Prescription Rights for New Zealand MRI Technologists – An Opportunity for Role Extension

Exelda Kruger

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Health Science

Unitec Institute of Technology
2011
Abstract

The New Zealand Institute of Medical Radiation Technology (NZIMRT) has approved a recommendation that would allow the profession to introduce a three tier career framework. This framework includes an advanced practitioner role within the scope of practice for medical radiation technologists (MRTs). Currently, prescribing is not within the scope of practice for MRTs; however, there is a potential for non-medical prescribing to become an extended role for magnetic resonance imaging (MRI) technologists.

Using case study research, the views of MRI technologists and radiologists were investigated with regard to extending the role of the MRI technologists into the area of prescribing with the emphasis on gadolinium-based contrast media, which are frequently utilised in MRI. Data were obtained from three sources. Ninety-nine MRI technologists and 69 radiologists responded to a questionnaire related to their experiences with gadolinium-based contrast media and prescription practices. Four MRI technologists and two radiologists were interviewed to gain a deeper understanding of the issues related to contrast media prescription. The data provided by the critical incident reports were integrated with the data collected from the questionnaires and interviews to support the opinions and experiences of participants.

The study has revealed that the prescription of contrast media is occurring rather haphazardly across New Zealand. There is evidence that gadolinium-based contrast media are already prescribed by some MRI technologists. However, there is resistance from radiologists and to a lesser extent from MRI technologists with regard to prescribing as a potential area of role extension. The results of the study have revealed that there is no definitive need for MRI technologists to gain prescription rights. In spite of this, 45.5% of respondents have expressed interest into extending their role into the area of non-medical prescribing. Prescribing could be introduced as part of an advanced practitioner role. However, a number of other issues have also been identified that needs addressing. They are: the introduction of a national IV certificate for MRI technologists, improvement of the current CPR training, and pharmacology for MRI technologists.
Declaration

Name of candidate: Exelda Kruger

This Thesis/Dissertation/Research Project entitled: Prescription rights for New Zealand MRI technologists – An opportunity for role extension is submitted in partial fulfilment for the requirements for the Unitec degree of Master of Health Science (MRI)

Candidate’s declaration

I confirm that:

- This Thesis/Dissertation/Research Project represents my own work;
- The contribution of supervisors and others to this work was consistent with the Unitec Regulations and Policies.
- Research for this work has been conducted in accordance with the Unitec Research Ethics Committee Policy and Procedures, and has fulfilled any requirements set for this project by the Unitec Research Ethics Committee.

Research Ethics Committee Approval Number: 2009-1034

Candidate Signature: ........................................... Date: .........................

Student number: 1281251
Acknowledgements

I would like to thank my supervisors, Dr Jill Yelder and Shelley Park for their guidance and support throughout this study and not giving up on me. A special word of appreciation goes to Jill for making research actually interesting.

A sincere thank you goes to the Todd Foundation Awards for Excellence. Your grant made it much easier to complete this study.

I would also like to express my gratitude to every respondent that contributed to this study, and the six interviewees. Without your time and participation this study would have been worthless.

I would like to thank my Clinical Manager, Lisa Brown for her continued support and patience throughout the last two years – I appreciate it!

Finally, to my husband André – Thank you for your encouragement, love and faith in me.
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<td>ACR</td>
<td>American College of Radiology</td>
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<td>ARSAC</td>
<td>Administration of Radioactive Substances Advisory Committee</td>
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<td>BMA</td>
<td>British Medical Association</td>
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<td>BNF</td>
<td>British National Formulary</td>
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<td>CIN</td>
<td>Contrast-induced neuropathy</td>
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<td>CMP</td>
<td>Clinical management plan</td>
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<td>CPR</td>
<td>Cardiopulmonary resuscitation</td>
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<td>CT</td>
<td>Computed tomography</td>
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<td>DCBE</td>
<td>Double contrast barium enema</td>
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<td>DTB</td>
<td>Drugs and Therapeutics Bulletin</td>
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<tr>
<td>eGFR</td>
<td>Estimated glomerular filtration rate</td>
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<tr>
<td>ESRD</td>
<td>End-stage renal disease</td>
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<td>GA</td>
<td>General anaesthesia</td>
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<td>GP</td>
<td>General Practitioner</td>
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<td>GSL</td>
<td>General sale list</td>
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<tr>
<td>HPRAC</td>
<td>Health Professional Regulatory Advisory Council</td>
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<td>IV</td>
<td>Intravenous</td>
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<td>MRI</td>
<td>Magnetic resonance imaging</td>
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<td>MRT</td>
<td>Medical Radiation Technologist</td>
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<td>MRTB</td>
<td>Medical Radiation Technologist Board</td>
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<td>NFD</td>
<td>Nephrogenic fibrosing dermopathy</td>
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<td>NHS</td>
<td>National Health Trust</td>
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<td>NPAC</td>
<td>New Prescribers Advisory Committee</td>
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<td>NPEF</td>
<td>Nurse Prescribers Extended Formulary</td>
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<td>NPF</td>
<td>Nurse Prescribers Formulary</td>
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<td>NSF</td>
<td>Nephrogenic systemic fibrosis</td>
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<td>NZIMRT</td>
<td>New Zealand Institute for Medical Radiation Technologists</td>
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<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>NZMA</td>
<td>New Zealand Medical Association</td>
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<td>NZNO</td>
<td>New Zealand Nurses Organisation</td>
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<td>NZSA</td>
<td>New Zealand Society of Anaesthetists</td>
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<td>PACS</td>
<td>Picture Archiving and Communications System</td>
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<td>PHARMAC</td>
<td>Pharmaceutical Management Agency of New Zealand</td>
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<td>POM</td>
<td>Prescription-only medicines</td>
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<td>RANZCR</td>
<td>Royal Australian and New Zealand College of Radiologists</td>
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<td>SCoR</td>
<td>Society and College of Radiographers</td>
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<td>UK</td>
<td>United Kingdom</td>
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CHAPTER 1

Introduction

Between June 2005 and early 2008 a series of research projects were carried out on behalf of the New Zealand Institute of Medical Radiation Technologists (NZIMRT) to investigate role development for Medical Radiation Technologists (MRTs) in New Zealand (Yielder, Murphy & Sinclair, 2008). The study aimed to investigate the need for advanced practice roles in both medical imaging and radiation therapy, as well as to recommend a possible structure for career progression.

