. 422) and Ivemark’s syndrome which is often characterised by agenesis of spleen (Saylor & Cordier, 1998). Hence, the fetal position should be determined precisely because the placements of the fetal anatomical structures often influence the interpretation of images and overall diagnoses (Filly & Feldstein, 2000).

**Biometry Measurements**

Gestational dating is essential in pregnancy management and it contributes towards the:

- Assessment of normal fetal growth
- Estimation of fetal weight
- Diagnosis of fetal growth disturbances
- Diagnosis of fetal anomalies mainly through indications of skeletal dysplasia and microcephaly
- Determination of timings for chorionic villous sampling (in 1st trimester), genetic amniocentesis (in mid-trimester) or caesarean delivery (in 3rd trimester), in the high risk patients
- Determination of timing for termination of pregnancy due to lethal fetal anomalies (where appropriate)

(Benson & Doubilet, 2005)

“Early ultrasound dating can, therefore, substantially reduce the number of pregnancies considered postdates, and decrease the need for term inductions” (Nyberg, Abuhamad & Ville, 2004, p. 3).

Gestational dating can be determined clinically by calculations based on the patient’s last menstrual period and physical measurement of the patient's uterine size, and sonographically by the fetal biometry measurements (Benson & Doubilet, 2005). It has been reported that dating by menstrual history and physical examination is often erratic and suboptimal (Dudley, Kirwin, Dack, Bown & Rose, 2004; Kalish & Chervenak, 2005; Ville & Nyberg, 2003) owing to uncertainty and irregularity of menstrual dates, recent use of oral contraceptives, early pregnancy bleeding, presence of uterine fibroids, multiple pregnancy
Conversely, sonographic fetal biometry measurements have been asserted to be the most useful and accurate tool for estimating gestational age, provided they are performed carefully and precisely (Benson & Doubilet, 2005; Hassall, 2004). Fetal biometry measurements in the mid-trimester for gestational dating are usually obtained by calculating the biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and the femur length (FL) (Australasian Society for Ultrasound in Medicine, 2005; Benson & Doubilet, 2005; Filly & Hadlock, 2000; Ville & Nyberg, 2003). Obstetric sonography studies have shown that in a normal fetus the growth of head, abdomen and femur correlate with the progress of gestational age, at least in the first half of the pregnancy (Nyberg, Abuhamad & Ville, 2004). However, if for some reason the above mentioned four parameters are inaccessible, other biometric parameters may be considered for determining gestational age, such as the length of any of the long bones preferably the humerus, clavicular length, the trans-cerebellar diameter (Ville & Nyberg, 2003), ear length, foot length and orbital diameters (Kalish & Chervenak, 2005). Kalish and Chervenak (2005) also mentioned that the use of multiple biometry parameters improves the accuracy of the gestational age assessment, reduces the effect of deviations in measurements caused by growth variations or fetal anomalies, and also reduces the technical measurement errors of a single parameter. It has also been suggested that to reduce the technical errors, all measurements should be taken at least twice to assign the gestational age using the mean value (Hassall, 2004). In consideration of the above explanation, the four commonly used fetal biometry parameters (BPD, HC, AC and FL) are discussed below, in accordance with the ASUM mid-trimester guidelines.

Fetal head measurements comprise the BPD and HC, which in turn indicate fetal head size and brain growth (Ville & Nyberg, 2003). Both of these parameters are measured (in mm) in the transverse image of the fetal head in the trans-thalamic plane (see Figures 2a, b) (Sanders & Miner, 1998; Schluter, Pritchard & Gill, 2004). More simply, the measurements must be taken at the level of the fetal head which demonstrates the cavum septum pellucidum (CSP) and thalami with the falx cerebri equidistant from the upper and lower borders of the skull so that one side of the brain appears as a mirror image of the other (see Figure 2b) (American Institute of Ultrasound in Medicine, 2003; Hassall, 2004; Schluter et al., 2004). It has been emphasised that the BPD and HC measurements must be obtained with the normal fetal head
in an ovoid shape (Sanders & Miner, 1998) without demonstrating the contents of the posterior fossa, which includes the cerebellum and the brain stem (Hassall, 2004). Once the trans-thalamic image is obtained, the BPD measurement should be taken “from the outer edge of the cranium nearest the transducer to the inner edge of the cranium farthest from the transducer” (see Figure 2c) (Benson & Doubilet, 2005, p. 1495) because obtaining BPD measurements from the outer to outer cranium edges often miscalculates the gestational age by ≤ 4 days in the early mid-trimester (Johnsen, Rasmussen, Sollien & Kiserud, 2004).

The HC measurement, which is the outer perimeter of the cranium, should be taken by placing an electronic ellipse around its outer edge at the same level as the BPD (Figure 2c) (Benson & Doubilet, 2005). Ville and Nyberg (2003) mentioned that the HC is a more desirable parameter for estimating the gestational age because the BPD measurements often get influenced by the fetal head positions and shape variations, especially in conditions like dolichocephaly (long, flattened head) and brachycephaly (short, wide head). This finding is in agreement with a study conducted by Johnsen et al. (2004) to determine the effects of maternal and fetal factors on fetal age assessment during the mid-trimester sonography. The authors conducted a prospective, cross-sectional study on 650 low-risk pregnant women for the BPD and HC measurements at 10 to 24 weeks’ gestation. The study conducted by Johnsen et al. revealed that maternal age, fetal gender, breech position and fetal head shape influence the BPD measurements which significantly affect the gestational age assessment. As far as HC measurements are concerned, it was found that only two factors, namely, maternal age and fetal gender, influenced the assessment of gestational age.

**Figure 2** BPD and HC measurement criteria

a) Trans-thalamic plane b) CSP, Falx and Thalami c) Sonographic measurements of BPD and HC
(Adapted from Sanders, 1998c, p. 121; Benson & Doubilet, 2005, p. 1497)

The third biometry parameter commonly measured is the AC, the outer perimeter of the fetal
abdomen. Nyberg, Abuhamad and Ville (2004) claimed that unlike the head measurements, obtaining the AC is the most difficult of the four measurements because the abdominal contents are not symmetrical compared to the brain anatomy and there is no bright bony margin as of the skull. As a consequence of the latter anatomical fact, the fetal abdominal shape is prone to become distorted if too much transducer pressure is applied upon it during the sonography examination. This may yield an erratic AC measurement, indicating abnormal fetal growth (Filly & Hadlock, 2000). Therefore, the AC should be measured once all the important anatomical landmarks have been sonographically identified, without placing too much external transducer pressure, so that it appears ‘round’ (Hassall, 2004). The AC is measured in a transverse plane by placing an electronic ellipse around the outer skin edge of the abdomen (see Figure 3) at the level that demonstrates the:

- Stomach;
- Intra-hepatic portion of the umbilical vein, that is, the region where the right and left portal veins are continuous with each other, sometimes also referred to as the ‘hockey stick’;
- Transverse plane of the fetal spine; and
- Symmetric appearance of the lower ribs.

(Benson & Doubilet, 2005; Filly & Hadlock, 2000; Hassall, 2004; Ville & Nyberg, 2003)

Figure 3 Transverse plane of the abdomen showing the landmarks for the AC measurement

(Mitchell & Stone, 2002, Abdominal circumference measurement; Sanders, 1998c, p. 121)

The fourth biometry parameter, FL is the most common long bone measurement used to estimate the gestational age. The entire length of the femur is measured by aligning the transducer to the long axis of the bone (Filly & Hadlock, 2000), making sure that the shaft of the bone is perpendicular to the ultrasound beam and casting a shadow (see Figure 4a) (Hassall, 2004). Hassall (2004) also emphasised that the femur that is proximal to the
transducer should be measured, rather than the distally located femur. The FL measurement is taken by placing cursors at the junction of the cartilage and the bone, excluding the femoral head and distal epiphysis (see Figure 4b) (Filly & Hadlock, 2000; Ville & Nyberg, 2003).

Figure 4  **Sonographic measurement of the femur length**

a) Criteria for FL measurement  b) Ultrasound image of FL measurement (Hassall, 2004, p. 31)

Once the biometry parameters are measured, their values are combined to assign or confirm the gestational age of the fetus. If reliable measurements were taken during the 1\textsuperscript{st} trimester scan, then the mid-trimester biometry measurements are used to confirm the already assigned expected date of delivery (EDD) and to assess the fetal growth (Chudleigh & Thilaganathan, 2004). However, if the scan was performed for the first time in the mid-trimester then the gestational age is either calculated automatically by the ultrasound machine or manually from an appropriate dating table (Chudleigh & Thilaganathan, 2004). The measurements are then plotted on an appropriate, reliable, population and culturally relevant normative growth chart (Schluter et al., 2004) to establish the gestational age and assessment of the fetal growth.

**Fetal Head**

The embryonic development of the central nervous system begins by the 5\textsuperscript{th} menstrual week and by the 15\textsuperscript{th} week almost all structures are in their final form except for the development of corpus callosum, cerebellar vermis, sulci and gyri, neuronal migration and myelination (Toi, 2005). The corpus callosum and vermis are completely developed between 18 to 20 weeks and the convolution of sulci and gyri are sonographically visible by the 28\textsuperscript{th} week of gestation (Toi, 2005). Hence, a meticulous anatomical survey of the fetal head during the mid-trimester period can demonstrate the head shape, bone density, ventricle, cavum septum pellucidi thalami (CSP), falx cerebri, cerebellum, vermis, cisterna magna (CM) and the nuchal fold or thickness (Mitchell & Stone, 2002; Sanders & Miner, 1998; Toi, 2005). Colour
or power Doppler techniques can be applied to identify the major intracranial blood vessels (Bowerman & Nyberg, 2003).

At least four common sonographic planes have been suggested, namely the thalamic, ventricular, cerebellar and coronal views, to assess the structures of the fetal brain which can yield over 95% of sonographically detected brain anomalies (Toi, 2005). The bony cranium and the normal ovoid shape of the head should be noted during these views since any distortion may suggest the presence of various congenital abnormalities. For example, the ‘lemon shape’ of the head suggests presence of spina bifida and a ‘strawberry shape’ indicates the risk of having trisomy 18 (Toi, 2005). The thalamic view should display the thalamus, midline CSP, third ventricle, fornices, basal ganglia, insula and ambient cistern (see Figure 2) (Toi, 2005). The presence of the CSP indicates that the midline structures of the brain are properly formed (Bowerman & Nyberg, 2003). The ventricular view should show the atria of the lateral ventricles and the inter-hemispheric fissure in which the falx cerebri sits (see Figure 5). The measurement of the ventricular atrium is important to exclude ventriculomegaly (>10mm) which is associated with a number of abnormal conditions and fetal syndromes, such as spina bifida, holoprosencephaly, Dandy-Walker complex, agenesis of the corpus callosum as well as intracranial infections (McGahan, Pilu & Nyberg, 2003). The ventricles contain the choroid plexus which produces the cerebrospinal fluid (CSF). The abnormal dangling motion of the choroid plexus in the fluid indicates occurrence of ventriculomegaly.

**Figure 5**  **Graphical and sonographic images of the fetal head in ventricular plane**

![Graphical and sonographic images of the fetal head in ventricular plane](Johnson, 2005, pp. 1050-1051)

The examination of the posterior fossa is achieved by the cerebellar view (see Figure 6). This view should display the cerebellum, CM, CSP and the anterior horns of the lateral ventricles
(Toi, 2005). It is becoming a regular practice to measure the trans-cerebellar distance in this view to estimate the fetal gestational age until the 26th week (Chudleigh & Thilaganathan, 2004). Toi (2005) maintained that the CM, which is the CSF space between the cerebellum and the occipital bone, must be measured in all the mid-trimester examinations because its abnormal size and shape suggests a Chiari II malformation found in 97% of patients having open spina bifida. The normal range of measurement for the CM in the midline is 3 to 10cm (McGahan et al., 2003). The cerebellar view is also an appropriate plane to measure the nuchal soft-tissue thickness (McGahan et al.) and in the mid-trimester period if it measures more than 6mm, it is considered to be increased and is a strong marker for chromosomal abnormality, especially Trisomy 21 (Down syndrome) (Chudleigh & Thilaganathan, 2004; Toi, 2005). Borrell et al. (2005) stated that approximately 80% of the newborn Down syndrome babies have increased nuchal thickness. Lastly, the fourth view of the fetal head in the coronal plane is often taken to obtain further images of the ventricles, CSP, cerebral hemisphere and the posterior fossa (see Figure 7) (McGahan et al.).

Figure 6   Graphical and sonographic images of the cerebellar view

(Johnson, 2005, pp. 1050-1051)

Figure 7   Coronal section through the mid-brain

(Adapted from Sanders, 1998c, p. 121)
**Fetal Face**

The fetal face can be seen with much clarity during the mid-trimester sonography examination in the sagittal, coronal, and axial planes (Filly & Feldstein, 2000). A midline sagittal plane of the face (see Figure 8), commonly known as the profile view, is important to demonstrate the outline of the frontal bones and forehead, the nasal bridge and the nose tip, midline of the maxilla and palate, apposed lips (Mohide & Mernagh, 2005) and, size and position of the mandible to exclude micrognathia (Bowerman & Nyberg, 2003). The coronal view (see Figure 9) is useful in displaying the relationship of the nasal tip with its symmetrical nares, upper lip and the anterior palate, lower lip, and the chin (Mohide & Mernagh, 2005). This coronal view helps to exclude cleft lip and/or palate which are usually associated with a number of fetal abnormalities and syndromes, such as holoprosencephaly, hypotelorism and Trisomy 13 (Sanders, 1998b). The axial view assists in displaying the presence, spacing and the size of the eyes (see Figure 10), and the shape of the maxilla and mandible (Mohide & Mernagh, 2005).

**Figure 8**  Mid-sagittal view of the fetal face

(Johnson, 2005, pp. 1050-1051)

**Figure 9**  Coronal plane; tangential to the nose and lips

(Johnson, 2005, pp. 1050-1051)
Fetal Spine

Sonographically, the fetal spine is best examined from 18 weeks’ gestation onward because of significant maturation changes that take place during this period, allowing better evaluation of spinal abnormalities like myelomeningocele (Filly & Feldstein, 2000). Examination of the entire fetal spine is conducted in three planes: parasagittal, coronal and transverse (see Figure 11) (Bowerman & Nyberg, 2003). The parasagittal and coronal planes provide the best overall views of the spine, while the transverse plane is optimum for the midline soft-tissue and subtle defects (Bowerman & Nyberg, 2003). These views should demonstrate the three ossification centres, namely, the developing vertebral body and the two posterior centres on each side. Any widening of the posterior centres and inconsistency of the skin line along the spinal column would suggest presence of neural tube defect (Bowerman & Nyberg, 2003), which is frequently indicative of several other craniospinal abnormalities, such as spina bifida and anencephaly (Chudleigh & Thilaganathan, 2004).
**Fetal Abdomen**

A basic evaluation of the fetal abdomen during the mid-trimester scan includes measurement of the AC and identification of the diaphragm, stomach, kidneys, urinary bladder, umbilical cord insertion and the abdominal wall (Bowerman & Nyberg, 2003). The abdominal contents should be assessed both in the transverse and longitudinal planes (Cullinan & Comstock, 2005). A normal single ‘bubble’ stomach is normally located on the left upper quadrant of the abdomen (see Figure 3 and 12a) and sonographically visualised from 13 weeks’ gestation and onward (Cullinan & Comstock, 2005). An abnormal ‘double bubble’ of duodenal atresia is associated with Down syndrome (Hayward & Furness, 1999).

The fluid-filled renal pelvis often aids in the sonographic location of the fetal kidneys (see Figure 12b) to rule out its absence and abnormalities (Cullinan & Comstock, 2005). The urinary bladder is visualised as a fluid-filled structure located low in the pelvic region (see Figure 12d). It is essential to confirm a normal umbilical cord insertion (see Figure 12c) so that abdominal wall defects such as, omphalocele and gastroschisis are ruled out, which are associated with several other anomalies (Chudleigh & Thilagathan, 2004). Similarly, it is important to assess the number of blood vessels of the umbilical cord to confirm the presence of two arteries and a vein (Figure 12d), and the blood flow pattern using colour or power Doppler (Cullinan & Comstock, 2005).

**Figure 12**  
**Graphical images of the fetal abdomen with its corresponding sonographic images below**

a. Longitudinal plane showing the fetal heart, diaphragm, stomach and cord insertion; b. Transverse plane showing both kidneys; c. Umbilical cord insertion; d. The three vessel cord imaged using colour Doppler (Johnson, 2005, pp. 1052-1053)
The Australasian Society for Ultrasound in Medicine (2005) protocol recommends that the fetal heart assessment be included in the mid-trimester routine sonography examination so that the fetal position, the four chambers, interventricular septum, foramen ovale, cardiac valves, outflow tracts and vascular arches are visualised. The protocol recommends recording of the cardiac blood flow using colour flow mapping, pulsed Doppler and M-mode screening. The normal fetal situs must be confirmed before the entire heart is assessed since variation in its position may indicate several cardiac abnormalities. Normally, the fetal heart occupies one third of the thoracic cavity on the left with its apex pointing to the left (Chudleigh & Thilaganathan, 2004), $43\pm7^\circ$ from the midline (Shipp, Bromley, Hornberger, Nadel & Benacerraf, 1995). When the axis of the heart is out of the normal range from the midline, it indicates high risk for cardiac malformations. On this note, Saylor and Cordier (1998) stated that the four-chambered heart and the outflow tract views alone can identify most of the cardiac malformations, if performed meticulously and precisely.

The four-chamber view (see Figure 13a) should demonstrate the following features of the fetal heart:

- The two ventricles and its walls, of equal sizes
- The two atria and its walls, of equal sizes
- The moderator band in the right ventricle
- The foramen ovale moving in the left atrium
- At least one of the pulmonary veins entering the left atrium
- Regular motion of the mitral valve between the left atrium and the left ventricle
- Regular motion of the tricuspid valve between the right atrium and the right ventricle
- Complete or intact interventricular septum to exclude significant ventricular septal defects which are associated with chromosomal anomalies like Down syndrome

(Chudleigh & Thilaganathan, 2004)

The four chamber view is a common plane from which the transducer can be further manoeuvred to demonstrate other aspects of the fetal heart. For instance, a $45^\circ$ rotational clockwise sweep (pointing towards fetal right shoulder) would show the left ventricular outflow tract (LVOT), also known as the aortic outflow tract (see Figure 13c) (DeVore & McGahan, 2003). According to Chudleigh and Thilaganathan (2004) the significance of this
The aortic arch view (see Figure 13d) should display the left ventricle, aortic valve and arch of the aorta, its head and neck vessels, giving it a ‘candy cane appearance’ (Mitchell & Stone, 2002). The ductal arch (‘hockey stick’ appearance) (see Figure 13e), pulmonary valve and pulmonary artery can also be assessed (Mitchell & Stone, 2002). Apart from studying the fetal cardiac anatomy, it is also important to provide information regarding the cardiac blood flow so that the severity of cardiac disease is assessed (Hornberger, Jaeggi & Trines, 2005) through the M-mode echocardiography (see Figure 13g), colour (see Figure 13f), spectral or pulsed Doppler examinations. These examinations are useful in differentiating the normal from abnormal blood flow patterns, confirming structural defects such as ventricular septal
defects, identifying outflow tracts and the direction of blood flow, and evaluating abnormal cardiac rhythms (DeVore & McGahan, 2003).

**Figure 13 (continued)  Graphical images of the fetal heart with its corresponding sonographic images below**

d. Aortic arch view with sonographic image below it; e. Ductal arch view with sonographic image below it; f. Colour Doppler image showing blood flow in the right atrium of fetal heart; g. Blood flow in M-mode (Johnson, 2005, pp. 1052-1053; Mitchell & Stone, 2002, Fetal heart)

**Fetal Extremities**

The Australasian Society for Ultrasound in Medicine (2005) protocol suggests that in the low risk patients the upper and lower fetal limbs must be examined as part of a basic anatomical survey. The number, shape and position of the limbs are determined to establish normalcy of the fetal skeletal anatomy and to rule out major abnormalities such as skeletal dysplasias (Jeanty, Valero, Bircher & Cavazos, 2003). Although there are more than 250 types of skeletal dysplasias, “majority of the lethal anomalies including thanatophoric dysplasia, achondrogenesis and osteogenesis imperfect type IIA”, can solely be diagnosed by ultrasound (Glanc, Chitayat & Unger, 2005, p. 1425). It is possible to sonographically image the long bones from the late first trimester and since the visibility rapidly increases from the early mid-trimester, the fetal digits should also be included in the mid-trimester examination (Filly & Feldstein, 2000).
The examination of the bilateral upper limbs (see Figures 14a & b) should involve assessments of each proximal long bone (humerus), the arms (radius and ulna) and the opening and closing of the hands with its five fingers (Sanders & Miner, 1998). Sonographic identification of extra, fused or missing fingers are pointers to chromosomal abnormalities (Glanc et al., 2005). Similarly, the examination of the lower limbs should involve assessment of the femur, leg (tibia and fibula) and foot, bilaterally (see Figures 14c & d). Talipes (clubfoot), rocker-bottom feet and sandal gap appearances of the feet are linked to chromosomal abnormalities and can be identified by careful sonography examinations (Chudleigh & Thilaganathan, 2004). Anatomically, there should be a sum total of twelve long bones, that is, one proximal and two distal long bones of the upper and lower limbs, respectively. This should be confirmed by performing both the longitudinal and transverse scans (Chudleigh & Thilaganathan, 2004).

**Figure 14** Images showing the upper and lower extremities

![Images showing the upper and lower extremities](image)

a. Fetal hand; b. Fetal arm; c. Fetal foot; d. Fetal thigh and leg (Johnson, 2005, pp. 1054-1055)

**Assessment of Placenta and Amniotic Fluid**

The placenta allows transfer of oxygenated blood and nutrients to the fetus and receives waste and deoxygenated blood from the fetus through the umbilical vessels. During the mid-trimester sonography examination, the placental location, appearance and its relationship to
the internal cervical os is determined (American Institute of Ultrasound in Medicine, 2003; Australasian Society for Ultrasound in Medicine, 2005). The placenta can be located at the fundus, anterior, posterior or lateral aspects of the uterus (Chudleigh & Thilaganathan, 2004). The implantation of the placenta in the lower uterine cavity covering the maternal cervix poses a serious threat at full term of pregnancy and usually demands a caesarean delivery (Roberts & Thilaganathan, 2007).

It has been reported that at mid-trimester only about 5% of women have low lying placentas (Chudleigh & Thilaganathan, 2004), of which 90% of the conditions get resolved by full term pregnancy due to the marked growth of the uterus which pulls the placenta away from the cervix (Sepulveda, Sebrie, Harris & Nyberg, 2003). During the mid-trimester period, the placenta should normally appear uniform in echotexture and measure less than 4 centimetres in thickness. However, an abnormally thickened placenta may be associated with a number of conditions such as maternal diabetes, maternal and fetal anaemia, placental haemorrhage and intrauterine infections (Sepulveda et al., 2003).

The placental and fetal kidney functions are also determined by the amount of amniotic fluid in the amnion cavity. Alterations in the amniotic fluid volume due to pathological or physiological conditions have a detrimental effect on the fetal and maternal health (Chudleigh & Thilaganathan, 2004). Hence, assessment of the amniotic fluid volume is an integral part of a mid-trimester sonography examination. The amniotic fluid volume can be reliably assessed by two methods, that is, either by measuring the single deepest pocket of the amniotic cavity (free of any fetal structures) or by calculating the amniotic fluid index (AFI) (Chudleigh & Thilaganathan, 2004). The former is obtained by measuring the deepest vertical single pocket of the amniotic cavity to exclude excessive (polyhydramnios; when more than 8cm in vertical depth) or deficient (oligohydramnios; when less than 2cm in vertical depth) fluid levels (Fong, Maxwell & Ryan, 2005). Alternatively, the AFI is obtained by measuring the deepest vertical pools of each quadrant of the maternal abdomen. The sum measurement represents the AFI, where a depth of less than 5cm indicates oligohydramnios and more than 25cm indicates polyhydramnios (Chudleigh & Thilaganathan, 2004). Oligohydramnios is often associated with chromosomal anomalies, intrauterine growth restrictions, post-term pregnancies and ruptured membranes. Similarly, polyhydramnios is associated with macrosomia, fetal malformations, twin-to-twin transfusion syndrome, rhesus disease and congenital infection (Hill, Sohaey & Nyberg, 2003).
Maternal Anatomy

As discussed earlier, sonography plays an important role in assessing fetal and maternal health in pregnancy. The ASUM guidelines suggest that the maternal uterus, adnexa and cervix be included in the basic mid-trimester sonography examination (Australasian Society for Ultrasound in Medicine, 2005). Most important of all is the examination of the cervix since “sonographic changes may be the earliest indicators of incipient cervical failure, often before they can be detected by digital and speculum examination, and before the presence of clinical symptoms associated with incompetent cervix or preterm labour” (Windrim, Okun & Fong, 2005, p. 1594). In other words, cervical examinations help to detect or exclude the risk of preterm deliveries which account for high infant deaths and neonatal diseases such as, cerebral palsy, visual and hearing impairment and chronic lung diseases (Antsaklis & Daskalakis, 2004). Of the three approaches to cervical scanning and measurements, namely, transabdominal, transperineal and transvaginal, the latter provides most accurate sonographic results (Windrim, et al., 2005). The maternal uterus and adnexa are examined to rule out any pelvic masses or fluid collections due to inflammatory processes (Australasian Society for Ultrasound in Medicine, 2005).

SUMMARY

This chapter has provided a synopsis of the development of obstetric sonography both in Fiji and globally. Over the years, ultrasound technology has made a tremendous advancement and has become the modality of choice for prenatal imaging. Apart from the diagnostic benefits of ultrasound, it has been reported that obstetric sonography provides an opportunity for the mothers to develop a bond with their babies (Ola-Ojo, 2005). Furthermore, prenatal diagnosis of fetal anomalies provides an opportunity to plan the mode and the site of delivery thus ensuring optimal care of the fetus and the newborn (Park, 2001).

At the urban public hospital in Fiji, where this study was located, there is only one examination room with a single ultrasound machine dedicated for obstetric sonography. The scans are performed by the radiographers who also interpret the sonographic images and write the diagnostic reports on behalf of the radiologists. In the absence of a standard written protocol, the radiographers perform scans using unwritten departmental guidelines. Thus, this research aims to evaluate the current practices and procedures used for the mid-trimester
obstetric sonography examinations at the hospital and examine the potential need for the development of an obstetric sonography protocol.

Adhering to standard guidelines can enable a detailed study of the fetal and maternal anatomical structures to confirm structural normalcy and detection of obvious fetal anomalies. Thus, this chapter has presented a comprehensive discussion on the standard criteria for a mid-trimester sonography examination. It has also presented justifications for scanning each parameter during the anatomical survey. This discussion established that a precise and meticulous anatomical survey is capable of producing accurate gestational dating and detection of obvious fetal anomalies.

Next, Chapter 3 presents a review of the research-relevant literature to establish the importance of performing mid-trimester obstetric sonography following standard practice guidelines. It further emphasises the need for curriculum-based education in sonography as a prerequisite to its practice.
CHAPTER 3

LITERATURE REVIEW

OVERVIEW

The purpose of conducting this literature review was to establish the importance of the research aims:

- *To evaluate the current practices and procedures used for mid-trimester obstetric sonography at an urban public hospital in Fiji.*
- *To examine the potential need for the development of a standard protocol for mid-trimester obstetric sonography examinations at the hospital where this research was located.*

Thus, the relevant literature was reviewed to describe what is already known and what more needs to be known about the dimensions of this research through systematic analyses of the published literature (Creswell, 2002). It became apparent very early in the search that there is no published academic literature related to obstetric sonography practice in Fiji. However, there are copious published articles and texts related to international practices with regard to obstetric sonography. The published literature was reviewed with a focus on mid-trimester sonography to identify relevant evidence related to its significance and use. Thus, the themes generated from the literature review, presented in this chapter, are: importance of performing mid-trimester sonography in pregnancy; identification of the most appropriate period for performing mid-trimester scans; identification of the factors that influence the visualisation of fetal anatomy and the detection of fetal anomalies; and the importance of education and adherence to a standard protocol in the practice of obstetric sonography. Definitions of the medical terminologies used in this chapter are presented in the Glossary.
SIGNIFICANCE OF MID-TRIMESTER SONOGRAPHY

Within the last five decades obstetric sonography has become an integral part of modern obstetric care due to its invaluable contribution to pregnancy management (Gegor, 1992). Obstetric sonography can be performed at any time during pregnancy, provided there is a valid medical reason for it (Johnson, 2005). For instance, sonography is often performed during the first trimester for an early evaluation of the pregnancy, that is, assessment of fetal life, pregnancy site (to exclude ectopic pregnancies), fetal number, gestational age estimated by measurement of crown rump length (prior to 12 weeks of gestation), nuchal translucency measurements and some obvious structural abnormalities, such as anencephaly (Sanders & Miner, 1998). Since development and maturation of fetal organs are incomplete during the first trimester period, only a limited anatomical survey is possible and therefore it is unlikely that the first trimester scan will ever replace the mid-trimester anatomical scan (Johnson, 2005).

The limitations of a transabdominal anatomical survey in the first trimester were demonstrated by Taipale, Ammala, Salonen and Hiilesmaa (2004) when they conducted a study on 4789 low-risk pregnant women to assess the value of two-stage ultrasound screening. In this study, the major fetal organs were sub-optimally visualised in 17% to 95% of the examinations during the early transabdominal scan (13 to 14 weeks’ gestation). Visualisation of fetal urinary bladder was considered sub-optimal in 17% of the examinations, kidneys in 36%, heart in 69% and the aortic arch in 95% of the cases. However, organ visibility increased as pregnancy progressed to the mid-trimester period, where the overall sub-optimal visualisation rate reduced to less than 1.5% for all the fetal organs (Taipale et al., 2004). Therefore, one of the conclusions of this study was that visualisation of all fetal organs is greater in the mid-trimester than in the late first trimester.

Although it is not a routine practice, sonography can also be performed during the third trimester for high-risk patients for re-assessment of previously diagnosed fetal abnormalities, assessment of suspected fetal abnormalities that were not apparent in the mid-trimester scan, post-term pregnancies, fetal lie, maternal complications, monitoring multiple pregnancies and fetuses suspicious of intrauterine growth restrictions (IUGR) (Ola-Ojo, 2005). Kerstin, Ryding and Hakan (2006) claimed that routine scans in the 3rd trimester do not improve the pregnancy outcome for the low risk patients if scans have already been performed during the
Conversely, mid-trimester sonography (which is also known as second trimester, anatomy, anomaly, screening or routine scan) is highly recommended for a full anatomical survey of the fetus. Sonography examination during this period provides a more accurate determination of gestational age through biometry measurements, reassurance of a normal pregnancy (Johnson, 2005), detection of major fetal defects, identification of early fetal IUGR, early detection of placental abnormalities and assessment for cervical incompetence (Scorza & Vintzilios, 1996). The ability to demonstrate a wide range of fetal anatomy and detect major anomalies is a key feature of mid-trimester sonography. These two issues are discussed in depth in the forthcoming sections, preceded by discussions on the identification of the most appropriate time for visualising the fetal anatomy and its limitations.

**Timing for Mid-Trimester Scans**

The most appropriate time to perform mid-trimester sonography has to be balanced between the earliest gestation when the necessary measurements and a full anatomical survey can be conducted, and the latest gestation at which a range of options can be offered to the parents if an abnormality is diagnosed (Chudleigh & Thilaganathan, 2004). According to Albalooshi and Benzie (2006), no study to date has established a fixed timing for mid-trimester sonography. However, several authors and institutes favour 18 to 22 or up to 23 weeks’ gestation as a suitable period for anatomy and anomaly scan (Albaloooshi & Benzie, 2006; Australasian Society for Ultrasound in Medicine, 2005; Australian Government Department of Health and Ageing, 2007; Chudleigh & Thilaganathan, 2004; Johnson, 2005; Sanders, 1998b).

At least three important reasons have been mentioned in the literature for considering 18 to 22 or 23 weeks’ gestation as an ideal period for performing mid-trimester scans. Firstly, biometry measurements made early in the mid-trimester for pregnancy dating, have fewer error deviations than if performed later in the pregnancy. For instance, Sanders & Miner (1998) reported that measurements of BPD may have an error deviation of about ± 7 days until 24 weeks of gestation, whereas the inaccuracy in measurement increases to ± 14 to 30 days after 28 weeks, with the rapid growth of the fetus. Similar inferences were made by Mongelli, Wilcox and Gardosi (1996) while evaluating the clinical implications of gestational
dating by clinical and sonography methods on 34,249 singleton pregnancies using nonparametric tests. The authors found that when the dating was calculated by sonographic means there was 70% reduction in the number of post-term pregnancies. Mongelli et al. (1996) concluded that sonographic fetal biometry measurements conducted in the first half of the pregnancy predict gestational dating more accurately than other traditional methods.

Likewise, Ville and Nyberg stated that the 1st and 2nd trimester biometry measurements for gestational dating offers more accurate estimations compared to those performed late in the pregnancy because “acceleration of normal fetal growth does not begin until the third trimester” (2003, p. 31). For instance, the abdominal circumference (AC) grows at a rate of 10 mm per week in the 3rd trimester and can generate measurement errors of 5 to 10 mm leading to a false positive diagnosis of fetal growth restriction, that is, a single 10 mm error may place a small fetus above the normal growth threshold indicating further monitoring or intervention in pregnancy (Dudley & Chapman, 2002). Hence, such error deviations in biometry measurements may falsely indicate a pregnancy to have reached its full term and consequently suggest a needless premature delivery, potentially having an impact on the baby’s survival (Roberts & Thilaganathan, 2007).

Secondly, while most of the fetal anatomy can be evaluated in the early mid-trimester (18-20 week gestation), it is often difficult to assess the fetal heart and its great vessels trans-abdominally prior to this period (Chudleigh & Thilaganathan, 2004; Sanders & Miner, 1998). The fetal heart is easier to visualise and examine as it increases in size with the progress of gestational age (DeVore, Medearis, Bear, Horenstein & Platt, 1993). DeVore et al. (1993) conducted a study to determine the rate of successful visualisation of the fetal heart during the mid-trimester period and the factors affecting its imaging. The study involved sonographic imaging of the 4-chambered heart and outflow tracts on 709 mid-trimester fetuses. While the authors concluded that an increase in gestational age is directly proportionate to the probability of successful visualisation of the fetal heart, an increase in maternal adipose tissue thickness due to obesity and a previous history of lower abdominal surgery decreased the probability of fetal heart imaging (DeVore et al.). For example, the data in this study showed that if a patient with a previous history of abdominal surgery and 2cm thickness of adipose tissue had an obstetric scan at 16 week gestation, there would only be a 55% probability of demonstrating the fetal cardiac anatomy. However, if the same patient is rescanned at 21 weeks’ gestation, the probability of visualising the fetal cardiac
anatomy would increase to 90% (DeVore et al.). Similarly, this study showed that visualisation of fetal cardiac anatomy and its related anatomical structures would improve with the progress of the pregnancy. However, it has been argued that 23 weeks 6 days should be the maximum gestation to perform mid-trimester sonography (Sanders, 1998b). The reason for this is explained below.

Thirdly, diagnosis of fetal anomalies incompatible with life in the early mid-trimester provides an opportunity for therapeutic abortion prior to the 24th week of pregnancy because “beyond this age a fetus may be viable” and born with an irreversible structural or organ damage (Sanders, 1998b, p. 134). Therefore, it has been suggested that for a full anatomical survey including the transabdominal fetal heart assessment, mid-trimester sonography can be performed until the end of the 23rd week of gestation - a gestational age when therapeutic ToPs are still an option (Chudleigh & Thilaganathan, 2004; Ola-Ojo, 2005; Peregrine & Pandya, 2005). While, it is important and desirable to perform mid-trimester sonography between 18 to 22 or 23 weeks’ gestation to establish fetal normalcy and rule out obvious anomalies, the success of visualising fetal organs during the mid-trimester period is often limited by several factors. The following section discusses the influence of these factors.