Advanced practice implies the development of a role and the application of knowledge to benefit and modernise clinical practice (Hardy & Snaith, 2006). The Society and College of Radiographers ([SCoR] as cited in the SCoR, 2003) has defined role development as “representing quantitative and qualitative change in the way radiographers contribute to patient management and health care services” (p. 6). Role development is happening worldwide in medical imaging and radiation therapy. Not only has role development become important in New Zealand to attract and retain MRTs, it has become critical for the profession to keep up with international trends and to enable New Zealand MRTs to work internationally and be recognised as well trained (Yielder & Sinclair, 2006). Role development can occur in two ways: as role expansion or role extension. Role expansion refers to the development within one’s own scope of practice where new technology offers an opportunity to broaden, adapt or build on the traditional role (White & McKay, 2004). An example of this is the Picture Archiving and Communications System, or PACS, which replaced the use of x-ray film and much of the equipment associated with this technology, for example cassettes, chemical processors and archive storage in various departments (Larsson et al., 2007). Role extension; however, is the execution of tasks not included in the normal training for registration, therefore enabling one healthcare professional to take up a role traditionally carried out by another healthcare professional (White & McKay, 2004). An example of this activity is the intravenous (IV) cannulation and contrast injection in
magnetic resonance imaging (MRI) by MRI technologists in New Zealand, a task that has traditionally been performed by radiologists and nurses.

At present there is no professional career structure for MRTs in New Zealand. There is a registered practitioner level only, with salary scales reflecting experience as the only means of progression within a clinical area, except if a practitioner is appointed to a management role (Yielder, 2007[a]). The minimum qualification required for registration in the scope of practice as a general diagnostic MRT, is a Medical Radiation Technologists Board (MRTB) approved undergraduate degree in medical diagnostic imaging. For registration in specialist areas such as nuclear medicine, ultrasound and MRI, a MRTB recognised postgraduate qualification is an additional requirement to practice in these areas (MRTB, 2004). However, Yielder (2007[a]) has noted that these are horizontal and not vertical scopes of practice. She has also noted that while some staff may be undertaking more advanced roles than their colleagues, this is not supported by any formalised structure that acknowledges their capabilities or level of responsibility. This is in contrast to the United Kingdom (UK) where the Council for the Society of Radiographers has approved a curriculum framework, which is a four-tiered model of professional development that enables a career structure for radiographers incorporating extended and advanced practice roles beyond the scope of what is available in New Zealand (Yielder, 2007[b]). The term radiographer is still used in the UK and Australia and will be applied where necessary in context of the literature.

The NZIMRT’s research-based approach to investigate MRTs perceptions of the need for role development has indicated that most MRTs want change (Yielder & Sinclair, 2006). They have found that MRTs want the opportunity to extend their roles, they want formal recognition for doing it, and they are prepared to complete further academic and clinical requirements as necessary. The results of a survey investigating the opinion of New Zealand radiologists with regard to role extension activities for MRTs have shown that there is some willingness on the part of radiologists to delegate tasks to appropriately trained and educated MRTs (Yielder, Sinclair, Gunn, Thompson & Nash, 2008).
Wanganui Hospital has one full-time radiologist as well as a partnership with Pacific Radiology Ltd in Wellington. Once a week one of their radiologists will visit Wanganui for a couple of days to share the departmental workload. During the remainder of the week the image reporting, which includes general x-rays, computed tomography (CT), MRI and ultrasound, is split between the Wanganui-based radiologist and Pacific Radiology Ltd who reports it through their teleradiology system. This situation has provided some challenges to the Radiology Department, including MRI. When the departmental radiologist is caught up for example in a hospital meeting, an interventional procedure or on leave, it makes it more difficult to consult with either him or the off-site radiologists regarding issues such as contrast prescription and administration. Wanganui Hospital has MRI protocols in place for most of its examinations and the MRI technologists know when contrast media needs to be administered in the majority of cases. Since this department’s MRI technologists have been trained and certified to perform peripheral IV cannulation and contrast injection, it has improved work flow and efficiency significantly; however, they are still faced with delays more often than not because the contrast medium needs to be prescribed by the radiologist. The policy at Wanganui Hospital states that the prescription needs to be written on the prescription grid on the patient safety questionnaire and consent form and be signed by the radiologist prior to injection of the contrast media. If the radiologist is unavailable, the MRI technologists are then dependant on non-radiologist doctors to assist. Generally, the resident medical officer (RMO) to that particular patient is delegated the task and this has caused MRI technologists as well as the CT-MRTs, a great deal of frustration and delays. This activity is not seen as urgent by the majority of doctors to come to the Radiology Department to sign off a prescription the MRTs have already completed on their behalf. More often than not, junior doctors have little or no experience with IV contrast media and the task falls onto the MRTs to educate them on the contra-indications and possible adverse reactions. This all takes up time and on occasion an RMO may be reluctant to prescribe the contrast if they are not feeling confident doing it because of their lack of experience. When I mentioned to one of the MRTs that prescribing our own contrast media would make work flow even more efficient and help to improve patient continuity, the idea was met with a lot of resistance. The objections that were raised were that contrast media are medical drugs that can only be prescribed by a doctor, that it can cause serious adverse reactions that cannot be dealt with by MRTs and neither MRTs nor radiologists would be supportive of
such an idea. However, results of a radiologist survey have shown some support for MRTs to prescribe and administer pharmaceuticals relevant to a procedure, for example, glucagon and hypnovel, with varying levels of supervision indicated (Yelder et al., 2008). This could be extended to include the non-medical prescribing of gadolinium-based contrast media by MRI technologists also. Non-medical prescribing is the term applied to prescribing by health care professionals who are not medically qualified (Thorpe, 2008).

The aims and structure of the study

The aim of this study is to provide a case for MRI technologists in New Zealand to have limited independent prescription rights that could be presented to the Ministry of Health, driven by the NZIMRT and supported by our statutory registration body, namely the MRTB. The objectives of this research are:

- To investigate the views of MRI technologists in New Zealand towards extending their role in the area of gadolinium-based contrast media prescription.
- To investigate radiologist opinions on this possible area of role extension for MRI technologists.
- To develop a case for the non-medical prescribing of gadolinium-based contrast media by MRI technologists and the administration thereof without a radiologist.

In order to meet this aim, the study investigated the experiences of MRI technologists regarding gadolinium-based contrast media such as the incidence and treatment of adverse reactions, protocols related to contrast media prescription and administering, the availability of radiologists when required, the need for limited independent prescription rights, and the willingness to undertake further training. The information was acquired through four methods of data collection. One questionnaire was sent to all New Zealand MRTs with either a scope of practice or a training scope of practice in MRI. A second questionnaire was sent to radiologists involved in MRI imaging reporting across New Zealand. A critical incident form was also sent to the MRI technologists and they were asked to share their experiences regarding gadolinium-based contrast media and where it might have been beneficial to them if they had prescription rights.
Finally these were followed up by interviews with four MRI technologists and two radiologists to gather more in-depth information regarding adverse reactions to gadolinium-based contrast media, their capability to respond to these reactions; the possibility of MRI technologists prescribing gadolinium-based contrast media under certain circumstances, the prescription of other drugs in MRI; possible support and resistance, and legal implications for MRI technologists.