**FACTORS INFLUENCING VISUALISATION OF FETAL ANATOMY**

With the progress of pregnancy, mid-trimester sonography offers an opportunity to thoroughly assess the fetal anatomy and hence structural normality (Chudleigh & Thilaganathan, 2004). An anatomical survey encompasses systematic examination of the fetus “literally from the head to toe” (Johnson, 2005, p. 1047), as well as scanning of the entire maternal uterine cavity. During the mid-trimester period, the ability to differentiate between normal and abnormal anatomical structures is greater than in the other trimesters since fetal anatomy is easily visualised with the progress of the pregnancy and there is minimal or no fetal crowding (Johnson, 2005). While sonographic visualisation of fetal anatomy is an integral part of mid-trimester obstetric examination, its success is influenced by several variables such as, gestational age, maternal habitus, sonographer’s expertise, quality of equipment used (Wolfe, Zador, Bottoms, Treadwell & Sokol, 1993), fetal position and above all, the amount of time spent scanning each organ system (the duration of scan per patient) (Catanzarite, et al., 2005).
**Gestational Age**

Earlier discussions of studies conducted by DeVore et al. (1993) and Taipale et al. (2004) established that transabdominal visualisation of fetal organs improves with the progress of pregnancy. A similar trend was reported by Wolfe et al. (1993) when they conducted a prospective study on 7092 singleton pregnancies over a six year period (1985-1991) to assess the changes in sonographic visualisation of fetal organs from the mid-trimester period to full term of pregnancy (15 to 40 week gestation). All the examinations were performed by qualified sonographers, supervised by perinatologists, and their emphasis of scan was on fetal head, heart, diaphragm, stomach, kidneys, intestines, urinary bladder, spinal column, extremities and umbilical cord. Even though 95% of six fetal organs (cerebral ventricles, stomach, bladder, diaphragm, kidneys and intestine) were visualised between 15 and 17 weeks’ gestation, visualisation of the fetal heart, extremities and spine remained poor (Wolfe et al., 1993). While the fetal heart was visualised better in the 3rd trimester, visualisation of fetal extremities was sub-optimal due to ‘fetal crowding’ and gradual decrease in the fetus/amniotic fluid ratio (Wolfe et al., 1993). The authors concluded that the overall visualisation of fetal anatomy is maximal between 21 and 23 weeks’ gestation. Limitations of this study are discussed below.

**Age and Quality of Equipment**

The age of ultrasound machines and transducers used during obstetric examinations plays an important role in the quality of diagnoses made (Foulkes, Joubert, Faber & Hiemstra, 2004). It is assumed that the quality of equipment is one of the factors contributing to high rates of sub-optimal visualisation of fetal anatomy in some of the studies of the last two decades. In the study of Wolfe et al. (1993), discussed above, a variety of ultrasound equipment with varying resolution and tissue penetration capabilities was used from 1985 till 1991. For instance, in 1985 the sonographers used an Aloka 256/280 scanner (3.5 MHz linear/sector transducers), in 1988 they used GE 3600 scanner (3.5MHz and 5MHz linear/sector-phased transducers), and in 1999 GE 3200/3600, Acuson 128, Siemens 450 and ATL Ultramark4 (3.5MHz and 5MHz curvilinear transducers) were used. As ultrasound technology was still emerging late last century, it is apparent that equipment such as ATL Ultramark4 (manufactured in 1991) had better sonographic capabilities than Aloka 256 (manufactured in 1981) (Woo, 1995). Hence with the introduction of newer equipment each year, the study of
Wolfe et al. (1993) showed a marked improvement in the number of fetal organs that were visualised over the six year period, that is, the overall organ visualisation progressed from 63% in 1985, to 86.5% in 1988 and 87.3% in 1991. According to Wolfe et al. (1993), sonography expertise had minimal influence on the improved visualisation since the cohort of sonographers performing the scans remained relatively stable at the institute where the study was conducted. Similarly, another study conducted in 1984-1985 by Zador, Bottoms, Tse, Brindley and Sokol (1988) using Aloka 256/280 (3.5 MHz linear/sector) ultrasound equipment, demonstrated results analogous to the study of Wolfe et al. (1993).

In contrast to the two earlier studies discussed above, a recent study showed better fetal organ visualisation rates using modern day ultrasound equipment. Catanzarite et al. (2005) conducted a study involving one hundred 16 to 22 week pregnant women to determine the relationship between visualisation of key fetal anatomical structures and the duration of each scan. This study utilised an Acuson Sequoia system equipped with 4/2-, 5/2-, and 8/4-MHz multi-frequency transducers. More than 96% of the cases demonstrated all the anatomical structures listed in the comprehensive checklist (similar to ASUM mid-trimester scan worksheet in Appendix 3) at 20 to 22 weeks 6 days’ gestation (Catanzarite et al.). This study also showed that organ visualisation rates increase with advancing gestational age. The visualisation rate increased from 67% to 96% from 16 weeks to the end of 21 weeks’ gestation. The authors acknowledged that the high rate of fetal organ visualisation was due to the use of an advanced ultrasound system and a high level of sonographer expertise.

**Maternal Habitus**

Maternal obesity, body/mass index (BMI) of more than 30kg/m\(^2\), is associated with an increased risk of hypertension, pre-eclampsia, gestational diabetes mellitus, labour abnormalities, infections, macrosomia, caesarean delivery and intrauterine fetal deaths (Cnattingius, Bergstrom, Lipworth & Kramer, 1998). Furthermore, Wolfe, Sokol, Martier and Zador (1990) presented data on 1622 women (15-40 week gestation) and reported that extreme maternal obesity causes suboptimal visualisation of fetal organs. In this study, a woman was considered obese if she had a BMI of greater than or equal to 36.21 kg/m\(^2\). The study revealed that there was a 14.5% overall decrease in organ visualisation amongst the obese women. Fetal heart was the commonest amongst the organs sub-optimally visualised (55% reduction in visibility) followed by the umbilical cord (25.8%) and fetal spine (17.2%).
With regard to fetal heart imaging, the study findings of Wolfe et al. (1990) correlated with the outcome of the study conducted by DeVore et al. (1993) (see Page 40).

Wolfe et al. explained that:

The dramatic reduction in organ visualisation in the very obese patient is mostly a consequence of ultrasound attenuation. Attenuation represents the loss of strength of the ultrasound waves as they propagate through the tissue. Of the three determinants of attenuation - beam width, scatter, and absorption – absorption is most likely the main reason for diminished visualisation in this population. (1990, p. 342)

Consequently, Wolfe et al. (1990) concluded that high rates of suboptimal visualisation of fetal organs in obese women pose a major risk for failure to diagnose fetal anomalies, predominantly neural tube and cardiac defects. Another finding of this study was that amongst the obese patients, advancing gestational age and duration of scan have no impact on fetal organ visualisation.

More recently, a study to examine the impact of maternal obesity on mid-trimester sonographic visualisation of fetal cardiac and craniospinal structures was conducted by Hendler et al. (2004). This study comprised 11,019 pregnant women, of which 38.6% were identified as obese (BMI of more than 30kg/m$^2$) and extremely obese (BMI more than or equal to 40kg/m$^2$). Increased severity of maternal obesity was associated with a suboptimal visualisation rate of both the cardiac (49.3%) and craniospinal structures (31%). The authors reported that the non-obese women had an increased rate of organ visualisation for both the anatomical structures from 22 to 24 weeks’ gestation. However, visualisation did not improve for the obese women after 18 to 20 weeks’ gestation. Hence, Hendler et al. (2004) suggested that the optimal period for visualisation of cardiac and craniospinal fetal anatomy in obese patients would be after 18 to 20 weeks’ gestation.

Although both the studies, Wolfe et al. (1990) and Hendler et al. (2004), showed that obesity is one of the major factors that cause suboptimal visualisation of fetal organs, there were obvious differences in the visualisation rates. For instance, Wolfe et al. (1990) demonstrated 55% decrease in visualisation of fetal heart whereas the study conducted by Hendler et al.
showed a 49.3% decrease. It is assumed that such variations are probably due to the differences in the study design. Wolfe et al. (1990) defined obesity as women having a BMI of more than or equal to 36.21kg/m² while Hendler et al. considered women to be obese if they had a BMI of more than 30kg/m². On the other hand, the study of Hendler et al. also had limitations of its own. The data was obtained retrospectively over an eight-year period involving different sonographers and a range of ultrasound equipment, causing possible variations in performance and interpretation of the examinations in the study.

**Sonographer Expertise**

Callen (2000) mentioned that in the early 1980s obstetric sonography was so popular that it was widely performed by a variety of medical professionals with varying levels of training. Any medical practitioner who could afford to buy an ultrasound machine performed obstetric sonography in his or her clinic (Benacerraf, 1993). Consequently, as the patient numbers dramatically increased, the quality of sonographic images decreased. This practice is still seen to be prevalent in some countries. A recent study by Foulkes et al. (2004) to determine the level of obstetric sonography training and practice of medical practitioners in a South African province, showed that more than a third of the participants performed obstetric sonography without formal training in ultrasound, even though various courses in sonography are available in South Africa. This study also revealed that more than 50% of the practitioners who practised sonography were unaware of their professional institute, namely the South African Society for Ultrasound in Obstetrics and Gynaecology. Although Foulkes et al. did not assess their participants’ levels of expertise in sonography practice, it is assumed that variations in the quality of diagnoses are inevitable amongst the practitioners in such situations. This phenomenon was obvious in the study of Hendler et al. (2004) discussed earlier (see Page 42). Further discussion with regard to sonographer expertise and its influence on obstetric sonography can be found in the section ‘Education and Sonography Protocol’.

**Duration of Scan**

The amount of time spent for scanning appears to be very important as far as comprehensive obstetric sonography examinations are concerned. This was demonstrated in two studies discussed below. To determine the relationship between visualisation of key fetal anatomical
structures during mid-trimester sonography examinations and the duration of scans, Catanzarite et al. (2005) reviewed 100 obstetric examinations at 16 to 22 weeks’ gestation. They excluded multiple gestations, women of more than 77 kg, with abdominal scarring and cases of suspected fetal anomalies. All the examinations were performed using the latest equipment (Acuson Sequoia with 4/2-, 5/2-, and 8/4- MHz multi-frequency transducers) by a qualified sonographer and a maternal fetal specialist, with more than 10 and 20 years of sonography experience respectively (Catanzarite et al.). The examinations involved imaging of the maternal uterus and adnexa, six fetal measurements (BPD, HC, AC, FL, humerus length (HL) and nuchal fold) and a comprehensive anatomical survey. The authors found that the anatomical survey, involving visualisation of key fetal and maternal organs, was complete in 10 minutes in only 8% of the cases, 31% were complete in 15 minutes, 53% in 20 minutes, 72% in 25 minutes and 81% of the cases were complete in 30 minutes duration. An incidental finding of this study was that higher rates of fetal organ visualisation occurred in women with the placenta positioned posteriorly as opposed to those who had placenta located anteriorly, covering partial or the entire anterior uterine wall. Catanzarite et al. concluded that in an ideal situation, an ultrasound facility with experienced sonographers, high-resolution equipment and medical assistants to help with the smooth flow of patients, an allocation of 40 minutes per scan or 12 examinations per sonographer per day would yield optimum quality sonography assessments.

Some limitations were noted in the study undertaken by Catanzarite et al. (2005). Firstly, the results of this study may not apply to all the obstetric patients since some technical factors such as, maternal obesity and multiple gestations were excluded from the study, although they are part of the usual patient population. Secondly, not all the sonographers and ultrasound practitioners who were participants in this study have similar expertise. Thirdly, Catanzarite et al. mentioned that some high-resolution ultrasound equipment may be slower to use than the machine used in this study. Finally, the 30 minutes cut-off time for the examinations in this study was somewhat misleading. A 30-minute examination only accounted for the time to acquire the first till the last image, that is, it did not include pre-and post-patient preparation and data entry time. Hence, it is assumed that a 30-minute examination may have involved an additional 10 to 15 minutes for completion of the entire examination.

A pilot study was carried out by Stewart, Treadwell and Zador (2001) to evaluate time
allocation during initial and repeated obstetric sonography examinations. This study involved 51 comprehensive examinations (assessment of 38 individual anatomical structures and 9 measurements per patient) of pregnant women between 14 and 38 weeks’ gestation. Contrary to the study of Catanzarite et al. (2005) discussed above, Stewart et al. (2001) included set-up, imaging, review and turnover time in their study. The 51 examinations were performed by 10 sonographers with 1-16 years of obstetric sonography experience. All the examinations and their duration were observed and recorded by a single observer - a qualified sonographer. From the analysis of the acquired data, it was found that 63% of a sonographer’s time was spent on performing the sonography examination while 37% of the time was spent on data entry, image review and cleaning of the examination suite (Stewart et al.). The authors concluded that the average time spent with each patient during a routine examination was approximately 15 ½ minutes and in regard to all the fetal anatomy, imaging of the fetal head took the majority of the time.

There were obvious pitfalls in the study of Stewart et al. (2001). Although the exclusion criteria were mentioned, the selection criteria for the study were unclear, that is, the examination unit received approximately 24,000 patients during the study period but only 51 were included. Furthermore, the cohort of sonographers whose examinations were included in the study, had a wide range of experience (1-16 years), with presumably disparate levels of expertise to visualise fetal organs. The authors also failed to mention the quality and the type of ultrasound equipment used in the study. Finally, in contrast to the study of Catanzarite et al. (2005), Stewart et al. did not mention the contents of their comprehensive anatomical survey and whether all the anatomical structures were successfully visualised in all the examinations performed. Hence, there are significant differences between the results of the two studies discussed above.

**Fetal Position**

It is apparent that if the fetal lie or position is unfavourable, it is difficult to visualise all the desired anatomical structures during an obstetric examination. For instance, if a fetus lies with the back of its head (occiput) facing the anterior aspect of the maternal abdomen, it is not possible to view the lips (Catanzarite et al., 2005). Although 3-D technology can reconstruct fetal anatomy inaccessible during an examination, shadows produced from the superimposed anatomical structures cannot be avoided (Catanzarite et al.). Hence,
unfavourable fetal position may also contribute towards a low rate of fetal organ visualisation, however, no specific research on this subject was found during the literature search.

**SONOGRAPHIC DETECTION OF FETAL ANOMALIES**

Every pregnancy must be considered at risk for a significant birth defect since most of the fetal anomalies occur without indication of any family history (Bowerman & Nyberg, 2003) and up to 90% without known risks (Luck, 1992). Therefore, while surveying the fetal and maternal anatomy for establishing structural normalcy (Chudleigh & Thilaganathan, 2004); the routine mid-trimester sonography should also focus upon optimizing the rate of fetal anomaly detection (Filly & Crane, 2002) to identify:

- Anomalies that are not compatible with life;
- Anomalies that have high morbidity and long term disability;
- Fetal conditions that have the possibility of intra-uterine therapy; and
- Fetal conditions that will require postnatal intervention.

(National Collaborating Centre for Women’s and Children’s Health, 2003)

Goldberg and Norton (2000) assigned fetal congenital anomalies into three categories according to their causes. The first category comprises structural defects caused by error in tissue formation resulting in malformation. An example of malformation is failure of neural tube closure causing myelomeningocele (Goldberg & Norton, 2000). The second type of defect includes an alteration in shape or position of normal structure caused by mechanical forces resulting in deformation, for example, the development of a clubfoot due to extra intrauterine forces upon normally developed feet. The third type of anomaly known as ‘disruption’ includes defects resulting from the destruction of previously normally developed structures, for instance, amputation of a limb caused by an amniotic band (Goldberg & Norton, 2000).

Approximately 2-4% of all newborns possess major structural anomalies in the “developed countries”, which account for 20-30% of all perinatal deaths and an even higher percentage of perinatal morbidity (Grandjean, Larroque & Levi, 1999, p. 446; Johnson, 2005). The relatively low prevalence of anomalies in the newborns mentioned above could be due to
spontaneous or induced prenatal abortions of abnormal fetuses (Johnson, 2005). However, Boyd, Chamberlain and Hicks (1998) claimed that more than 50% of the abnormal fetuses can be identified sonographically, increasing the options for pregnancy management and, where feasible, providing intrauterine therapies. In the abnormal fetuses, approximately 75% of anomalies can be detected during the 18-22 week sonography (Carrera, Scazzochio, Torrents & Munoz, 2005).

There are two types of ultrasound findings related to fetal anomalies: 1) obvious structural anomalies such as a missing limb, congenital diaphragmatic hernia or anencephaly (absent skull and all or part of the fetal brain); and 2) normal variants known as ‘soft markers’ which are not structural anomalies but rather ultrasound appearances or pointers to major anomalies (Boyd et al., 1998). Soft markers such as a thickened nuchal fold, echogenic bowel, mild ventriculomegaly, cardiac echogenic focus and a choroid plexus cyst are often associated with chromosomal disorders, while a single umbilical artery, enlarged cisterna magna and pyelectasis are associated with non-chromosomal anomalies when seen in isolation (Van den Hof & Wilson, 2005). Whilst there are innumerable fetal anomalies discussed in the literature, it is unlikely that routine sonography will be able to detect 100% of them (Park, 2001). In order to determine the number of fetal anomalies often detectable by routine sonography and screening procedures, several large trials have been performed worldwide. The ensuing subsections discuss six such studies conducted in the United States, Europe, New Zealand and Australia.

**RADIUS Trial**

The RADIUS (Routine Antenatal Diagnostic Imaging with Ultrasound) trial is the most frequently discussed study of prenatal sonography screening in the literature. This multicentre American study was conducted from 1987 to 1991 on 15,151 low-risk pregnant women, to determine the efficacy of prenatal ultrasound screening on perinatal outcome (Ewigman et al., 1993). This study comprised two groups: a group of women who had sonography examinations at 15 to 22 weeks’ and 31 to 35 weeks’ gestation, and a control group who were scanned only for medical indications specified by their clinicians. The authors concluded that sonography screening amongst low-risk patients does not improve perinatal mortality and morbidity rates, hence, sonography screening does not offer any clinically significant benefit.
The rationale for such a conclusion was due to Ewigman et al. documenting low sensitivity rates in detecting fetal anomalies using ultrasound (35% in screened group and 11% in the control group). The detection rate was even less for gestations prior to 24 weeks (16.6% sensitivity).

The findings of the RADIUS study have been criticised for two key reasons. Firstly, the staff who performed the scans lacked sonography expertise (out of 91 physicians and 60 technicians, only one of them was a qualified sonographer). Consequently, the more experienced staff detected 35% of anomalies compared with only 13% by those who were less experienced (Filly & Crane, 2002). The RADIUS study would have shown benefits of obstetric sonography on perinatal outcome had it achieved comparable detection rates as in more successful European trials discussed below. Secondly, according to Johnson (2005) the RADIUS trial was too small to properly evaluate the accuracy of sonographic detection of severe birth defects. Hence, it minimised the potential of diagnostic sonography.

**European Studies**

Luck (1992) conducted a four-year study to evaluate the accuracy of detection of fetal structural abnormalities at 19 weeks’ gestation in an unselected population of 8523 pregnant women, to see its effect on obstetric and neonatal care. All the scans were performed by qualified sonographers who had more than four years of sonography experience. The detection rate of fetal anomalies at 19 weeks was 85% (sensitivity) with a specificity of 99.9%. Luck’s (1992) study yielded 100% detection rates in abnormalities of the renal and the central nervous systems but less in the cardiopulmonary system (33 to 36%). The latter low detection rates were due to inexperience of the sonographers in performing scans of the cardiopulmonary system and a series of defects such as, atrial and ventricular septal defects, aortic and pulmonary stenosis, and aortic coarctations, being often missed (Luck, 1992).

Another European prenatal ultrasound screening trial, the Eurofetus study, has demonstrated high sonographic detection rates of fetal anomalies. The Eurofetus study is considered to be the “only study large enough to specifically evaluate the sensitivity of routine ultrasound screening for fetal malformation” (Johnson, 2005, p. 1042). Grandjean et al. (1999) conducted the Eurofetus study on 200,000 pregnant women (18 to 22 weeks’ gestation) in 60 obstetric units in 14 European countries over a 3-year period. Their purpose was to determine
the accuracy of antenatal detection of fetal anomalies by routine sonography, performed by qualified sonographers. It recorded an overall 61.4% sensitivity of detection of fetal abnormalities in the mid-trimester period. During the study 4615 malformations were detected in 3685 fetuses, representing 1.25 abnormalities per malformed fetus.

The most accurately detected anomalies were those of the urinary system (88.5%), central nervous system (88.3%) and the major musculoskeletal system (73.6%), while the major cardiac abnormalities were detected at 38.8% and, cleft lip and palates at 18.0% sensitivities (Grandjean et al., 1999). Overall, 84% of malformations detected were true positives, 9.9% were false positive and 6% comprised diagnostic errors that were rectified in the subsequent scans (Johnson, 2005). This Eurofetus study was valuable as it provided information on the prevalence of fetal structural abnormalities across a large number of countries and the effectiveness of ultrasound for identifying these conditions over a large population, hence making it a reliable study. Grandjean et al. pointed out that a high sensitivity of 85% in Luck’s (1992) study, compared to their 61.4%, is most likely due to inclusion of some easily detectable fetal anomalies, such as hydronephrosis, in Luck’s study.

**Australasian Studies**

Between 1988 and 1989, Roberts, Hampton and Wilson (1993) conducted an audit of ultrasound screening for fetal abnormalities in central Auckland. The authors studied 12,909 births with a prevalence of 249 anomalies in 218 (1.7%) births. Of the 218 babies with birth defects, 88% had prenatal anomaly scans. The overall sonographic fetal anomaly detection rate was 48% (27% before 24 weeks). Roberts et al. (1993) found that their detection rate matched the studies performed in other countries and concluded that major anomalies of the central nervous system, renal tract and abdominal wall have a higher detection rate than the anomalies of the cardiovascular system, face and the gastrointestinal system. One of the pitfalls of this study was that the fetal scans were performed at various private and hospital-based sonography departments by radiologists, doctors and sonographers. Hence, the scans were performed in an environment with varied levels of sonography expertise and equipment. Roberts et al., therefore, felt that their study could have yielded better detection rates if the scans had been performed at a single location.

Another similar study was conducted by Anderson, Boswell and Duff (1995) in New
Zealand, upon 9162 pregnancies after 16 weeks’ gestation. Of the total number of pregnancies, 7880 mothers were scanned between 16 and 20 weeks’ gestation. This study recorded an overall 61.4% sensitivity of detection of fetal anomalies, probably because all the examinations were performed by qualified sonographers under the direct supervision of a radiologist. Another reason for a high detection rate could be the inclusion of high risk patients in the study, since the authors indicated that 50% of the anomalous fetuses were prenatally terminated during the study. Although the detection rate of this study was higher than a previous study conducted in New Zealand by Roberts et al. (1993), the prevalence of fetal anomaly in the population remained almost the same (1.98% and 1.7% in the studies of Anderson et al. and Roberts et al., respectively). This study yielded the detection of central nervous system anomalies (92%), cardiac anomalies (31%) and craniofacial anomalies (25%). These findings were analogous with the previous New Zealand study by Roberts et al. where the detection rate of fetal cardiac and craniofacial anomalies was similarly poor. One of the reasons for the variation in the detection of anomalies amongst the different organ systems is that fetal development and organ maturation is a gradual process and therefore certain organs are deemed to be visible later in pregnancy. This phenomenon was prevalent in two other studies that are discussed following the Australian study below.

More recently, Albalooshi and Benzie (2006) conducted a study in Sydney, Australia, to determine the detection rate of fetal anomalies in different organ systems during a second trimester scan. This study was specifically conducted to see the efficacy of fetal sonography between 18 to 22 weeks of gestation. The authors’ study of 4371 women with a singleton fetus who had mid-trimester scans done, revealed an overall sensitivity of 82.4% (highest of all the studies discussed earlier) with a prevalence of 2.3% fetal and neonatal anomalies in their population. The sensitivities of anomaly detection in the different organ systems ranged from 66-91%, where the best detected anomalies were of the urinary (90.9%), central nervous (88%) and major musculoskeletal systems (88%). The lowest detection rates were of cardiac (68.8%) and, face and neck anomalies (66.7%) (Albalooshi & Benzie, 2006). Overall, 63.7% of fetal anomalies were detected between 18 to 22 weeks and the rest were made thereafter, both prenatally and postnatally. Hence, the authors of this study concluded that the mid-trimester sonography screening has potential and is effective in detecting fetal anomalies, especially for the central nervous, genito-urinary and musculoskeletal systems. It is believed that a high detection rate in this study was possible due to inclusion of a combination of high and low risk patients (unselected population), use of current technology and modern
equipment (Voluson 730 machine and 3-D transducers), and scans performed by six qualified sonographers who followed a detailed ASUM mid-trimester protocol.

Other Studies

Taipale et al. (2004) conducted a study in Helsinki, Finland, on 4789 consecutive low-risk pregnant women to assess the value of two-stage screening. A 1st trimester scan (13 to 14 weeks) was followed by a 2nd trimester (18-22 weeks) scan to detect selected major fetal anomalies. Their study yielded 48% sensitivity for the dual stage scanning, wherein screening at early pregnancies showed 18% sensitivity and 30% for the mid-trimester. The authors reported that visualisation of the fetal kidneys, urinary bladder and the four-chamber view of the heart was inadequate during the early scan; however, organ visibility and detection of fetal anomalies with ultrasound imaging increased as the pregnancy progressed from early to 18 to 22 weeks’ gestation.

A study conducted by Whitlow, Chatzipapas, Lazanakis, Kadir and Economides (1999), to determine the cost effectiveness of anomaly scans on 6634 unselected women, showed an increase in anomaly detection rate when the results of the 1st trimester scans were combined with those of the mid-trimester. This study conducted in the United Kingdom yielded a 59% detection rate of fetal anomalies at 11 to 14 (+ 6) weeks in a mixed population of 6634 high- and low-risk pregnant women. When Whitlow et al. (1999) combined the results with the 18 to 20 week scan, detection rate of fetal anomalies increased to 81%. The high combined detection rate (81%) of this study compared to the study of Taipale et al. (2004) (30%) is possibly due to the inclusion of high-risk patients in the study of Whitlow et al.

Disparities in Anomaly Detection Rates

The ability of obstetric sonography to demonstrate normal fetal anatomy and anomalies has been well documented in the literature but with variable detection rates. Mid-trimester sonography cannot detect all fetal anomalies or, to some extent, certain anatomical structures, especially when the image quality is compromised by maternal obesity, fetal position, early pregnancy, limitations of equipment and inexperience of the sonographer (Bowerman & Nyberg, 2003). This suggests that the patients should be informed about obvious limitations of obstetric sonography so that they are not alarmed when some subtle anomalies remain
undiagnosed.

In the earlier discussion of the six studies, based on efficacy of prenatal sonography in detecting fetal anomalies, the detection rates ranged from 35% to 82%. The rationale for these variations in the anomaly detection rate has been frequently discussed in the literature, some of which are as follows:

- Inclusion and exclusion criteria vary amongst the studies. Inclusion of high-risk patients has shown higher detection rates.
- The difference in the prevalence of anomalies in the population screened. Ideally, the sample should represent the population.
- Discrepancies in the reports of the authors, that is, some authors report the number of fetuses/newborns with anomalies, while some report the number of anomalies in the fetuses/newborns.
- The definitions of anomalies vary widely amongst the studies. Some definitions may favour easily detectable anomalies and, consequently, report higher detection rates.
- The gestational age at which diagnoses are made also has an influence on the outcome of the study. For example, absence of sonographic signs such as, Down syndrome with no structural anomaly or late appearance of sonographic sign, such as duodenal atresia and hydrocephalus. Some anomalies are difficult to diagnose, such as facial and cardiac defects, early in pregnancy.
- The number of sonography examinations performed during the screening has an effect on the overall detection rate. The studies which had scans performed more than once during the pregnancy showed a significant improvement in the detection of anomalies.
- Technical difficulties such as maternal obesity, fetal position and multiple pregnancies influence the detection rates.
- Expertise of the sonographer(s) and the capabilities of the ultrasound machine to detect anomalies have an obvious impact on the detection rate.
- Although one should give no room to erroneous diagnosis, human error cannot be completely disregarded. Therefore, there is also a risk of unintentional overinterpretation and misdiagnosis.

(Albaloooshi & Benzie, 2006; Anderson et al., 1995; Callen, 2000; Grandjean et al., 1999; Johnson, 2005; Park, 2001)
EDUCATION AND SONOGRAPHY PROTOCOL

WHO SHOULD PERFORM OBSTETRIC SONOGRAPHY?

Those who perform obstetric sonography should, ideally, have an exceptionally higher level of knowledge and skills than those performing general sonography, as obstetric sonography is “potentially a very litigious area of imaging and certainly demands appropriate training, [education] and experience” (McHugo, 2001, p. 2156). Similar sentiments were expressed by Benacerraf (1993):

Evaluating the unborn fetus sonographically is an enormous responsibility.

The true hazard of performing an obstetrical ultrasound examination does not lie in any unconfirmed biohazard of sound waves but in the all too frequent inaccuracy of those reading the scan. Over-diagnosis or under-diagnosis can be very hazardous to a pregnancy since it can result in drastic changes in obstetrical management and even termination of normal fetuses thought to be abnormal. (p. 1)

To take full responsibility for performing obstetric sonography, a sonographer must have had adequate training involving both didactic and supervised clinical experience (Callen, 2000) through an appropriate postgraduate course (Australasian Society for Ultrasound in Medicine, 2007). Apart from specialised training in ultrasound, sonographers are also trained to deal with situations demanding psychological responses and ethical issues related to sonography examinations (Gegor, 1992). On the other hand, in some countries obstetric sonography is still performed by non-medical imaging practitioners, such as midwives, nurses and general practitioners, who belong to various medical disciplines without the acquisition of appropriate sonography skills and standards (Benacerraf, 1993). The practitioners who have not had training through an appropriate curriculum-based education, mostly learn ultrasound by ‘observing and doing’, that is, a more experienced colleague provides ‘on-the-job’ training. Brezinka (2006) referred to this as a “chaotic autodidactic training system” (p. 223) since it promotes bad practice habits from the ‘teacher’.

Inadequate training and limited education of the practitioners in obstetric sonography was one
of the main reasons why the RADIUS trial of Ewigman et al. (1993) failed to show expected benefits of ultrasound on perinatal outcomes. Similar outcomes prevailed in two other studies where ultrasound examinations were performed by non-ultrasound practitioners. In one of the Swedish studies five midwives, who had one to five years of obstetric sonography experience, performed examinations on 8228 pregnant women (15 to 22 weeks’ gestation) to assess the sensitivity for detection of fetal anomalies (Eurenius, Axelsson, Cnattingius, Eriksson & Norsted, 1999). This study yielded an overall sensitivity of only 22.1%. Of the 145 anomalous fetuses, 20 were false positives and 113 false negatives. Seventy fetuses were diagnosed with cardiac anomalies by the specialists but none was detected by the midwives. Eurenius et al. (1999) admitted that a low sensitivity rate in this study was due to the limited expertise of the midwives and failure to use an examination checklist during the examinations.

In another study, Glazebrook et al. (2004) conducted a survey in a variety of settings including rural hospitals, general practices and Aboriginal communities throughout Australia on the educational needs of 314 rural and remote non-specialist doctors who performed obstetric ultrasound. They found that 30% of the doctors included in the study had neither postgraduate education nor training in sonography, while 29.09% lacked confidence in detecting fetal abnormalities and 27.27% in image interpretation. Glazebrook et al. concluded that obstetric sonography is an area of high need in continuing professional development.

Conversely, other studies discussed earlier, namely, the Eurofetus (Grandjean et al., 1999) and the three Australasian studies (Albalooshi & Benzie, 2006; Anderson et al., 1995; Roberts et al., 1993) showed exceptionally high anomaly detection rates. One of the reasons for the above outcome was that the examinations in these studies were performed by qualified and experienced sonographers. Similarly, a high fetal organ visualisation rate was noted in the study conducted by Catanzarite et al. (2005) where examinations were performed by a qualified sonographer and a sonography specialist (see Page 44).

Since crucial decisions in pregnancy are made from the outcomes of obstetric sonography, it is recommended that sonography examinations be performed and interpreted by professionals who have had adequate expertise in sonography practice through formal education, observations and experiential learning in clinical settings (Callen, 2000). Similarly, Brezinka (2006) emphasised that to maintain high standards of sonography practice and to minimise
knowledge gaps and the number of litigations, curriculum-based qualification programmes, continuous professional development and certification must be established in every country. Meire (1986) recapped that the unscrupulous private use of ultrasound in Australia in the early days was curbed by the introduction of a diploma in sonography course, which also required the practitioners to obtain a licence to practise. Consequently, a curriculum-based education and annual registration to practice sonography improved the standards of practice in the region.

CONTINUING PROFESSIONAL DEVELOPMENT

Continuing professional development (CPD) in medical imaging continues to develop in some countries such as, the United Kingdom and New Zealand (Henwood, Yelder & Flinton, 2004). In these countries, it is a requirement for annual registration and a licence to practise in the profession (Medical Radiation Technologists Board, 2007; Society of Radiographers, 2008). CPD provides an opportunity for sonographers to enhance their professional growth, add credibility to their career, update knowledge and gain new knowledge for self-satisfaction and improved patient care (Phillips & Smith, 2008).

Although CPD is mandatory in some countries, not everyone undertakes it with the same enthusiasm. Henwood et al. (2004) conducted a survey to explore the attitudes of radiographers towards mandatory CPD in the United Kingdom and New Zealand. This study showed low rates of participation in CPD at that time and the qualitative data indicated that the majority of the participants had a negative attitude towards CPD. Regardless of the sonographers’ preferences, ASUM expects them to maintain a high level of continuing professional development by engaging in at least 50 hours of learning activity annually in sonography for professional competence (Australasian Society for Ultrasound in Medicine, 2007). Similarly, Roberts and Thilaganathan emphasised that, “unless our understanding and knowledge keeps pace with technology, we are not likely to correctly use or interpret ultrasound” (2007, p. 84).

SONOGRAPHY PROTOCOLS

Callen (2000) recalled that in the infancy of obstetric sonography practice, scans were performed by a variety of practitioners with varied levels of training resulting in inconsistent
scanning patterns. The resultant poor quality scans were a major concern as the number of examinations increased. Hence, in order to combat this problem, the American Institute of Ultrasound in Medicine developed a standard protocol for consistency in obstetric sonography practice. The purpose of an examination protocol is to cautiously assess the maternal and fetal anatomical structures in pregnancy according to a comprehensive checklist pro-forma to establish normalcy and detect major abnormalities in anomalous fetuses (Australasian Society for Ultrasound in Medicine, 2005).

Further to this, Chudleigh and Thilaganathan (2004) emphasised that each examination protocol must provide information on the scope of the examination, describe how the examination should be undertaken, what anatomical structures and measurements will be imaged, when a finding will be considered abnormal, how the images will be interpreted and who will report the findings of the examination. As far as diagnostic reports are concerned, the Australasian Society for Ultrasound in Medicine (2007) suggested that “the final diagnosis and writing of the report are the responsibility of the medical practitioner” preferably the radiologist (¶ 10). Likewise, Hayward and Furness (1999) emphasised that a comprehensive protocol must describe a process for counselling the parents if an anomaly is detected and whenever it seems necessary, a second opinion should be sought.

From the earlier discussions, it has been seen that obstetric sonography studies that did not adhere strictly to a standard protocol produced poor results in fetal organ visualisation and detection of fetal anomalies. For instance, Eurenius et al. (1999) identified that one of the pitfalls of their study was the failure of the midwife practitioners to use a checklist during the examinations, yielding low sensitivity for anomaly detection (see Page 54). Therefore, Flarey and Blancett (1998) highlighted that standard protocols decrease variation in practice and manage patients through the health care field by ensuring quality service and cost-effectiveness. Hence, sonography departments should not be complacent about the implementation and revision of examination protocols since they are essential tools designed to assist sonographers and other ultrasound practitioners in providing an optimum level of patient care (Chudleigh & Thilaganathan, 2004). Protocols also act as evidence of high practice standards in cases of law suits.
Consequences of Poor Practice

Breach of duty of care, practice standards, code of ethics and professional conduct stipulated by one’s professional institute, are signs of poor practice and considered litigious (Chudleigh & Thilaganathan, 2004). While sonography continues to become more sophisticated, appropriate knowledge and adherence to an appropriate examination protocol are absolute necessities, and any failure to do so may increase the chances of medico-legal liabilities (Mulhearn, 1999). Poor practices leading to legal liabilities in obstetric sonography are mainly related to failure to perform sonography adequately, incomplete studies, misdiagnosis, mis-interpretation of images, poor image interpretation due to inadequate instrumentation and sonographer incompetency, and complications from invasive procedures (Gegor, 1992).

There are a number of reports on undesirable pregnancy outcomes due to sonographers’ negligence during obstetric scans. In 1999, the Austrian Supreme Court ruled that a mother was robbed of the legitimate choice of having an abortion done when obvious anomalies were undiagnosed during the prenatal ultrasound (Brezinka, 2000). Similarly, in a recent case, O’Conner (2007) reported in the South Wales Echo about a radiographer in the United Kingdom who was banned from practising sonography after he was found to have misdiagnosed several pregnancies which led to serious consequences. It was reported that, between 2004 and 2005, the radiographer mis-diagnosed sonography images in five cases which included missing multiple anomalies in a fetus, mis-interpreting a normal pregnancy as an ectopic pregnancy and mis-diagnosing a renal tumour (O’Conner, 2007).

Hence, Dudley and Chapman (2002) warned that practising without standard protocols and expertise can lead to inappropriate interventions, perinatal compromises and legal implications. While it may not be possible to detect all fetal anomalies by obstetric sonography, adherence to a detailed protocol and expertise in obstetric sonography practice can maximise the accuracy and detection rate of such anomalies as well as in reporting fetal normalcy (Haak, 2005).
SUMMARY

Primarily, the intentions of this literature review were to establish the importance of performing mid-trimester obstetric sonography following a standard practice guideline and to emphasise the need for curriculum-based education in sonography as a prerequisite to its practice. Through analyses of several studies it was ascertained that the optimal time for performing mid-trimester sonography is between 18 to 23 weeks’ gestation because this enables visualisation of the majority of the fetal organs, including fetal heart assessments, through a systematic anatomical survey. The 18 to 23 week mid-trimester scans also provide an opportunity for therapeutic abortion prior to a 24 week pregnancy when fetal anomalies incompatible with life are diagnosed (Sanders, 1998b). Furthermore, the literature review also unveiled several factors that influence the visualisation of fetal organs and detection of fetal anomalies during an obstetric examination. The success of a meticulous mid-trimester sonography examination is limited by the gestational age, fetal position, maternal habitus, sonographer’s expertise, quality and age of the equipment, and the duration of scan.

A precise anatomical survey is capable of producing accurate gestational dating and detection of obvious fetal anomalies. Timely detection of anomalies provides clinicians with adequate information for pregnancy management, prenatal counselling and thorough discussion of pregnancy options. Furthermore, prenatal diagnosis of fetal anomalies provides opportunity to plan the mode and the site of delivery and thus ensuring optimal care of the fetus and the newborn (Park, 2001). Several trials have been conducted to determine the accuracy of routine sonography in detecting fetal anomalies. Six large studies, conducted in the United States, Europe, Australia and New Zealand, were discussed in this chapter and identified a varied range of anomaly detection rates (35%-82%). While it is not possible to detect all fetal anomalies, adherence to a detailed protocol and education in obstetric sonography practice can maximise the accuracy and detection rate of fetal anomalies. Conversely, practising without standard protocols and expertise can lead to inappropriate interventions, perinatal compromises and legal implications (Dudley & Chapman, 2002).

Selection of a wide range of literature (1988–2008) for review provided an opportunity to study the trend of practice in obstetric sonography over the last two decades. With the current advancement of ultrasound technology, availability of postgraduate studies and implementation of CPD programmes in obstetric sonography, some of the recent studies
showed higher visualisation of fetal organs and detection of fetal anomalies than the studies of the last two decades. Furthermore, this literature review has disclosed several issues relevant to this research project such as, the influence of subtle factors affecting visualisation of fetal organs and detection of fetal anomalies, effect of inadequately trained practitioners performing obstetric sonography and the threats posed by performing scans without adhering to a standard protocol.

It follows, therefore, that none of the reviewed literature discussed the current practice standards, the levels of expertise of the ultrasound practitioners and the quality of equipment used for obstetric sonography in the Pacific Island nations. Thus, this thesis attempted to uncover the gaps and limitations associated with the current practice in obstetric sonography at an urban public hospital in Fiji, a Pacific Island nation where obstetric sonography practice is still in its infancy. The process of data collection, analysis and interpretation of this investigation has been described in Chapter 4.
CHAPTER 4

RESEARCH PROCESS

OVERVIEW

In order to conduct research, one needs to follow an authentic structured process. This chapter describes such a process that has been used to collect, analyse, interpret and describe data relevant to the aims of this study. The research paradigm and the rationale for positioning the study within it have been discussed in this chapter. Details of each method of data collection and the participants involved are provided. Furthermore, this chapter justifies the sampling method used and enlightens the reader with the inspirations and limitations encountered during the data collection. The data analysis process is also identified and explained. Finally, the chapter concludes by considering the ethical issues entailed in the research process and the way they were dealt with.
METHODOLOGY

INTERPRETIVE PARADIGM

The selection of an appropriate research method is integral to a valid research design. A research method involves collecting, analysing, interpreting and describing data pertinent to the study, in order to answer the research question adequately (Cohen, Manion & Morrison, 2000). This study is positioned within an interpretive paradigm which aims to bring meaning to, and make sense of, the phenomenon under study (Cohen et al., 2000), that is, the current practice of obstetric sonography in Fiji.

According to Saks and Allsop’s definition, an interpretive paradigm refers to the framework from which knowledge is “socially constructed” and the reality is believed to be “subjective” (2007, p. 17). This is contrary to the traditional and long dominating positivist paradigm where “objective knowledge” is constructed through detailed methodologies (Saks & Allsop, 2007, p. 17). This research depicted some important features of the interpretive paradigm, particularly:

- **Interpretivist**: understanding and inferences were sought with a focus on subjective meanings and interpretations presented by the participants.
- **Naturalistic**: entire data was collected at the natural setting of the host hospital without disruption of the participants’ daily activities.
- **Subjectivity**: this research design demanded the emergent theory to be drawn subjectively instead of conducting the research and producing knowledge objectively.
- **Complexity**: the research theory has been developed from the depth of analysis rather than inferences alone.
- **Validity**: the emergent theory may not necessarily be generalisable as it relied on my interpretations as a researcher. However, it is believed to be high on validity as it was drawn on the understanding of the research subjects.

(Adapted from Saks & Allsop, 2007, p. 26)

Employing the interpretive paradigm, I have endeavoured to explore and critically assess observations and perceptions of a cohort of radiographers performing mid-trimester sonography. Consequently, I have presented narrative accounts of the sonography specialists involved with obstetric sonography. According to the interpretive philosophy, instead of just
collecting statistical facts, different constructions and meanings of the sonography specialists’ own experiences and practices have been comprehensively described (Amaratunga & Baldry, 2001). Hence, I addressed the objectives of this research by systematically integrating the qualitative and quantitative data.

**CASE STUDY**

I used the *case study* method for my research because of the holistic in-depth investigation needed to answer my research question. The case study method is the most appropriate since this approach facilitates a comprehensive description of the ‘case’ under study and evidence for the development of hypotheses and theories (Cohen et al., 2000). As a researcher I have minimal control over the research case, and the case study strategy accommodates this very well (Yin, 2003).

A case study is defined as an inquiry that investigates a “phenomenon in a real life context or a specific instance in action” (Yin, 2003, p. 13). As with other forms of research methods, case study also has its strengths and limitations. The main characteristics of case studies are that they highlight the significance of the phenomenon under study rather than just the quantitative frequencies (Cohen et al., 2000). Consequently, the researcher can gain in-depth insights into the realities of the individual(s) or the situation(s). Further to this, a case study helps to identify unique themes and inferences that are strong on reality, obtained from multiple sources that may otherwise be lost in larger scale data (Yin, 2003).

A case can be an individual, a community, an institute and/or a programme. In this research the *case* for study is the ‘current obstetric sonography practice at an urban public hospital in Fiji’. The aim of this case study research is to evaluate the current practices and procedures used for the mid-trimester obstetric sonography examinations at the host hospital and to examine the potential need for the development of an obstetric sonography protocol. In this interpretive research an attempt has been made to construct “analytical generalisations” from a single case study (Yin, 2003, p. 10).

There are at least four applications of a case study model mentioned in the literature relevant to my research:

- *To explain complex causal links in real-life interventions.* This study has explored the
dynamics of the relationships between the themes that emerged from the data analysis such as limited expertise and resources of the radiographers who performed mid-trimester scans, their workload, time constraints, requirements of the international scanning protocol and the expectations of the specialists involved in obstetric sonography at the host hospital.

- To describe the real-life context in which the intervention has occurred. Both qualitative and quantitative data were obtained at the Ultrasound Department where patients were being scanned. This was done to identify the scanning criteria used by the radiographers in their daily practice, its effect on their diagnosis and the alignment of the radiographers’ scanning methods with that of the international guidelines.

- To describe the intervention itself. The current obstetric sonography practice has been described from the radiographers’ and the specialists’ perspectives, and the researcher’s interpretations.

- To explore those situations in which the intervention being evaluated has no clear set of outcomes. One of the themes of this case study was to find the effects of the current practice on the patients, practitioners and the institute as a whole, especially in the absence of a documented mid-trimester protocol.

(Adapted from Tellis, 1997, p. 2)

Whilst the programme evaluation method could have been employed to conduct this research, the case study method is deemed more appropriate because the former is applicable when there is a need for a review of an already established programme, its outcomes, effectiveness and the consequences (Yielder, 2007). However, the intention of this research was not to implement a protocol and subsequently assess its outcomes, but to identify gaps in the current practice of obstetric sonography at the host hospital and to make appropriate recommendations.

A similar case study approach was used by Aymerich, Almazan, Estrada, Sanchez and Mías (2002) in a research project that aimed to compare the systemic review of prenatal diagnosis of Down syndrome with the established clinical practice guidelines. The authors had chosen ultrasound imaging for routine prenatal care as their case for study. A meta-analysis of nuchal fold thickness as a second trimester marker for Down syndrome was carried out and the studies to be included were identified through several bibliographic search strategies.
according to a minimal set of quality criteria. However, in my case study research I took a different route and employed multiple data collection methods as discussed in the following sub-section.

**DATA COLLECTION METHODS**

Merriam (1998, p. 70) defined data as “bits and pieces of information” obtained from the research relevant environment. Whether such information is considered to be useful data totally depends on the research aims and themes. Data can be gathered by various means and further categorised as qualitative or quantitative. While some researchers prefer to use either qualitative or quantitative data, I preferred to use both – employing multiple methods of data collection in my research, which predominantly entailed qualitative data supported by the quantitative data. Blending the qualitative and quantitative data in my research allowed me to achieve a more comprehensive understanding of the phenomenon being evaluated (Pope & Mays, 1995).

*Qualitative research* has been described as “an umbrella concept covering several forms of inquiry that help [the researcher] to understand and explain the meaning of social phenomena with as little disruption of the natural setting as possible” (Merriam, 1998, p. 5). Adding to this, Denzin and Lincoln stated that qualitative research puts the researcher in the real-life situation so that rich descriptive data can be collected from “personal experiences, introspections, life stories, interviews, cultural texts, observations … that describe routine and problematic moments and meanings in individuals’ lives … hoping to better understand the subject matter at hand” (2000, pp. 3-4).

There are three important features of qualitative case studies mentioned in the literature that are relevant to my study:

- **Particularistic** – when the main focus is on a particular situation, event or programme. My research is based on the mid-trimester sonography practice at a particular hospital with limited resources.

- **Descriptive** – when the end product is an illustration of the complexities of the phenomenon under study. My participants provided rich descriptive data through the questionnaire and interview responses.
• **Heuristic** – when various themes that emerge from the qualitative data bring about new meanings, realisations, reasons and justifications to answer the research question. The descriptive data that was obtained in my research was subjected to analysis, from which various themes were drawn.

(Adapted from Merriam, 1998, pp. 29-30)

Alternatively, **quantitative research** has been described as that which involves the researcher in quantifying relationships between different variables through statistical analysis (Gillham, 2000). Usually, large amounts of data are obtained for analysis from a number of participants and/or cases without much personal interaction and thus the researchers deliberately avoid presenting rich descriptive information (Janesick, 2000). Gillham also highlighted the importance of quantitative data in case study researches by stating that, “case study research does not equate qualitative methods and data only ... quantitative data and its analysis can [also] add to the overall picture” (2000, p. 80). In my research, quantitative data was used to statistically represent the phenomenon under study (Bouma & Ling, 2004). In this case study, multiple data collection methods were employed to understand a phenomenon from several viewpoints, that is, from the perspectives of different obstetric ultrasound practitioners at various professional and hierarchical levels (Johnson, Onwuegbuzie & Turner, 2007). The quantitative aspect provided further evidence to support the emergent theory and indicated relationships in the qualitative data that may have otherwise gone unnoticed (Amaratunga & Baldry, 2001), that is, the inferences made from the analysis of the quantitative data were used to support the themes that emerged from the descriptive data.

The issue of validity has been repeatedly addressed in the literature and refers to the worthiness of the research tool or the research tool’s ability to measure what it is meant for (Cohen et al., 2000). In order to maximise the validity of my research, I used triangulation of data collection methods, participant-checks and made repeated observations (Merriam, 1998). These are discussed further in the ensuing sub-section.

**Sources of Data and Sampling**

Three different sources, namely, observations, questionnaires and interviews were used to obtain data for my case study research, which ultimately lead to methodological triangulation. This not only helped to increase confidence in the data interpretation and rigour of my study
(Denzin & Lincoln, 2000) but also maximised its validity (Yin, 2003). Stakes described triangulation as, “a process of using multiple perceptions to clarify meaning[s], verifying the repeatability of an observation or interpretation” (2000, p. 443). He also agreed that it is not possible to always reproduce the same data from observations or perceptions; hence, triangulation plays an important role in presenting various perspectives of the same phenomenon.

There are four types of triangulation mentioned in the literature as listed below, of which the first three have been applied in this study, namely:

- **Data triangulation** – data obtained from a variety of sources, for example, observations, questionnaires and interviews were used in this research.
- **Methodological triangulation** – use of multiple methods to answer a research question. For instance, I used multi-method approach for data collection which yielded both qualitative and quantitative data.
- **Theory triangulation** – use of multiple views and perspectives of the participants, and theories from the published literature. My participants comprised radiographers, radiologists and obstetricians. My inferences were supported by specific ultrasound-related literature and international practice guidelines.
- **Investigator triangulation** – this is possible when several researchers work on a particular study. In my case this was not an option since it is mandatory to conduct individual research as per the programme requirement.

(Adapted from Denzin, cited in Johnson, Onwuegbuzie & Turner, 2007, p. 114)

Prior to discussing the three sources of data in depth, it is important to discuss the sampling design of this study and issues relevant to it. **Sampling design** as described by Collins et al. refers to the “framework within which the sampling occurs” (2007, p. 271). A “critical case sampling scheme” was used to purposively select participants based on their professional characteristics so that they could provide quality in-depth views on the research inquiries (Collins et al., p. 272). This research comprised a sample size of ten ultrasound professionals, six of whom were radiographers, while the remaining four were two radiology and two obstetric specialists. This sample size adequately met the minimum criterion of “three to five (3–5)” participants for a case study research recommended by Creswell (2002, p. 197).
This research involved a complex sampling framework. The data collected from the radiographers entailed a sequential design using identical samples, where both the qualitative and quantitative data was obtained from the same sample subsequently (Collins et al., 2007). Once quantitative data was obtained from the observations, the radiographers were then given questionnaires to answer; this yielded a major portion of qualitative data from them. On the other hand, a substantial amount of qualitative data was concurrently obtained from the specialists through interviews. The three methods of data collection are discussed below.

1. **Observations**

To review the current practices and procedures used during the mid-trimester sonography examinations at the host hospital, an observation technique was used. Since no documented protocol for scanning existed at this hospital during the period of data collection, observations at the Ultrasound Department were made to identify the scanning guidelines used by the different participants (radiographers performing scans). Hence, this helped to obtain detailed descriptions of the examinations in a natural setting. Cohen et al. (2000) maintained that the observation technique enables the researcher to understand the context of the programme in a natural environment and unveil the issues that the participants may not reveal in an interview or a questionnaire.

Since the study was not based on the assessment of the practitioner’s personal behaviour or the accuracy of their diagnosis, the unit of analysis was observation of the step-by-step procedures used by the cohort of radiographers to conduct the mid-trimester sonography examinations. A non-participant/complete observer role was adopted to take field notes using a structured observation protocol (see Appendix 2) whereby categories or checklists were worked out prior to data collection. The observation protocol was prepared from the ASUM guidelines (see Appendix 3) with the assistance of an obstetrics and gynaecology sonography expert based in a clinical facility in Auckland. These international guidelines were considered to be the ‘gold-standard’ since they are the most commonly adopted ultrasound guidelines followed by major public hospitals in New Zealand and, supposedly, in the Australasian region (Hooper, 2006; Tee, 2004). An overt approach for observation was taken whereby the radiographers were informed prior to the observation and they were aware of being observed by the researcher (Cohen et al., 2000). Cohen et al. suggested that employing an overt approach while conducting observations helps to maintain the principle of informed consent.
and minimises invasion of the participants’ privacy.

Despite the advantages mentioned earlier, there were also several limitations and challenges associated with the observation technique. These included participant discomfort during observations, inter-observer bias, intense workflow, time consumption in data collection and the Hawthorne effect, which is a change in the practitioner’s performance due to being observed by the researcher (Polgar & Thomas, 2000). The feeling of being threatened in the presence of a researcher was further outweighed when the nature, purpose, significance of the research, and the impact of their contribution upon their current practice were fully discussed. Furthermore, written informed consent was sought from all the participants after issues of confidentiality, anonymity and non-traceability were assured, and the right to withdraw prior to a scheduled date was offered. In order to further alleviate participants’ psychological stress, I held debriefing sessions with each of them after the observation.

The radiographers’ support and willingness to participate in the research was encouraging. From the outset there was no obvious sign of hesitation to reveal information about their current practice. In informal conversations, the radiographers also disclosed to me that this research was timely as it would help to highlight their concerns about the current status of sonographic practice to the relevant authorities in Fiji. The willingness to participate in the research was an added advantage to the data collection process as the radiographers’ cooperation prevailed over some of the limitations of the observation technique.

On the other hand, the possibility of participant-researcher familiarity causing a potential Hawthorne effect (Polgar & Thomas, 2000) was minimised by keeping the contents of the checklist concealed. The Hawthorne effect was further minimised by adopting a complete observer approach, that is, observations were made without interrupting the radiographers during the sonography examinations. Therefore, there was no communication or interaction with any party during the observation period, except with the radiographers at the end of the session for clarification. The aim was to keep the integrity of the study uncompromised.

The researcher’s own assumptions and preconceived ideas about the phenomenon under study can influence the way data is collected during the observation period. Such observer biases were minimised in this research by adhering strictly to the detailed structured observation protocol and incorporating a similar checklist in the questionnaire which was
completed by the radiographers independently. As a researcher, my limited clinical experience in sonography was a limiting factor and, therefore, frequent consultation and guidance were sought from an Obstetrics and Gynaecology sonography expert based in a clinical facility in Auckland.

Although a high proportion of pregnant mothers were scanned each day at the ultrasound department where this research was located, a limited number of patients presented for 18 to 23 weeks’ anatomy/anomaly scans (see statistics in Table 1). Since the host hospital did not follow a patient booking system for ultrasound scans, I patiently waited for the appropriate cases and observed the examinations in the order they were done. Consequently, the observation process consumed an enormous amount of my time.

With permission of the radiology manager, at the completion of each ultrasound examination, the radiographers’ reports were studied. Procedures and reports were analysed to:

- Identify the minimum criteria followed by the radiographers for mid-trimester scans, that is, the scanning sequence and their emphasis during the scans.
- Note the depth of their report writing, that is, check the depth of information they acquired from their scanning.
- Identify the radiographers’ alignment of their practice to the observation checklist and the ASUM guidelines.

Participants

Six (6) radiographers from an urban public hospital were purposively selected to participate in the study. It is important to note that none of the radiographers had any formal academic qualification in the ultrasound speciality at this hospital. They had been trained ‘on-the-job’ by the more experienced radiographers and the visiting ultrasound specialists from Australia. The participants were selected according to their availability on the duty roster and their years of experience in sonography practice. They were selected from the following three categories:

- 3 months – 1 year;
- 1 year – 3 years; and
- More than 3 years of experience.
Since it was presumed that the radiographers’ scanning guidelines may vary due to differing sonography experience, the participants were selected from three different categories mentioned earlier. Therefore, two (2) radiographers from each category made a total of 6 participants for observation. Two obstetric scan procedures per participant equated to a total of 12 sonography examinations to be observed. The obstetric examinations were selected in accordance with the following criteria:

- Solely mothers with single pregnancies were included to maintain consistency in the study.
- Patients with gestational age of 18-23 weeks were selected. This was determined by the obstetrician’s clinical report and/or the patient’s first trimester obstetric scan data.
- The patients who were selected to be scanned presented for the first time for an anatomy and/or anomaly scan with the assumption that they would have a full anatomical survey.

The rationale for selecting only 12 sonography examinations for observation was that:

- An average of two patients per day presented for anatomy and/or anomaly scans (see Table 1) during the data collection period. Of these, only a limited number of obstetric cases met the inclusion criteria mentioned above.
- Not all sonography staff met the inclusion criteria of the research. The examinations in the Ultrasound Department where the observations were made were distributed amongst the participant and non-participant radiographers throughout the day. Therefore, the participant radiographers performed scans intermittently during the day, thus the number of examinations meeting the inclusion criteria was limited.
- The scans were performed without any prior bookings, therefore, ultrasound cases that eventually met the selection criteria did not always coincide with the participants’ scanning period.

Hence, due to the limitations mentioned above, it was only possible to make a limited number (12) of observations.

It is evident that the radiographers of less than 3 months’ experience in sonography practice were excluded. This is due to the fact that during the first 3 months they only assist the experienced radiographers and learn sonography mostly through observation. It is also apparent that the patients less than 18 weeks and more than 24 weeks pregnant were
excluded; this was the reflection of the majority of the literature which stated that 18 to 23 weeks’ gestation is the most appropriate period for mid-trimester scanning (Chudleigh & Thilaganathan, 2004; Royal College of Obstetricians & Gynaecologists, 2000; Sanders, 1998b). The rationale for selecting 18 to 23 weeks’ gestation as the most appropriate period for performing the mid-trimester sonography has already been discussed in detail in Chapter 3. Furthermore, it is important to note that the obstetric patients were not considered to be the active participants of this research. While they were scanned, observations on the radiographers’ practises were monitored and not the patients. However, verbal consent was taken from each patient to include their scans in the research and no further interaction was made with them thereafter.

2. Questionnaires

To obtain first hand information about the radiographers’ perspectives regarding the current obstetric sonography practice in Fiji each participating radiographer was given a questionnaire to complete at the completion of the field observation. The selected radiographers were provided with information about the research prior to observation and had also signed a consent form to participate in the questionnaire phase. They also returned the questionnaires to me promptly before the scheduled return date. These questionnaires extracted in-depth insights about the radiographers’ experiences of performing obstetric sonography at the host hospital. Confidentiality and anonymity were maintained at all times. Burns (2000) explained that a unique feature of the use of questionnaires is that the participants are free to respond at their own pace without any fear of being watched or interrogated by the researcher. However, he also warned that there is a high possibility of misinterpretation of the questions if the questionnaire is poorly structured or if the document is lengthy, as participants may return it incomplete.

The original questionnaire was piloted on three Medical Radiation Technologists (MRTs). One of them was a qualified sonographer while the other two were postgraduate medical imaging students. The pilot group was purposefully selected so that they could suitably represent my research participants (Williams, 2003) and provide feedback from a sonography perspective. The sonographer was very instrumental in critiquing the sonography aspects of the questions and offered valuable suggestions. Similarly, the two postgraduate students, who had some previous teaching experience in sonography, made valuable contributions regarding
the layout and sequencing of the questions. Consequently, several alterations were made to the original questionnaire, resulting in the omission of some questions either because they indicated an anticipated outcome or were repetitious. It was also suggested that a footnote be added to indicate a questionnaire return date and to acknowledge the participants. It is believed that the piloting process increased the “acceptability, validity and reliability” of the research questionnaire (Williams, 2003, p. 249).

The questionnaire was divided into two parts, Part A for the demographic questions and Part B which referred to the radiographers’ professional practice in ultrasound (see Appendix 2). The advantage of such a design is that it leads the participants to the crux of the questionnaire without their being intimidated by challenging questions at the very beginning (Burns, 2000). The questionnaire involved an “intramethod mixing”, that is, it comprised open-ended and closed questions such as dichotomous, multiple choices, rating scales, fill-in response and open-ended questions to yield both qualitative and quantitative data (Johnson & Turner, 2003, p. 304). To avoid confusion and ambiguity, clear guidelines were provided throughout the questionnaire on how to respond to the questions.

Considering the features of a poorly designed questionnaire, as mentioned earlier, my questionnaire was succinct in structure. Instead of lengthy questions related to the radiographers’ scanning preferences during mid-trimester sonography, the questionnaire featured a checklist similar to the observation protocol. Many questions, including the checklist, required the participants to tick the most appropriate preferences. Almost all the questions in Part B gave the participants an option to explain their responses. An information sheet containing details about the research, the questionnaire and the researcher’s contacts was attached with all the questionnaires (see Appendix 1). A 100% response was obtained from the questionnaire in the form of both quantitative and qualitative data.

**Participants**

The sample set for the questionnaires was identical to the observation method, that is, the same six radiographers were observed and then, subsequently, given the questionnaires to complete.
3. Interviews

Interviews were conducted with the specialists involved in obstetric sonography in order to obtain the professional opinion of the obstetricians and the radiologists on the current obstetric scan practices at the hospital where this study was located. These specialists are fully qualified and are the most senior professionals in their respective fields at the host hospital. All the interviewees were purposively selected and given information about the research. Due to the limited number of specialists involved in obstetric sonography at the host hospital, it was fairly challenging to confirm appointments for interviews. One of the radiologists was interviewed after the normal business hours while an obstetrician was interviewed during the lunch break.

In Fiji, the consultant radiologist is responsible for the Ultrasound Department at the hospital. The radiographers who perform obstetric scans interpret and endorse all the obstetric examination reports on behalf of the radiologist. Unless an emergency occurs or the radiographers find it too difficult to scan a patient, the radiologists do not attend the examination or interpret the images. In rare cases, the obstetricians are present during the scans. None of the public hospitals in Fiji has PACS whereby digital images can be archived and then sent to the radiologists to assess and make diagnostic reports. Hence, the radiologists at the host hospital were interviewed regarding the status of the current obstetric sonography practice, image reporting issues, employment of standard protocols and education of the radiographers performing sonography scans.

Interviews were also conducted with the obstetricians who refer their patients to the Ultrasound Department for assessment during pregnancy. A similar interview structure was used for both types of specialists (see the interview schedules in Appendix 2). Data were collected on their views about the current practice in obstetric sonography, that is, whether the specialists’ sonography needs were met by the radiographers, the specialists’ limitations regarding obstetric sonography and their contribution towards the educational needs of the radiographers performing ultrasound scans. The interview technique was deemed the most appropriate method for data collection from the specialists, so that rich qualitative data could be obtained from them especially when they were limited in number. This technique allowed some degree of flexibility in terms of repeating the questions or probing for additional information when the interviewees provided incomplete responses (Burns, 2000). Apart from
this, face-to-face interviews allowed me to capture the participant’s real-time actions and their perceptions of the gravity of the issues. Burns has explained that sometimes the interviewees may feel threatened because they are put “on spot” (2000, p. 583). Similarly, Ary, Jacobs, Razavieh and Sorensen (2006) cautioned of the social desirability biases in interviews where inconsistent probing by the researcher can mislead the interviewees to provide responses that the researcher expects.

To minimise possible biases in this research, an open-ended interview schedule was used, whereby the interviewees were allowed to comment freely on the questions. The semi-structured format allowed questions to be rephrased when certain responses appeared ambiguous or incomplete (Cohen et al., 2000). All the interviews were recorded using a digital voice recorder and later transcribed. Debriefing sessions were conducted at the completion of each interview to alleviate any concerns of the participants. The interviewees were given copies of their transcripts for review and to encourage transparency in the research. When transcripts were returned no editions were needed to be made to the original copies because none were requested. The ethical issues relevant to the three methods of data collection are discussed separately later in this chapter.

**Participants**

A total number of four (4) specialists at the hospital were interviewed. Due to the limited number of radiologists in Fiji and the scope of the study, only two (2) of them were purposively selected for the study. Similarly, two (2) obstetricians were interviewed. The most experienced obstetricians closely affiliated to the ultrasound department were selected.

**Methods of Data Analysis**

The quantitative data that was obtained from the observations and the questionnaires was subjected to manual statistical analysis. The analysis mainly involved identification of variables, tabulations and identification of relationships between the variables, and was used to support the qualitative data (Cohen et al., 2000). An enormous amount of raw data was obtained from the observations that were made at the host hospital, and questionnaire responses from the radiographers. These raw data sets were then condensed and summarised into separate data tables. From these tables further themes and relationships were constructed.
and have been presented in Chapter 5.

The qualitative data obtained from the questionnaires and interviews was also manually analysed. A cross-sectional thematic analysis approach was used to present rich descriptions of the participants’ responses (Cohen et al., 2000). This analysis was conducted in four stages:

- The qualitative data was classified into various themes using the coding method.
- The data was interpreted and linked to identify relationships.
- Then the data was reselected and revised using colour coding.
- The final stage involved the identification of development of an emerging theory.

(Morse, 1995)

More simply, manual analysis of the qualitative data involved colour coding of the raw texts in relation to the research question and aims. Significant repeated ideas were electronically cut and pasted into separate computer files. Finally, the themes were organised by grouping the repeated ideas to develop a theoretical framework (Auerbach & Silverstein, 2003). Important themes and relationships that emerged from the qualitative data are discussed in Chapters 6 to 8. It is worth noting that the quotations used in this thesis are verbatim and may indicate the participants’ difficulty with English as a second language. Hence, some of the quotations required clarification which is substantiated by my personal comments in the brackets [

**ETHICAL ISSUES**

The ethical issues concerning this research were confidentiality, anonymity, non-traceability of the participants and their procedures, and their right to withdraw prior to a scheduled date. Firstly, formal written approval was sought from the Unitec Research Ethics Committee (UREC) as per the requirements of the research course at Unitec NZ (see Appendix 1). Following this, further approval was sought from the Fiji National Health Research Committee (FNHRC), Fiji National Research Ethics Review Committee (FNRERC) (see Appendix 1) and the consultant radiologist for conducting the research at the institute in which the research was located. Also, approval was sought to access the Ultrasound Department in which the study was conducted.
Secondly, the radiographers, radiologists and the obstetricians were offered information about the research (see Appendix 1) explaining the aims of the study, what is expected of them as the participants, and how and to whom the information would be disseminated. They were given time to decide whether they chose to participate in the research. Having agreed to do so, they were asked to sign a consent form (see Appendix 1). The participants had the right to withdraw from the study up to a specified date. Similarly, after consultation with the radiology manager, I obtained verbal consent from the patients to be present in the examination room during the observation period. The patients were provided with the information about the study. There was no other interaction with the patients as they were not the unit of analysis during the data collection.

Debriefing sessions were conducted after each observation and interview to alleviate the participant’s possible concerns, if there were any. The interviewees were encouraged to read the copies of their transcript to enhance transparency in the research. Questionnaire responses and details of the patients’ reports were kept confidential. Recorded digital audio files and the interview transcripts are locked safely in my office cabinet. As mentioned earlier, the host hospital name has been kept confidential at all times.

The issue of anonymity and non-traceability were addressed by concealing the participants’ and patients’ identities. The research participants were assigned pseudonyms, only known to the researcher and the research supervisors, as follows:

- Radiographers – Robin, Nancy, Cathy, Rachel, Maggie and Nick
- Radiologists – Dr. Smith and Dr. Murray
- Obstetricians – Dr. Reed and Dr. Lloyd

Due to traceability issues, the specialists were deliberately assigned names belonging to the same gender. The rationale for this is that the host hospital has a limited number of specialists who are affiliated to obstetric sonography and, therefore, using the correct gender related pseudonyms would have easily revealed their identity.
SUMMARY

This study employed a case study approach positioned in an interpretive paradigm to investigate the current obstetric sonography practice at an urban public hospital in Fiji. A multi-method approach was employed for data collection which predominantly entailed qualitative data through methodological and data triangulation of observations, questionnaires and interviews. While the quantitative data was obtained from the observations made on the scanning guidelines used by the radiographers, most of the qualitative data was obtained from the questionnaires and the interviews. The participants were purposively selected and comprised a cohort of ‘on-the-job’ trained radiographers performing obstetric sonography, radiologists and obstetricians.

There were several limitations and challenges faced during the process of data collection. These included the limited number of cases available for observation, participants’ discomfort, the Hawthorne effect, observer bias, radiographers’ intense workload and the time required to conduct the observations. These limitations were dealt accordingly to effectively answer the research question. The participants’ overwhelming support and eagerness to contribute towards the research were an added advantage. The participants were assured of confidentiality, anonymity and non-traceability at all times. The statistical analyses of the quantitative data and a summary of themes that emerged from the qualitative data are presented in Chapter 5. The inferences made from the analysis of the research data are discussed in Chapters 6 to 8.
CHAPTER 5

RESULTS

OVERVIEW

One of the critical components of a research project is the findings. Data for this research was obtained using a multi-method approach of observations, questionnaires and interviews. This chapter firstly presents the quantitative data obtained from the observations that were made on the radiographers’ scanning guidelines and the questionnaires that were given to them at the completion of the observations. The observation data that was subjected to manual statistical analysis has been tabulated and graphically presented. Similarly, the quantitative aspects of the questionnaire data have been tabulated and presented as bar graphs and pie charts. The second section of this chapter presents the qualitative data that was obtained from the questionnaires and the interviews. The themes that emerged from the manual thematic analysis of these qualitative data have been presented in a table format. In this chapter, each illustration of the research findings has been accompanied by a brief description. Inferences made from the analysis of the research data will be presented in Chapters 6 to 8.
QUANTITATIVE DATA

OBSERVATIONS

A total number of 12 examinations (n=12) performed by six radiographers were observed. Each radiographer scanned two obstetric patients who met the selection criteria (see Chapter 4). Table 3 illustrates the quantitative data that was obtained using a structured observation protocol (see Appendix 2). The raw data was firstly condensed into a data summary table (see Appendix 4) from which the information in Table 3 was deduced. Referring to Table 3, each examination was divided into 10 categories of specific fetal and maternal anatomical structures, highlighted as ‘blue’ rows. These 10 categories were adopted from the ASUM guidelines (see Appendix 3). Each category has several important anatomical structures, totalling to 44 items, listed in the first column. Ideally and according to the ASUM guidelines, the radiographers were expected to carefully scan as many anatomical structures in each category prior to making provisional examination reports (Australasian Society for Ultrasound in Medicine, 2005).

Furthermore, Table 3 shows the number of examinations (from the total 12 cases) in which the radiographers either scanned, or did not scan, a particular anatomical structure, depending on the Ultrasound Department’s unwritten scanning guidelines in the absence of a departmental protocol. The ‘green’ row of cells, which are further categorised into three separate columns, depict the number of examinations in which attempts were made to scan. The first category, labelled as “Met ASUM Criteria”, lists the number of examinations that met the minimum ASUM criteria during the anatomical survey. The second column of numerical data corresponds to the number of examinations where images were recorded at incorrect anatomical levels as opposed to the ASUM criteria. The third column of numerical data labelled as “Unacceptable Image”, represents the number of examinations that the radiographers attempted but recorded technically and visibly unacceptable images as opposed to the observation protocol. The last column of numerical data in Table 3 corresponds to the number of examinations in which the radiographers did not attempt to scan the respective anatomical structures. It is revealed from Table 3 that a high proportion of anatomical structures were never scanned by any of the radiographers in either of the two examinations they performed. Data in Table 3 has been further analysed in correlation with the radiographers’ years of experiences and presented in Table 4 on Page 81.
### Table 3  Observation data of the radiographers’ scanning sequences

<table>
<thead>
<tr>
<th>Fetal and Maternal Anatomical Structures</th>
<th>n = 12*</th>
<th>Met ASUM Criteria</th>
<th>Scanned Incorrect Level</th>
<th>Unacceptable Image</th>
<th>Never Scanned</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fetal Life &amp; Position Assessment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Fetal Heart Activity</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>10</td>
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<tr>
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<tr>
<td>Hand &amp; Fingers</td>
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<td>0</td>
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<td>12</td>
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<tr>
<td><strong>Fetal Heart</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fetal Heart Motion</td>
<td>12</td>
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<td>0</td>
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<td></td>
</tr>
<tr>
<td>Fetal Heart Activity in M-Mode</td>
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</tr>
<tr>
<td>4 Chambered Heart</td>
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<td>0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Cardiac Valves</td>
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<td>0</td>
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<td>12</td>
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</tr>
<tr>
<td>Outflow Tracts</td>
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<td>0</td>
<td>0</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>Placenta &amp; Amniotic Fluid</strong></td>
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</tr>
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<td>Placental Site</td>
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<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Placental Echotexture</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Distance from Cervical Os</td>
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<td>0</td>
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<tr>
<td>Amniotic Fluid Index</td>
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<td>0</td>
<td>12</td>
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<td><strong>Maternal Anatomy</strong></td>
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</tr>
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<td>Cervix</td>
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<td>12</td>
<td></td>
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<td>Adnexa</td>
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<td>10</td>
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</tr>
</tbody>
</table>

*Note:* n = 12 obstetric examinations observed on six radiographers

80
Table 4  Radiographers’ scanning patterns according to their years of experience

<table>
<thead>
<tr>
<th>Radiographers</th>
<th>No. of Structures Scanned Close to ASUM Criteria (Exam-1)</th>
<th>No. of Structures Scanned Close to ASUM Criteria (Exam-2)</th>
<th>No. of Structures in Common Across Both Examinations</th>
<th>No. of Structures Never Scanned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robin</td>
<td>18</td>
<td>15</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>Nancy</td>
<td>14</td>
<td>6</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Cathy</td>
<td>12</td>
<td>16</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Rachel</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>31</td>
</tr>
<tr>
<td>Maggie</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>33</td>
</tr>
<tr>
<td>Nick</td>
<td>6</td>
<td>9</td>
<td>6</td>
<td>32</td>
</tr>
</tbody>
</table>

Years of experience:  
- More than 3 years;  
- 1 to 3 years;  
- Less than 1 year

As mentioned earlier, n = 44 refers to the total number of fetal and maternal anatomical structures listed in the observation protocol to be scanned by the radiographers in each of their examinations. Table 4 consists of five columns, where the first column lists the radiographer participants according to their years of experience in sonography practice. The radiographers’ years of work experience has been colour coded with their respective references beneath the table. The second and the third columns in Table 4 show the number of anatomical structures that correlated with the minimum ASUM scanning criteria during the two examinations performed by the radiographers.