After this introductory chapter, Chapter Two will present a review of the literature that will be focused on three areas, which are role development, non-medical prescribing, and the use of contrast media. The first part of the review will attempt to provide a brief summary on the background with regard to role development in the UK and also the current state of affairs for MRTs in New Zealand. Because of the absence of non-medical prescribing by MRTs in New Zealand, the second part of the review will focus on the experiences of the UK nurse practitioners and radiographers. This will also include an overview of the experiences of New Zealand nurse practitioners with regard to non-medical prescribing. The literature review will then continue with an analysis of the two most common contrast media used in radiology, namely iodinated contrast media in CT and gadolinium-based contrast media in MRI.

Chapter Three will offer a discussion on the research processes for this thesis, including the choice of case study as the research method. Ethical considerations are discussed, data collection methods and data analysis are explained, and the research process is evaluated. Chapter Four will then quantitatively present the results of both the MRI technologist and radiologist questionnaires.

Chapters Five and Six will integrate the data presented with information obtained from the critical incident reports and the interviews in a qualitative discussion. Six themes have been derived from the interview data through a process of cross-sectional thematic analysis. Chapter Five will investigate current practices and experiences of MRI technologists in New Zealand regarding IV cannulation and training, adverse reactions to gadolinium-based contrast media; the prescription and administration of these contrast media, and the administration of other adjuncts in MRI. Chapter Six will explore prescribing as an extended
role activity for MRI technologists, the necessity and the advantages of prescribing gadolinium-based contrast media and other drugs; prerequisites for being trained into the role, and the barriers that might prevent this from happening.

Chapter 7 will provide an overview of the results and key findings of this study. Based on these findings, recommendations will be offered in support of MRI technologists interested in extending their role into the area of non-medical prescribing.
CHAPTER 2

Evaluating the issues related to non-medical prescribing and contrast media: A literature review

The aim of this literature review is to provide the reader with an overview of role development and career progression as it occurred in the UK and the way it currently is for MRTs in New Zealand. The review will then examine the socio-historical context of non-medical prescribing in the UK and New Zealand. Since there is no literature on non-medical prescribing by New Zealand MRTs, the experiences of New Zealand nurse practitioners and other non-medical professions will be evaluated. This will be followed by an analysis of the two most common contrast media utilised in radiology departments, namely iodine- and gadolinium-based contrast media.

Role development
Around the world radiographers are bound by scopes of practice that define their responsibilities and boundaries (Cowling, 2008). Some practitioners have found these restrictive and have sought ways to improve and expand their practice in order to fully realise their potential in medical radiation technology (ibid.). Price (2001) for example, disclosed that radiography reporting was at the centre of an on-going conflict with the medical profession in the formative years of radiography. The medical profession essentially prevented non-medical members from reporting; thereby determining the occupational boundaries of radiography and the direction of radiography practice for 70 years. In 1971, Swinburne, a radiologist by profession, recognised that radiographers were functioning below their full potential and suggested that they could alleviate radiological workloads (as cited in Price, 2001). He maintained that radiographers all over the world assisted in the interpretation of x-ray film and he suggested that it was time to give ‘official’ recognition of the fact. He was of the opinion that recruitment would be improved and an enhanced role could lead to an advancement in a radiographer’s career structure at
graduate level. However, these proposals were not put into practice for at least another 20 years (ibid.).

In terms of role development and career progression, the UK leads the world (Yielder, 2007[a]). Paterson (as cited in Smith & Reeves, 2009) concluded that following the first nationwide survey in 1995 on the expansion of the radiographer role, it had been developing on such a scale that it was unstoppable. Rudd (2003) reported that the ‘red dot’ flagging system had been adopted in many accident and emergency departments whereby a radiographer would signal that an acute abnormality might be present on an x-ray film. Price and Le Masurier (2007) reported that 81% of respondents in their study indicated that a red dot system was in operation in their trust. However, it was the highly critical Audit Commission report of radiology departments (as cited in Nightingale & Hogg, 2003) that drew the attention to the long waiting lists for complex examinations such as double contrast barium enemas (DCBE). It was found that many examinations were being left unreported or were reported too late on to influence patient management. Somers, Stevenson, Laufer, Gledhill and Nugent (as cited in Nightingale & Hogg, 2003) considered DCBE to be a potential area for role delegation, which could be described within a pre-defined standard protocol. It was not until 1995 when Mannion, Bewell, Langan, Robertson and Chapman (as cited in Nightingale & Hogg, 2003) published their successful pilot study regarding a barium enema training programme for radiographers, that the UK seriously considered that role delegation. As a result, a growing number of radiographers (an estimated 82%) across the UK have performed and reported on barium enemas over the past 15 years (Price & Le Masurier, 2007; Smith & Reeves, 2009).

Paterson (as cited in Keenan, Muir & Cuthbertson, 2001) also drew attention to the demand for radiographers performing IV injections. The benefits of radiographers performing IV injections were listed as a reduction in waiting times of up to 30 minutes per patient, which resulted in enhanced continuity of patient care and a reduction in radiologists’ workload (Nuttall, as cited in Smith & Reeves, 2007). Price and Le Masurier (2007) reported that 95% of managers indicated that IV injections were performed by radiographers in their trust. Hogg and Hogg (2003) identified radiographer prescribing as an area of role development; however, this will be discussed later in this chapter.
It is obvious that radiographers have been progressively taking on greater responsibilities in areas that have previously been considered the domain of radiologists. In 2003 the UK Department of Health led an initiative called *Radiography Skills Mix*. The idea behind the project was to introduce and evaluate a new tiered service delivery model, which was designed to aid radiography workforce issues. Some of the issues included:

- The worldwide shortages of radiologists and radiographers
- Pressure from radiographers to develop effective career development pathways
- A large percentage of part-time staff, high staff turnover and a current working population approaching retirement age
- The need to remove blockages occurring within general diagnostic processes.

The Department of Health (2003, p.7) outlined the initiative as “a four-tier multidisciplinary model, designed to shape a clinical team around client and care requirements rather than professional boundaries.” It was further envisaged that the model would be implemented as a whole and not as single tiers. In 2004 the curriculum framework defining these roles was approved by the Council for the Society of Radiographers (Yielder, 2007[a]). The four tiers are:

- Unregistered assistant practitioner (limited scope of practice)
- Registered practitioner (as in New Zealand)
- Registered advanced practitioner (recognising responsibility for an extended role within a scope of practice)
- Registered consultant practitioner (clinical leadership role embracing an extended role, including research, education and development).