The fourth column presents the number of anatomical structures that were scanned consistently across both the examinations. The last column on the right of the table shows the total number of anatomical structures that were not scanned at all across both the examinations. Although only two examinations per participant were observed, it is apparent from Table 4 that there is a gradual decline in the number of anatomical structures that were scanned by the radiographers with fewer years of experience. Inferences made from Tables 3 and 4 are further discussed in Chapters 6 to 8.
From the observation data summary (see Appendix 4), it is apparent that the radiographers had placed a major emphasis on the biometry measurements during the mid-trimester scans. Although this research was not conducted to assess the radiographers’ diagnostic accuracies, due to the comprehensive nature of the observation protocol, some obvious discrepancies in the radiographers’ scanning approach were inevitably noticed and recorded. These discrepancies entailed scans or measurements taken at incorrect levels, sonographic presentations of unacceptable images and anatomical structures that were not scanned at all.

Inferences regarding the discrepancies were made following discussions with an Obstetrics and Gynaecology sonography expert based in a clinical facility in Auckland (see Chapter 4) and in accordance with the ASUM guidelines (see Appendix 3). Figure 15 illustrates the number of examinations in which discrepancies occurred during the measurements of the biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL). The colour coded references below the bar graphs represent the outcomes of the scans.
Figure 16  Radiographers’ time span per obstetric sonography examination

Figure 16 illustrates the amount of time (in minutes) each radiographer had spent during the two sonographic examinations they performed; the examination numbers have been indicated by the colour codes. It is apparent from Figure 16 that the maximum time spent on an examination was 8 minutes and the minimum was 2 minutes. In the twelve examinations that were observed, the cumulative average time spent per examination was calculated to be 4 minutes and 50 seconds.

Furthermore, Figure 16 shows that all the radiographers except Robin, had spent more time performing the second examination although all the selected patients were referred for the same diagnostic procedure, that is, an anomaly scan. A number of factors may have caused the variations in the duration of scans. Being influenced by my presence in the examination room (Cohen et al., 2000), I assume that the radiographers spent more time on their second examination to enhance the quality of their scans, although accuracy in scanning was not the unit of analysis in this research. Other factors that may have influenced the scanning time could have been radiographers’ clinical experience and confidence level, maternal size, fetal position, fetal and maternal movements (Kalish & Chervenak, 2005), and the number of patients waiting to be scanned.
**Questionnaires**

At the completion of the observations of the radiographers’ scanning criteria, the radiographers were given questionnaires to complete. A number of questions yielded quantitative data that has been tabulated and graphically presented in this section of the current chapter. The demographic questions in Part A of the questionnaire (see Appendix 2) produced simple responses that did not require the data to be tabulated or graphically presented. The responses from Part A revealed that all the radiographers only had a Diploma in Diagnostic Radiography qualification without any ultrasound specific qualification. Other responses in Part A confirmed that the participants met the research selection criteria, as stipulated in Chapter 4.

**Table 5  Questionnaire responses on number of mid-trimester scans done per week**

<table>
<thead>
<tr>
<th>Radiographers</th>
<th>Number of Examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robin</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>Nancy</td>
<td>10 - 30</td>
</tr>
<tr>
<td>Cathy</td>
<td>51 - 70</td>
</tr>
<tr>
<td>Rachel</td>
<td>31 - 70</td>
</tr>
<tr>
<td>Maggie</td>
<td>31 - 70</td>
</tr>
<tr>
<td>Nick</td>
<td>10 - 30</td>
</tr>
</tbody>
</table>

Part B of the questionnaire began with an inquiry of the number of mid-trimester sonography examinations performed by the radiographers. In response, the radiographers provided varying feedback. According to Table 5, the majority of the participants stated that they performed more than 30 mid-trimester scans per week.

Table 6 (Page 85) presents the data obtained from the questionnaire responses on the radiographers’ approach to mid-trimester sonography. The first column on the left lists the anatomical structures recommended by the ASUM guidelines, to be assessed during the mid-trimester examinations. The second column lists the number of radiographers (n=6) who often included the corresponding anatomical structures in their mid-trimester examinations, while the third column lists the remainder of the radiographers who do not include certain anatomical structures in their assessments.
Table 6  Radiographers’ perspectives on their approach to mid-trimester sonography

<table>
<thead>
<tr>
<th>Fetal and Maternal Anatomical Structures</th>
<th>No. of Radiographers (n = 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Often Assess</td>
</tr>
<tr>
<td><strong>Fetal Life &amp; Position Assessment</strong></td>
<td></td>
</tr>
<tr>
<td>Initial Fetal Heart Activity</td>
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<tr>
<td>Fetal Position</td>
<td>2</td>
</tr>
<tr>
<td><strong>Biometry</strong></td>
<td></td>
</tr>
<tr>
<td>Bi-Parietal Diameter (BPD)</td>
<td>6</td>
</tr>
<tr>
<td>Head Circumference (HC)</td>
<td>6</td>
</tr>
<tr>
<td>Abdominal Circumference (AC)</td>
<td>5</td>
</tr>
<tr>
<td>Femur Length (FL)</td>
<td>6</td>
</tr>
<tr>
<td><strong>Head Scan</strong></td>
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</tr>
<tr>
<td>Head Shape</td>
<td>5</td>
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<td>Falx Cerebri</td>
<td>4</td>
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<tr>
<td>Corpus Septum Pellucidum</td>
<td>1</td>
</tr>
<tr>
<td>Lateral Ventricles / Choroid Plexus</td>
<td>5</td>
</tr>
<tr>
<td>Cisterna Magna</td>
<td>6</td>
</tr>
<tr>
<td>Nuchal Thickness</td>
<td>2</td>
</tr>
<tr>
<td><strong>Fetal Face</strong></td>
<td></td>
</tr>
<tr>
<td>Orbits</td>
<td>2</td>
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<tr>
<td>Nose</td>
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<tr>
<td>Lips</td>
<td>1</td>
</tr>
<tr>
<td>Jaw</td>
<td>0</td>
</tr>
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<td>Profile</td>
<td>0</td>
</tr>
<tr>
<td><strong>Fetal Spine</strong></td>
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<tr>
<td>3 Ossification Centres (Transverse plane)</td>
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<tr>
<td>Skin Line</td>
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</tr>
<tr>
<td>Coronal Plane</td>
<td>3</td>
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<tr>
<td>Sagittal Plane</td>
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</tr>
<tr>
<td><strong>Fetal Abdomen</strong></td>
<td></td>
</tr>
<tr>
<td>Abdominal Wall</td>
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</tr>
<tr>
<td>Diaphragm</td>
<td>1</td>
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<td>Stomach</td>
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<td>Kidneys</td>
<td>5</td>
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<td>Urinary Bladder</td>
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</tr>
<tr>
<td>3 Vessel Cord</td>
<td>0</td>
</tr>
<tr>
<td>Umbilical Cord Insertion</td>
<td>0</td>
</tr>
<tr>
<td><strong>Fetal Extremities</strong></td>
<td></td>
</tr>
<tr>
<td>12 Long Bones</td>
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<td>Hand &amp; Fingers</td>
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<td>Feet &amp; Toes</td>
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<tr>
<td><strong>Fetal Heart</strong></td>
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<tr>
<td>Fetal Heart Motion</td>
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<tr>
<td>Fetal Heart Activity in M-Mode</td>
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</tr>
<tr>
<td>Heart Position</td>
<td>4</td>
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<tr>
<td>4 Chambered Heart</td>
<td>6</td>
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<tr>
<td>Cardiac Valves</td>
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<td>Outflow Tracts</td>
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<tr>
<td><strong>Placenta &amp; Amniotic Fluid</strong></td>
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<td>6</td>
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<td>Placental Echotexture</td>
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<td>Distance from Cervical Os</td>
<td>2</td>
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<td>Amniotic Fluid Index</td>
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<td><strong>Maternal Anatomy</strong></td>
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<td>Cervix</td>
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<td>Adnexa</td>
<td>4</td>
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<tr>
<td>Uterus</td>
<td>4</td>
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</table>
Figure 17 above, illustrates the radiographers’ perspectives on their approach to scanning, that is, it shows the number of anatomical structures each radiographer indicated that he/she often includes in the mid-trimester sonography examinations they perform. Radiographers Robin and Nancy who were more than 3 years experienced, and Cathy and Rachel, who had more than a year of sonography experience, indicated that they scan less than 50% of the anatomical structures suggested in the ASUM guidelines for a routine mid-trimester sonography examination. Contrasting responses were shown by two radiographer participants who had less than a year of sonography experience. While Maggie indicated that she often includes at least 16 anatomical structures, Nick indicated that he includes almost twice as many anatomical structures as Maggie.

In the questionnaire, the radiographers were asked if they followed a written obstetric sonography protocol as a common guideline during the examinations. As shown in Figure 18 (Page 87), the majority of the radiographer participants responded that they were not aware if such a document existed in the Ultrasound Department. Moreover, anecdotally, all the participants revealed that none of them uses a written departmental protocol.
Figure 18  Radiographers’ responses on the presence of an ultrasound protocol

![Pie chart showing responses to ultrasound protocol]

- Protocol Does Not Exist: 5
- Protocol Exists: 1

n=6 radiographers

Figure 19  Radiographers’ personal ratings of their confidence in detecting fetal anomalies

![Pie chart showing confidence ratings]

- Always Sure: 1
- Unsure: 3
- No Response: 2

n=6 radiographers

It is apparent from Figure 19 that fifty percent of the participant radiographers felt very confident in their obstetric sonography practice while the rest were either unsure of what they were doing or did not want to make any comments.
According to the questionnaire responses, Figure 20 illustrates that the majority of the radiographers felt that their sonographic skills could be rated either as good or average.

In the questionnaire, radiographers were also asked how often they placed emphasis on assessing fetal anomalies during the mid-trimester scans. Their responses, as shown in Figure
indicate that while a small proportion of the participants mentioned that they always assessed fetal anomalies, the rest only looked for fetal anomalies less often or when it was specifically requested by the obstetricians.

**Figure 22** Radiographers’ preferences for writing and endorsing final scan reports

According to the questionnaire data obtained from the radiographers, a high proportion of the radiographers preferred not to write and endorse the final sonography patient reports on behalf of the radiologists, although that has been a departmental practice for the last two decades.

**QUALITATIVE DATA**

**INTERVIEWS AND QUESTIONNAIRES**

The qualitative data was obtained from the interviews and the comments from the open-ended questions in the questionnaires. This data was subjected to manual thematic analysis. Significant repeated ideas were electronically extracted and pasted into separate computer files. The themes were then organised by grouping them into different categories of issues. A summary of issues that emerged from the qualitative data is summarised in Table 7 on Page 90. Information from the qualitative data and issues relevant to it are integrated in the Discussion Chapters 6 to 8.
Table 7  Summary of themes obtained from the analysis of interviews and questionnaires

<table>
<thead>
<tr>
<th>Themes</th>
<th>Summary of Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiographers’ practice of obstetric sonography</td>
<td>• Radiographers’ scanning criteria &lt;br&gt;  o Scanning patterns &lt;br&gt;  o Radiographers’ perspectives on their scanning &lt;br&gt;  o Performance of anomaly scans &lt;br&gt;  o Discrepancies in biometry measurements</td>
</tr>
<tr>
<td>Radiographers’ needs and constraints</td>
<td>• Reporting of Sonography Images &lt;br&gt;  • Factors influencing radiographers’ scanning &lt;br&gt;  o Radiographers’ expertise and supervision &lt;br&gt;  o Examination protocol &lt;br&gt;  o Current workload</td>
</tr>
<tr>
<td>The effect of limitation of resources on radiographers’ practice</td>
<td>• Specialists as resource personnel &lt;br&gt;  o Radiologists’ and obstetricians’ limitations &lt;br&gt;  o Relationship issues &lt;br&gt;  • Scanning facilities &lt;br&gt;  o Ultrasound room and equipment &lt;br&gt;  • Funding and influence of political environment in Fiji</td>
</tr>
</tbody>
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SUMMARY

In this research, a significant amount of quantitative data was obtained from the observations and the questionnaires, which has been tabulated and graphically presented in this chapter. The results of the observation data revealed the scanning patterns employed by the radiographer participants, and the relationship between the radiographers’ scanning patterns and their length of experience. Taking biometry measurements was a common practice amongst the participants, however, some obvious discrepancies were observed, namely, taking anatomical measurements at incorrect levels and making inferences from technically and visibly unacceptable images. The data from the quantitative section of the questionnaire revealed that a high proportion of radiographers did not follow a documented sonography protocol. Although they were quite confident in their practice, the radiographers felt that their competency levels ranged from ‘good’ to ‘average’. The majority of the radiographers also disclosed that it was not their responsibility to write and endorse the final sonography reports.

The interviews and the questionnaires also yielded a significant amount of qualitative data. This data was subjected to thematic analysis and tabulated at the end of this chapter. At least three major themes emerged from the analysis of the research data, namely, the nature of the radiographers’ practice of obstetric sonography, their needs and constraints, and limitations of resources for sonography practice at the host hospital. The subsequent chapters further integrate and discuss the issues relevant to these themes and the relationships that were constructed from both the quantitative and qualitative data to develop a theoretical framework.
CHAPTER 6

DISCUSSION

RADIOGRAPHERS’ PRACTICE OF OBSTETRIC SONOGRAPHY

OVERVIEW

This research was conducted primarily to evaluate the current practices and procedures used by the radiographers in Fiji during mid-trimester sonography. Hence, to explore the scanning guidelines used by the radiographers to perform routine mid-trimester sonography examinations, two methods of data collection were used, namely, observations of the examinations at the clinical site and a questionnaire completed by the radiographers. In addition, the obstetricians and the radiologists at the hospital were also interviewed to obtain the specialists’ perspectives on the radiographers’ performances of the mid-trimester sonography, the specialists’ limitations regarding obstetric sonography and their contribution towards the radiographers’ professional development. This chapter discusses the themes that emerged from the analysis of the data, namely, the radiographers’ scanning patterns and priorities during an anatomical survey, self-assessment of the radiographers’ confidence and competence in performing anomaly scans, and issues related to their writing of sonographic reports, both from the radiographers’ and the sonography specialists’ perspectives. Furthermore, while the intention of this study was neither to assess the accuracy of the sonographic diagnoses made by the radiographers nor to determine their anomaly detection rates, this chapter entails discussion of obvious discrepancies observed in the radiographers’ practice. In this chapter, references have been made to Tables 1, 3, 4, 5 and 6, and Figures 15, 16, 17, 19, 20 and 21.
RADIOGRAPHERS’ SCANNING CRITERIA

Ideally, sonography examinations are performed by skilful sonographers (Society of Diagnostic Medical Sonography, 2007) following a standard examination protocol (Nyberg, 1989), while the final diagnostic reports are compiled by the radiologists (Australasian Society for Ultrasound in Medicine, 2007). However, it is an accepted practice at the urban public hospital where this study was located, for the radiographers to perform, interpret and report the findings of the obstetric sonography examinations, regardless of their level of expertise and qualification. At the clinical site where the observations were made, the radiographers perform an average of 325 obstetric examinations per week on pregnant women with their gestations ranging from early to full term pregnancies (see Table 1). The six radiographers (Robin, Nancy, Cathy, Rachel, Maggie and Nick) who were selected to participate in this study did not hold an ultrasound qualification and were therefore trained ‘on-the-job’. The radiographer participants’ experience varied between 3 months to 13 years. Although none of the radiographer participants had any ultrasound-specific qualification at the time of the research, 4 out of 6 radiographers mentioned that they performed more than 30 mid-trimester scans per week (see Table 5). Since the radiographers lacked specialist training and education in obstetric sonography, it was assumed that their criteria for scanning may differ. Hence, their scanning patterns were evaluated by conducting observations at the clinical site and obtaining their perspectives on their practice through questionnaires. The following sections describe the radiographers’ approach to performing mid-trimester scans at the host hospital.

SCANNING PATTERNS

At the host hospital the radiographers employ unwritten departmental guidelines for performing all the obstetric sonography examinations. In this research, the ASUM mid-trimester guidelines were used as an ideal standard for obstetric scans for comparison with the radiographers’ scanning criteria. Further, the ASUM guidelines suggest scanning of as many of the 44 fetal and maternal anatomical structures as possible during a routine mid-trimester sonography (Australasian Society for Ultrasound in Medicine, 2005). These 44 anatomical structures also include 4 biometry measurements namely the BPD, HC, AC and FL. Filly and Crane (2002) recommended that if an anomaly or anatomy scan is requested during the mid-trimester period, a comprehensive fetal anatomical survey including detailed
assessment of the fetal heart, extremities and face must be conducted to confirm fetal normalcy or alternatively to rule out anomalies. This examination also entails sonographic assessment of the maternal uterine cavity.

The analysis of the observation data of 12 anatomy/anomaly scans performed by the radiographers on 18 to 23 weeks’ pregnant women identified the radiographers only included a few selected fetal and maternal anatomical structures in their examinations in order to prepare a full diagnostic report. The above findings are reflected in Table 3 which shows that during the scan most of the radiographers placed their emphasis only on the assessment of the:

- fetal position
- fetal biometry comprising the BPD, HC and FL
- fetal head shape and falx cerebri
- fetal spine in the coronal plane
- fetal heart motion later in the scan
- placental site and echotexture

Conversely, the observation data showed that a high proportion of anatomical structures did not get scanned by the radiographers during the two examinations they performed. Table 3 shows that all the radiographers but one failed to initially assess the fetal heart activity to confirm fetal life before proceeding with the scan. Ling (1998) has claimed that initial assessment of the heart activity is an integral aspect of obstetric sonography since there is no point in continuing to scan if the fetal heart activity and life are absent (confirmed by the biophysical profile test), unless clinically indicated. Furthermore, the observation data in Table 3 revealed the areas of the scan in which the majority of the radiographers failed to meet the requirements of the ASUM guidelines. These were:

- measurement of the abdominal circumference (AC)
- assessment of some important anatomical contents of the fetal head namely, CSP, lateral ventricles, choroid plexus and CM
- assessment of the nuchal thickness
- examination of the facial anatomy
- presentation of the spines in sagittal and axial planes to demonstrate the 3 ossification centres and skin line
• assessment of the fetal abdominal contents
• imaging of the fetal extremities (except in some cases a single femur was visualised to measure the FL)
• fetal heart assessment where the majority of the radiographers did not attempt to assess the position of the fetal heart, the 4 chambers, cardiac valves, outflow tracts and the fetal heart activity in M-Mode
• assessment of the maternal cervix and adnexa, and the amniotic fluid volume

Consequently, the failure of the radiographers to meet the requirements of the ASUM guidelines led to disparities in their scanning patterns as discussed below.

**Disparities Observed in Scanning Patterns**

When each of the radiographer’s scanning patterns were scrutinised during the observation, it was found that there were inconsistencies in scanning amongst each of the examinations performed by the individual radiographers (see Table 4). For instance, Robin, who had 11 years of sonography experience, assessed 18 anatomical structures in his first examination and 15 in the second examination, but only had 10 common anatomical structures scanned across both the examinations. Similarly, Nick, who had less than a year of sonography experience, scanned 6 anatomical structures in the first examination and 9 in the second examination but only had 6 common anatomical structures scanned across both the examinations. This implies that the radiographer’s inclusion of the anatomical structures changed with every patient since the scanning patterns appeared to vary from patient to patient.

Likewise, it was found that the scanning patterns between the radiographers differed. During the observation it was noted that some radiographers scanned certain anatomical structures while others completely omitted them. The observation data summary table in Appendix 4 shows that amongst the six radiographers, only Robin assessed the initial fetal heart activity. In another instance, the position of the fetal heart (relative to the other abdominal organs to confirm situs normalcy) was only assessed by Cathy and Robin, but was not assessed by the other radiographers. These variations in the scanning patterns were prominent amongst all the radiographer participants. Consequently, it was found that the patients who presented for a comprehensive anatomical survey for the exclusion of fetal anomalies did not get adequately
scanned, according to the requirements of the ASUM guidelines, by any of the radiographer participants. Explicitly in this research, sonographic examinations of the anatomical structures were considered adequate if they met the criteria stated in the observation protocol, adopted from the ASUM mid-trimester guidelines.

One of the possible reasons for inadequate scanning could have been the limited amount of time spent per examination, as reflected in Figure 16, which demonstrates that the maximum time spent to complete an examination ranged between two and eight minutes. In the 12 examinations that were observed, the cumulative average time spent per examination was calculated to be 4 minutes and 50 seconds. In contrast to the amount of time spent by the radiographer participants on their obstetric examinations, Catanzarite et al. (2005) reported that in an ideal situation (an ultrasound facility with experienced sonographers, high-resolution equipment and adequate patient booking system) an optimum quality anatomy/anomaly scan would consume an average of 40 minutes per examination. During the interview, the specialists also expressed similar sentiments and stated that:

3 to 4 minutes is not enough. There is a system of doing it [anatomy/anomaly scans]*, from [fetal] head right down to the toes... At least 40 minutes to 1 hour must be spent, especially if you [radiographers] are novice. (Dr. Murray – Radiologist)

At my level of experience, I take a minimum of half an hour [per anomaly scan]. I am lucky if I can get it done in 20 minutes and [if] the baby is sitting in the right position and cooperating well. For the radiographers, I’ll be looking at half an hour allocations [per scan].

(Dr. Reed – Obstetrician)

Similarly, radiographers Robin and Cathy reflected in their patients’ reports that they did not have adequate time to perform a full anatomical survey (see Appendix 4). Furthermore, Figure 16 shows that all the radiographers except Robin, had spent more time performing the second examination that was observed although all the selected patients were referred for the same diagnostic procedure, that is, anomaly scans. It is assumed that due to being observed during the research (Hawthorne effect), the radiographers spent more time on their second

* Quotations within the brackets [ ] are my personal comments.
examination to enhance the quality of their scans (Polgar & Thomas, 2000). Other factors that may have influenced the radiographer’s scanning patterns have been discussed in Chapter 7.

**Scanning Patterns and the Years of Experience**

Although only two examinations per participant were observed (for the reasons explained earlier in Chapter 4), it was noted that there was a gradual decline in the number of anatomical structures scanned as the radiographer’s years of experience lessened (see Table 4, column 2). This pattern was only consistent in each of the first examinations performed by the radiographers. However, the above pattern did not remain true for the second examination performed by the radiographers. For instance in the second examination, Nancy, who had 13 years of sonography experience, examined only 6 out of 44 anatomical structures in the second examination compared to Cathy (3 years of experience) who scanned 16 anatomical structures (compare columns 2 and 3 in Table 4). It is assumed that the radiographers’ performances may also have been influenced by the Hawthorne effect (Polgar & Thomas, 2000), and technical factors such as, fetal position and maternal habitus (Catanzarite et al., 2005).

In addition, the radiographers’ years of experience did not directly correlate with the number of anatomical structures that were scanned commonly across both the examinations they performed (see Table 4, column 4). For instance, Nancy, who had 13 years of sonography experience, only had 6 anatomical structures common to both of her examinations, while Cathy, who had less than 3 years of experience, scanned 10 anatomical structures common to the two examinations she performed (see Table 4). When Nancy’s scanning patterns were compared with Nick’s (who had less than a year of experience), it was noted that they both scanned the same number of anatomical structures commonly across their two examinations (see Table 4) although Nancy was expected to scan more anatomical structures due to her greater experience.

Similarly, the data in Table 4 also reflects that optimal performance of obstetric sonography does not solely depend on the years of experience gained through training at the clinical site (Foulkes et al., 2004), as in the case of the radiographer participants of this research. It is apparent from the ⁵th column of Table 4 that even a radiographer with 11 years of experience in obstetric sonography could barely meet 50% of the ASUM scanning requirements, that is,
Robin did not scan 21 out of 44 anatomical structures consistently during both of his examinations. Overall, the number of anatomical structures that the radiographers did not attempt to scan increased as the radiographers’ experience in sonography lessened (see column 5 of Table 4).

**Radiographers’ Perspectives on Their Scanning**

Apart from my own observations of scans performed by the radiographers, their perspectives on their approach to mid-trimester scans were obtained from the questionnaire responses, which contained a checklist that was adopted from the ASUM mid-trimester guidelines (see Appendix 3). The radiographers were required to select, by ‘ticking’, the anatomical structures they often included in the anatomy/anomaly scans they performed. The inclusion of a checklist in the questionnaire ensured that the rigour and transparency of the research was maintained and the inferences made about the radiographers’ scanning criteria were not solely based upon the observation data, which can be influenced by observer bias (Polgar & Thomas, 2000). According to the results (Table 6), all the radiographers revealed that the biometry measurements (BPD, HC, AC and FL) were their main priority during the mid-trimester anatomy/anomaly scans and this was consistent with the observation data.

Furthermore, in the questionnaire data, the majority of the radiographers indicated that during a mid-trimester anomaly/anatomy scan they often included the assessment of the fetal head shape, falx cerebri, lateral ventricles and the cisterna magna, although the latter two were not seen to be frequently scanned during the observation. Only three out of six radiographers indicated that their examinations involve assessment of the fetal spine. As far as sonography of the fetal abdomen was concerned, the majority of the radiographers indicated scanning of the stomach, kidneys and the urinary bladder, similar to the observation data. The questionnaire responses showed that 4 out of 6 radiographers indicated that their approach to mid-trimester scanning often involved visualisation of all the 12 long bones, contrary to the observation data, which demonstrated that all the radiographers had only identified a single femur to measure its length (FL).

The questionnaire responses further revealed that the majority of the radiographers do not include the fetal cardiac anatomy in the mid-trimester examinations except for the heart motion, position and its four chambers. It was noted that the latter two parameters were
included in less than 3 out of the 12 examinations that were observed. Except for the placental site and the maternal uterus, many radiographers indicated that they do not assess the amniotic fluid volume and the maternal cervix during the mid-trimester examinations. This was quite consistent with the observation data which showed that all except one radiographer completely omitted the examination of the maternal anatomy. Further, the questionnaire responses revealed that the assessment of the initial fetal heart activity to confirm fetal life and imaging of the fetal face were the two areas least selected by the radiographers for scanning. These findings correlated with the observations that were made. Overall, the questionnaire responses (as shown in Table 6) indicate that a significant proportion of the participants (4-6 participants) divulged that they often include only 18 out of 44 (41%) anatomical structures in their mid-trimester scans.

Furthermore, the questionnaire data did not show a specific relationship between the number of anatomical structures selected by the radiographers and their years of experience in obstetric sonography (see Figure 17). For instance, two radiographers who had more than 10 years of experience in obstetric sonography practice (Robin and Nancy), selected 21 out of 44 (approximately 48%) anatomical structures suggested in the ASUM guidelines (see Figure 17), while Cathy and Rachel, who had 1-3 years of experience, selected 18 and 21 out of 44 anatomical structures, respectively. However, the two radiographer participants who had less than a year of sonography experience showed contrasting responses. While Maggie indicated that she often included at least 16 anatomical structures in her scans, Nick indicated that he often included almost twice the number of anatomical structures than his colleague in the mid-trimester scans he performed (see Figure 17). Contrary to the above questionnaire responses, the observation data shows that Maggie and Nick did not attempt to scan approximately 75% (33 out of 44) of the anatomical structures stipulated in the ASUM guidelines (compare Table 4 and Figure 17).

The short duration of time spent on each scan (a range of 2 to 8 minutes) by the radiographer participants and an optimal time of 40 minutes to complete an anatomy/anomaly examination as mentioned by Catanzarite et al. (2005), are incompatible. Hence, it is apparent from the questionnaire responses and the observations made at the clinical site, that the radiographers at the host hospital were not able to completely meet the requirements of the ASUM guidelines for mid-trimester obstetric examinations. It is understood that apart from the time limitations for scans there are other constraints that influence the radiographers’ practice.
These limitations and constraints are explored in Chapter 7. Prior to that, the ensuing section discusses the radiographers’ scanning approach to performance of anatomical survey for exclusion of fetal anomalies.

**Performance of Anomaly Scans**

The observation data showed that during an anomaly/anatomy scan, the radiographers were more inclined to take biometry measurements, paying minimal attention to some of the key assessments such as, the examination of the cranio-facial anatomy, fetal spine, abdomen, extremities, heart and the assessment of the maternal uterine cavity (see Table 3). Similarly, in the questionnaire, when the radiographers were asked how often they performed comprehensive anatomical surveys to exclude anomalies, except for one radiographer, all of them responded “sometimes” or “only when specific requests were made by the obstetricians” (see Figure 21). One of the radiographers mentioned:

*Sometimes, since it’s quite busy. We can’t easily detect anomalies unless if it’s obvious...* (Nancy)

Nancy’s comments implied that while their examination room was often busy with a significant number of obstetric patients for sonography, the radiographers also lacked confidence and competence in performing anomaly scans. Foulkes et al. highlighted that years of hands-on training “does not imply competent practice” (2004, p. 27). Hence, the radiographers were asked to provide personal ratings of their confidence and levels of competence in detecting fetal anomalies. Figure 19 illustrates that 3 out of 6 radiographer participants felt that they were very confident in detecting anomalies while the rest of the radiographers were either unsure of what they were doing or chose not to comment on the issue. Furthermore, while Nick reported that he had excellent skills in performing anatomy scans to detect fetal anomalies (contrary to the observation data in Table 4), the other radiographers felt that their sonographic skills could be rated either as good or average (see Figure 20). Nonetheless, some of the sonography specialists at the hospital disagreed with Nick and stated that:

*I think some of the sonographers [radiographers] at the hospital are not so sure of what they are looking at.* (Dr. Lloyd – Obstetrician)
They probably are good in doing CRLs. But fetal anomalies ... do not get picked up [at] 18-20 weeks ... because we don’t routinely do mid-trimester scans to check for anomalies. (Dr. Reed – Obstetricians)

Since mid-trimester sonography, which demands a comprehensive study of the fetal and maternal anatomical structures, requires an exceptionally high level of skill (McHugo, 2001), incompetency in acquiring quality images and its interpretations may often result in misdiagnoses of gross anomalies (Foulkes et al., 2004). Similar sentiments were expressed by the sonography specialist participants of this research about the radiographers’ performances:

It’s true now and then we [radiographers] miss some abnormalities. Truly [they] will miss a missing limb or supernumerary...

(Dr. Smith – Radiologist)

Last year there were 2 cases which were born with anomalies and which should have been picked up by the radiographers. One of them was actually an omphalocele, that’s a fairly easy one to pick up.

Ultimately, what I am saying is that the standard of anatomy scanning done in Fiji is not good. If I have to get it done properly, I will [rather] do it myself. I can’t give it to the technicians [radiographers].

(Dr. Reed – Obstetrician)

Alternatively, to diagnose anomalies it is essential for the radiographers to understand the normal appearances of the anatomical structures (McHugo, 2001) otherwise it is likely that a number of false positive cases will be reported. This phenomenon was reported by Eurenius et al. (1999) when they conducted a study in Sweden to assess detection rates of anomalies on 8228 pregnancies. All the examinations were performed by midwives with varying levels of experience. Of 165 cases identified as anomalous, 20 turned out to be false positive. Eurenius et al. (1999) admitted that one of the reasons for such a result was the limited skills of the midwives to perform anomaly scans. Similarly, in this research, the obstetricians at the host hospital identified incidences of false positive reports compiled by the radiographers. They reported that:
Last year there were two cases in which anomalies were said to be recognised and the baby was born normal. (Dr. Lloyd – Obstetrician)

Just within this year we may have had 3 women [diagnosed with] single fetus in the first [scan and] then twins in [the] 2\textsuperscript{nd} ultrasound.

(Dr. Reed – Obstetrician)

Hence, it is apparent from the above statements that the specialists at the host hospital are aware of the occasional misdiagnoses made by the radiographers. The obstetricians’ comments also imply that the standard of anatomy/anomaly scans performed by the radiographers does not completely meet their expectations as it was further confirmed by one of the obstetricians:

\begin{quote}
During the scans, from the head it would be the lateral ventricles, the cerebellum, looking for the thalamus, checking the thickness of the nuchal fold. Coming down the spines, making sure there is not spina bifida, or meningeomyloceles. 4CH [4 chambered heart] at least, I don’t think they are very good at doing RVOTs [right ventricular outflow tracts] and LVOTs [left ventricular outflow tracts]. For abdomen, seeing the stomach, picking up the double bubble, checking for the 3 vessel cord and checking for the cord insertion. Femur length and fingers and toes, I’d love to see but they don’t get checked. (Dr. Reed – Obstetrician)
\end{quote}

Dr. Reed’s remarks indicate that during the anomaly/anatomy scans the obstetricians expect a comprehensive sonographic examination of the fetal and maternal structures but their expectations are not fully met due to the radiographers’ own limitations. The following section further highlights some scanning pitfalls that were obvious during the observation and could not be excluded from the raw data.

\textbf{DISCREPANCIES IN BIOMETRY MEASUREMENTS}

During the observation some incidental findings were made. As mentioned earlier, although this research was not conducted to assess the radiographers’ diagnostic accuracies, due to the comprehensive nature of the observation protocol, some obvious discrepancies in the
radiographers’ scanning were inevitably noticed and recorded (see Figure 15). Apart from the list of anatomical structures that the radiographers failed to scan, there were some aspects where the radiographers attempted but did not meet the ASUM criteria, during the observation. These entailed scans or measurements taken at incorrect anatomical levels (in comparison with the criteria stipulated in the observation protocol in Appendix 2) and sonographic presentations of unacceptable images. Following the observation protocol, certain images were considered unacceptable if the measurements were taken with an inappropriate selection of technical factors such as, use of excessively high or low image gain and inappropriate field of view, making it difficult to visualise the anatomical structures. Scans performed with a low image gain produced images of insufficient echo brightness while a high image gain made the display monitor appear too bright, both causing loss of diagnostic information (Gent, 1997).

In some instances, the radiographers failed to demonstrate a close-up view of the ‘region of interest’. Consequently, the contents of the anatomical structures appeared too small to visualise on a comparatively large field of view. Alternatively, a relatively smaller field of view at an appropriate depth and the use of the ‘zoom’ function, where necessary, could have expanded the area of interest on the ultrasound monitor for better visualisation (Gent, 1997). Similarly, in one of the examinations, a radiographer attempted to measure the BPD while the image was partially obscured by an image artifact. This artifact was produced from the damaged transducer used by the radiographers, which caused streak marks appearing on the ultrasound screen, partially obscuring the images.

These discrepancies were mostly observed when the radiographers took biometry measurements to assess gestational age. Figure 15 shows that three parameters, namely, the BPD, HC and AC were measured at incorrect anatomical levels in at least 4 out of 12 examinations that were observed. In 4 examinations the FL was measured whilst the entire extremity was neither visible nor perpendicular to ultrasound beam. The majority of the radiographers did not measure the AC and those who attempted, measured it at incorrect anatomical levels, that is, they failed to demonstrate the ideal anatomical landmarks, namely, stomach, intra-hepatic portion of the umbilical vein (‘hockey stick’; see Chapter 2), transverse plane of the fetal spine and the symmetric appearance of the lower ribs (Benson & Doubilet, 2005; Hassall, 2004). When the reason for excluding the AC from the biometry measurements was sought, one of the radiographers responded that:
A visiting radiologist from Australia told us not to perform the AC before 23 weeks [gestation] but I am not sure why. (Robin)

Bottoms et al. (1999) have explained that the AC measurements may be excluded from biometry assessments because it is a parameter that is often influenced by inter-operator variation. Fetal abdominal shape is also prone to distortion if too much transducer pressure is applied during the examination, resulting in erratic AC measurements (Filly & Hadlock, 2000). Furthermore, Dudley and Chapman (2002) conducted a study in the United Kingdom to evaluate factors that contribute to inaccuracy in fetal measurements and to assess the clinical importance of measurement quality. The authors studied 100 images of the BPD, HC and AC and concluded that the quality criteria for the AC are more difficult to recognise than the other biometry parameters.

In addition to the above inference, Dudley and Chapman (2002) also identified three main factors that contribute towards inaccuracy in biometry measurements: 1) acquisition of sub-optimal quality image for measurements; 2) inaccurate machine calliper; and 3) use of measurement charts inappropriate for the local population. While the first phenomenon was identified in this research, the latter two issues need further investigation relative to obstetric sonography practice in Fiji. Furthermore, to meet the quality criteria for fetal measurements, the images should be appropriately magnified, callipers should be correctly placed, measurement planes of the anatomical structures should be correctly aligned, landmarks should be sufficiently demonstrated and the measurement planes should be at an appropriate angle to the ultrasound beam (Dudley & Chapman, 2002). Any discrepancies on the above criteria may lead to inaccurate measurements, which may falsely indicate pathological conditions in the fetus (Salomon & Ville, 2005) and cause untimely obstetric interventions and perinatal compromises (Dudley & Chapman, 2002).

REPORTING OF SONOGRAPHY IMAGES

As mentioned earlier, the radiographers at the hospital where this research was located are expected to interpret the sonographic images they acquire and compile the final diagnostic reports as part of their regular practice. Nonetheless, the World Health Organisation (1998) report on training in diagnostic ultrasound demanded that the specialist physicians, preferably
the radiologists (Witcombe & Radford, 1986), interpret the findings of sonography examinations and make diagnostic decisions. A similar statement was issued by the Australasian Society for Ultrasound in Medicine (2005) which stated that “the final diagnosis and writing of the report are the responsibility of the medical practitioner” (¶ 10).

While no attempt was made to evaluate the accuracy of diagnostic reports prepared by the radiographers in this research, the contents and usefulness of these reports are noteworthy. Despite the requirements of a full comprehensive anatomical study during an anomaly scan, the radiographers performed short examinations, scanning only a few fetal anatomical structures. Consequently, their diagnostic reports were also diminutive. One of Nancy’s reports read:

*Single fetus. Transverse lie. Anterior placenta. No P.P., FH seen. Liquor volume normal. BPD-6.0cm; 24w2d / AC-21cm; 25w2d / MG-24w3d.*

In another instance, Robin did not attempt to take the biometry and ventricular measurements and yet reported as follows:

*Inadequate time for anomaly scan. However, intracranial ventricles not dilated. Normal cisterna magna, fetal spine, left sided 4-chambered heart and urinary bladder seen.*

Moreover, during the observations it was noted that none of the radiographers measured the amniotic fluid index nor assessed the maternal anatomy, yet 10 out of 12 examination reports contained the statement, ‘liquor volume normal’, indicating that the amniotic fluid volume was within the normal range. While scanning the upper and lower limbs, none of the radiographers checked for the presence of all the twelve long bones, that is, they only scanned a single femur to take biometry measurements. Similarly, as discussed earlier, the observation and questionnaire data revealed that the radiographers did not follow the contents of the ASUM guidelines in their entirety. However, the sonographic reports prepared by the radiographers implied that the fetuses they scanned were normal. For instance, one of the reports stated:

*Single fetus. FH normal. Vertex right. Anterior placenta. No P.P. Liquor*
volume normal. BPD-5.8cm; 23w4d / HC-21.8cm; 23w5d / AC-19.5cm; 23w5d / FL-4.5.cm; 24w4d / MG-24w/1d. No definite fetal anomaly noted.

(Report by Rachel)

SHOULD THE RADIOGRAPHERS WRITE SONOGRAPHIC REPORTS?

Since the radiographer participants of this research lacked formal training and education in obstetric sonography, their writing and endorsement of reports on behalf of the consultant radiologist can be a contentious issue. The World Health Organisation (1998) cautioned that such practices are harmful to the patients, referring to cases of misdiagnoses and misinterpretations made by ultrasound practitioners with minimal or inadequate training. Likewise, Meire (1986) stated that “unacceptable burdens are being placed on some radiographers” when the sonographic reports that they write are endorsed on behalf of the radiologists who “neither saw the examination nor could make any comment on its technical adequacy or findings” (p. 77).

Similar sentiments were shared by the radiographer participants of this research, as 5 out of 6 of them felt that it is not their responsibility to write the sonographic reports (see Figure 22). Conversely, Cathy disagreed with her colleagues and insisted that the radiographers should write the reports themselves as she stated that “we [the radiographers] are the ones doing the scans”. However, the majority of the radiographers felt that they were compelled to write the reports because they had no choice:

*Because we do not have a qualification in U/S [ultrasound] e.g. DMU [Diploma of Medical Ultrasonography] but it is a practice in Fiji, so we go by the flow.* (Robin)

*Since we do not have [a] specialised skilled Radiologist to do the scans, we’re taking up the responsibilities.* (Nancy)

*Final report should be written by someone who has had proper training in U/S.* (Rachel)
Conversely, some of the sonography specialists who participated in this research reflected that some radiographers lacked competency and therefore their scans and reports were inadequate:

Some [radiographers perform] scan[s] but [are] not always sure. They don’t want to commit to what they are seeing. They always call for the radiologist. They have so many referrals [made to the radiologists]. The thing is I have been called for the same type of referrals [several times].

(Dr. Smith – Radiologist)

The ones [radiographers] that I know, do ultrasound very well. I can say that they are effective. They probably are numbered just 5 on my fingers. The rest of them not at all. Some of them I still need to call up and say, ‘you haven’t given me the placenta, don’t give the liquor that says normal, give me the cm [measurement], I don’t like the liquor normal business’.

(Dr. Lloyd – Obstetricians)

These insights of the specialists suggest that while they do not discourage the practice of sonography reporting by the radiographers at their hospital, they are concerned about their levels of competence and the diagnoses made by the radiographers. Similarly, the majority of the radiographers refuted the idea of writing sonography reports on behalf of the radiologists because they felt that they did not have sufficient expertise to do so despite it being part of their routine practice.
SUMMARY

This chapter has discussed the radiographers’ scanning criteria during the anatomy/anomaly scans, the personal ratings of the radiographers’ confidence and competencies in interpreting the mid-trimester sonographic images and the contents of their sonographic reports. The observation data revealed that during the mid-trimester anatomy/anomaly scans the radiographers placed major emphasis on the biometry measurements and some aspects of the fetal head, spine, heart motion and the placenta. However, the radiographers did not attempt to scan a high proportion of fetal and maternal anatomical structures stipulated in the checklist, adopted from the ASUM guidelines.

During the observations, in the first examination it was noted that there was a gradual increase in the number of anatomical structures scanned as the radiographer’s years of experience increased. However, this pattern did not remain true for the second examination performed by the radiographers. There were obvious variations seen in the scanning patterns amongst the radiographers and between the individual examinations of each radiographer. Hence, the patients who presented for a comprehensive anatomical survey for exclusion of fetal anomalies did not get adequately scanned according to the criteria stipulated in the ASUM mid-trimester guidelines. One of the major concerns was the amount of time spent per examination, which ranged from 2 to 8 minutes with an average of 4 minutes and 50 seconds. Although this research did not intend to assess the radiographers’ diagnostic accuracies, some incidental findings were made. Obvious discrepancies in the radiographers’ scanning were noted during the observation; especially during the measurements of the biometric parameters. These mostly entailed measurements taken at incorrect anatomical levels and presentations of unacceptable images due to the selection of inappropriate technical factors and the effects of image artefacts.

The radiographers’ scanning patterns as deduced from the observations were compared to their own perspectives on their approach to mid-trimester scans. The latter data was obtained from the questionnaire responses. Similar to the observation data, the questionnaire responses indicated that the biometry measurements were the main priority for the radiographers during the mid-trimester scans. Overall, the questionnaire responses indicate that a significant proportion of the participants (4 to 6 participants) divulged that they often include only 18 out of 44 (41%) anatomical structures in their mid-trimester scans.
While some of the radiographers felt that they were confident in performing anomaly scans, others thought that they lacked competence. Similar sentiments were expressed by the sonography specialist participants who admitted that the radiographers occasionally misinterpreted their findings. Furthermore, the obstetricians mentioned that the radiographers were not able to completely meet their expectations during the anatomy/anomaly scans. Hence, knowing their limitations, the majority of the radiographers neither felt confident nor supported the idea of writing the obstetric sonography reports although it is an accepted practice at their hospital. The rationale for such a practice at the host hospital will be explored in the ensuing chapters. The next chapter (Chapter 7) entails discussion of the limitations and constraints faced by the radiographers in the practice of obstetric sonography at the urban public hospital in Fiji where this research was located.
CHAPTER 7

RADIOGRAPHERS’ NEEDS AND CONSTRAINTS

OVERVIEW

In Chapter 6 it was revealed that the radiographers at the hospital where this research was conducted, had disparate patterns of performing the anatomy/anomaly scans. Since the radiographers did not meet the requirements of the ASUM protocol for mid-trimester obstetric sonography in its entirety, it can be assumed that the patients who presented for an anatomical survey did not undergo a comprehensive scan according to the ASUM guidelines. This chapter will examine some of the key reasons for the limited practice of obstetric sonography at the host hospital. The thematic analysis of the qualitative data revealed that the radiographers’ major constraints during the practice of obstetric sonography revolve around their levels of expertise in obstetric sonography, the current system of training and supervision within their organisation, the absence of a documented examination protocol and extensive workload. Further, this chapter elaborates on the consequence of the above limitations on the radiographers’ daily practice and explores their educational needs. Limitations relevant to sonography resources are discussed in Chapter 8.
FACTORS INFLUENCING RADIOGRAPHERS’ SCANNING

Radiographers’ Expertise and Supervision

In this research, the analyses of the observation and the questionnaire data showed that the radiographer participants had disparate scanning patterns which led to inadequate scanning, according to the ASUM guidelines, of patients who presented for anatomy/anomaly scans. Since “the value of ultrasound examinations depends heavily on the preparation of the personnel carrying out the examination” (Papp & Fekete, 2003, p. 339), one of the probable reasons for the radiographers’ failure to meet the requirements of the ASUM guidelines, stipulated in the observation schedule, could have been their lack of expertise and supervision in obstetric sonography practice.

In order to adequately perform and interpret obstetric sonography examinations, it is necessary for an ultrasound practitioner (for example, a radiographer, radiologist, obstetrician or a general practitioner) to have knowledge of the ultrasound principles, sonographic imaging and interpretation, embryology and obstetrical pathophysiology so that instrumental, clinical and sonographic information is effectively integrated to make diagnostic decisions (Di Renzo & Clerici, 1998). The World Health Organisation report claimed that, “in fact, the skill and training of the [ultrasound] user are often more important than the equipment used” (1998, p. 2). In this research none of the radiographer participants had an ultrasound qualification but rather a Diploma in Diagnostic Radiography qualification from the Fiji School of Medicine (FSMed). Their experiences were based upon the ‘on-the-job’ training they received from the more experienced radiographers. The Diploma in Diagnostic Radiography programme at the FSMed involves teaching of ultrasound at a preliminary level for the undergraduate students, which is only a stepping-stone for the radiographers who wish to pursue sonography as a profession later in their career through a postgraduate qualification at a recognised institute abroad. However, to date none of the radiographers at the host hospital has yet obtained a postgraduate qualification in sonography.

Moreover, the questionnaire data established that none of the radiographer participants had any specific qualification or formal clinical training in obstetric sonography. This was confirmed by the radiographer participants who mentioned that:

Actually I am practising whatever knowledge I gained practically and
through text books... we do not hold a qualification in U/S [ultrasound] e.g. DMU. (Robin)

I am not specialised or qualified in ultrasound, we have general knowledge. (Nancy)

We have had no proper training in U/S [ultrasound]. (Rachel)

We are not qualified sonographer[s]. (Maggie)

Similarly, one of the radiologists at the hospital, while appreciating the radiographers’ efforts in performing scans despite their limited expertise, confirmed that the radiographers who perform obstetric sonography at the host hospital lack ultrasound-specific qualification:

You cannot expect lots from them because they are just radiographers. They are not radiologists or qualified sonographers. And that’s the whole point, some people are expecting too much from them. (Dr. Murray - Radiologist)

It is apparent from the above comments that the radiographers’ limited experiences are a major constraint in their practice and a primary concern for both the radiographers and the specialists. Hence, the radiographers’ need for appropriate clinical training and education in obstetric sonography was repetitively emphasised in their questionnaire responses. They mentioned that:

We need further or detailed U/S [ultrasound] qualification, attachments overseas to enhance knowledge, textbooks for references [and] in-house educational sessions... send some staff for DMU get resource persons more often. (Robin)

[We] need to learn more on theory and practical, especially [sonographic] anatomy. (Nancy)

Experience alone cannot be counted on but rather we need to be educated about this [obstetric sonography]. (Nick)
The above sentiments expressed by Robin, Nancy and Nick are noteworthy and supported by Callen (2000), who stated that didactic and supervised clinical experiences through an established postgraduate course is a fundamental aspect of sonography practice. However, currently the radiographers at the host hospital learn sonography by observing the more experienced colleagues. Brezinka (2006) referred to this phenomenon as a “chaotic autodidactic training system” (p. 223) since it promotes passing on bad habits of practice from the colleagues, especially when the supervisors are not qualified in the field of practice. The following subsection further elaborates on the current method of supervision and its effect on the radiographer participants at the hospital where this research was undertaken.

**Supervision in Sonography**

According to the Australasian Society for Ultrasound in Medicine (2008) “adequate supervision requires the presence, on the premises, of an accredited medical sonographer and/or sonologist (specialist medical practitioner...) who is available and has sufficient time to participate in the examination at the required level” (¶ 4). Contrary to the ASUM statement above, the quality of teaching and supervision provided by the ‘experienced’ radiographers to their colleagues at the host hospital is debatable, since the analysis of the observation data in this research (see Table 3) showed that even the radiographers who had more than 10 years of experience and who supervise their fellow colleagues barely met 50% of the ASUM mid-trimester guidelines (refer to the discussion in Chapter 6). In other words, the radiographers who supervise their colleagues have limited expertise in the field of obstetric sonography and therefore, it is likely that the supervisee’s expectations of their professional development may not sufficiently be met. Hence, the specialists showed concern about the quality of supervision in sonography at the host hospital, stating that:

> So with the hands on training, you can only do as good as what you can...those who are senior in there, they teach the young radiographers.

*(Dr. Smith – Radiologist)*

> They [radiographers] learn on job and I am not sure who teaches them the right or proper ultrasound. So basically if they are taught properly, they [would] know how to pick anomalies then we would be getting things right.

*(Dr. Lloyd – Obstetrician)*
In the absence of a qualified supervisor, such as a sonographer, a radiologist or an obstetrician, it is likely that the quality of images and the reports prepared by the radiographers may not meet the expectations of the specialists. In this regard, one of the obstetricians mentioned that:

As far as the quality of the scans is concerned, we have no way to verify it. In other words, there is nobody else to see the pictures that we see [images produced by the radiographers], and we do not have the technology that will allow us to do that. Virtually, if somebody wants quality control they actually have to be at the shoulder of the scanner [radiographer] and watch them do it [perform scan] and randomly check the quality of images.

(\textit{Dr. Reed} – Obstetrician)

Dr. Reed implied that while the host hospital does not have a qualified sonographer to assess the quality of images and diagnostic reports made by the radiographers, unavailability of the radiologists at the clinical site, makes it even more difficult to assure a high standard of practice from the radiographers. Additionally, it also puts the radiographers under constraint for making diagnostic decisions on behalf of the radiologists who have no access to the sonographic images produced by the radiographers. Issues related to this limitation are discussed in Chapter 8. The following sub-section elaborates on the current methods of training and teaching of radiographers in sonography at the host hospital.

\textbf{Workshops and Teaching Sessions}

In order to impart the fundamental principles of ultrasound to the radiographers, a few sonography workshops and teaching sessions have been held at the hospital in the past. There were teaching sessions run by the obstetricians to train the radiographers in anatomy/anomaly scans but the hospital could not retain those radiographers for too long, as Dr. Reed reports:

\textit{I went for formal training in 2000 from then until now I have at least dealt with 5 radiographers, I have trained and I considered them proficient enough for me to send them anomaly scans and out of that 5, 4 of them have gone to the private practice. The more we train, the more go out.}

(\textit{Dr. Reed} – Obstetrician)
Furthermore, in the past, some radiographers were selected for a few months of clinical attachment at overseas hospitals (mostly Australia and New Zealand) by the radiology management (Singh, 1999). Anecdotally, a radiographer informed that their overseas clinical attachments mostly involved learning through observation since the radiographers from Fiji did not have an appropriate qualification to directly scan the patients. This sort of additional learning also came to a halt for the reasons explained below:

We used to do this thing in the past. Now I am against it. It has advantages and disadvantages. Rather than sending people abroad, it’s best for us to get a resource person over here. That way lot of people gain experience from the resource person rather than one person [going abroad]. One person it’s ok, may come back and teach for a while or may teach or openly divulge his or her knowledge but if he [or she] gets transferred somewhere [else] then we lose that one [him or her] and that investment is gone.

(Dr. Smith – Radiologist)

Hence, due to financial constraints, the hospital management decided to invite sonologists/radiologists from Australia to conduct workshops for the radiographers and the obstetricians wishing to perform sonography. During the research interview, Dr. Smith stated that the visiting specialists initially came to train the obstetricians in sonography, but later the obstetricians invited a few radiographers to participate in their workshop. However, since 2006, these workshops have come to a halt due to the political crisis in Fiji. The effect of Fiji’s political environment on the health care services is further discussed in Chapter 8.

Apart from learning through observations at the clinical site, the radiographers have been meeting fortnightly to discuss sonography relevant topics to enhance their knowledge, although with little involvement of the specialists. This was confirmed by one of the radiologists:

Every 2 weeks they [radiographers] have their session... it could be obstetrics, general, musculo-skeletal or small parts. They conduct it themselves. I think you can’t be teaching them these things every time. It’s for them to take up initiatives. We do encourage them that they are young and have to do it on their own. There are lots of websites... we help them
sometimes if they are not conversant with something.

(Dr. Smith – Radiologist)

From Dr. Smith’s comments it can be assumed that the effectiveness of the radiographers’ teaching sessions are not assessed by the more qualified specialists since their involvement in these teaching sessions is minimal. Anecdotally, and as mentioned earlier in this chapter, the radiographers claimed that their practice would be more effective if they acquired sonographic knowledge through formal education rather than short teaching sessions and sporadic workshops. The specialists also shared similar sentiments:

They [the radiographers] should really have a teacher who can teach them how it is done [obstetric sonography is performed]. They should have clinical and theoretical classes. There should be an educational programme for these radiographers... if we have qualified sonographers, they can teach them [the radiographers]. Like FSM [the Fiji School of Medicine] is having Bachelor in Radiography, they can have Bachelor in Ultrasound [programme]. (Dr. Murray - Radiologist)

Education is the main foundation because once they [radiographers] get taught properly, they’ll never go wrong. (Dr. Reed - Obstetrician)

Hence, it is apparent from the comments of the radiographers and the specialists that the radiographers at the host hospital lack sufficient expertise to perform comprehensive obstetric sonography examinations to meet the international standards. Furthermore, the research participants also suggested that the current system of ‘on-the-job’ training for the radiographers needs to be supplemented by a curriculum-based educational programme. While the radiographers’ current level of expertise has been highlighted as a major constraint on their practice of obstetric sonography, the following section further explores other relevant limitations.

EXAMINATION PROTOCOL

The radiographers at the host hospital have been performing obstetric scans following the ‘unwritten departmental guidelines’. Despite several training workshops being conducted by
the specialists, both from Fiji and abroad, to date no written standard obstetric sonography protocol has been established by the Ultrasound Department at the major public hospital where this research was located. When the radiology manager at the hospital was requested to provide the examination protocol for obstetric sonography, he produced a decade old document which only had information about the examination room management for the radiographer in-charge. The contents of this so-called ‘ultrasound protocol’ document did not have any information relevant to obstetric examination criteria for sonography practice. In contrast, Chudleigh and Thilaganathan (2004) claimed that each examination protocol must provide information on the scope of the examination, describe how the examination should be undertaken, what anatomical structures and measurements will be imaged, when a finding will be considered abnormal, how the images will be interpreted and who will report the findings of the examination.

Consequently, the majority of the radiographer participants responded in the questionnaire that they were not aware if an obstetric sonography examination protocol existed in the Ultrasound Department (see Chapter 5, Figure 18). Moreover, the radiographer participants revealed that none of them used a written departmental protocol. Some of them mentioned that:

*No, we do not have a written protocol in place. (Robin)*

*Scan is done according to what is requested. (Nancy)*

*No, we do not have a departmental protocol for ultrasound. (Rachel)*

*No, there is no departmental protocol to follow while doing [the] scan. (Maggie)*

In the absence of a standard written protocol, the radiographers have been following what has been taught to them by their senior colleagues. The consequences of such ‘on-the-job’ training were noted during the data collection period. The analysis of the observation data revealed that there were inconsistencies in each of the scans performed by the individual radiographers. Similarly, the scanning patterns between the radiographers also differed (refer to the discussion in Chapter 6). These disparities were also obvious from the analysis of the
questionnaire data. When the radiographer participants were asked to identify the anatomical structures they most often included in their anatomy/anomaly scans (in the questionnaire checklist, adopted from the ASUM guidelines), it was noted that some of their selections were different from their colleagues. Furthermore, a significant proportion of the radiographer participants indicated that often they only included 18 out of 44 anatomical structures, stipulated in the ASUM guidelines, in their mid-trimester scans (refer to the discussion in Chapter 6). This implies that the current unwritten departmental guidelines for obstetric sonography do not encourage standardisation and consistency in scanning.

Further, to verify the radiographers’ claims that they have no standard written examination protocol to follow, the radiologists were asked if their department had a written obstetric sonography protocol for the radiographers. The specialists responded as follows:

*I don’t think we have one [written protocol]. I haven’t seen one but I have an idea that it had existed... the knowledge has infiltrated down.*

*(Dr. Murray – Radiologist)*

*I think it [written protocol] is in the department. [It got implemented] if I remember correctly in 1999 or 2000. I may be wrong... I’ll have to get it confirmed. We may have altered lately but I am not aware of. I will need to find out.* *(Dr. Smith – Radiologist)*

It appears from the radiologists’ comments that they were confused about the existence of a written protocol and none of them had actually seen a copy of the written protocol but they assumed that it existed. It seems that the radiographers have been performing obstetric sonography according to what they have learnt from observations at the clinical site, ultrasound textbooks and workshops. Hence, one of the radiologists stated that:

*We really need a written protocol. That is one thing that we do not have [my emphasis]. I know that some sort of protocol that exists but in little notebooks of the radiographers. But a formal one is needed so that no one forgets this is how it is to be done. So that there is going to be uniformity and that will contribute towards the upgrading of the standards of the work that we are doing. There still exists some inconsistency in practice that*
needs to be improved through proper protocol and education.

*(Dr. Murray – Radiologist)*

Eventually, Dr. Murray admitted that the Ultrasound Department does not currently have an established written protocol for obstetric sonography. Dr. Murray also stated that there is inconsistency in the current practice, which is in agreement with the analysis of the observation and questionnaire data discussed earlier. Similarly, the obstetricians pointed out that in the absence of a standard written protocol, the radiographers are in a dilemma as to which scanning criteria to follow:

*The problem is that they [radiographers] don’t know what standards they need to aspire for. We haven’t got a critical proportion of them [radiographers] pushing towards those standards. They need to get some consensus on that kind of standards and the quality we want to maintain in order to profile themselves [radiographers] as competent workers.*

*(Dr. Reed – Obstetrician)*

Hence, being wary of radiographers’ inconsistent practice of obstetric sonography, in 2003 the obstetricians had offered the Ultrasound Department a written protocol so that the obstetricians’ needs and expectations could be met. One of the obstetricians reported that:

*We had one protocol for our department and a separate protocol that I [had] designed for the Radiology Department. This protocol was to get ultrasound done as early as possible so that people could count ultrasound as a routine part of the clinic bookings, dating ultrasound [and] fetal anomaly ultrasound.* *(Dr. Lloyd – Obstetrician)*

Unfortunately, the Ultrasound Department rejected the obstetrician’s offer for the reasons further explained by Dr. Lloyd:

*Basically we had tried to set up a protocol but that has not functioned at all and that was just about the beginning for us but it hasn’t been eventuated unfortunately. We showed it [written obstetric sonography protocol] to them but they were not very happy about it so we didn’t get it through. I*
Dr. Lloyd’s statements imply that despite the efforts of the Obstetric Department to offer a sonography protocol for the Ultrasound Department, it did not get implemented. Dr. Lloyd further insisted that the Ultrasound Department should have a written protocol for obstetric examinations to prevent perinatal compromises and inappropriate interventions (Dudley & Chapman, 2002). The comments made by Dr. Lloyd also indicate that significant patient numbers at the host hospital are another major factor that affects radiographers’ scanning and prohibits them from performing obstetric sonography examinations comprehensively. However, Flarey and Blancett (1998) argued that standard protocols decrease variation in sonography practice and effectively manage patients’ diagnostic needs. The constraints of the current workload on the radiographers’ sonography practice are discussed below.

**CURRENT WORKLOAD**

Currently, the public hospitals in Fiji are facing a major crisis with regard to the significant number of patients referred for obstetric sonography. At the hospital where this research was located, two to three radiographers are rostered in the obstetric examination room, whereby one of them performs scans and the other radiographers manage the patient flow and write the diagnostic reports dictated by the radiographer performing the scans. According to the latest statistics shown in Table 1 (Chapter 2), at least 70 obstetric patients are scanned each day per examination room, which increases to 80-100 patients on busy days. During the interview one of the obstetricians confirmed the above statistics stating that:

> Those numbers 70-100 [for obstetric sonography] are correct and during the busy periods they [radiographers] would be getting more than 100 [patients], and those busy periods are for about 6 months per year. So I feel sorry for them too, for their workload. (Dr. Lloyd – Obstetrician)

While Dr. Lloyd’s comments suggest that the obstetricians are aware of the radiographers’ extensive workload due to a significant number of patients, the radiologists, however, felt that
to some extent the obstetricians are responsible for such constraints on the radiographers, stating that:

_We have suggested more scans to be performed by obstetricians to clear some of these normal cases such as AFIs and routine antenatal [examinations], and high risks groups to be sent here [Ultrasound Department], we’ll do it. We have asked them [obstetricians] to earmark that these are the high risk patients and are special cases. Not come together with the whole lot, coming with AFI and routine gestational age._

_(Dr. Smith – Radiologist)_

_These doctors (obstetricians) are not considerate. They don’t want to check on the patients clinically. They’d rather send the patient for scan. It's like that; just send the patient for scan. Sometimes our radiographers do not want to argue with the doctors, they will just do it [perform the scans] to shut them up, to make them go away. I think the whole system should be overhauled._

_(Dr. Murray – Radiologist)_

It appears from the radiologists’ remarks that the obstetricians unsystematically refer all their patients for sonography. It was apparent during the observations at the clinical site that there was no patient booking system within the Ultrasound Department and thus there was no control upon the number of patients referred for obstetric sonography examinations. According to Dr. Murray’s comments above, since there is no patient booking system at the Ultrasound Department, it seems that the obstetricians refer most of their patients for sonographic assessment even though some of them may only require clinical assessment. Singh (1999) expressed a similar sentiment about sonography practice in Fiji, stating that, “to add to the ongoing problem (radiographers’ workload) now and then patients are often asked to be scanned first then clinically assessed later” (p. 512). Consequently, this has been increasing the radiographers’ workload.

Additionally, during the observation period it was noticed that patients of all gestational age were referred for sonography with various clinical requests, that is, many patients were referred only for confirmation of gestational dates while others were sent for individual examinations, such as, assessment of amniotic fluid volume, placental position or fetal
presentation. Hence, the patients at the host hospital are referred for unscheduled obstetric sonography, unlike the recommendations of the international sonography organisations, such as, the ASUM, the AIUM, the ACR and the RCOG, which suggest obstetric scans to be performed in a standard manner at specific intervals during pregnancy, namely, first, mid and the third trimesters and/or other times when clinically indicated. In contrast, during the observation period it was noticed that the majority of the obstetric patients presented for their initial scans late in the pregnancy (third trimester) at the host hospital. One of the radiologists explained the rationale behind the late presentation of the patients:

_You must understand the geographical set-up in the Fiji group - so many islands. [For] those from the interior, coming regularly is not acceptable to them because of transport and financial issues and when they come we may miss some diagnoses earlier or when we see a full blown abnormality, you know that is too far gone. That even though we can set-up a rule that you must come [early], you must understand the population here. There is quite a good deal of them in the rural areas. That is the problem. So if somebody comes for [antenatal] booking towards the 36 weeks we always accept them, we accommodate them [for scan]. That’s the rule._

_(Dr. Smith – Radiologist)_

Dr. Smith suggested that one of the reasons for the patients’ late presentation for scans is that some of them reside in the rural settings and have financial and transportation problems, hence, they are unable to reach the hospital on time. However, one of the obstetricians disagreed with Dr. Smith and mentioned that:

_I wouldn’t say that because geographically now there are scans that are available [at the major health centres]. Financially, I would not say financially because it’s still a public service [at the host hospital] so scans are still free. So I don’t think geographical and financial things have any relation to the above._

_One of the main reasons I would confidently say is when they [patients] do get booked early [at the antenatal clinic], I think the doctors [obstetricians] are not aware that you can pick up an anomaly at 18 to 20 weeks’ scan. So_
that would be one of the main reasons and of course because they are not thinking that anomalies can be picked up at that stage, they are not actively requesting the ultrasound [early]. So in fact if they [patients] do come and book early, they still get an ultrasound requested very late.

(Dr. Lloyd – Obstetrician)

Dr. Lloyd’s comments reveal that some of the referring obstetricians may not understand the significance of anatomy/anomaly scans during the mid-trimester period and, therefore, refer their patients late in the pregnancy for scans. Similarly, it was also noticed during the observation at the clinical site that the obstetric patients were rarely referred for a complete anatomical survey during the mid-trimester period or even when they presented later in the pregnancy. This is evident from the obstetric sonography statistics for the host hospital (Table 1) and the limited number of mid-trimester examinations that met the inclusion criteria for this research (see Chapter 4).

During the interview an obstetrician mentioned that they perform or request anatomy/anomaly scans selectively, mostly when the obstetricians feel that it is essential. The phenomenon is explained below:

We do that [anatomy/anomaly scans] on the patients that we select to do it on. Essentially, most of the patients that we do are those who strongly express a genuine concern with relation to the anatomy of their baby, [such as], patients who have previous history of congenital anomalies, are 40 years and over and have come for [antenatal] booking early enough.

(Dr. Reed – Obstetrician)

Dr. Reed’s comments imply that at the public hospital where this research was undertaken, performance of comprehensive anatomy/anomaly sonography is not a routine practice and it is mostly performed on the patients who present with a genuine concern. Later in the interview Dr. Reed mentioned that it would be a problem for them if all the patients start to request a comprehensive sonography examination:

In essence our anatomy scans are mostly to deal with the concern of the patients as expressed by them. I guess, if all our patients in Fiji were more
 educated and all of them started expressing their concern then we will be left in rather a difficult position. But at the moment the number of patients who are requesting or expressing concern about the anatomy of their babies are very few.

I mean it’s a problem of awareness, so it means that as a programme, anatomy scanning is difficult to institute unless people get more aware of its need and it’s very hard for us to make people aware of its need when we know that we can’t provide the service. So from that angle, we do not promote it. Basically, unawareness of this is sort is a blessing in disguise [my emphasis]. (Dr. Reed – Obstetrician)

A mid-trimester anatomical survey is considered an integral component of obstetric sonography practice for accurate determination of gestational age, reassurance of a normal pregnancy (Johnson, 2005), detection of major fetal defects, identification of early fetal IUGR, early detection of placental abnormalities and assessment for cervical incompetence (Scorza & Vintzilios, 1996). However, the obstetricians at the host hospital do not wish to propagate its importance. Dr. Reed mentioned, above, that patients’ ignorance about the benefits of a comprehensive anatomy/anomaly scan is an advantage for them because the hospital would not be able to provide such services to all of its patients. Dr. Reed’s comments, above, also imply that a patient’s right to have an anatomy/anomaly scan is often compromised due to limited facilities and expertise at the hospital. It is unfortunate that such critical information about pregnancy management is withheld by the very specialists who are supposed to ensure that all pregnant women are provided with quality health care (Flarey & Blancett, 1998). The following sub-section further discusses the effects of radiographers’ workload on the quality of the scans they perform.

**Time Constraint and Quality of Scans**

It is apparent from the above discussion that neither the Ultrasound nor the Obstetric Department has any control over the patient numbers for scans. A patient number of 70-100 per day for sonography examinations is overwhelming for the radiographers (see Table 1). The analysis of observation data in Figure 16 (Chapter 6) shows that due to a significant workload the radiographers are only able to spend an average of 4 minutes and 50 seconds
with a range of 2-8 minutes per examination. During this period they are expected to prepare the patient for the examination, perform the scan and write the diagnostic report. Luck (1992) stated that it takes almost 5 minutes to accurately perform biometry measurements to establish gestation age. From the studies of Catanzarite et al. (2005) and Stewart et al. (2001), discussed in Chapter 3, it is obvious that obstetric scans performed in less than 5 minutes may not yield optimal quality diagnostic results. Furthermore, Catanzarite et al. (2005) have reported that in an ideal situation (an ultrasound facility with experienced sonographers, high-resolution equipment and an adequate patient booking system) optimum quality anatomy/anomaly scans would consume an average of 40 minutes per examination. The sonography specialist participants in this research also expressed similar sentiments and mentioned that sonography examinations performed within a short duration compromise the quality of the scans and the diagnostic reports:

> You can’t see anomalies in 3-4 minutes. That’s ridiculous. It has to be 30 minutes for anomaly scans. The biggest problem in Fiji is to do the scan quickly and when they try to do it quickly they don’t get the views that they really want and they press the ‘freeze’ button and get the measurement. Because they are such short-staffed and are under pressure all the time, they tend to develop bad habits and that to me is the biggest impediment to quality. (Dr. Reed – Obstetrician)

> The problem is that if they [radiographers] keep getting forced to do each scan in 3-4 minutes then the quality will go down. (Dr. Lloyd – Obstetrician)

> We [Ultrasound Department] get so much big number of cases and then if there is so much number of cases, you cannot guarantee the quality of the scans. (Dr. Murray – Radiologist)

The comments made by the specialists, above, are in agreement with the observation and questionnaire data which showed that time constraints during the sonography examinations have been one of the contributing factors causing inconsistent scanning patterns and disparate levels of sonography practice at the host hospital (as discussed earlier in Chapter 6). The length and contents of the diagnostic reports also reflected that the examinations were
incomplete due to time constraints (see ultrasound reports in Appendix 4). Moreover, one of the obstetricians also mentioned that the current practice of obstetric sonography at the host hospital does not meet the international standards of practice due to the short duration of time spent per examination as a result of extensive workload:

*There are international standards of quality of pictures before you make measurements or conclusion. So in terms of good time to scan, to meet the needs of the country, we don’t have that [my emphasis].*

*(Dr. Reed – Obstetrician)*

Furthermore, the short duration for scans at the host hospital, due to the current workload, not only affected the quality of the diagnoses made but also prevented the radiographers effectively communicating with the patients. During the observation period at the clinical site it was noticed that the radiographers rarely spoke to the patients. The majority of the time the radiographers’ communication with the patients comprised only a few phrases of instructions, such as, “please lie down on your back” and “please take a seat outside in the waiting room for your report”. Alternatively, Having (2000) claimed that effective communication during the obstetric sonography examinations “can provide multiple opportunities to promote good prenatal health habits ... that can potentially affect both mother and baby” (p. 242). Having (2000) further explained that describing the sonographic images and showing the mother her baby’s movements, breathing and heart motion reduces her anxiety and fosters bonding between the mother and the fetus. However, the current workload and stress at the host hospital hinder effective communication between the patients and the radiographers. The following sub-section further discusses the issue of radiographers’ stress at work due to the current workload.

**Physical and Psychological Stress**

Although it may appear that sitting on a chair and waving a transducer over a patient’s body is light work, ultrasound practitioners who have been performing this task for years often complain of work-related injuries and psychological stress since much of their work requires leaning away from one’s centre of gravity in awkward positions (Stieler, 1998). Most commonly reported ergonomic problems of sonography practice are injuries to the shoulder and elbow, pain in the wrist, neck and lower back, problems with eyesight, psychological
stress and cross-infection from the patients (Stieler, 1998).

A workload of 70-100 patients for obstetric sonography per day is undoubtedly a demanding job for the radiographers at the hospital where this research was located. The radiographers’ stressful working environment, due to their extensive workload, has been acknowledged by the specialists at the hospital:

> It stresses them. I believe 70 is big number but it’s also the system and how the department is run [at the host hospital]. It’s bearing down on them. It’s not really efficient. *(Dr. Murray – Radiologist)*

> I understand that these people [radiographers] have stress, ergonomics. It’s OHS [Occupational Health and Safety] problem - 70 patients a day. We managed to come to a common ground, reduce it rather than completely limit the number, but the exact figure is not possible [since] some new people [obstetricians] there who tend to order repeatedly. *(Dr. Smith – Radiologist)*

> There definitely needs to be a bit of discipline into ‘dating’ scan. We [obstetricians] have made the rule that after 24 weeks we will not ask for dating scans. But as everybody knows you can use other words on the request form and you still get the information that you want. *(Dr. Reed – Obstetrician)*

> On the other hand, on our part the patient numbers are beyond our control. We have [an] average [of] 6000-7000 [obstetric] patients a year [booked for delivery]. So I feel sorry for them [radiographers] too, for their load. *(Dr. Lloyd – Obstetrician)*

While the specialists recognised that the current workload is affecting the health and safety of the radiographers who perform obstetric scans, it seems that they have not done enough to combat this problem. The comments of Dr. Smith and Dr. Reed, above, imply that the obstetricians sometimes refer patients without genuine clinical indications and, therefore, make an unnecessary contribution to the current workload. Similarly, with regard to obstetric
sonography practice in Fiji, Singh (1999) reported that, “unnecessary requests for ultrasound scans remain a problem despite repeated requests to physicians to re-look at their criteria for ultrasound scan” (p. 512). These comments are in line with Dr. Murray’s observation, who mentioned that:

> The doctors [obstetricians] here do nothing. They always depend on what the x-ray report says, what the ultrasound report says, what the CT scan report will be. They treat the report not the patient. They do 3rd trimester [scans] to decide [whether to] send them [patients] home or admit them. These people [obstetricians]… I can say it on their face they are very low [poor] in their clinical, on doing the clinical aspects.