The impact of the four tier career progression on the practice of radiography was investigated and was found to have led to improvements to patient services and work quality but there was mixed results with regard to recruitment issues (Woodford, 2006). The example was given of healthy recruitment figures for assistant practitioners in breast screening units but vacancies left in consultant positions (Nickerson & Cush, as cited in Woodford, 2006).
According to Smith, Yielder, Ajibulu and Caruana (2008) role development activities for MRTs in New Zealand have been, until recently, ad hoc with various role extension activities being introduced according to local need. The results of a MRT survey regarding role development indicated that 54% of respondents believed that their skills and knowledge were not used to their full potential and that they were capable of more than the confines of their existing role (Yielder & Sinclair, 2006). A number of respondents stated that they wanted to advance their clinical expertise; something they might lose should they take up a management position. They agreed that establishing a formalised advanced practice role would be good for the profession and would also increase job satisfaction and retention. The results of a research study concerning career progression for MRTs in New Zealand supported these findings and demonstrated that MRTs and Clinical Managers see role development as a positive and necessary change (Yielder et al., 2008). The NZIMRT has therefore approved a recommendation that the profession introduces a three tier career framework (Smith et al., 2008). The framework includes:

- Assistant practitioner
- Practitioner
- Advanced practitioner

Initial emphasis will be on developing the advanced practitioner pathway and once these positions are well established, there will be the prospect of a consultant practitioner level (ibid.). Results of a radiologist survey (Yielder et al., 2008) indicated that some MRI technologists are prescribing pharmaceuticals such as buscopan and glucagon for certain MRI examinations. Prescribing is not in the scope of practice for MRI; however, non-medical prescribing could potentially become a role extension activity for MRI technologists.

**Non-medical prescribing by the health care professions**

This section aims to provide insight into the legislation surrounding the prescription, sale, supply, and use of medicinal products. The first part will examine some pieces of legislation together with the history and development of non-medical prescribing in the UK. This will include an explanation of the three different forms this can take on, namely Patient Group Directives (PGDs), supplementary prescribing, and independent prescribing and how it
affects radiography. The second part will examine New Zealand legislation concerning the prescription, supply, and use of medicinal drugs in addition to non-medical prescribing by New Zealand nurse practitioners and other health professions.

1. United Kingdom
The development of non-medical prescribing, from recognition of need to widespread availability, took several years (Hogg et al., 2007). Borthwick, Short, Nancarrow and Boyce (2010) described that in the early 1960s, public confidence in healthcare was undermined because of unexpected complications arising from the use of the approved drug thalidomide. Silverman (2002) indicated that in 1958, thalidomide was marketed as ‘the drug of choice’ for pregnant women with morning sickness and nausea. Because of its explicit claim of safety, the drug was sold over-the-counter, first in Germany and later other European countries, eventually selling in 46 countries. It was not until November 1961, that reports from Australia and Germany linked thalidomide to a sharp increase in the numbers of infants born with teratogenic deformities, such as phocomelia or seals’ flippers, demonstrating markedly stunted growth of limbs (Silverman, 2002). It was clear that existing medicines legislation was inadequate and a new system had to be designed to address topics, such as the manufacturing, marketing and licensing of medicines; alongside new mechanisms for regulating access, administration, sale and supply of it (Borthwick et al., 2010). As a result the Medicines Act 1968 was passed.

The Medicines Act 1968
The Act begins by prohibiting almost all dealings with medicinal products, and then sets out exemptions that allow the manufacture and sale of medicinal products under licence (Thorp, 2008). The Act also exempts various activities of professions and who can and cannot prescribe. Under the Act, drugs are divided in three main categories with each category subject to different legal requirements:

- General sale list (GSL)
  This includes all medicines that have been produced under licence or are composed of materials that are exempt from licensing arrangements (Thorp, 2008). These items, also known as over-the-counter drugs, may be supplied from premises other
than a registered pharmacy, for example a supermarket and by persons other than a pharmacist. Examples of such drugs are aspirin and paracetamol, antacids and some topical anti-fungal cream (Thorp, 2008).

- **Pharmacy medicines (P)**
  These items may only be supplied to the public from a pharmacy or other registered premises by or under supervision of a pharmacist (Thorp, 2008).

- **Prescription-only medicines (POM)**
  POM are drugs that are specifically referred to in the Prescription Only Medicines (Human Use) Order in 1997 and is regularly amended (Thorp, 2008). These items may only be sold or supplied from a registered pharmacy and only with a prescription (ibid.). According to the Medicine Act 1968 these drugs are available only to ‘appropriate practitioners,’ who are identified as doctors of medicine, dentists and veterinary practitioners (Borthwick et al., 2010). Thorp (2008, p. 273) gives the following examples of the types of drugs that are POM:

  i. Any drug controlled by the Misuse of Drugs Act 1971 unless it is:
     - codeine, dihydrocodeine, morphine or pholcodeine
     - subject to only one of these being in a product AND that it does not exceed a certain strength
  
  ii. Certain specific items, for example radiopharmaceuticals
  
  iii. All products for administration by injection
  
  iv. All other listed drugs in order unless there is a specific exemption, for example when given a certain route or when low in concentration.

**The Misuse of Drugs Act 1971**
This Act was introduced to control the manufacture, supply, possession and use of drugs that are dangerous or otherwise harmful. They are now referred to as ‘controlled drugs’ (Thorp, 2008). The Misuse of Drugs Regulations 2001 and subsequent amendments permit the use of controlled drugs for medicinal purposes and define classes of people who are authorised to supply and possess these during the course of their professional activities
Controlled drugs are divided into five Schedules by the Regulations, which are further classified according to the degree of danger that misuse of them presents under the act (Appendix One).

The Crown Reports

According to Borthwick et al. (2010), the political landscape gradually began to change and policy reforms throughout the 1980s made access to restricted medicines possible. In the mid-1980s the Thatcher Government introduced a series of reforms that impacted directly on the autonomy of the medical profession and its exclusivity in the delivery of certain services, including the supply of medicines.

The Government first addressed the possibility of non-medical prescribing following the report Neighbourhood nursing - a focus for care by Baroness Julia Cumberlege, which was published in 1986 (Drug & Therapeutics Bulletin [DTB], 2006; Hogg et al., 2007). She noticed that patient care was often complicated by the nurses’ inability to prescribe the evidence-based treatment that they would suggest to be prescribed by the general practitioner (GP) following a full assessment (Francis & Hogg, 2006). The report highlighted the potential for community nurses to make certain prescribing decisions within their area of competence (DTB, 2006). However, three years passed before a working party, chaired by Dr June Crown produced the first of two reports on prescribing, which played a key role to non-medical prescribing in the UK (DTB, 2006; Francis & Hogg, 2006). The Report of the Advisory Group on Nurse Prescribing (Crown I) outlined who should prescribe; what they should prescribe; and how it should be funded. It identified nurses with a district nurse or health visitor qualification working in primary care to prescribe from a limited formulary designed around common areas of practice. The report also proposed that nurses should be able to supply and/or administrate medications within what were called ‘group protocols.’ This is a specific written instruction, drawn up locally by doctors and pharmacists, for the supply and administration of named medications by other health professionals in an identified situation, for example nurse led immunisations (Francis & Hogg, 2006; Stephenson, 2000). Since only doctors, dentists, and veterinary surgeons could legally prescribe under the Medicines Act 1968, the act had to be reviewed and also any relevant secondary legislation made under the Act. In 1992 legislation was passed to amend the Act
to permit nurses to prescribe (Francis & Hogg, 2006). Borthwick et al. (2010) reported that these changes did not mean progress towards allied health professional prescribing would be unproblematic; in fact, role boundary disputes arose and created obstacles to change.