*(Dr. Murray – Radiologist)*

Dr. Murray’s comments, above, imply that some of the obstetricians depend entirely on sonographic reports when certain obstetric decisions can be made from clinical examinations alone. Consequently, such practice by the obstetricians unnecessarily increases the radiographers’ workload. Earlier, Dr. Murray was also quoted as saying that, “sometimes our radiographers do not want to argue with the doctors, they will just do it [perform the scans] to shut them up, to make them go away”. This suggests that the radiographers do not complain about their constraints and stress because they do not wish to confront the obstetricians.

Mason and Gregory (2006) stated that every Ultrasound Department should be proactive in reducing work-related injuries and stress. The authors further suggested that the best means to curb the ergonomic-related problems are by:

- using equipment that is fully adjustable, allows for better visualisation and reduces fatigue
- booking a reasonable number of patients so that the workload is manageable
- employing lightweight transducers for easy manoeuvring
- allowing the sonographers to take intermittent breaks between the examinations to relax stressed muscles
- creating awareness amongst the sonographers about ergonomic-related problems and encouraging them to take up fitness programmes

In accordance with the above statements, one of the participants in this research stated that:
I guess in terms of reducing the stress ... bring more people – increase the number of sonographers, bring more scanners and have extra one or two [sonography examination] rooms. (Dr. Reed – Obstetrician)

However, it appears that over the years the Ultrasound and Obstetric Departments have neither implemented any strict measures to control the number of patients referred for obstetric sonography nor improved the working conditions to reduce the radiographers’ work-related stress. The current statistics in Table 1 (Chapter 2) show that over a decade the patient numbers at the public hospitals in Fiji have doubled compared with the average of 35 patients per day reported by Singh (1999). Despite the increase in the patient numbers, the host hospital only has one examination room with a decade old ultrasound machine to cater for 70-100 obstetric sonography examinations daily. Hence, the current set-up and the extensive workload do not show any promising signs of combating the radiographers’ physical and psychological stress. The limitations of resources in sonography practice at the host hospital are discussed in greater detail in Chapter 8.

**SUMMARY**

In this chapter it was established that the radiographer participants of this research had limited experience in sonography practice since they lacked appropriate education and clinical training. It is anticipated that the current level of education, inadequate supervision and ineffective training are some of the probable factors that have contributed towards inconsistency in scanning amongst the radiographers. Hence, the radiographers have made a strong request for a curriculum-based educational programme for their professional development.

Analysis of the research data has also shown that the host hospital does not have a written examination protocol for the practice of obstetric sonography and the current scanning guidelines followed by the radiographers are yielding disparate scanning patterns amongst the radiographers. Furthermore, in the absence of a patient booking system, the radiographers have been receiving a significant number of patients for scans each day. It was also revealed that the majority of the patients are referred for initial sonography examinations late in their pregnancy because some of the referring obstetricians lack knowledge and understanding of
the importance of a mid-trimester anatomical survey. However, those obstetricians who are aware of the importance of a mid-trimester sonography do not reveal it to the patients because of the limited expertise and facilities at the hospital.

The current statistics show that 70 to 100 obstetric patients are scanned each day at the host hospital by the radiographers with a single ultrasound machine. Due to a significant workload, the radiographers are unable to spend sufficient time in performing each scan, therefore, compromising the quality of the scans and subsequent diagnoses. It was also noted that the short duration of scanning time led to ineffective communication between the radiographers and the patients. According to the radiologists, in order to avoid clinical examinations, some of the obstetricians unnecessarily refer their patients for scans. Consequently, this contributes to the radiographers’ existing workload. Unfortunately, it seems that the host hospital and the specialists are not doing enough to minimise the radiographers’ current workload and stress. Hence, it is imperative for the authorities at the host hospital to develop strategies to overcome the problems of obstetric sonography practice, due to “pressures of time, workload, administrative demands and complacency” (Dudley & Chapman, 2002, p. 195).

While this chapter identified some of the factors that influence the radiographers’ scanning practices and their consequences, the following chapter further explores the constraints of current sonography practice due to limitations of resources at the urban public hospital where this research was located.
CHAPTER 8

THE EFFECTS OF LIMITATION OF RESOURCES ON RADIOGRAPHERS’ PRACTICE

OVERVIEW

Previously, in Chapter 7, the limitations and needs of the radiographers performing obstetric sonography at an urban public hospital were discussed. This chapter focuses on the limitations of the resources at the host hospital and their subsequent adverse effects on the radiographers’ obstetric sonography practice. The thematic analysis of the research data unveiled three main resource limitations at the hospital. These limitations relate to the resource personnel (specialists affiliated to obstetric sonography practice) at the host hospital, current status of scanning facilities and financial constraints. Further, this chapter describes the influence of Fiji’s political environment on its health care services.
SPECIALISTS AS RESOURCE PERSONNEL

This research employed three categories of participants, namely, radiographers, radiologists and obstetricians, who were closely affiliated to obstetric sonography practice at the urban public hospital where this study was undertaken. In Chapter 7, the radiographers’ constraints exemplified by their limited expertise, inappropriate professional development and supervision, absence of a documented protocol and extensive workload, have been discussed. The following section explores the limitations of the sonography specialists (resource personnel) and the consequences of their limitations on the radiographers’ practice of obstetric sonography.

RADIOLOGISTS’ LIMITATIONS

In pregnancy, crucial decisions are made from the outcomes of obstetric sonography examinations and, therefore, it is recommended that sonography examinations be performed by professionals, such as, qualified sonographers (Callen, 2000) and that the final diagnostic reports be compiled by the specialist physicians, preferably radiologists (Australasian Society for Ultrasound in Medicine, 2005; World Health Organisation, 1998). It is important for the radiologists to make diagnostic decisions during obstetric examinations so that the “safest and best practice can be offered to the expectant mother and obstetrician” (McHugo, 2001, p. 2157). However, contrary to the above recommendations, at the host hospital the radiographers are expected to perform scans, interpret images and write the final diagnostic reports with minimal involvement of the radiologists, as confirmed by both of the radiologist participants:

*We [radiologists] only see the special cases, the problematic cases. We don’t see the ordinary cases. We don’t see the routine. We only get to see those who need a second opinion, the one where radiographer gets difficulty to report.* (Dr. Murray – Radiologist)

*Unless the request comes directly to us [radiologists]... you know, [when] the obstetrician realises there is something wrong and they need something*
during the mid-trimester [examination], so then we [radiologists] go there to scan. (Dr. Smith – Radiologist)

The comments made by both of the radiologists, on the previous page, substantiate that currently the radiographers perform obstetric scans and make diagnostic decisions independent of radiologist’s involvement, despite the radiographers’ limited expertise in sonography (as discussed in Chapters 6 and 7). It is, therefore, anticipated that the radiologists’ minimal involvement in monitoring the radiographers’ practice of obstetric sonography could be one of the factors contributing towards their inconsistencies in scanning. The analysis of the research interview data revealed some key reasons for the radiologists’ minimal involvement in obstetric sonography practice at the host hospital. Firstly, the urban public hospital where this research was conducted only has two radiologists sharing the hospital’s entire medical imaging responsibilities. One of the specialists highlighted this as a major constraint faced by the hospitals in Fiji:

One of our biggest problems that we have in terms of supporting them [radiographers in obstetric sonography] is that we don’t have many radiologists. Doctors going to radiology are few in Fiji. Because radiology as a specialty is considered to be a support specialty rather than a core specialty and the evidence for this is the number of posts or vacancies available for the radiologists. So if radiology doesn’t get the profile it requires, it will be even harder for sonography to get the profile within radiology. (Dr. Reed – Obstetrician)

Dr. Reed’s remarks indicate that the Health Ministry in Fiji considers radiology (medical imaging) as a minor profession and, therefore, the non-specialist doctors prefer to pursue a career in specialities other than radiology. As mentioned by Dr. Reed above, since radiology is considered a “support speciality”, the Ministry of Health in Fiji has allocated a minimum number of established positions for radiologists. Anecdotally, one of the specialist participants divulged that currently there are a total of only 5 radiologists in Fiji, two of whom are based at the hospital where this research was located.

Furthermore, the analysis of the research data divulged another limitation that prevents the radiologists from getting directly involved in teaching and supervising the radiographers who
perform obstetric scans. During the research interview, one of the radiologists reported that:

*Because of the way the hospital is planned, the way the ultrasound machines are located, they are spread apart, and the [limited] number of radiologists, it does not allow us to sit down there [at the obstetric ultrasound room] and scan as much as it would be in an ideal setting. Location is an issue, obstetrics scans are done far away from the radiologists’ office.*

*We [radiologists] have to put ourselves physically near fluoroscopy room and near the CT [computed tomography] scan room because these are areas we give contrast [dye for diagnostic imaging] and these are the areas where people can get life-threatening events very quickly. Like if they [patients] develop anaphylactic reaction to the dye, we will have to act very quickly. We have to be present. That is why we choose to stay here [at the main Radiology Department]. We are near where the people are given contrast. If we stay away from this place then one day we are going to have mortality because of that.* (Dr. Murray – Radiologist)

The comments made by Dr. Murray reveal that the current location of the obstetric sonography examination room is not in close proximity to the radiologists’ office. In fact, the obstetric sonography examination room is located more than a kilometre away from the main Radiology Department but adjacent to the Obstetrics and Gynaecology Department for patients’ convenience. Dr. Murray’s remarks also indicate that the radiologists prefer to stay in close proximity to the imaging facilities where the risks of radiological emergencies are high, so that they can intervene immediately if required. Hence, the radiologists claim that the remote location of the obstetric examination room is another reason why the radiographers have to perform, interpret and write diagnostic reports by themselves, on behalf of the radiologists.

It may be true that the radiologists’ contribution to obstetric sonography practice at the host hospital is minimal due to the remote location of the obstetric scan room. However, during the data collection period it was noticed that the radiographers who performed scans at a second ultrasound room (which is in close proximity to the radiologists’ office) also held full
responsibility for scanning, interpreting and writing diagnostic reports on behalf of the radiologists. One of the reasons for such a practice could be the limited number of radiologists and their heavy workload at the host hospital, making it difficult for them to meet all the demands of the radiology services. The radiologists substantiated the above possibility, saying that:

_We were short of staff and for me to be at ultrasound [examination room];_  
_I’ll have to disregard my other responsibilities. At the moment [there are] only two of us._ (Dr. Smith – Radiologist)

_Look at it, there are only two radiologists and how many machines are working… one CT [computed tomography] scanning, two ultrasound machines, and a number of x-ray machines are going on._  
_(Dr. Murray – Radiologist)_

Since there are only two radiologists at this major public hospital and a number of medical imaging machines are in operation, it is difficult for the radiologists to be present at the clinical site where obstetric scans are performed, contrary to the recommendations of McLeary (1980) who stated that the radiologists should become directly involved with obstetric sonography. The above comments made by Dr. Smith also indicate that the radiologists’ extensive workload and staff shortages prevent them from personally guiding the less experienced radiographers in obstetric sonography. A similar sentiment was expressed by Dr. Reed, earlier in this chapter, with regard to the support provided by the radiologists to the radiographers. Hence, as far as the radiologists as resource personnel are concerned, their contribution and involvement in obstetric sonography practice at the host hospital are minimised by at least three main factors, namely, their limited number, demanding workload and the remote location of the obstetric scan room. Having explored the limitations for the radiologists, the ensuing section examines the limitations for the obstetricians at the host hospital and their effect on the practice of obstetric sonography.
OBSTETRICIANS’ LIMITATIONS

A significant number of the obstetric patients (an average of 70 patients) who attend the antenatal clinic at the host hospital are referred for sonography each day by the obstetricians. As discussed earlier in Chapter 7, the radiologists at the host hospital felt that to some extent the obstetricians are responsible for the radiographers’ extensive workload. However, one of the obstetricians argued that they also face inevitable constraints, as indicated in the following excerpt:

On our part the patient numbers are beyond our control. We have [an] average of 6000 to 7000 patients [for pre- and post-natal care] per year. In terms of trying to control the number of patients going for late scan, that’s one of the priorities we’re working on. (Dr. Lloyd – Obstetrician)

It is apparent from the comments above, that one of the reasons for the radiographers’ heavy workload is the significant number of patients requiring pre- and post-natal care at the host hospital. In order to reduce the radiographers’ stress, the radiologists suggested that the obstetricians should share some of the workload with the radiographers:

We have suggested more scans to be performed by obstetricians to clear some of these normal cases such as AFIs and routine antenatal [examinations], and high risks groups to be sent here [ultrasound department], we’ll do it. (Dr. Smith – Radiologist)

Being concerned with the quality of scans performed by the radiographers and their workload, the obstetricians mentioned that they would prefer to perform scans on high risk patients themselves:

What I am saying is that the standard of anatomy scanning done in Fiji is not good … if I have to get it done properly I will do it myself. (Dr. Reed – Obstetrician)

Ideally, I want to be there when they [radiographers] get an anomaly. So that personally I would repeat it the same day and confirm the finding and
take the patient for counselling ... however, there are only two of us who can do those anomaly scans in the department. Not all of our doctors [obstetricians] are trained to do scans. (Dr. Lloyd – Obstetrician)

The comments made by Dr. Reed and Dr. Lloyd, on the previous page, suggest that while they wish to perform scans on most of the high risk patients, one of their major constraints is that they are the only obstetricians at the host hospital who can perform obstetric sonography. However, the obstetricians also have several other responsibilities which restrict them from performing scans frequently, as indicated in the following excerpt:

We don’t have time. Even if you have to offer us a 3-D [3-dimensional] machine, I don’t think we have the time to do the scan any more.

(Dr. Lloyd – Obstetrician)

Dr. Lloyd implied that even if the Radiology Department provided the obstetricians with an advanced ultrasound machine, they would still not be able to meet the demands of the radiologists due to time limitations. Hence, the obstetricians highlighted three main constraints that affected the radiographers’ obstetric sonography practice, namely, a significant number of patients requiring pre- and post-natal care and consequently sonography examinations, a limited number of obstetricians who can execute obstetric scans, and time constraints preventing the obstetricians being able to share the radiographers’ workload.

Apart from the above mentioned constraints, the thematic analysis of the research data also revealed the effect of interpersonal relationships on the radiographers’ performance of obstetric scans. The following section discusses the dynamics of relationship issues amongst the personnel affiliated to obstetric sonography at the host hospital.

THE OBSTETRICIANS AND RADIOLOGY INTERPERSONAL RELATIONSHIPS

A healthy professional relationship is an integral component of a multidisciplinary health care service, such as, obstetric sonography which involves staff members of the Obstetrics and Gynaecology, and Medical Imaging (Radiology) Departments (Thompson, 2001). Development of interpersonal relationships through effective communication reduces
professional isolation caused by workloads, routines and stress (Bedward & Daniels, 2005; Driscoll, 2000). A healthy relationship in a multidisciplinary team:

- Provides an opportunity to reflect on the practice, highlight shared problems and resolve problematic issues;
- Promotes better cooperation between members of other departments;
- Removes the historical hierarchy; and
- Promotes greater respect and understanding of each other’s roles.

(Adapted from Bedward & Daniels, 2005, p. 59)

However, from the analysis of the research data it appears that to a certain extent an ineffective relationship between the obstetricians and the radiologists exists which may be contributing towards some of the current problems in obstetric sonography practice at the host hospital. In this regard, the radiologists mentioned that:

*They [obstetricians] don’t want to check on the patients clinically. They’d rather send the patient for scan. And they are very demanding about that [my emphasis]. These people [obstetricians]… I can say it on their face [my emphasis], they are very low [poor] in their clinical, on doing the clinical aspects.*

*(Dr. Murray – Radiologist)*

*Sometimes obstetricians don’t want to meet with us*

*(Dr. Smith – Radiologist)*

Dr. Murray’s remarks imply that some animosity exists between some of the radiologists and the obstetricians at the host hospital. The above comments also suggest that the obstetricians can be authoritarian at times. Furthermore, Dr. Smith’s comment, above, indicates that there is a lack of cooperation between the two groups of specialists. Hence, it can be anticipated that some of the more obvious problems, such as, the radiographers’ extensive workload, have not been resolved due to an ineffective relationship between the sonography specialists at the host hospital where this research was located.

With regard to the significant number of obstetric patients being referred for sonography, one
of the radiologists mentioned that:

*These doctors (obstetricians) are not considerate ... Sometimes our radiographers do not want to argue with the doctors, they will just do it [perform the scans] to shut them up, to make them go away.*

*(Dr. Murray – Radiologist)*

Dr. Murray’s comments indicate that sometimes the radiographers do not wish to confront the obstetricians, despite working under a lot of stress due to a significant number of patients presenting for sonography each day. From Dr. Murray’s comments above, it can be interpreted that due to the obstetricians’ hierarchical position and medical expertise, the radiographers are sometimes obliged to perform scans (especially examinations with no genuine clinical indications) without questioning them (Bond & Holland, 1998). Cotton (2001) stated that when there is an imbalance of power in the workplace, due to professional expertise and hierarchies in an organisation, there may be risks of subordinates being disempowered. Luck (1992) insisted that it is important for the health professionals affiliated with obstetric sonography to “work closely together to facilitate good communication with and counselling of the patient” (p.1477).

Thus far, this chapter has discussed the limitations for the specialists and the issues related to the interpersonal relationships between the radiographers, radiologists and the obstetricians at the host hospital. The following section will explore the consequences of limited scanning facilities upon the radiographers performing obstetric sonography.

**SCANNING FACILITIES AT THE URBAN PUBLIC HOSPITAL**

**Obstetric Ultrasound Machine**

One of the factors that determine the quality of obstetric scans is the status of the ultrasound machine in use: its age, technology and maintenance (Salomon & Ville, 2005). The Australasian Society for Ultrasound in Medicine (2005) recommended that to perform obstetric examinations, especially for detection of fetal anomalies, hospitals should have “state of the art” ultrasound equipment (¶ 5). However, during the observation at the clinical site, it was noticed that the obstetric sonography examination room at the host hospital
employs a single Toshiba JustVision-400 machine (2000 model), which was donated by the Japanese International Cooperation Agency (JICA) in 2003. This ultrasound machine has deteriorated over the years of usage without being replaced, as acknowledged by one of the specialists during the research interview:

_You can see the status of our equipment. It is really beyond our control._

_Our machines have multiple parts [my emphasis]. That’s what the biomedical department is doing to assist, you know, to get the work done._

_You may not get a good picture come out._ (Dr. Smith – Radiologist)

The radiologist’s comment, above, confirms that due to its deterioration, certain parts of the original Toshiba ultrasound machine have been replaced by multiple spare parts of the redundant machines at the host hospital. Hence, it was noticed during the observation period that the images produced by the machine were of unacceptable quality, as stated above by Dr. Smith. For instance, the transducer used by the radiographers to perform obstetric scans was damaged and produced streak marks (known as image artifacts) upon a quarter of each image. Moreover, the obstetric ultrasound machine at the host hospital does not have up-to-date capabilities, for example, Doppler. Consequently, the obstetric patients who require Doppler assessments are referred to the main Radiology Department for additional scans.

The current obstetric equipment does not have Picture Archiving and Communication System (PACS) capabilities that allow transmission of images from the ultrasound machine to the radiologist’s workstation. There is a critical need for PACS or a similar system at the host hospital, since both the radiologists are based at a remote location away from the obstetric sonography examination room and it is not possible for them to review scans, write sonography reports and provide assistance to the radiographers continuously. Consequently, the obstetric sonography examinations are performed, interpreted and reported by the ‘on-the-job’ trained radiographers using a decade-old ultrasound machine. The following statement made by one of the specialist participants further explains the consequences of the above situation at the host hospital:

_As far as the quality of the scans is concerned, we have no way to verify it._

_In other words, there is nobody else to see the pictures that we see [images produced by the radiographers], and we do not have the technology that_
will allow us to do that. Virtually, if somebody wants quality control they actually have to be at the shoulder of the scanner [radiographer] and watch them do it [perform scan] and randomly check the quality of images.  

**(Dr. Reed – Obstetrician)**

Despite the poor condition of the current ultrasound machine, the Ultrasound Department at the host hospital continues to accommodate a significant number of patients for obstetric sonography examinations each day. Thus, for accurate biometric measurements and diagnostic interpretations, the obstetricians demanded additional equipment for sonography practice at the hospital:

*We currently do around 6,000 deliveries a year but we book into pregnancy at least about 8,000 pregnancies. So for us to have one machine to do 8,000 women is probably unfeasible.* **(Dr. Reed – Obstetrician)**

*The Radiology Department should be fighting to get [new] machines. We need quality, we don’t want quantity.* **(Dr. Lloyd – Obstetrician)**

With regard to purchasing a new ultrasound machine, one of the radiologists mentioned that:

*Budget is the problem with us. These are not cheap materials. You are talking about thousands of dollars.* **(Dr. Smith – Radiologist)**

Dr. Smith’s comments imply that the Radiology Department at the host hospital is currently facing major financial constraints and is not in a position to upgrade its services. Discussion on the issue of financial constraints is addressed later in this chapter under the section ‘Funding and Influence of the Political Environment’.

One of the specialists reported that there is no systematic quality assurance programme in place for the maintenance of the ultrasound machines at the host hospital:

*On top of that to maintain the machine for repair, we don’t have a standard maintenance programme. People [biomedical technicians] come in every now and then to see the status of our machine. Most of our maintenance is*
done opportunistically. So we can’t sustain huge loads on the ultrasound machines. (Dr. Reed – Obstetrician)

A quality assurance programme for an ultrasound machine involves several measurements taken periodically to ensure that the ultrasound equipment and instruments are operating at the expected level of performance (Gent, 1997). Such a programme may help in identifying prospective problem areas before they may actually emerge. A quality assurance programme provides confidence that image data, such as distance measurements and area estimations are accurate and that the image quality is optimal (Zagzebski, 1996). However, Dr. Reed’s comments, above, exemplify that there is no monitoring programme for assessing the performance of the ultrasound equipment at the host hospital and this explains why the ultrasound machine currently used for obstetric sonography has been deteriorating over time.

The following subsection presents a brief discussion on another resource constraint at the host hospital, namely, the obstetric sonography examination room.

**Obstetric Sonography Room**

As mentioned earlier, a significant number of obstetric patients are booked for pre- and post-natal care at the host hospital annually. Obstetricians selectively scan some patients at their clinic either to confirm anomalies or for the purpose of teaching other obstetricians. However, the majority of the patients are referred to the Radiology Department for sonography. Despite the extensive workload and deteriorating condition of the current ultrasound machine, the Radiology department only has one examination room with a single machine dedicated for obstetric examinations. The above phenomenon is undoubtedly problematic as demonstrated by the frustration expressed by a radiologist:

*Look at the room up there, there is so much of space in that room. I tell you it is unused. The physical layout of the room is not good. I don’t know why. That’s why it is not conducive to put patients through fast, in and out, in and out ... the way it’s run, the way it’s set-up. They should put both machines [machines at the Ultrasound Department and Obstetrics and Gynaecology Department] together in the room, both side by side.*

(Dr. Murray – Radiologist)
Dr. Murray claimed that the obstetric sonography examination room has the capacity to accommodate more than one ultrasound machine. It was further suggested by Dr. Murray that since the obstetricians do not frequently use their ultrasound machine, it would be wise to transfer it to the Ultrasound Department so that the radiographers’ workload is shared. During the observation at the clinical site, it was apparent that there is plenty of space at the obstetric sonography room which is under-utilised. That is, while a large space was dedicated as a patients’ waiting area, the radiographers used a small corner of the room to perform the scans. A radiographer anecdotally mentioned that another section of the obstetric sonography room, with the capacity to accommodate a second ultrasound machine, has been locked for years and could be used to ease their workload. A specialist agreed with the radiographer’s proposal stating that:

\[ \text{Again we’ve got to provide more staff and [examination] room because this is the central area, referral and teaching centre.} \] (Dr. Smith – Radiologist)

Dr. Smith agreed that the host hospital needs more resources in terms of personnel and equipment to cope with the demands of obstetric sonography practice due to the urban location of the hospital. The following section explores the influence of Fiji’s political environment and the financial constraints faced by the Radiology Department at the host hospital.

**FUNDING AND INFLUENCE OF POLITICAL ENVIRONMENT**

Fiji’s health care system has been under scrutiny for some years. Recent comments in the media in Fiji highlighted the ongoing adversity of the health care services in Fiji. Heatley (2008) reported in *The Fiji Times* about the Fiji Medical Association’s concern that the medical equipment and facilities at the public hospitals in Fiji are deteriorating and that the current system needs a total overhaul. According to Heatley (2008), the Fiji Medical Association demanded more funds from the government to upgrade the medical services in Fiji since the services are lagging 30 years behind its neighbouring countries, namely, Australia and New Zealand. More recently, *The Fiji Times* featured another news article titled “Health Crisis” which reported that surgical and medical imaging equipment at the major public hospitals in Fiji are deteriorating and getting funds to repair or replace the equipment
is difficult (Rauto, 2008). The World Health Organisation (2005) report stated that over a
decade Fiji’s total health expenditure has not risen above 3% of its Gross Domestic Product
(GDP), which is the lowest rate amongst the Pacific Island nations. Of this 3%, 62-67% is
allocated for personal emoluments at the public hospitals and health centres, while a very
limited amount is allotted for the maintenance of equipment and physical infrastructure
(World Health Organisation, 2005).

Furthermore, during the research interview the specialists at the host hospital expressed that
they were finding it difficult to replace the current obstetric sonography machine due to
financial constraints. One of the radiologists mentioned that:

Normally, I look for any opportunity in finance to upgrade the machines. I
always push every year to get something new. And it is subject to
availability of finances.

So budget is the problem with us. These are not cheap materials; you are
talking about thousands of dollars.

(Dr. Smith – Radiologist)

It is anticipated that recurrent coups d’état in Fiji have also, to some extent, contributed
towards the poor state of health services at the public hospitals. Four political coups within
the last 20 years (2006 being the most recent one) have badly affected Fiji’s economy and
ultimately the health care services in the country (Australian Agency for International
Development, 2008). With regard to Fiji’s economy, the Asian Development Bank report
highlighted that:

A series of coup d’états has undermined investor confidence, damaged the
country’s tourism image, led to trade bans, and reduced international
funding. Gross domestic product fell by 6.4% in 1987 and 1.7% in 2000,
reflecting the impact of coups in those 2 years. Following the coup in
December 2006, the Fiji Islands endured a year of negative economic
contraction of 3.9% due to a decline in tourism, sugar, construction, and
gold mining earnings growth. Several funding agencies suspended most
new aid proposals, although many existing projects have continued. (2008, ¶ 3)

The physical infrastructure at some of the major public hospitals and health centres is deteriorating and there are continuous shortages of pharmaceuticals, health supplies and breakdowns of essential equipment causing risks to patients’ health (Australian Agency for International Development, 2008). Sharma (2002) reported that the health services in Fiji are deteriorating due to limited financial resources, lack of health planning and political instability in the country. Furthermore, the World Health Organisation (2005) report stated that the recurrent political crises in Fiji have led to a “large-scale emigration” of skilled health professionals, creating a negative impact on health services (p. 70).

Similarly, with regard to professional development of the radiographers in obstetric sonography, one of the specialist participants mentioned that:

*Because of our budget and interim period [country run by military government since 2006], we can’t promise anything. We really have to wait for the election. So that’s the problem.* (Dr. Smith – Radiologist)

Dr. Smith’s remarks imply that the Radiology Department has postponed all its future plans and developments until more funds are available and a new democratic government is elected. Further, in an effort to standardise practice in medical imaging (which also encompasses sonography practice), the Fiji Society of Radiographers urged the government in early 2006 to establish a Radiation Health Board. However, the legislative process to establish a Radiation Health Board came to a halt when the Fiji Military Forces took over the previously elected government on the 5th of December 2006 (Parliament of Fiji Islands, 2006). Hence, due to the current political environment no registration board could be established to oversee the radiography and sonography practices in Fiji. It is anticipated that the absence of a regulatory board in Fiji also contributes toward the radiographers’ inconsistency in obstetric scanning.
SUMMARY

Currently, the host hospital is facing various challenges in providing obstetric sonography services to its patients due to limitations of resources, as one of the specialists had commented during the research interview:

You know our resources, infrastructures, the drawbacks, and the difficulties we face. It is the reality of it. It is a long journey. (Dr. Smith – Radiologist)

A significant number of obstetric patients are scanned each day by the radiographers, who also interpret and make the final diagnostic reports on behalf of the radiologists. This chapter identified three main factors that contribute to the above problem, namely, the specialists’ own constraints, limited scanning facilities at the host hospital and insufficient funds to optimise obstetric sonography services at the public hospitals in Fiji. This chapter also briefly described the effects of the recurrent political upheavals on health care services in Fiji.

Ideally, it is the radiologists who make diagnostic decisions in obstetric sonography (Australasian Society for Ultrasound in Medicine, 2005); however, in Fiji the radiologists’ involvement in the practice of obstetric sonography is minimal. In this regard, three main reasons emerged from the analysis of the qualitative data, namely, the extreme shortage of radiologists at the host hospital; the remote location of the obstetric sonography examination room from the radiologists’ office; and the radiologists’ excessive workload. In addition, Dr. Reed, one of the research participants, disclosed that the Ministry of Health in Fiji considers radiology a “support speciality”. This indirectly discourages medical practitioners from pursuing a career in radiology and as a result, the major hospitals in Fiji lack radiology specialists. Similarly, the obstetricians at the host hospital also have certain limitations, such as a significant number of patients requiring pre- and post-natal care and, consequently, sonography examinations; a limited number of obstetricians who can execute obstetric scans; and the obstetricians’ time constraints preventing them from sharing the radiographers’ workload. The research data also revealed the existence of an ineffective relationship between the obstetricians and the radiology staff (radiologists and radiographers), preventing positive dialogue and the implementation of strategies to resolve the problems related to obstetric sonography practice.
The Radiology Department, where this research was undertaken, has only one obstetric sonography examination room with a single ultrasound machine. The current obstetric ultrasound machine is deteriorating and is being repaired with multiple parts from the redundant machines. It also lacks modern technology for scanning and PACS for transmitting images to the radiologists’ workstation. Furthermore, the analysis of the qualitative data revealed that there is no systematic quality assurance programme in place for the maintenance of the ultrasound machines at the host hospital.

Apart from the above mentioned limitations, the host hospital also faces financial constraints. Unacceptably low national health expenditure has created adverse effects on the health care service in Fiji (World Health Organisation, 2005). There are insufficient funds to upgrade, maintain and purchase new ultrasound machines to cope with the demands of obstetric sonography services. Further, the recurrent political instability has led to weakening of the national economy and mass emigration of skilled health professionals (Australian Agency for International Development, 2008; World Health Organisation, 2005). The 2006 military coup has also caused a delay in the establishment of a registration board to ensure standardisation of obstetric sonography practice in Fiji (Parliament of Fiji Islands, 2006). Therefore, it is surmised that the above limitations have led to inconsistencies and disparities in radiographers’ obstetric scanning at the host hospital.

This concludes the discussion of the findings of this research. The following chapter presents a summary of the key findings, limitations, implications and the conclusions from this research. It also highlights issues that require further research and presents recommendations for minimising the gaps in the current obstetric sonography practice at the urban public hospital where this research was located.
CHAPTER 9

CONCLUSION

OVERVIEW

This study employed a case study approach positioned in an interpretive paradigm to investigate the current obstetric sonography practice at an urban public hospital in Fiji. The primary aims of this research were to:

- Evaluate the current practices and procedures used for the mid-trimester obstetric sonography examinations at an urban public hospital in Fiji; and
- Examine the potential need for the development of a standard protocol for the mid-trimester obstetric sonography examinations at the hospital where this research was located.

Thus, the research question that this study addressed was: How does the current mid-trimester obstetric sonography practice in Fiji meet the professional expectations of the obstetricians and the radiologists, and the international standards?

In consideration of the research topic, aims and the research question, this chapter presents a discussion of the key findings of this study, limitations and implications of this study, and suggests suitable recommendations for the enhancement of obstetric sonography practice in Fiji. This chapter ends with the concluding statements for this research.
KEY FINDINGS

In order to evaluate the current practices and procedures used by the radiographers during mid-trimester sonography examinations at an urban public hospital in Fiji, a multi-method approach was employed for data collection, which predominantly entailed qualitative data supported by quantitative data. The multiplicity of the data collection methods, namely, the in-field observations, questionnaires and in-depth interviews, enabled the triangulation of data and contributed to enhancing the overall reliability and validity of the research. The participants comprised a cohort of ‘on-the-job’ trained radiographers performing obstetric sonography, radiologists and obstetricians. All the participants were purposively selected using a “critical case sampling scheme” to obtain detailed descriptive data, based on the participants’ professional characteristic (Collins et al., 2007, p. 272).

This study has demonstrated that the radiographers at the hospital where this research was conducted, have disparate patterns of performing the mid-trimester obstetric scans. There were obvious variations seen in the scanning patterns amongst the radiographers and between the individual examinations performed by each radiographer. The observation data revealed that during the mid-trimester anatomy/anomaly scans the radiographers placed major emphasis on the biometry measurements and some aspects of the fetal head, spine, heart motion and the placenta. However, the radiographers did not attempt to scan a high proportion of fetal and maternal anatomical structures stipulated in the observation checklist, adopted from the ASUM guidelines (considered to be a ‘gold standard’ international sonography protocol in this research). Hence, the patients who presented for a comprehensive anatomical survey for exclusion of fetal anomalies during the mid-trimester period did not undergo an entire scan, as stipulated in the ASUM mid-trimester guidelines.

Additionally, in the questionnaires which were employed to compare the observation data with the radiographers’ own perspectives on their approach to mid-trimester scans, the participants indicated that they include a maximum of 18 out of the 44 (41%) anatomical structures recommended in the ASUM mid-trimester guidelines. The questionnaire data was closely aligned with the observations that were made at the clinical site, since the latter showed that even the most experienced radiographers barely met 50% of the ASUM scanning requirements for the mid-trimester sonography examinations. Similar to the observation data, the questionnaire responses indicated that the biometry measurements were the
radiographers’ main priority during the mid-trimester scans. Although this research was not conducted to assess the radiographers’ diagnostic accuracies, due to the comprehensive nature of the observation protocol some obvious discrepancies in biometry measurements were noted. These discrepancies comprised measurements taken at: incorrect anatomical levels; with inappropriate selection of technical factors; and with the anatomical structures being partially obscured by image artifacts. Hence, the analysis of the research data strongly suggests that the current obstetric sonography practice at the urban public hospital in Fiji, where this research was located, does not fully meet the requirements of the international standards of practice.

During the interview, when the obstetricians were asked if the radiographers are able to meet their sonography needs during the mid-trimester scans, one of the obstetricians mentioned:

*No, definitely not as far as anatomy scans are concerned.*

(Dr. Reed – Obstetrician)

The sonography specialist participants mentioned that, due to the radiographers’ limited expertise, they occasionally misinterpreted the sonographic findings during the obstetric examinations. Agreeing with the specialists, the radiographers indicated in the questionnaire that they lacked both confidence and competence in anatomy/anomaly scanning. Despite their lack of confidence and expertise, the radiographers are expected to perform scans, interpret the images and write the diagnostic reports, as a routine practice at the host hospital. A high proportion of the radiographer participants indicated that they are reluctant to make diagnostic decisions on behalf of the radiologists, although it is anticipated that this practice, to some extent, meets the immediate needs of the radiologists since they are limited in number.

This research has unveiled several factors influencing the radiographers’ current practice of obstetric sonography at the hospital where this research was located. The radiographers’ level of education, their inadequate supervision and ineffective training have been identified as some of the factors contributing towards their inconsistencies in scanning. The research data established that none of the radiographer participants had any specific qualification or formal clinical training in obstetric sonography. Their current practice is based upon the ‘on-the-job’ training they receive from their colleagues. Since the host hospital does not have a qualified
sonographer to lead the Ultrasound Department and supervise the radiographers in sonography, it is anticipated that the radiographers’ professional development is limited. Hence, the radiographers strongly indicated the need for a curriculum-based educational programme for their professional development.