In spite of this, Dr June Crown’s working party produced their second report, Review of prescribing, supply and administration of medicines in 1999. The report dealt principally with the question of who else should be able to take on prescribing responsibilities and to allow new groups of healthcare professionals in specific therapeutic areas with expertise in those areas (Stephenson, 2000). The expectation was that extending prescribing would optimise the use of resources, enhance professional relationships, and improve patient access to care (Francis & Hogg, 2006). This policy direction was rapidly accepted by Government since pressure for change stemmed from a number of converging dilemmas facing the future of health care provision: an ageing population, changing disease profiles, and a reduced workforce (Borthwick et al., 2010). This was coupled with a looming crisis in healthcare recruitment and retention, fiscal constraints, and the challenge of the European Union Working Time Directives (ibid). It was suggested that the Government’s enthusiasm for non-medical prescribing was because of anticipated cost savings (Stephenson, 2000). This was based on research indicating that nurse practitioners tended to prescribe less than physicians (ibid.). Crown II also defined mechanisms for what were to become PGDs; supplementary prescribing; and independent prescribing.

**Patient group directions (PGDs)**

PGDs are a method by which POM may be supplied or administered without a normal prescription to specified groups of patients (Thorp, 2008). This is strictly speaking not prescribing; instead it is a written instruction made in favour of health care professionals and requires the signature of a doctor (or dentist) and a pharmacist. The use of a PGD must be authorised by the National Health Service (NHS) Trust; Health Authority; or Primary Care Trust (ibid.). It applies to a defined user group within a health provider organisation; enabling registered health professionals who have been named as competent to supply and administer a specified medication to patients who may not be individually identified before presentation of treatment (Kwentoh & Reilly, 2009). A PGD can include a variable dose range; hence permitting health care professionals to decide on a suitable dose for individual
patients. However, it can only be used where there is a clear benefit for patients (Thorp, 2008). Since 2003, qualified registered podiatrists, dieticians, occupational therapists, radiographers, and speech and language therapists comprise the list of professionals able to supply medicinal products under PGDs (ibid.). Thorp (2008) gives an example of its use in accident and emergency analgesia where a nurse or physiotherapist is allowed to administer an analgesic prior to the patient seeing a doctor.

**Supplementary prescribing**

Supplementary prescribing is the voluntary partnership between an independent prescriber, for example a doctor or dentist; and a supplementary prescriber, for example a nurse or pharmacist, to implement an agreed patient-specific clinical management plan (CMP) with the patient’s agreement (Department of Health, as cited by Aronson, 2004). It was first introduced in the UK in 2003 for nurses and pharmacists; then extended in England during 2005 to include chiropodists/podiatrists, physiotherapists, radiographers and optometrists (DTB, 2006). Following diagnosis by the independent prescriber, the CMP is drawn up with the supplementary prescriber, who can then prescribe any medications specified in the plan (ibid.). Provided that the medicines are prescribable by a doctor or dentist at NHS expense, and are referred to in the patient’s CMP, the complete British National Formulary (BNF) is available to prescribe from (Hogg et al. 2007). However, its usage should be restricted to those items within the prescriber’s competency areas (Francis & Hogg, 2006). Supplementary prescribing is intended to improve patient access to care, to make it easier for patients to get their medications they need; to make the best use of clinical skills of health care professionals, and to enhance professional relationships (Thorp, 2008). It is therefore likely to be the most suitable to patients who have chronic conditions but can be managed by a supplementary prescriber between reviews by the doctor (ibid.). However, the disadvantage of supplementary prescribing is that it is dependent upon cooperative physicians, who are essentially both mentors in training and independent prescribers in practice (Borthwick et al., 2010).

**Independent prescribing**

Independent prescribing is defined as “prescribing by a practitioner responsible and accountable for the assessment of patients with undiagnosed and diagnosed conditions, and
for decisions about the clinical management required, including prescribing” (DTB, 2006, p. 33). Two forms of independent nurse prescribing developed in the UK. The first form was piloted in 1994 and rolled out to all NHS regions in 1998; and consisted of prescribing by community nurses from the *Nurse Prescribers’ Formulary for District Nurses and Health Visitors (NPF)*. According to the Royal College of Nursing (RCN), as of March 2008, there are approximately 49,112 nurse prescribers in the UK with 33,000 health visitors and district nurses prescribing from the NPF (Kwentoh & Reilly, 2009; Lomas, 2009).

The second form of independent prescribing for nurses was introduced in England in 2002, allowing registered nurses and midwives with additional training to prescribe from the *Nurse Prescribers’ Extended Formulary (NPEF)*. The formulary covered over 120 POMs for specific conditions, plus licensed pharmacy GSL medicines prescribable on the NHS for those conditions (DTB, 2006). By 2006, almost all of the BNF was opened up to independent and supplementary nurse prescribers to include medications for emergency and first-contact care and certain controlled drugs for specified conditions, replacing the need for the NPEF (ibid.).

**Response to non-medical prescribing**

The announcement by the Secretary of State for Health, Patricia Hewitt, that doctors’ unique privilege to prescribe from the entire formulary would in future be usurped by nurses and pharmacists, subject to checks on their professional competencies, raised the hackles of doctors who saw it as another attack on their professional status (Keighley, 2006). The British Medical Association (BMA) claimed that it was not safe to prescribe without training in diagnosis (Avery & Pringle, 2005). Horton (as cited in Aronson, 2004) implied that the rate at which nurse prescribing was being implemented held grave dangers. There were reservations about pharmacology taught to nurse prescribers. Dean, Schachter, Vincent and Barber (as cited in Aronson, 2004) reported that hospital doctors made errors in 1.5% of prescriptions and potentially serious errors in 0.4% of prescriptions; it constituted a total of 34 potentially serious errors every week in one teaching hospital. It was Aronson’s opinion that nurses were likely to make as many prescribing errors, probably even more. However, reassuring evidence from general medicine practice surveys demonstrated that
independent nurse prescribers generally prescribed appropriately when reviewed by medically trained assessors (Latter et al., as cited in Kwentoh & Reilly, 2009).

**Radiographer prescribing**

The Society and College of Radiographers (SCoR) also recognised the need for continuous improvement in patient care and established a working party to investigate the implications of the Crown Report for radiographers (SCoR, 2001). The working party was comprised of both clinical and educational representatives and also representatives from the Pharmacy Profession and the Radiographers Board at the Health Professional Council. They wrote to individual members of the profession who were identified as those most likely to be involved in the supply and administration of medications (ibid.). The working party received very positive feedback since radiographers were quick to recognise this opportunity for role development. Some reported that they were already involved in the supply and administration of medications under PGDs and would welcome the moves to establish the practice within a sound medico-legal framework. The working party found that the benefits for patients would be significant if radiographers could prescribe certain drugs. Subsequently a submission document was prepared to support the case for radiographers to be authorised as dependent and/or independent prescribers (ibid.). The Society’s view was that “radiographer prescribing is not an option for the future, it is a requirement” (SCoR, 2001, p. 5).