Analysis of the research data has also shown that the host hospital does not have a written examination protocol for the practice of obstetric sonography. The current scanning guidelines used by the radiographers are yielding disparate scanning patterns amongst the radiographers, that is, analysis of the observation data showed that there were inconsistencies in each of the scans performed by the individual radiographers. Similarly, the scanning patterns between the radiographers also differed. Therefore, the obstetrician participants insisted that the Ultrasound Department should have a written protocol for obstetric examinations to prevent perinatal compromises and inappropriate interventions (Dudley & Chapman, 2002).

Furthermore, in the absence of a patient booking system, the radiographers have been performing 70-100 obstetric scans each day using a single ultrasound machine at the host hospital. Due to an extensive workload, the radiographers have not been able to spend sufficient time performing the scans, therefore, compromising the quality of the scans and subsequent diagnoses. The observation data revealed that the radiographers spent an average of 4 minutes and 50 seconds (with a range of 2 to 8 minutes) per mid-trimester obstetric examination. However, Catanzarite et al. (2005) reported that in an ideal situation (an ultrasound facility with experienced sonographers, high-resolution equipment and adequate patient booking system) optimum quality anatomy/anomaly scan would consume an average of 40 minutes per examination. One of the obstetricians mentioned that the radiographers at the host hospital are not able to meet the international standards of practice since their durations of scans are extremely short. The above inference correlated with the observation and questionnaire data which divulged that the radiographer participants of this research barely met 50% of the mid-trimester scanning criteria stipulated in the ASUM guidelines. It was also noted that the short duration of scanning time led to ineffective communication between the radiographers and the patients.

The results of this study revealed that the obstetricians referred some of their patients for sonography without genuine clinical indications. The radiologist participants indicated that in
such cases obstetric sonography has been used by the obstetricians as a substitute for obstetric clinical examinations. Consequently, such practices have dramatically increased the radiographers’ existing workload, leading to unnecessary physical and psychological stress. It was also disclosed that the majority of the obstetric patients are referred for initial sonography examinations late in their pregnancy, because some of the referring obstetricians lack knowledge and understanding of the importance of a mid-trimester anatomical survey.

Apart from the above mentioned issues, this study has also uncovered various challenges faced by the host hospital due to limitations of resources that subsequently affect the radiographers’ performances of obstetric sonography. The thematic analysis of the research data unveiled three main resource limitations at the hospital, namely, the specialists’ own constraints, limited scanning facilities at the host hospital and insufficient funds to optimise obstetric sonography services at the public hospitals in Fiji.

In Fiji, despite the radiographers’ limited expertise in sonography, the radiologists’ involvement in the practice of obstetric sonography is minimal. The analysis of the qualitative data revealed that there is an extreme shortage of radiologists at the host hospital. According to one of the obstetrician participants of this research, since the Ministry of Health in Fiji does not consider radiology a core speciality, the medical practitioners prefer not to pursue a career in radiology (see Dr. Reed’s comments in Chapter 8, Page 133). Hence, the major hospitals in Fiji lack radiology specialists. In fact, there are only five radiologists in Fiji. Further, due to the radiologists’ excessive workload and remote location of the obstetric sonography examination room from their offices, the radiologists are unable to personally teach and supervise the less experienced radiographers in obstetric sonography. Consequently, the ‘on-the-job’ trained radiographers perform scans, interpret the sonographic images and make diagnostic decisions independently.

Similarly, the obstetricians at the host hospital also have certain limitations, such as a significant number of patients (6000 to 7000 patients per year) requiring pre- and post-natal care and, subsequently, sonography examinations; a limited number of obstetricians who can execute obstetric scans; and the obstetricians’ time constraints preventing them from sharing the radiographers’ workload. Considering the radiographers’ inconsistencies in scanning and their inability to meet the obstetricians’ expectations, the obstetricians prefer to perform scans on most of the high risk patients. However, the obstetricians’ numerous other responsibilities
restrict them from performing scans frequently. This study has also revealed the existence of an ineffective relationship between the obstetricians and the radiology staff (radiologists and radiographers), preventing positive dialogue and the implementation of strategies to resolve the problems related to obstetric sonography practice.

This study has also highlighted the issue of limited scanning facilities at the host hospital. The Radiology Department, where this research was undertaken, has only one obstetric sonography examination room with a single ultrasound machine. The Toshiba JustVision-400 (2000 model) ultrasound machine has deteriorated over the years of usage without being replaced with a new one. Currently, certain parts of the original Toshiba machine have been replaced by multiple spare parts from the redundant ultrasound machines at the host hospital. One of the radiologist participants mentioned that due to the poor state of the ultrasound machine, the sonographic images produced by the machine are of unacceptable quality. Similarly, during the observation period at the clinical site, it was noticed that the obstetric images were obscured by image artifacts, making interpretation of the images difficult. The obstetric ultrasound machine at the host hospital also lacks modern technology for scanning and PACS for transmitting images to the radiologists’ workstation. Furthermore, the analysis of the qualitative data revealed that there is no systematic quality assurance programme in place for the maintenance of the ultrasound machines at the host hospital.

Apart from the above mentioned limitations, the host hospital also faces financial constraints. Unacceptably low national health expenditure has created adverse effects on the health care service in Fiji (World Health Organisation, 2005). There are insufficient funds to upgrade, maintain or purchase new ultrasound machines to cope with the demands of obstetric sonography services. Due to limited financial resources and lack of health planning, there are continuous shortages of health supplies and deterioration of health care facilities (Sharma, 2002). Further, the recurrent political instability has led to weakening of the national economy and mass emigration of skilled health professionals (Australian Agency for International Development, 2008; World Health Organisation, 2005). The 2006 military coup has also caused a delay in the establishment of a registration board to ensure standardisation of obstetric sonography practice in Fiji (Parliament of Fiji Islands, 2006). Therefore, it is anticipated that the above limitations have contributed to inconsistencies and disparities in radiographers’ obstetric scanning at the host hospital. A summary of the key findings of this research is illustrated in Figure 23 on the following page.
Factors that have **direct** influence:

- Excessive Workload
  - 70-100 patients/day
  - No patient booking system
  - Report writing
  - Work-related stress

- Short Durations of Scans
  - Brief scans done
  - Quality of scans compromised
  - Minimal patient communication

- Absence of a Written Protocol
  - Inconsistencies in scanning
  - Amongst radiographers
  - Between exams

- Radiographers’ Lack of Expertise
  - Non-ultrasound qualification
  - Lack of CPD
  - Inadequate supervision

- Lack of Scanning Facilities
  - 1 room & machine
  - Machine deteriorating
  - No Doppler & PACS
  - No quality assurance

Factors that have **indirect** influence:

- Limited Number of Specialists
- Ineffective Relationship
- Limited Scanning Facilities
- Lack of funds
- Delay in establishment of a Radiation Board
- CPD plans on hold

**Summary of the Research Findings**

**Current Obstetric Sonography Practice in Fiji**

- Does not entirely meet *International Standards*
- Does not entirely meet *Obstetricians’* expectations
- Meets *Radiologists’* immediate needs
RESEARCH LIMITATIONS

Several limitations were encountered during the course of this study, especially during the observations at the clinical site for data collection. Firstly, being a former colleague of the radiographer participants (participant-researcher familiarity) and the radiographers’ awareness of being watched by me during their performances of scans (overt research) could have potentially caused a Hawthorne effect (Polgar & Thomas, 2000). That is, there are possibilities that my presence at the clinical site could have influenced the radiographers’ approach to scanning.

Secondly, having assumed a “non-interventionist’s” role (a non-participant observer) during the observations, I could not interrupt the examinations in which obvious discrepancies were noted (Cohen et al., 2000, p. 315). Thirdly, only two mid-trimester examinations per radiographer participant were observed (a total of 12 examinations). It is anticipated that inclusion of more examinations would have increased the reliability of the quantitative data. Issues relevant to the above limitation have been discussed earlier in Chapter 4. Furthermore, since there was no booking system for obstetric sonography examinations at the host hospital, identifying and including patients who met the selection criteria for the study, was a time consuming exercise.

Moreover, it was not feasible to estimate the sampling error for this study since a non-probability sampling was employed to purposively select the participants (Emerek, 2008). Another limitation was that the questionnaires and the interviews entailed questions related to sensitive issues, thereby causing the possibility of social desirability bias to occur. Such biases occur when the research participants provide responses which are socially acceptable or favourable to the researcher (Ary, Jacobs, Razavieh & Sorensen, 2006). Lastly, the quotations used in this thesis are verbatim and may indicate the participants’ difficulty with English as a second language. Thus, some of the participant’s quotations are accompanied by my personal comments, within the brackets, for the purpose of providing clarification.
PERSONAL LIMITATIONS

In my capacity as a researcher, I have observed, interviewed, transcribed and interpreted the research data with integrity. Although I had employed a detailed structured observation protocol, it is possible that inter-observer variability, my own assumptions and preconceived ideas about the phenomenon under study could have influenced the way data was collected during the observation period. That is, there is a possibility that, to some extent, my personal bias may have affected the interpretations of the observation data. Finally, as a researcher, my limited clinical experience in sonography was a restricting factor and, therefore, frequent consultations and guidance were sought from an obstetrics and gynaecology sonography expert based in a clinical facility in Auckland. These limitations have been addressed earlier in Chapter 4.

Despite the above personal limitations, I have strived to be open-minded and as objective as possible during this research so that I can address the insights of the research participants. The following section presents a discussion on the implications of this study on the obstetric sonography practice in Fiji and the areas worthy of further research.

IMPLICATIONS FOR PRACTICE AND FUTURE RESEARCH

It is anticipated that the outcome of this study may encourage the relevant authorities (such as the Ministry of Health and the major hospitals in Fiji) to increase awareness amongst the obstetricians, the radiographers and the patients about the importance of a comprehensive mid-trimester obstetric sonography examination during pregnancy. The integration of a first trimester dating scan with a comprehensive anatomical survey in the mid-trimester period may enhance the benefits of obstetric sonography practice in Fiji. That is, by substituting several short sonography examinations throughout the pregnancy with a scheduled comprehensive examination, it may help the obstetricians to optimise pre- and post-natal patient care. Such practice, to some extent, may also reduce the radiographers’ current workload and resultant stress.

The research findings may encourage the host hospital to implement and adhere to appropriate sonography guidelines which may bring consistency in practice and consequently improve sonography services at the hospital. Furthermore, it is anticipated that highlighting
the educational needs of the radiographers in this research may encourage the Ministry of
Health and the Fiji School of Medicine to develop strategies to provide a curriculum-based
medical ultrasound programme for all the ultrasound practitioners (the radiographers,
obstetricians and the general practitioners) in Fiji.

The outcome of this study may also draw the attention of the international sonography
organisations, such as, ASUM, AIUM, World Federation for Ultrasound in Medicine and
Biology (WFUMB) and other donor agencies to provide assistance in terms of funds,
equipment, resource personnel or teaching aids to initiate an ongoing professional
development programme for the ultrasound practitioners. Ultimately, this would optimise
sonography services in Fiji.

Apart from the above implications, at least 4 issues were identified during the course of this
research that are worthy of further investigation:

- Since my research focussed on the scanning guidelines used by the radiographers for
  obstetric examinations, a further study could be undertaken to assess the accuracy of
  the radiographers’ obstetric scanning at the hospitals in Fiji. Such a study may also
  assess the efficacy of the radiographers’ sonography reports in pregnancy
  management. Additionally, similar research could be conducted to assess the quality
  of non-obstetric sonography examinations performed by the radiographers in Fiji.
  Such studies would further highlight the strengths, weaknesses, opportunities and
  threats that the current practice has on the patients, radiographers and the hospital. It
  would also help to improve the diagnostic services at the hospitals in Fiji.

- It is important to investigate the applicability of the fetal growth charts currently
  being used by the hospitals in Fiji. Such a study may aim to establish normal growth
  curves from a multicultural population in Fiji, for fetuses of 6 to 40 weeks’ gestation
  by using sonographic measurements of the CRL (Crown Rump Length), BPD, HC,
  AC and FL. Currently, the host hospital, where my research was located, uses charts
  devised by Hadlock et al. who deduced their data from the white American population
  in 1982 (Westerway, 2000). A population-based nomogram would provide accurate
  data for fetal development, wellbeing and pregnancy management.

- Since there is no quality assurance programme for the ultrasound equipment at the
  host hospital, it is important to investigate whether the ultrasound equipment and its
measurement software programs (callipers) are operating at the expected level of performance. Similar investigations could be made at the other health care facilities which provide ultrasound services.

- During the course of this thesis, it was difficult to establish the number of fetal deaths that occur in Fiji and their causes. The Fiji Bureau of Statistics and the World Health Organisation websites only presented statistics on the infant death rates in Fiji. However, there was no information on the prenatal deaths. Therefore, a study could be conducted to investigate the number of fetal deaths that occur in Fiji, their common causes, the effectiveness of timely obstetric sonography to diagnose the potential causes of the deaths, and the possibility of medical interventions to minimise fetal deaths.

**RECOMMENDATIONS**

Based on the results of this study, the following recommendations have been made to optimise obstetric sonography practice and services in Fiji:

- It is imperative for the hospital in Fiji to devise and implement a standard written obstetric sonography protocol. Such examination guidelines may be best devised in collaboration with the radiologists, radiographers and the obstetricians. Adoption of any existing protocol, such as the ASUM obstetric sonography guidelines, would need to be tailored to suit the needs and facilities available at the hospitals in Fiji. It is anticipated that standard guidelines would promote consistency in scanning, “improve communication with patients, promote the uniform development of ultrasound services, and lift the medicolegal burden from the radiographers” (Witcombe & Radford, 1986, p. 115).

- The Ministry of Health and the Fiji School of Medicine would benefit from collaborating to instigate a post-qualification/postgraduate course in medical ultrasound. It may begin as a basic course for the radiographers to meet the immediate needs of their sonography practice. The relevant authorities could make a proposal to the international ultrasound organisations (such as ASUM, AIUM and WFUMB) for their assistance to provide necessary resources for the educational programme. The authorities in Fiji could also liaise with the Pacific Society for Reproductive Health organisation, which, in collaboration with the sonography experts at the University of
Auckland, is developing a basic ultrasound course for the practitioners in the South Pacific region (Jenny Mitchell, personal communication, October 10, 2008). Such an educational programme could increase the ultrasound practitioners’ knowledge, clinical competency and confidence in scanning so that they are realistic in judging the quality of their scans (Dudley & Chapman, 2002). Consequently, a curriculum-based ultrasound course may help the radiographers to meet the expectations of the sonography specialists and the needs of the obstetric patients. With regard to an ultrasound course in Fiji, one of the participants of this research commented that:

*Education is the foundation, because once you get taught properly, you’ll never go wrong. I would think they should have a protocol of their own. So with good teaching, good examination of the fetus and good checking of the ultrasound [interpretation of the images], they’ll [radiographers] never go wrong. (Dr. Lloyd – Obstetrician).*

- As a priority, the government of Fiji may consider establishing the Radiation Technologists Board at the reinstatement of its parliament. This would ensure that sonography practice in Fiji is standardised, the patients receive quality and timely diagnostic services and the radiographers continue their professional development.
- The host hospital could seriously consider implementing a patient booking system so that the obstetric patients are scheduled at the appropriate time for sonography examinations, preferably during the first trimester between 11 to 14 weeks’ gestation (Vankayalapati & Hollis, 2004), mid-trimester between 18 to 23 weeks’ gestation (Sanders, 1998b) and third trimester for patients with genuine clinical indications. Moreover, the obstetricians could review their criteria for referring patients for scans so that they are clinically assessed adequately prior to being referred for scans.
- The government of Fiji could allocate more funds to the Ministry of Health so that new ultrasound machines, with modern technology (such as Doppler and PACS), are installed at the host hospital. However, it is anticipated that there will be competition for such resources in the other areas of the health care services. Increasing the number of machines, examination rooms and sonography staff, would reduce the current workload and work-related stress, increase duration of scans, improve scan quality, promote effective patient communication and help the obstetricians manage their
patients better. It is also recommended that PACS or a similar technology be introduced at the host hospital so that the radiologists’ contribution to obstetric sonography is increased and they are able to make diagnostic decisions and monitor the radiographers’ practice. The hospitals would benefit from having a standard quality assurance programme so that the performance of all their medical equipment is optimal at all times.

• The Ministry of Health would benefit from employing more radiologists at the major hospitals to meet the needs of the country’s health system. It could consider acknowledging radiology as a core speciality and recognising the importance of the radiologist’s role in medicine. This may encourage more medical practitioners to pursue a career in the radiology profession.

Hence, it is imperative for the stakeholders to collaborate and genuinely contribute towards optimising the quality of sonography services in Fiji so that ultrasound is used as a powerful and not a maligned diagnostic tool (Dudley & Chapman, 2002).

CONCLUDING STATEMENTS

This study employed a case study approach positioned in an interpretive paradigm to investigate the current obstetric sonography practice at an urban public hospital in Fiji. Multiple data collection methods were employed to collect predominantly qualitative data through methodological and data triangulation of observations, questionnaires and interviews. While the quantitative data was obtained from the observations made on the scanning guidelines used by the radiographers, most of the qualitative data was obtained from the questionnaires and the interviews. The findings of this study revealed that there are obvious gaps in the current practice of obstetric sonography in Fiji, as summarised by the specialist participants in the following excerpts:

"There’s obvious gap in quality. One of the biggest reasons for it is the time spent per patient [short durations for scans]. The other gap is of course the training, there is no formal training and I think in a sense the quality, standards and the training programme are related."

(Dr. Reed – Obstetrician)
There are gaps. There are some you can bridge [but] there are some beyond our control. You know our resources, infrastructures, the drawbacks, and the difficulties we face. It is the reality of it. It is a long journey. (Dr. Smith – Radiologist)

The analysis of the research data substantiates the specialist participants’ inferences above. The evaluation of the radiographers’ criteria for the mid-trimester obstetric sonography examinations at the host hospital showed inconsistencies in their current practice. Absence of a standard written protocol, insufficient expertise, training and supervision, excessive workload and lack of resources, have been identified as some of the major factors influencing the radiographers’ sonography practice at the host hospital. Therefore, it is concluded that due to the above limitations and constraints, currently the obstetric sonography practice at the host hospital neither meets the international standards nor the expectations of the sonography specialists in its entirety. Hence, there is a genuine need for the implementation of standard obstetric sonography examination protocols at all the hospitals which provide ultrasound services. In addition, it is imperative for the stakeholders in Fiji to introduce and enforce continuing professional development for the ultrasound practitioners through a curriculum-based medical sonography programme to minimise the gaps in the current practice. Thus, the analysis of the data in this research surmises that obstetric sonography practice in Fiji needs to focus on developing improved strategies for the early recognition of fetal and maternal wellbeing, and pregnancy related problems, so that the patients’ health care needs are delivered safely, effectively and in a timely fashion without compromises (Kady & Gardosi, 2004).
BIBLIOGRAPHY


# Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Trimester</td>
<td>first 14 weeks of pregnancy in humans</td>
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<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Trimester</td>
<td>15 to 27 weeks of pregnancy in humans</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Trimester</td>
<td>28 weeks pregnancy till birth in humans</td>
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<tr>
<td>Agenesis</td>
<td>condition in which a body part fails to develop</td>
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<tr>
<td>Amniotic fluid index/volume</td>
<td>sonographic assessment of amniotic fluid within a pregnant woman’s uterus, also referred to as ‘liquor volume’</td>
</tr>
<tr>
<td>Anatomical survey</td>
<td>comprehensive ultrasound study and description of structures and organs of the fetus and maternal pelvic cavity</td>
</tr>
<tr>
<td>Anomaly</td>
<td>abnormality or marked deviation from normal</td>
</tr>
<tr>
<td>Antenatal</td>
<td>pregnancy period or before birth</td>
</tr>
<tr>
<td>Anterior</td>
<td>in front of</td>
</tr>
<tr>
<td>Axial plane/view</td>
<td>horizontal plane, also known as transverse plane</td>
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<tr>
<td>Biometry parameter</td>
<td>fetal anatomical structures which are sonographically assessed to determine fetal age and growth</td>
</tr>
<tr>
<td>Cervical</td>
<td>pertaining to maternal cervix</td>
</tr>
<tr>
<td>Computed tomography</td>
<td>imaging modality that produces cross-sectional images using x-rays</td>
</tr>
<tr>
<td>Congenital</td>
<td>(condition) acquired at birth or during pregnancy</td>
</tr>
<tr>
<td>Coronal plane/view</td>
<td>vertical plane dividing the body into front and back portions</td>
</tr>
<tr>
<td>Coup d’état</td>
<td>sudden overthrow of an elected government</td>
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<tr>
<td>Crown rump length</td>
<td>length of a fetus/embryo from the vertex of skull to its buttocks</td>
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<tr>
<td>Current practice</td>
<td>procedures currently being followed during a mid-trimester sonography examination at the hospital where this research was located</td>
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<tr>
<td>Deformation</td>
<td>alteration in shape or position of a normal body part by mechanical forces in a fetus</td>
</tr>
<tr>
<td>Disruption</td>
<td>destruction of previously normally developed structures</td>
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Doppler: process of measuring velocities of a moving body fluid (such as blood) using ultrasound.

Down syndrome: disorder caused by presence of an extra chromosome (47 instead of 46 chromosomes), also referred to as Trisomy 21.

Embryology: study of the origin and development of a living organism till the end of the eight week of pregnancy.

Extremities: fetal limbs.

Fetal: pertaining to an unborn child in a mother’s womb, from the 9th week after conception until birth.

Fetal crowding: maternal uterus getting occupied by the growth of fetus.

Field of view: area of patient seen on the display monitor during scan.

General practitioner: private physician or medical doctor.

Gestational age: estimated age of a fetus.

Gestational dating: sonographic determination of fetal age.

Gold standard: an ideal model or criteria.

Hawthorne effect: participant’s change of behaviour or performance due to being observed during a research.

High-risk patients: women pregnant with fetuses who have high chances of developing abnormalities.

Host hospital: the urban public hospital in Fiji where this research was located.

Image artifact: sonographic appearances which do not accurately correspond to anatomical features or characteristics in the patient.

Image gain: amplification of echoes (sound) on an image.

In utero: within the uterus.

In-patients: patients admitted at the host hospital.

International standards: standards for obstetric sonography practice developed by an international organisation such as ASUM.

Intrauterine: within uterus.

Low-risk patients: women pregnant with fetuses who have low chances of developing abnormalities.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tr>
<td>Magnetic resonance imaging</td>
<td>diagnostic modality that produces cross-sectional images with the use of magnets and radio waves</td>
</tr>
<tr>
<td>Malformation</td>
<td>structural defects caused by error in tissue formation</td>
</tr>
<tr>
<td>Maternal</td>
<td>pertaining to a child bearing mother</td>
</tr>
<tr>
<td>Mid-trimester</td>
<td>synonym for 2nd trimester</td>
</tr>
<tr>
<td>M-mode</td>
<td>time motion scanning producing wavy lines on screen</td>
</tr>
<tr>
<td>Morbidity</td>
<td>diseased condition</td>
</tr>
<tr>
<td>Mortality</td>
<td>pertaining to death</td>
</tr>
<tr>
<td>Neonatal</td>
<td>pertaining to first 4 weeks of birth</td>
</tr>
<tr>
<td>Nomogram</td>
<td>A population-based predictive graph or chart used for obstetric sonography measurements</td>
</tr>
<tr>
<td>Nuchal thickness / fold</td>
<td>thickness of the skin fold behind the nape of the neck</td>
</tr>
<tr>
<td>Nuchal translucency</td>
<td>fluid filled space behind the nape of the fetal neck</td>
</tr>
<tr>
<td>Obstetric</td>
<td>synonym for pregnancy</td>
</tr>
<tr>
<td>Obstetric sonography</td>
<td>ultrasound scan performed during pregnancy</td>
</tr>
<tr>
<td>Obstetrician</td>
<td>specialised doctor who provides health care to pregnant women through pregnancy and childbirth</td>
</tr>
<tr>
<td>On-the-job trained</td>
<td>on the job training of radiographers in sonography at the hospital where this research was conducted</td>
</tr>
<tr>
<td>Pathological</td>
<td>pertaining to disease</td>
</tr>
<tr>
<td>Pathophysiology</td>
<td>study of functional changes associated with or resulting from disease or injury</td>
</tr>
<tr>
<td>Perinatal</td>
<td>pertaining to the period from 20th week of pregnancy till the 4th week after birth</td>
</tr>
<tr>
<td>Placenta previa</td>
<td>condition when the placenta partially or totally covers the maternal cervix in pregnancy</td>
</tr>
<tr>
<td>Posterior</td>
<td>at the back of</td>
</tr>
<tr>
<td>Postnatal</td>
<td>pertaining to the period after birth</td>
</tr>
<tr>
<td>Post-term pregnancy</td>
<td>pregnancy beyond 42 weeks in duration</td>
</tr>
<tr>
<td>Prenatal</td>
<td>synonym for antenatal</td>
</tr>
<tr>
<td>Protocol</td>
<td>detailed and formal plan of a procedure</td>
</tr>
<tr>
<td>Radiographer</td>
<td>technologist responsible for performing medical imaging procedures using ionising radiation</td>
</tr>
<tr>
<td>Radiologist</td>
<td>specialist medical doctor trained in interpreting medical</td>
</tr>
</tbody>
</table>
images, performing interventional diagnostic procedures and making diagnostic decisions

**Radiology**

medical science that deals with diagnostic images of anatomical structures using various medical imaging modalities to provide diagnostic findings

**Real-time images**

instant sonographic visualisation of internal body parts

**Sagittal plane/view**

longitudinal plane that divides the body in bilateral symmetry

**Situs**

site or position

**Soft markers**

minor structural variants in fetus which are usually pointers to major abnormalities

**Sonographer**

specialised skilled professional who uses ultrasound to produce images for diagnosis

**Sonography**

diagnostic medical procedure that uses ultrasound to produce dynamic visual images of organs, tissues and blood flows within the vessels

**State of the art**

referring to the latest technology in ultrasound

**Transabdominal**

ultrasound scans performed from the top of the abdominal region

**Transducer**

ultrasound equipment that produces sound waves and receives the echoes from the organs/parts being scanned

**Transvaginal**

ultrasound scans performed via the vaginal passage

**Transverse plane/view**

synonym for axial plane/view

**Ultrasound**

mechanical sound vibrations at very high frequency of over 20,000 KHz, normally ranged from 3 to 15 MHz for diagnostic use

**Ultrasound practitioners**

referring to radiographers, radiologists, obstetricians and/or physicians who perform ultrasound scans

**Unwritten departmental guidelines**

unwritten scanning sequences followed by the radiographers to perform scans at the host hospital

**Zoom function**

ability of the ultrasound machine to expand the image size
APPENDIX 1

ETHICAL PROCEDURES
RESEARCH PROPOSAL APPROVAL

11 September 2007
Sanjalesh Kumar
87C Nikau St
New Lynn
Waitakere 0600
AUCKLAND

Dear Sanjalesh

Thank you for submitting your research proposal ‘Obstetric sonography in Fiji: A review of the current practice and recommendations for a mid-trimester protocol’. The proposal was well written and clearly outlined a valuable study. The proposals committee of the School of Health Science has considered and approved your proposal. We have several suggestions which we would like you to consider and these are on the attached sheet. Please talk these over with your supervisors.

Your principal supervisor is Andrea Thompson and your associate supervisor is Jennie Billot.

Please be aware that ethical approval may be required for your research once you have finalised your proposal. To determine the need for ethics application and approval, we recommend that you read the Guidelines for Ethical Approval in the Research folder on the Blackboard site Postgraduate Students Resources, to identify any ethical issues that may arise. Discussion with your supervisor or the ethics committee (email: ethics@unitec.ac.nz) may also assist in this decision process. This will help determine the need, or otherwise, for a full application for ethical approval. Ethics applications and accompanying documents should be submitted as email attachments to the above address.

Please contact us if you have any questions, or if we can assist you in your research, by contacting me on extension number 7465 or email address jbillot@unitec.ac.nz.

We wish you every success in completing your research project.

Yours sincerely,

[Signature]

Dr Jennie Billot
School of Health Science Proposals Committee: Convenor

*Please note that the working title has been modified (the same is applicable to the subsequent documents).
RESEARCH ETHICS APPROVAL – UNITEC NZ

Sanjalesh Kumar
87C Nikau St
New Lynn
Waitakere 0600

October 23, 2007

Dear Sanjalesh

Your file number for this application: 2007.768

Title: Obstetric Sonography in Fiji: A review of the current practice and recommendations for a mid-trimester protocol

Your application for ethics approval has been reviewed by the Unitec Research Ethics Committee (UREC) and has been approved for the following period:

Start date: 17 October 2007
Finish date: 30 November 2008

Please note that:
1. the above dates must be referred to on the information AND consent forms given to all participants
2. you must inform UREC, in advance, of any ethically-relevant deviation in the project. This may require additional approval.

This letter has been copied to the Principal Supervisor for Unitec student research projects.

You may now commence your research according to the protocols approved by UREC. We wish you every success with your project.

Yours sincerely

Portia Richmond
Deputy Chair, UREC

RMOL ref#: 1043

cc: Andrea Thompson
Carla Sutton
2nd November 2007

Sanjalesh Kumar

Postgraduate Student (Master in Health Science)
Unitec NZ, Auckland – New Zealand.

87C Nikau Street, New Lynn
Auckland, New Zealand.
Ph: 00649 8272503 / Mob: 0064 2102374876

Dear Mr. Kumar,

Thank you for your application for ethical review to the Fiji National Research Ethics Review Committee (FNRERC).

I am pleased to advise that the FNRERC has approved the following proposal submitted to the Secretariat.

**Project Title**

Obstetric Sonography in Fiji: A Review of the Current Practice and Recommendation for a Mid-trimester Protocol

**Primary Investigator:** Mr. Sanjalesh Kumar

**Co-Investigators:** Nil

**FNRERC reference Number:** 019 – 2007

I am pleased to advise you that the FNRERC has granted Ethical and Technical approval for your above-mentioned study with conditions.

The Project has been approved for the period expiring 31/12/08. It is your responsibility to ensure that all people associated with this particular project are made aware of what has actually been approved.

Please apply for renewal of your current approved study before December 2008.
Please note that the following conditions apply to your approval. Failure to abide by these conditions may result in suspension or discontinuation of approval and/or disciplinary action.

(a) Variation to Project: Any subsequent variations or modifications you might wish to make to your project must be notified formally to the Chair, Fiji National Research Ethic Review Committee for further considerations and approval. If the Chair considers that the proposed changes are significant, you may be required to submit a new application for approval of the revised project.

(b) Incidence or adverse affects: Researchers must report immediately to the Chair of the FNRERC anything which might affect the ethical acceptance of the protocol including adverse effects on subjects or unforeseen events that might affect continued ethical acceptability of the project. Failure to do so may result in suspension or cancellation of approval.

(c) Monitoring: Projects are subject to monitoring at any time by the ethics Committee.

(d) Annual Report: You must submit an annual report on this project at the end of the year or at the conclusion of the project if it continues for less than a year. The Secretary of the Fiji National Research Ethics Review Committee sends out request for annual reports.

Please quote the FNRERC reference number and the name of the project in any future correspondence.

If you have any further queries on these matters or required additional information, please do not hesitate to contact the undersigned on telephone: (679) 3221424 or email: ravi.reddy@health.gov.fj

Yours sincerely,

[Signature]

Ravi Reddy
Secretary, FNRERC

for
Chairperson, FNRERC.
INFORMATION FOR THE PARTICIPANTS

Obstetric Sonography in Fiji: A Review of the Current Practice and Recommendations for a Mid-trimester Protocol

Dear Prospective Participant,

My name is Sanjalesh Kumar. I am a postgraduate student pursuing a Master of Health Science degree at Unitec NZ and intending to undertake research to explore current obstetric sonography practice in Fiji.

What am I going to do?
I intend to evaluate the current practices and procedures used for mid-trimester obstetric sonography at your hospital. Following this, it is anticipated that a suitable standard protocol for mid-trimester obstetric sonography acquired from an international practice guideline will be recommended.

What will it mean for you?
If you are a Radiographer and willing to participate in this study then:

- Firstly, I would like you to perform two mid-trimester obstetric scans on patients of 18-24 weeks’ gestation. For the purpose of this research, while you will perform the examinations I would like to observe your procedure for scan / practice. It is important to note that this observation is NOT to assess your performance but the procedure for scans. The diagnostic reports made by you will also be viewed. The details of your procedures and the patients’ reports will be kept confidential at all times. Patients will not be active participants of this study.
- Secondly, I would like you to complete a questionnaire after you have finished scanning two of your patients.

If you are a Radiologist or an Obstetrician then:
I would like to interview you to establish your views on the current practice of obstetric sonography at your hospital and training aspects of the radiographers performing obstetric sonography. I will audio-record the interview and transcribe it at a later date. The transcriptions will then be returned to you for verification. The recorded material will be kept in a safe locked place to assure confidentiality. The storage period for these materials would be 5 years following the completion of this research.

How will you benefit?
By participating in this research, you would help me to study current mid-trimester sonography practice and assess the educational / training needs of the radiographers at your hospital. This research will have the potential for your ultrasound department to adopt a standard protocol for mid-trimester scans. It may also encourage the Ministry of Health in collaboration with the Fiji School of Medicine to embark on offering a Postgraduate program for the prospective students interested in practicing Medical Sonography.
What will I do with this?
In addition to providing a feedback to you, your hospital, the Ministry of Health, the Fiji School of Medicine and Unitec regarding the results, I would like to present this research at an appropriate conference. Also if possible, I would like to publish the information in a reputable, professional journal. However, strict anonymity will be adhered to and your name, department or hospital will not appear in the information.

Consent
If you agree to participate, you will be asked to sign the consent form attached. However, if you wish to withdraw from this project, you may do so at any time before ___/____/2007 without being disadvantaged in any way.

Confidentiality and Anonymity
Any information that may identify you would be kept confidential. All information collected from you will be kept in a safe locked place. The only people having access to this information would be my supervisors and me. For anonymity, you would be given a pseudonym known only to the researcher and the research supervisors.

If you have any concerns about the research project, you may contact my research supervisors:

1. Andrea Thompson
   Ph: 00 649 8154321 ext: 8413
   E-mail: athompson@unitec.ac.nz

2. Dr Jennie Billot
   Ph: 00 649 8154321 ext: 7465
   E-mail: jbillot@unitec.ac.nz

If you need any further information, please do not hesitate to contact me. Thank you for your valuable time.

Sanjalesh Kumar
87C Nikau Street,
New Lynn, Auckland – NZ
Ph: 00 649 8272503 / mob: 0064 2102374876 (NZ) / mob: 9269232 (FJ)
E-mail: kumars45@studentmail.unitec.ac.nz

This research has been approved by:

Unitec Research Ethics Committee (UREC) on: 23/10/2007
UREC Reference Number: 2007.768

FNRERC Reference Number: 019-2007
CONSENT FORM FOR THE PARTICIPANTS

Obstetric Sonography in Fiji: A Review of the Current Practice and Recommendations for a Mid-trimester Protocol

This consent form will aid in obtaining information for research to establish if the current mid-trimester sonography practice at an urban public hospital in Fiji adequately meets the professional expectations of the Radiologists and the Obstetricians within the hospital, and the international standards for mid-trimester sonography.

I understand that:

- (Applicable to the Radiographer) The researcher will observe and make notes during two sonography examinations that I will perform.
- My patients’ identities and diagnostic reports will be kept confidential at all times.
- (Applicable to the Radiologist or the Obstetrician) My discussion during the interview will be audio-taped and transcribed. The transcription will be returned to me to review.
- Having signed this consent form, I will have the independence to withdraw from the project at any time before ___/___/2007 without being disadvantaged in any way.
- Any information that may identify me would be kept confidential and my identity will be kept concealed at all times by allocation of a pseudonym.
- All information collected from me will be kept in a safe locked place and the only people having access to this information will be the researcher and the supervisors.
- In addition, the results will also be disseminated to the hospital in which the study is located, the Ministry of Health – Fiji, the Fiji School of Medicine and possibly be published in a reputable professional journal or presented at a scientific seminar.
- I can contact the following persons if I have any concern or queries regarding the research at any time:

<table>
<thead>
<tr>
<th>Researcher</th>
<th>Research Supervisors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanjalesh Kumar</td>
<td>Andrea Thompson</td>
</tr>
<tr>
<td>Ph: 00649 8272503</td>
<td>Ph: 00649 8154321 ext: 8413</td>
</tr>
<tr>
<td><a href="mailto:kumars45@studentmail.unitec.ac.nz">kumars45@studentmail.unitec.ac.nz</a></td>
<td><a href="mailto:athompson@unitec.ac.nz">athompson@unitec.ac.nz</a></td>
</tr>
</tbody>
</table>

I have read and understood the information sheet and the details of the research project have been explained to me by the researcher. I have also had the opportunity to ask questions and have them answered.

I have had time to consider everything and I agree to be part of this research.