**Radiotherapy**

With the publication of the *Calman Hine Report* in 1995, the importance of therapy radiographers in the development of cancer treatment delivery was identified (Frances & Hogg, 2006). The report recognised the wide range of skills needed by therapy radiographers such as the technical expertise to deliver day to day radiation treatment, counselling and supportive care of patients during the course of their treatment, and the managerial skills to ensure a safe and efficient service. Francis and Hogg (2006) stated that these radiographers were well placed to enhance the delivery of seamless care in the support of patients undergoing radiotherapy. However, the services they offered in care and advice were constrained by their inability to prescribe drugs for the management of treatment toxicity.
Since 1998 therapy radiographers were trained to administer selected drugs from a limited range under PGDs for the management of treatment side effects, for example pain, constipation, diarrhoea, skin reactions, nausea, and vomiting (ibid.). Hogg et al. (2007) regarded the philosophy of supplementary prescribing to be well suited to the management of therapy patients since cancer is a chronic condition and it is highly feasible to set up a CMP between the oncologist (independent prescriber) and the therapy radiographer (supplementary prescriber). These authors were of the opinion that supplementary prescribing would be more advantageous than PGDs with respect to toxicity management for the following reasons:

- PGDs are restricted to specific medications at specific doses that cannot be altered or changed to an alternative medication within a specific PGD, therefore making it inflexible
- In accordance with Trust policies, PGDs require regular updating and the associated processes could be labour intensive
- Supplementary prescribing allows for more responsive and individual care and management since it allows therapy radiographers to have broad personal latitude within their competence in the medications they prescribe and the amount they administer.

Hogg et al. (2007) anticipated that most radiotherapy services would be organised in such a way that the patients’ needs would be partly met through the use of PGDs and partly through supplementary prescribing.

**Nuclear medicine**

In nuclear medicine, technicians and radiographers often have similar responsibilities; for example the scanning of patients where there is frequently a requirement to administer adjunct drugs such as diuretics (Hogg et al., 2007). Radiographers have been working under PGDs in order to administer these; however, technicians are not legally permitted to use PGDs and neither can they be delegated by a radiographer. On advice of the Administration of Radioactive Substances Advisory Committee (ARSAC) new legislation was passed (Ryan & Brown, 2005). This legislation allows locally written protocols to be used for
the administration of adjunct drugs and might look similar to PGDs; yet it permits technicians to work within these new protocols and thus allowing for a more efficient method of working. However, PGDs cannot be used for radiopharmaceuticals (Hogg et al., 2007).

**Diagnostic radiography**

Very little evidence has been published regarding the use of PGDs and supplementary prescribing in radiography. According to Hogg et al. (2007) many diagnostic imaging departments have implemented PGDs for patients who have the same investigations. The reasoning is that for many diagnostic imaging procedures the patient pathway through the examination follows a fairly set format. The following examples illustrate when a PGD can be used for patients who will be managed in a specified and predetermined fashion as indicated by Hogg et al. (2007):

- Barium enema patients requiring bowel cleansing, achieved by oral laxatives prior to the examination
- The introduction of contrast enhancers such as barium sulphate and iodine-based liquids during imaging
- The administration of drugs to improve diagnostic efficacy for instance smooth muscle relaxants, diuretics and cardiac stimulation agents.

These medicinal products are commonly incorporated into PGDs within diagnostic imaging departments. On the other hand, supplementary prescribing has not had a widespread uptake in diagnostic radiography yet; probably because supplementary prescribing is most useful in dealing with long term medical conditions while diagnostic radiography, for the most part, involves one-off examinations (ibid.).

2. **New Zealand**

This section will examine some of the legislative pieces concerning the prescription, sale, supply and use of medicinal drugs in New Zealand. This will include an overview of two of the acts, namely the *Misuse of Drugs Act 1975* and the *Medicines Act 1981*. This will be
followed by a review with regard to nurse practitioner prescribing in New Zealand and the opportunities available for other health care professionals.

The Misuse of Drugs Act 1975

This Act is also known as the *Principal Act* and regulates the classification of controlled drugs in New Zealand and establishes offences and penalties in relation to illicit drugs (Misuse of Drugs Act, 1975). However, amendments to the Act were necessary to include a legislative framework in which new drugs could be classified and existing ones reclassified in order to bring the Act into line with developments in the manufacture and supply of illicit substances; referred to as the Misuse of Drugs Amendment Act 2000 (the Act). The classification of a drug under the Act (Appendix Two) is determined by criteria concerning the risk of harm a drug poses to individuals or society by its misuse (McNab, 2003).

The Medicines Act 1981

This Act is the legislation that defines and regulates medicines in New Zealand. The Medicines Act 1981 (No 118), Section 19 (1), states that “a prescription medicine may be administered to any person only in accordance with (a) the directions of the authorised prescriber who prescribed the medicine; or (b) a standing order” (p. 34). Furthermore, Section 19 (3) states that “every person commits an offence against this Act who contravenes subsection (1)” (p. 34). The Act authorises a registered medical practitioner, dentist or midwife to prescribe, administer or arrange for the administration of medicines for the treatment of patients in their care. According to Section 8 of the Medicines Act 1981, the Minister may appoint advisory or technical committees to advise him of the purposes of the Act. It is under this section that the New Prescribers Advisory Committee (NPAC) was established in 2002 (Borthwick et al., 2010). The Committee was responsible for providing advice to the Minister of Health on issues regarding proposals from health professions seeking limited independent prescribing rights (NPAC, n.d. [a]). The New Zealand Government was in agreement that extending limited independent prescribing authority to other health professionals was one way to improve access to health care in the community and deliver better health care services (NPAC, n.d. [b]). However, in 2006 the Committee was disestablished and taken over by the Ministry of Health; which will assess the appropriateness of future applications for the extension of prescribing rights (ibid.).
has been established that only registered health practitioners may seek limited independent prescribing authority (NPAC, n.d. [c]).

Implementation of nurse practitioner prescribing

In 1995, the Government started examining the feasibility of legislating nurse prescribing (New Zealand Nurses Organisation [NZNO], 2005). In 1999, the Medicines Act 1981 was amended that enabled the making of regulations to allow other registered health professionals to prescribe from a specified list of medicines (Ministry of Health, 2002). In 2001 regulations were passed that allowed nurse prescribing in child health and aged care (NZNO, 2005). In July 2005 the Ministry of Health released a consultation document titled Implementing Nurse Practitioner Prescribing and gave several justifications for the proposed change:

- Midwives prescribe
- International evidence demonstrates the safety, effectiveness and cost-effectiveness of nurse prescribing
- Greater collaboration between team members
- No research could be found by the Nursing Council to support the case that the nursing master’s degree is insufficient for independent prescribing (Ministry of Health, 2005)

Moller and Begg (2005[a]) argued that in the example of the midwives there was no monitoring on whether midwife prescribing was as safe as it was supposed to be since the loss of medical involvement in primary obstetric care. Regarding the issue on safety and competence, they questioned how someone with less training in physiology, pathophysiology, pathology, diagnosis, and pharmacology could prescribe with the same degree of safety and competency as a doctor. The authors reasoned that appropriate prescribing depended on accurate diagnosis; which is the fundamental purpose of a medical education. Nursing training though, has been more about appropriate care. Furthermore, Moller and Begg (2005[a]) were sceptical if there would be enhanced collaboration between team members. The authors gave the example of independent midwifery in New Zealand
with reference to misadventures in the delivery and management of new-born infants due to lack of consultation when the midwife did not recognise the difficulties. In the authors’ opinion, independent nurse prescribing would risk serious damage to teamwork with unforeseen consequences on standards of safety and competence. It was suggested that dependent prescribing was a better alternative.

Renouf (2005) was quick to respond to the authors’ comments and emphasised that nurse practitioners received an extensive postgraduate clinical education within the master’s degree. Renouf (2005) stated that the following aspects are included in the degree:

- Pharmacology and pharmacotherapeutics (developed in conjunction with New Zealand’s pharmacy schools and medical specialists, and at least equivalent to medical school training at the University of Auckland;
- Diagnostic reasoning and specialty practice courses (taught in part by Medicine); and
- Evidence-based practice, research, and practicums culminating in a prescribing practicum being signed off/passed by a medical colleague (p. 1).

Renouf (2005) added that the nurse practitioner would then undergo a process of Nursing Council endorsement through a portfolio, site visits, and an interview by a panel, which would include a physician/doctor in the applicant’s scope of practice. Only then could nurse practitioners incorporate independent prescribing into the range of care offered to their patients. This could take a minimum of eight to ten years of combined university education and years of practice to achieve (ibid.). Nurses’ objective is to improve care, improve timely access, and to improve healthcare teamwork. However, dependent prescribing would mean working under standing orders or getting every script co-signed and neither would be practical to a nurse practitioner on a day-to-day basis (ibid.). Renouf (2005) reasoned that even though nurse practitioners came from a different paradigm, they could prescribe just as well as doctors could ‘care’. In return, Moller and Begg (2005[b]) responded that it was self-evident that nurses level of training could not match that of a doctor until it duplicated it and “that the medical team, which has evolved over centuries, remains the best model” (p.4).
Hosking (2005) also responded to the comments by Drs Moller and Begg. She worked in the UK as an epilepsy nurse specialist at a tertiary referral hospital and provided over 3,000 epilepsy consultations a year. She gave consultations to patients who had complex neurological, pharmacological; surgical, physiological; social, and psychiatric problems. Hosking (2005) consulted with medical colleagues when necessary over the management of patients; however, she made most treatment decisions autonomously and was clinically responsible and professionally accountable for that advice. She claimed that consultants, GPs and patients were all satisfied with the service. Her services reduced the demand for urgent consultations, shortened the waiting times for a consultant appointment, and freed up the consultant’s time to see more patients. In Hosking’s (2005) experience, most medical practitioners who prescribe anti-epileptic drugs have little training and experience in epilepsy, deliver few epilepsy consultations, and do not attend conferences specific to the condition. She was of the opinion that the scarcity of specialists in epilepsy and the management by non-specialist doctors contributed to the high rate of misdiagnosis, mismanagement, and morbidity and mortality among people with epilepsy. Hosking (2005) therefore welcomed the development of independent nurse prescribing in New Zealand since the consequences of such a change were likely to improve standards of care.

However, the New Zealand Medical Associations’ (NZMA) view in their submission to the Nursing Council of New Zealand was that “the minimal training necessary for prescribing medications other than those safe enough to be available over the counter, should be a basic medical degree” (2005, as cited in Bukofzer, n.d., p. 4). Notwithstanding, nurse prescribing in New Zealand gained Royal assent on September 12, 2005 and nurse practitioners are now eligible to prescribe within their specified scope of practice a range of identified classes of medicines (Hoare, 2006; NZNO, 2002). Sixty-three nurse practitioners have been registered nationally up until January 2010 but not all have elected to attain prescribing rights (McLean, 2010). However, the resistance to the development and implementation of nurse prescribing has been a shared experience between the UK and New Zealand.
**Optometrists**

The New Zealand Association of Optometrists (NZAO) in conjunction with the Department of Optometry and Vision Science (DOVS); Auckland University; and the Optometrists Board submitted a joint application to the Ministry of Health for optometrists to be designated prescribers (NZAO, 2010). In 2005 the Therapeutic Pharmaceutical Agents (TPA) scope of practice for optometry came into effect. From 2006, all New Zealand optometrists graduating from DOVS are TPA-endorsed (ibid).

**Dietitians**

In November – December 2009 the Dietitians Board of New Zealand and the New Zealand Dietetic Association submitted a joint application to the Ministry of Health for dietitians to access the PHARMAC schedule for Special Foods (McNab, 2009). Special Foods are not listed in the Medicines Schedule; however, they are considered by the Ministry of Health to be covered by a similar process to the NPAC application process (ibid.). Six months later the PHARMAC Board agreed to allow authorised, currently practising dietitians to prescribe Special Foods and some related products after they had completed the *Dietitian Prescribers Training Course*. This course was developed by the Dietitians Board in conjunction with the School of Pharmacy in Auckland (Dietitians Board, 2011). Only dietitians who have attended the course may apply to be authorised to prescribe Special Foods (ibid.).

**Medical radiation technologists**

Currently, New Zealand MRTs have no direct authority to prescribe or administer drugs (Health Professional Regulatory Advisory Council [HPRAC], 2008). MRI technologists do however administer contrast media under the supervision of a radiologist. A number of MRI technologists also administer pharmaceuticals relevant to a procedure, for example glucagon and buscopan (Yielder et al., 2008). However, a radiologist survey revealed that some technologists were already prescribing these pharmaceuticals as well (ibid.). This raises the question whether IV contrast media are handled appropriately since they are POM (Thorpe, 2008). The package inserts of these drugs carry a list of contra-indications, warnings, precautions, and adverse reactions like any other prescription-only drug. The next section will therefore analyse the usage of contrast media.
3. Contrast media
The importance of contrast media in medical imaging is undeniable and has become an instrumental part in the effectiveness of diagnostic imaging. IV contrast media are frequently used for both CT and MRI to detect, characterise, and stage disease (Weinreb, 2008). The ever increasing use of contrast media in the various imaging modalities comes with a great deal of responsibility (Morrison & Odle, 2007); but despite their use in tens of millions of procedures every year, there are relatively few serious and life-threatening events (Weinreb, 2008).