Participant’s Signature: ………………………… Date: ……………………

Researcher’s Signature: ………………………… Date: ……………………

This research has been approved by the Unitec Research Ethics Committee (UREC) on 23/10/2007 (Ref: 2007.768) and the Fiji National Research Ethics Review Committee (FNRERC) on 2/11/2007 (Ref: 019-2007)
APPENDIX 2

DATA COLLECTION FORMS AND INSTRUMENTS
RESEARCH OBSERVATION PROTOCOL

Participant Code: ____________ Participant Category: ______________ Examination No._____ Duration of Scan: start________ end _______
Patient’s clinical history / indications: ________________________________________________________________

<table>
<thead>
<tr>
<th>ASSESSMENT OF FETAL LIFE AND POSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Assessed initial fetal heart activity</td>
</tr>
<tr>
<td>☐ Assessed fetal position</td>
</tr>
<tr>
<td>Comments:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BIOMETRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPD</td>
</tr>
<tr>
<td>☐ Transverse measurements</td>
</tr>
<tr>
<td>☐ Falx cerebri</td>
</tr>
<tr>
<td>☐ Cavum septum pellucidum in midline</td>
</tr>
<tr>
<td>☐ Paired thalami</td>
</tr>
<tr>
<td>☐ Measured from outer to inner at the widest point of skull</td>
</tr>
<tr>
<td>Comments:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HC</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Transverse measurements</td>
</tr>
<tr>
<td>☐ Measurement taken at the same level as BPD</td>
</tr>
<tr>
<td>☐ Ellipse placed at the outer edge of the widest point of skull</td>
</tr>
<tr>
<td>Comments:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Transverse measurements</td>
</tr>
<tr>
<td>☐ Stomach on the left</td>
</tr>
<tr>
<td>☐ Ellipse placed at the outer skin margins</td>
</tr>
<tr>
<td>Comments:</td>
</tr>
</tbody>
</table>

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Left portal vein liver</td>
</tr>
<tr>
<td>3 ossification centres of the spines</td>
</tr>
<tr>
<td>BIOMETRY (Continued)</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>FL</td>
</tr>
<tr>
<td>□ Longitudinal measurements</td>
</tr>
<tr>
<td>□ Ultrasound beam perpendicular to the bone</td>
</tr>
<tr>
<td>□ Measurement along the diaphysis excludes the distal femoral epiphysis</td>
</tr>
<tr>
<td><em>Comments</em>:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HEAD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shape</strong></td>
</tr>
<tr>
<td>□ Transverse plane</td>
</tr>
<tr>
<td>□ Checked for normal globe-like calvaria</td>
</tr>
<tr>
<td>□ Checked for abnormal calvaria</td>
</tr>
<tr>
<td>• Banana-shape cerebellar hemisphere</td>
</tr>
<tr>
<td>• Lemon-shape anterior portion</td>
</tr>
<tr>
<td>• Partial/complete absence of cranium</td>
</tr>
<tr>
<td><em>Comments</em>:</td>
</tr>
</tbody>
</table>

| **Lateral Ventricles & Choroid Plexus** |
| □ Transverse and/or coronal planes |
| □ Checked for presence of symmetrical lateral ventricles filled with choroid plexus |
| □ Measured ventricular width (normal < 10mm) |
| □ Checked for angle of choroid plexus (> 75° is abnormal – dangling) |
| *Comments*: |

| **Falx Cerebri** |
| □ Transverse plane |
| □ Checked for inter-hemispheric fissure |
| *Comments*: |

| **Cisterna Magna** |
| □ Transverse oblique, at the level of cerebellum |
| □ Checked for normal fluid-filled spaces between cerebellum and skull |
| *Comments*: |

| **CSP** |
| □ Transverse plane |
| □ Checked for a triangular space between lateral ventricles anterior to thalami |
| *Comments*: |

<p>| <strong>Nuchal Thickness</strong> |
| □ Transverse oblique, at the level of cerebellum |
| □ Measured nuchal thickness at level of cistern magna (normal is &lt; than 6mm) |
| <em>Comments</em>: |</p>
<table>
<thead>
<tr>
<th>FACE</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lips</strong></td>
<td></td>
<td><strong>Nose</strong></td>
</tr>
<tr>
<td>□ Demonstrated both the lips</td>
<td></td>
<td>□ Demonstrated both nostrils (single nostril suggests abnormality- holoprosencephaly)</td>
</tr>
<tr>
<td>□ Transverse view through face and orbits to show gap between upper lip and maxilla to exclude cleft lip/palate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Comments:*

<table>
<thead>
<tr>
<th>Jaw</th>
<th></th>
<th><strong>Profile</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Demonstrated fetal mandible</td>
<td></td>
<td>□ Placed transducer at right angle to the views that showed maxilla (must not include orbits / must show side elevation of nose, lips and chin)</td>
</tr>
</tbody>
</table>

*Comments:*

<table>
<thead>
<tr>
<th>Orbits</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Transverse or coronal planes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Measured binocular and intraocular distances (intraocular should be 1/3 of binocular)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Comments:*

<table>
<thead>
<tr>
<th>SPINE</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Checked entire spine with 3 ossification centres in Transverse Plane</td>
<td>□ Checked skin-line</td>
<td></td>
</tr>
</tbody>
</table>

*Sagittal plane* □  
*Sagittal plane* □  
*Sagittal plane* □  
*Coronal plane* □  
*Coronal plane* □  
*Coronal plane* □  
*Transverse plane* □  
*Transverse plane* □  
*Transverse plane* □  

*Comments:*
<table>
<thead>
<tr>
<th>ABDOMEN</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diaphragms</strong></td>
<td>□ Demonstrated bilateral diaphragms</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Comments:</em></td>
<td></td>
</tr>
<tr>
<td><strong>Abdominal Wall</strong></td>
<td>□ Checked for abdominal wall consistency</td>
<td></td>
</tr>
<tr>
<td><strong>Stomach</strong></td>
<td>□ Checked for presence and position of stomach</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Comments:</em></td>
<td></td>
</tr>
<tr>
<td><strong>Urinary Bladder</strong></td>
<td>□ Checked for urinary bladder</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Comments:</em></td>
<td></td>
</tr>
<tr>
<td><strong>Kidneys</strong></td>
<td>□ Checked for both kidneys in transverse plane</td>
<td>□ Checked for abnormal echotexture within it</td>
</tr>
<tr>
<td></td>
<td><em>Comments:</em></td>
<td></td>
</tr>
<tr>
<td><strong>Umbilical Cord Insertion</strong></td>
<td>□ Checked for cord insertion into fetal abdomen</td>
<td>□ Checked abdominal wall defect at this site</td>
</tr>
<tr>
<td></td>
<td><em>Comments:</em></td>
<td></td>
</tr>
<tr>
<td><strong>3 Vessel Cord</strong></td>
<td>□ Checked for 2 arteries &amp; 1 vein, with Doppler</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Comments:</em></td>
<td></td>
</tr>
</tbody>
</table>

<p>| EXTREMITIES | □ Checked 12 Long bones |
|            | □ Longitudinal plane |
|            | □ Transverse plane |
|            | □ Checked for both hands &amp; 10 fingers |
|            | □ Checked for both feet &amp; 10 toes |
|            | <em>Comments:</em>          |</p>
<table>
<thead>
<tr>
<th>HEART</th>
<th>M-Mode Doppler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Motion</td>
<td>Checked for fetal heart motion</td>
</tr>
<tr>
<td>Comments:</td>
<td>Comments:</td>
</tr>
<tr>
<td>Heart Position</td>
<td>Checked for situs</td>
</tr>
<tr>
<td>Comments:</td>
<td>Comments:</td>
</tr>
<tr>
<td>4-Chambered Heart</td>
<td>Checked for the 4 chambers of heart</td>
</tr>
<tr>
<td>Comments:</td>
<td>Comments:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outflow Tracts</th>
<th>Cardiac Valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checked for RVOT</td>
<td>Checked for mitral &amp; tricuspid valves</td>
</tr>
<tr>
<td>Checked for LVOT</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td>Comments:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PLACENTA &amp; AMNIOTIC FLUID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checked for placental site</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MATERNAL ANATOMY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessed cervix</td>
</tr>
</tbody>
</table>

Radiographer’s Scan Report:

........................................................................................................................................................................
........................................................................................................................................................................
........................................................................................................................................................................
........................................................................................................................................................................
RESEARCH QUESTIONNAIRE

(Participant Code..................)

Part A: Education & Clinical Experience
(Note: where tick boxes are provided please tick (✓) only 1 box)

1. What Medical Imaging qualification do you currently hold?
   - Certificate □
   - Diploma □
   - Degree □
   - Postgraduate Certificate / Diploma □
   - Other □
   If ticked ‘Other’ above, then please specify...........................................................................

2. Which year did you qualify with the above qualification? ______

3. Do you hold any Medical Sonography specific academic qualification(s)?
   - No □
   - Yes □
   - Year: ____ Please specify qualification .................................................................

4. How many years of experience do you have in sonography practice?
   - 3 months – 1 year □
   - 1-3 years □
   - > 3 years □

5. How long have you been practising Obstetric Sonography?
   - 3-6 months □
   - 6-12 months □
   - 1-3 years □
   - > 3 years □

Part B: Professional Practice
(Note: where tick boxes are provided please tick (✓) only 1 box, unless stated otherwise)

6. How often do you perform the Mid-trimester scans per week?
   - < 10 □
   - 10-30 □
   - 31-50 □
   - 51-70 □
   - 71-100 □
   - > 100 □

7. Do you follow a documented departmental protocol for the Mid-trimester scans?
   (Please tick an appropriate box and provide an explanation where required)
   - Yes □
   - No □
   - If ‘No’ then state why? ...........................................................
   - ...........................................................................................................
   - ...........................................................................................................

192
8. From the list provided in the table below, please TICK the regions / measurements / fetal anatomy that you often include in your Mid-trimester survey? (Please tick as many boxes applicable to you for Question 8)

<table>
<thead>
<tr>
<th>Fetal Life &amp; Position</th>
<th>□ Initial Fetal Heart Activity</th>
<th>□ Fetal Position</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biometry</td>
<td>□ BPD</td>
<td>□ HC</td>
<td>□ AC</td>
<td>□ FL</td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td>□ Shape</td>
<td>□ Falx Cerebri</td>
<td>□ Corpus Septum Pellucidum</td>
<td>□ Lateral Ventricles/ Choroid Plexus</td>
<td>□ Cisterna Magna</td>
</tr>
<tr>
<td>Face</td>
<td>□ Orbits</td>
<td>□ Nose</td>
<td>□ Lips</td>
<td>□ Jaw</td>
<td>□ Profile View</td>
</tr>
<tr>
<td>Spine</td>
<td>□ 3 Ossification Centres</td>
<td>□ Skin Line</td>
<td>□ Coronal Plane</td>
<td>□ Sagittal Plane</td>
<td>□ Transverse Plane</td>
</tr>
<tr>
<td>Abdomen</td>
<td>□ Abdominal Wall</td>
<td>□ Diaphragm</td>
<td>□ Stomach</td>
<td>□ Kidneys</td>
<td>□ Urinary Bladder</td>
</tr>
<tr>
<td>Extremities</td>
<td>□ 12 Long Bones</td>
<td>□ Hands &amp; Fingers</td>
<td>□ Feet &amp; Toes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart</td>
<td>□ Fetal Heart Motion</td>
<td>□ Fetal Heart Activity in M-Mode</td>
<td>□ Heart Position</td>
<td>□ 4-Chambered Heart</td>
<td>□ Cardiac Valves</td>
</tr>
<tr>
<td>Placenta &amp; Amniotic Fluid</td>
<td>□ Placental Site</td>
<td>□ Placental Echotexture</td>
<td>□ Distance from External Os</td>
<td>□ Amniotic Fluid Index</td>
<td></td>
</tr>
<tr>
<td>Maternal Anatomy</td>
<td>□ Cervix</td>
<td>□ Adnexa</td>
<td>□ Uterus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. How often do you focus on detecting fetal anomalies during the mid-trimester scans?  
Always □     Sometimes □     Never □     Other □ □ please specify  
................................................................................................................................................................................

10. How confident are you in detecting fetal anomalies during the mid-trimester scans?  
Always sure □     Confused □     Unsure □     Other □ □ please specify  
................................................................................................................................................................................
11. How competent do you feel you are in detecting fetal anomalies during the mid-trimester scans?
   Excellent □       Good □       Average □       Poor □

12. How often do you document fetal anomalies in your reports during the mid-trimester scans?
   Always □       Sometimes □       Never □
   Other □       please specify .................................................................

13. Who confirms your findings?
   Radiologist □       Radiographer in-charge □       No one □
   Other □       please specify .................................................................

14. Do you think it is your responsibility to make the final scan report?
   (Please tick an appropriate box and explain)
   Yes □       No □       Please explain your response below
   ...........................................................................................................
   ...........................................................................................................

15. Do you have any specific educational needs in your practice of obstetric sonography?
   (Please tick an appropriate box and explain)
   Yes □       No □       Please explain your response below
   ...........................................................................................................
   ...........................................................................................................

16. How else do you think your practice in obstetric sonography can be enriched?
   ...........................................................................................................
   ...........................................................................................................
   ...........................................................................................................

17. Any other comments in relation to this study.
   ...........................................................................................................
   ...........................................................................................................
   ...........................................................................................................

*Please return the questionnaire by: ____/____/200__

Thank you for your participation

This research has been approved by the Unitec Research Ethics Committee (UREC) on 23/10/2007 (Ref: 2007.768) and the Fiji National Research Ethics Review Committee on 2/11/2007 (Ref: 019-2007)
INTERVIEW SCHEDULE FOR THE RADIOLOGISTS

1. How do you contribute to the practice of obstetric sonography at your hospital?

2. Does your hospital have a written formal protocol for the mid-trimester obstetric sonography examinations? If YES, then:
   - When the protocol was formally implemented at your department?
   - Who developed it and where was it acquired from?
   - Is this protocol consistently used by all of the radiographers who perform the mid-trimester scans? (If not, then please explain)
   - Do you think the protocol meets the international practice guidelines? (If yes, which guidelines does it comply with?)
   - Do you think it meets the obstetricians’ needs at your hospital?
   - Was the protocol reviewed for its effectiveness? (If not, could there be a particular reason(s) for it?)

   If NO to Question 2, then:
   - Is there a particular reason(s) why a written protocol hasn’t been implemented?
   - Do you think practising without a formal protocol could cause problems for the ultrasound practice at your hospital? (Explain)
   - In the absence of a formal protocol, what guidelines do the radiographers follow during the mid-trimester obstetric scans at your hospital?
   - How do you think consistency in practice is maintained by the radiographers without any formal guidelines?
   - Do you think these criteria meet the international practice guidelines? (Explain)
   - Do you think it meets the obstetricians’ needs at your hospital?

3. It has been noticed that approximately 70 obstetric patients are scanned per day at your obstetric ultrasound examination room and on a very busy day it even exceeds 100 patients. As such, the radiographers spend 3-4 minutes to scan a patient.
   - How much time do you think the radiographers need for performing a comprehensive anatomical survey during mid-trimester examinations?
   - Do you think the information gained from the radiographers’ short obstetric scans is sufficient?
4. In their questionnaire, the radiographers have reported to be working under psychological and physical stress. How do you think the current situation can be improved?

5. It has been observed that at your hospital, the radiographers make the final reports on the obstetric scans they perform. What could be the reasons for the radiologists’ minimal involvement in obstetric sonography practice at your hospital?

6. How confident do you feel about the radiographers’ performance of fetal anomalies scans?

7. How often do you receive reports of misdiagnosis of fetal anomalies from the obstetricians? How do you rectify such situations?

8. What do you think are the educational needs of the radiographers in obstetric sonography?

9. Do the radiographers participate in any form of continuing professional development programmes in obstetric sonography?

10. How often do you personally hold teaching sessions with the radiographers on obstetric sonography?

11. Are the radiographers sent for overseas attachments for ultrasound training? -If yes, how effective do you think these attachments are?

12. What are your/hospital’s future plans for the radiographers who would like to pursue education in sonography?

13. Do you think there are gaps in the current practice of obstetric sonography in Fiji? How would you like to contribute towards it? (Explain).

14. Any other comments relevant to my research topic?

Thank you very much for taking your valuable time out to participate in my research. I assure that your identity and the name of the hospital will remain anonymous, and the contents of this interview will be kept confidential at all times.
INTERVIEW SCHEDULE FOR THE OBSTETRICIANS

1. How do you contribute to the practice of obstetric sonography practice at your hospital?

2. In most of the countries abroad such as Australia and New Zealand, it is mandatory or a routine practice to perform an anatomical survey or full anomaly scans during 18-23 weeks of pregnancy so that prenatal and postnatal timely interventions are made. What is the practice at your hospital?

3. How often and what could be some reasons for sending patients for anatomy/anomaly scans during the mid-trimester period?

4. What do you expect the radiographers to investigate during an anatomy/anomaly scan?

5. What prenatal and postnatal interventions are made at your hospital when fetal anomalies are detected?

6. During my observations at the Ultrasound Department, I have noticed that most of the pregnant mothers are referred for a late scan during their pregnancy. Are they booked late or are there other reasons? (Explain).

7. During my observations at the Ultrasound Department, I have noticed that approximately 70 obstetric patients are scanned per day and on a very busy day it even exceeds 100 patients. As such, on average radiographers only spend 3 minutes on a patient. How much time do you think the radiographers should spend scanning for the fetal anatomy and anomalies?

8. Due to the amount of workload, the radiographers have reported to be working under inevitable psychological and physical stress. What do you think the O&G department can do about this?

9. How confident and competent do you think the radiographers are performing anomaly
/anatomy scans?

10. How often are anomalies misdiagnosed by the radiographers?

11. What sorts of anomalies often go misdiagnosed?

12. How often do you repeat the same scan in your clinic? (Explain).

13. Unlike in other countries, it has been observed that at your hospital the radiographers make the final reports on the scans. How confident do you feel about their reports?

14. Having worked with the radiographers who perform scans, what do you think would be some of their educational needs in obstetric sonography practice?

15. How could the obstetricians contribute towards the educational needs of these radiographers?

16. What could be some of the gaps in the current practice of obstetric sonography at your hospital? (Explain).

17. Any other comments relevant to my research topics?

Thank you very much for taking your valuable time out to participate in my research. I assure that your identity and the name of the hospital will remain anonymous, and the contents of this interview will be kept confidential at all times.
APPENDIX 3

ASUM MID-TRISMEISTER SONOGRAPHY GUIDELINES AND WORKSHEET
ASUM GUIDELINES: Mid-trimester Obstetric Ultrasound Scan

Policies and Statements

D2
Guidelines For The Mid Trimester Obstetric Scan


18-20 weeks is the most common time for performing this scan in an otherwise low risk pregnancy but examining the fetal anatomy may be appropriate at other times depending on the clinical situation.

The information gained aims to provide the patient and the doctor involved in her care with as much information as possible about the pregnancy in the safest and most cost-effective manner.

The limitations of ultrasound must be appreciated. Technical factors, such as fetal position and maternal obesity, may make full assessment impossible.

EQUIPMENT
Studies should be performed using high quality real time equipment. M mode should be available. The availability of Colour, Power and Spectral Doppler is advisable.

If state of the art equipment is not available both the patient and the referring doctor should be aware that the examination is less complete and the ability to detect fetal abnormality may be reduced.

COMMENT
Each department/practice should decide its own policy on making hard copy images available to the referring doctor and the patient.

THE EXAMINATION CHECKLIST

1. Fetal number
2. Fetal cardiac activity
3. Gestational age
4. Fetal anatomy, including detection of malformation

Head
- Falx
- Cavum Septum Pellucidum
- Skull Bones
- Lateral Ventricles
- Choroid Plexus
- Cerebellum/Vermis
- Nuchal thickness
- Cisterna Magna

Face
- Orbits
- Nose
- Jaw
<table>
<thead>
<tr>
<th>Section</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diaphragm</td>
<td>- Lips</td>
</tr>
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<td></td>
<td>- Profile</td>
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<tr>
<td></td>
<td>- Right</td>
</tr>
<tr>
<td></td>
<td>- Left</td>
</tr>
<tr>
<td>Heart</td>
<td>- FHMD</td>
</tr>
<tr>
<td></td>
<td>- Position</td>
</tr>
<tr>
<td></td>
<td>- Axis</td>
</tr>
<tr>
<td></td>
<td>- 4 Chambers</td>
</tr>
<tr>
<td></td>
<td>- Intraventricular Septum</td>
</tr>
<tr>
<td></td>
<td>- Foramen Ovale</td>
</tr>
<tr>
<td></td>
<td>- Mitral Valve</td>
</tr>
<tr>
<td></td>
<td>- Tricuspid Valve</td>
</tr>
<tr>
<td>Great Vessels</td>
<td>- Left Ventricular Outflow Tract</td>
</tr>
<tr>
<td></td>
<td>- Right Ventricular Outflow Tract</td>
</tr>
<tr>
<td></td>
<td>- Aortic arch</td>
</tr>
<tr>
<td></td>
<td>- Ductal Arch</td>
</tr>
<tr>
<td>Abdomen</td>
<td>- Stomach / Situs</td>
</tr>
<tr>
<td></td>
<td>- Kidney (Left) (Right)</td>
</tr>
<tr>
<td></td>
<td>- Bladder</td>
</tr>
<tr>
<td></td>
<td>- Abdominal Wall</td>
</tr>
<tr>
<td>Spine</td>
<td>- Ossification Centres</td>
</tr>
<tr>
<td></td>
<td>- Coronal</td>
</tr>
<tr>
<td></td>
<td>- Sagittal</td>
</tr>
<tr>
<td></td>
<td>- Axial</td>
</tr>
<tr>
<td></td>
<td>- Skin Line</td>
</tr>
<tr>
<td>Extremities</td>
<td>- 12 Long bones</td>
</tr>
<tr>
<td></td>
<td>- Hands/Fingers</td>
</tr>
<tr>
<td></td>
<td>- Feet/Toes</td>
</tr>
<tr>
<td></td>
<td>- Position of joints</td>
</tr>
<tr>
<td>Umbilical Cord</td>
<td>- Insertion</td>
</tr>
<tr>
<td></td>
<td>- 3 Vessels</td>
</tr>
</tbody>
</table>

5. Amniotic Fluid Volume

6. Placenta
   - Site
   - Clear of Os
   - Distance from internal os (cm)
   - Reaching/Covering os

7. Cervix
   - Normal length
   - Open/Closed

8. Maternal anatomy
   - Uterus
   - Adnexa

**COMMENTS**

**GESTATIONAL AGE**
This should be assessed by the biparietal diameter (BPD), head circumference (HC) and femur length (FL). Abdominal circumference (AC) is normally measured to check fetal proportions.
These values should be reported and a single gestational age assessment given. If the ultrasound due date differs from the menstrual date by more than 2 standard deviations, a revised estimated date of delivery (EDD) together with a predicted range should be given.

The biometry charts (see Policy and Statements D7 Statement on Normal Ultrasound Fetal Measurements) distributed by the Australasian Society for Ultrasound in Medicine (ASUM) are recommended.

**FETAL ANATOMY INCLUDING THE DETECTION OF ABNORMALITIES**
Each practice should develop a protocol on the procedure to be followed when an abnormality is detected. This protocol should include guidelines for the immediate care of the patient and how the referring doctor will be informed.

Careful evaluation of normal fetal anatomy according to the checklist should detect many major anatomical abnormalities.

It is important to remember that an apparently minor defect may be the only pointer to a major chromosomal abnormality.

Some structures may not be demonstrated because of maternal size, fetal position and other factors. Repositioning or rebooking the woman may be necessary to complete the examination.

If the assessment of fetal anatomy is limited, for whatever reason, the report should reflect the limitations of the scan.

**SEX DETERMINATION**
Determination of the sex of the fetus is rarely medically indicated. Care should be taken not to show the genitalia to those not wishing to know the sex of their fetus. If sex determination is requested this information should be provided based on positive identification of the external genitalia. Patients should be made aware that ultrasound assessment of fetal gender is not 100% accurate.

**MULTIPLE PREGNANCY**

1. Additional information required when a multiple pregnancy is diagnosed.
2. Ensure that the anatomy of each fetus is demonstrated.
3. Comparison of fetal size and amniotic fluid volume of each sac should be made.
4. Placental number, presence or absence of interposed membrane should be recorded.
5. An attempt should be made to confirm or determine chorionicity.
6. Identifying the sex of each fetus may assist in determining the chorionicity.

**PLACENTAL LOCALISATION**
The relationship between the lower margin of the placenta and the internal os should be determined. If the relationship between placental position and the internal os is still uncertain at the end of the scan, preferably with both a full and empty bladder, then a repeat scan at 34 weeks, or earlier if clinically indicated should be considered. Repeat scans should only be necessary in about 5% of all cases.

**AMNIOTIC FLUID VOLUME**
Qualitative evaluation of amniotic fluid is accurate when assessed by an experienced operator. It can be supplemented by quantitative evaluation of the 4 quadrant cumulative measurement of amniotic fluid or in cases of oligohydramnios, the depth of the deepest pocket of fluid.

**MATERNAL ANATOMY**
All pelvic masses should be documented, measured and where possible the organ of origin be determined and a short differential diagnosis given. If a pelvic mass is present the position and appearance of the maternal kidneys should be documented.

The cervix should be assessed.
Obstetric Worksheet – 18+ Weeks Morphology

<table>
<thead>
<tr>
<th>Name</th>
<th>Date of Birth (Age)</th>
<th>Patient Number</th>
<th>Episode Number</th>
<th>Imaging Location</th>
<th>Overall scan quality</th>
<th>Notes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>LMP (w/ d)</th>
<th>EDD (LMP) (w/ d)</th>
<th>Current Gest (w/ d)</th>
<th>Parity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre US (w/ d)</td>
<td>EDD (US) (w/ d)</td>
<td>Singleton/Multiple No.</td>
<td>Fetus No.</td>
</tr>
</tbody>
</table>

**Foetal Lie and Biometry:**

- Mobile
- Cephalic
- Breech
- Oblique
- Transverse
- Spine to maternal L. 
- \( /R \)
- Legs Flexed \( / \) Extended 

- BPD \( \ldots \ldots \text{mm} \)
- Corr BPD \( \ldots \ldots \text{mm} \)
- HC \( \ldots \ldots \text{mm} \)
- Cerebellum \( \ldots \ldots \text{mm} \)
- AC \( \ldots \ldots \text{mm} \)
- Nuchal Fold \( \ldots \ldots \text{mm} \)
- FL \( \ldots \ldots \text{mm} \)
- Average gest age estimate \( \ldots \ldots \text{w} \ldots \ldots \text{d} \)
- EFW \( \ldots \ldots \text{mm} \)
- EFW \( \ldots \ldots \% \)

- Discordance with previous estimates of gestational age
- IOM Y/N
- Earlier US Y/N
- Discordance 1-2 wk
- \( > 2 \) weeks

**Placental Position**

- Fundal
- Anterior
- Posterior
- Clear of os
- Y/N
- \( \text{mm} \)
- Lower placenta to int. os
- \( \ldots \ldots \text{mm} \)
- Reaches Int Os
- \( \text{Y/N} \)
- Covers Int os
- Distance across int. os
- \( \ldots \ldots \text{mm} \)

**Foetal Anatomy:**

- Circle if abnormal and describe

<table>
<thead>
<tr>
<th>Head/Neck</th>
<th>Abdomen/Pelvis</th>
<th>Spine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebellum</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Ant Horns
- mm
| Stomach
- \( \square \)
| Skin Line
- \( \square \)
| Intact
- \( \square \)
| Post Fossa
- \( \square \)
| Bowel
- \( \square \)
| Limbs
- \( \text{Rt} \text{ (cm)} \)
| \( \text{Lt} \text{ (cm)} \)
| Cavum S P
- \( \square \)
| Cerebellum
- \( \square \)
| Abdo wall
- \( \square \)
| Humerus
- \( \ldots \ldots \text{mm} \)
| Thorax
- \( \square \)
| 3 vessel cord
- \( \square \)
| Radius
- \( \ldots \ldots \text{mm} \)
| Ventricle R
- \( \square \)
| Diaphragm
- \( \square \)
| Bladder Full
- \( \square \)
| Ulna
- \( \ldots \ldots \text{mm} \)
| Ventricle L
- \( \square \)
| Lungs
- \( \square \)
| Bladder empty
- \( \square \)
| Hands
- \( \ldots \ldots \text{mm} \)
| Choroid Plexus
- \( \square \)
| 4 Chamber views
- \( \square \)
| Kidney Rt
- \( \ldots \ldots \text{mm} \)
| Femora
- \( \ldots \ldots \text{mm} \)
| Palate
- \( \square \)
| A-V valves
- \( \square \)
| Kidney Lt
- \( \ldots \ldots \text{mm} \)
| Tibii
- \( \ldots \ldots \text{mm} \)
| Nose/Lips
- \( \square \)
| LOT/ROT
- \( \square \)
| Pelvis Rt
- \( \ldots \ldots \text{mm} \)
| Fibulac
- \( \ldots \ldots \text{mm} \)
| Orbit
- \( \square \)
| Arch
- \( \square \)
| Pelvis Lt
- \( \ldots \ldots \text{mm} \)
| Feet/Toes
- \( \ldots \ldots \text{mm} \)
| Eye/lens
- \( \square \)
| Rhythm
- \( \square \)
| Aorta/Renals
- \( \square \)
| Profile
- \( \square \)
| Heart Rate BPM

**Comments**

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<tr>
<th>Amniotic Fluid</th>
<th>Total (mm)</th>
<th>In Normal Range</th>
<th>RU Quadrant</th>
<th>I. L Quadrant</th>
<th>R. I. Quadrant</th>
<th>I. L. Quadrant</th>
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<tr>
<td>S/D ratio(s)</td>
<td>( \ldots \ldots \text{mm} )</td>
<td>( \ldots \ldots \text{mm} )</td>
<td>( \ldots \ldots \text{mm} )</td>
<td>( \ldots \ldots \text{mm} )</td>
<td>( \ldots \ldots \text{mm} )</td>
<td>( \ldots \ldots \text{mm} )</td>
</tr>
<tr>
<td>Umbilical Cord Dopplers</td>
<td>In Normal Range</td>
<td>PI</td>
<td>MCA PI</td>
<td>MCA/Cord PI ratio</td>
<td></td>
<td></td>
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<tr>
<td>Uterine Artery</td>
<td>Rt RI</td>
<td>Notched</td>
<td>Lt RI</td>
<td>Notched</td>
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<td>( \ldots \ldots \text{cm} )</td>
<td>( \ldots \ldots \text{cm} )</td>
<td>( \ldots \ldots \text{cm} )</td>
<td>( \ldots \ldots \text{cm} )</td>
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Sonographer Reported by: ASUM Ultrasound Bulletin 2003 November 8: 4

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APPENDIX 4

RAW DATA - OBSERVATION
### OBSERVATION DATA SUMMARY

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<th>Face</th>
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<td></td>
<td>BPD</td>
<td>HC</td>
<td>AC</td>
<td>FL</td>
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<td>PO2(1)</td>
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</tr>
<tr>
<td>PO3(1)</td>
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<td>I-3 (2)</td>
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(Table continued from above)

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<tr>
<th>Part.</th>
<th>Abdomen</th>
<th>Extremities</th>
<th>Heart</th>
<th>Placenta</th>
<th>Maternal Anatomy</th>
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<tr>
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<td>Diap</td>
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</table>

12LB- 12 long bones; 3OC-3ossification centres; 3VC-3vessel cord; 4CH-4 chambered heart; AC-abdominal circumference; AFI-amniotic fluid index; BPD-biparietal diameter; C/Plane-coronal plane; CI-cord insertion; CM-cisterna magna; CSP-corpus septum pellucidum; CX-cerevisx; Adnx: adnexa; Diap-diaphragm; Echotxt-echotexture; F/Pos-fetal position; F/T-feet/toes; FC-falx cerebri; FHM-fetal heart motion; FL-femur length; H/F-hands/fingers; HC-head circumference; IFHA- initial check for fetal heart activity; Kid-kidneys; LV-lateral ventricles; CP-choroid plexus; M/Mod-M-mode Doppler; NT-nuchal thickness; OsDt-os distance; OTs-outflow tracts; Part- participants; Pos-heart position/situs; S/Line-skin line; S/Plane-sagittal plane; Stom-stomach; U/B-urinary bladder; Utrs- uterus; xL-incorrect level; UI-unacceptable image; Numbers: (1)-examination 1; (2)-examination 2; >3-More than 3 years experience; 1-3-1 to 3 years experience; <1-Less than 1 year experience. Dots (.) refer to the examinations that met the observation criteria, designed using the ASUM mid-trimester guidelines.
## RADIOGRAPHERS’ SCAN REPORTS

<table>
<thead>
<tr>
<th>Participant</th>
<th>Exam Duration</th>
<th>Obstetric Sonography Reports by the Radiographers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P01</strong></td>
<td>5mins</td>
<td>Inadequate time for anomaly scan. However, intracranial ventricles not dilated. Normal cisterna magna, fetal spine, left sided 4-chambered heart and urinary bladder seen.</td>
</tr>
<tr>
<td>Exam (1)</td>
<td>4mins</td>
<td>Single fetus, vertex middle. Posterior placenta, marginally low-lying. FH / Liquor volume – normal. BPD-3.9cm/ 17w9d ; HC-15.4cm/ 18w1d ; FL-2.7cm/ 18w0d; MG-18w0d</td>
</tr>
<tr>
<td>Exam (2)</td>
<td>4mins</td>
<td>Single fetus, vertex Lt. FH seen. Posterior placenta, No P.P. Liquor Volume normal. BPD-5.6cm/ 22w5d; HC-21.9cm/ 23w6d; AC-19.6cm/ 24w1d; FL-4.0 cm/ 24w0d; MG-23w/4d</td>
</tr>
<tr>
<td><strong>P02</strong></td>
<td>8mins</td>
<td>Single fetus. Transverse lie. Anterior placenta. No P.P. FH seen. Liquor volume normal.BPD-5.8cm/ 23w5d; AC-19.2cm/23w4d; MG-23w/4d</td>
</tr>
<tr>
<td>Exam (1)</td>
<td>4mins</td>
<td>Single fetus. Vertex midline. Posterior placenta.BPD-4.2cm/18w4d; HC-15.8cm/ 18w4d; FL-3.1cm/19w2d; MG-18w6d. Inadequate time to do full anomaly scan. However, intracranial ventricles not dilated, spines normal, 4-chambered heart seen, U/Bladder not seen.</td>
</tr>
<tr>
<td>Exam (2)</td>
<td>7mins</td>
<td>Single fetus. Vertex midline. Posterior placenta. No P.P. Liquor volume normal. BPD-4.8cm/20w2d; HC-17.0cm/ 19w4d; FL-3.3cm/20w2d; MG-20w/0d. Inadequate time to do full anomaly scan. However, intracranial ventricles not dilated, spines normal, 4 chambered heart and both orbits seen, U/Bladder normal.</td>
</tr>
<tr>
<td><strong>P03</strong></td>
<td>3mins</td>
<td>Single fetus, Breech left. FH normal. Posterior fundal placenta. Liquor volume normal. BPD-4.1cm/18w1d; HC-16.6cm/ 19w2d; FL-3.2cm/19w2d; MG-19w/0d</td>
</tr>
<tr>
<td>Exam (1)</td>
<td>4mins</td>
<td>Single fetus. FH normal. Vertex right. Anterior placenta. No P.P. Liquor volume normal. BPD-5.8cm/23w4d; HC-21.8cm/ 23w5d; AC-19.5cm/24w0d; FL-4.5cm/ 24w4d; MG-24w/1d. No definite fetal anomaly noted</td>
</tr>
<tr>
<td><strong>P05</strong></td>
<td>5mins</td>
<td>Single viable fetus. Breech to the right. Posterior fundal placenta. Liquor volume normal. BPD-4.6cm/19w3d; HC-16.2cm/ 19w0d; FL-3.0cm/ 19w0d; MG-19w1d</td>
</tr>
<tr>
<td>Exam (1)</td>
<td>7mins</td>
<td>Single viable fetus. Breech to the right. Posterior fundal placenta. Liquor volume normal. BPD-4.3cm/19w2d; HC-16cm/ 19w0d ; FL-3.0cm/19w0d; MG-19w0d</td>
</tr>
<tr>
<td><strong>P06</strong></td>
<td>2mins</td>
<td>Single fetus. Vertex right. Posterior fundal placenta. No P.P. FH seen. Liquor Volume normal. BPD-4.0cm/17w6d; HC-14.7cm/ 17w6d; FL-2.6cm/17w5d; MG-17w/6d. Intracranial ventricles not dilated, spines normal, 4-chambered heart seen, U/Bladder not seen.</td>
</tr>
<tr>
<td>Exam (1)</td>
<td>4mins</td>
<td>Single fetus. Vertex Left. Posterior fundal placenta. No P.P. FH seen, Liquor Volume normal. BPD-5.2 cm/ 22w1d; HC-21.1cm/23w0d; AC-19.5cm/ 24w0d; FL-3.9cm/ 23w4d; MG-23w/1d. Intracranial ventricles not dilated, spines normal, 4-chambered heart seen, U/Bladder not seen.</td>
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* n = 12 examinations observed, that is, 2 examinations performed per radiographer.