Iodinated contrast media
Siddiqi (2010) states that radiographic iodinated contrast media have been among the most prescribed drugs in the history of modern medicine since their introduction in the 1950s. They are often used in CT examinations and certain fluoroscopic procedures, such as urograms. They are mostly administered intravenously but can be used intra-arterially, intra-thecally, and intra-abdominally (Singh & Daftary, 2008).

Due to their chemical characteristics, they are categorised into high-osmolality and low osmolality contrast media. Osmolality is defined as the number of molecules per kilogram of water (Singh & Daftary, 2008). Contrast media are generally viscous with a greater osmolality than blood, plasma, or cerebrospinal fluid (CSF). High-osmolality contrast media have 5-8 times the osmolality of plasma while low-osmolality contrast media have 2-3 times the osmolality of serum (ibid.). Contrast media can be ionic or non-ionic and refers to the characteristic of the molecule to dissociate into a positively charged cation and a negatively charged anion; therefore increasing the osmolality. Non-ionic contrast media do not have this ability and are less osmolar and potentially less chemotoxic than the ionic ones (Siddiqi, 2010).

Adverse reactions to iodinated contrast media
Although the diagnostic value of iodinated contrast media is indisputable, they are like any other pharmaceuticals: not entirely devoid of risks and adverse side effects can occur. Adverse reactions are defined as any unfavourable or unintended alteration in the clinical status of the patient that is temporarily associated with the use of contrast media; even if
they are not considered to be related to administration of the drug (Li, Wong, Wong, Lee & Au Yeung, 2006). It has been said that iodinated contrast media are in the top ten drugs responsible for anaphylactic reactions (Wang, as cited in Morcos, 2005). Singh and Daftary (2008) state that reactions are infrequent and range between 5% and 12% for high-osmolality contrast media and between 1% and 3% for low-osmolar contrast media. Adverse reactions to contrast media can be either anaphylactic/idiopathic; or nonanaphylactic/nonidiopathic; or a combination of both. Anaphylactic or acute allergic-like reactions are the most frequent and may have serious, sometimes fatal, complications that typically begin within 20-60 minutes of contrast administration (Singh & Daftary, 2008). Symptoms associated with anaphylactic reactions are usually categorised as mild, moderate, or severe according to the classification system proposed by the American College of Radiology (ACR, 2010). A reaction is classified as mild if signs and symptoms appear self-limited without evidence of progression and necessitates either no treatment or treatment limited to antihistamine. A moderate reaction is more pronounced and necessitates immediate medical treatment other than antihistamine and requires close observation for possible progression to a life-threatening event. A reaction is classified as severe if it is life-threatening and requires prompt recognition and aggressive treatment. These patients are often hospitalised if an outpatient or emergency department patient (ibid.). Non-anaphylactic reactions occur possibly because of the ability of contrast media to disrupt the homeostatic balance within the body; especially the blood circulation. They are usually dependent on the physical properties of the contrast media, such as the ionicity, which may disrupt electrical charges associated with nervous or cardiac activity; and osmolality, which may cause large shifts in fluid volumes (Singh & Daftary, 2008). Symptoms associated with non-anaphylactic reactions include bradycardia, hypotension; vasovagal reactions, neuropathy; cardiovascular reactions, sensations of warmth, and a metallic taste in the mouth (ibid.). Late adverse reactions may occur between one hour and one week after the administration of intravascular iodinated contrast media and are typically skin reactions (Siddiqi, 2010). It is stated that previous adverse reactions to iodinated contrast media increase the relative risk of a repeat reaction 3.3- to 6.9-fold compared with the risk in the general population (ibid.). This figure corresponds reasonably with Morcos et al. (2008) who have estimated that there is a six-fold increase in the incidence of severe reactions to both ionic and non-ionic contrast media in patients with a previous history of adverse reaction. It
was calculated that approximately 60% of patients who had hives previously after contrast media administration had hives with a repeat exposure. Similarly, the recurrence rate of facial edema and bronchospasm in patients was 68% and 38% respectively. It has also been reported that asthma is another important risk factor that may increase the risk of a severe reaction six- to ten-fold in such patients (ibid.).

Some studies have demonstrated the effectiveness of oral prophylactic treatment prior to contrast injection in patients with a history of previous adverse reactions (Greenberger & Patterson, as cited by Siddiqi, 2010; Lasser et al., as cited in Siddiqi, 2010). It can lower the incidence of adverse reactions from 9% to 6.4%. Freed, Leder, Alexander, De Long and Kliewer (2001), on the contrary, have found no significant reduction in the rate of adverse reactions despite premedication with steroids. However, the ACR (2010) recommends premedication to those who, in the past, have had moderate or severe reactions that required treatment. Deaths as a result from iodinated contrast media are rare; Katayama et al. (as cited in Morcos, 2005) found that the incidence was 1:170,000.

Another issue frequently encountered with the use of iodinated contrast media is the concern for chemotoxic reactions such as contrast-induced nephropathy (CIN). It refers to the impairment in renal function and is measured by an increase in the serum creatinine level; usually more than 25% above baseline, and occurring within three days after receiving IV contrast media and in the absence of an alternative etiology (ACR, 2010; Elicker, Cypel & Weinreb, 2006). It is the third most common cause of hospital-acquired acute renal failure (Darwish, 2009). Patients at most risk for CIN are those with pre-existing renal impairment and diabetes mellitus (ibid.). Other factors that have been implicated are dehydration, advanced age, congestive heart failure, hyperuricemia, hypertension, hypotension; and recent exposure to other nephrotoxic drugs such as non-steroidal anti-inflammatory agents (Darwish, 2009; Siddiqi, 2010). The risk of CIN is significantly increased with the presence of multiple risk factors in the same patient. Many radiology departments have developed protocols that are aimed at identifying patients at risk for CIN prior to CT imaging and then offering alternative imaging. The problem with these protocols is that they create other risks for the patient, for example the alternative imaging modality may be less efficacious.
leading to under-diagnosis; while gadolinium-enhanced MRI may pose its own threats to certain patients (Buckenham, 2010).

**Gadolinium-based contrast media**

Bushong (2003) stated that it was initially assumed that contrast enhancement would not be needed in MRI because of the naturally good available contrast among tissues in the body. Even though MRI is extremely sensitive to detecting pathological conditions, it has become clear that under certain circumstances the addition of a contrast medium significantly increases the diagnostic value of MRI by improving disease sensitivity and specificity as well as delineating pathological processes. It has been estimated that 40-50% of all MRI studies performed worldwide are contrast-enhanced and are expected to increase in the future (Lin & Brown, as cited in Bellin & Van der Molen, 2008). Gadolinium is used since it is highly paramagnetic due to its seven unpaired electrons. Therefore, MRI images do not demonstrate the gadolinium itself, but its paramagnetic effect on the surrounding tissues (Bushong, 2003). Gadolinium belongs to the lanthanide series of elements (rare earth metals), is highly toxic in its free form, and acts as an inorganic blocker (Bellin & Van der Molen, 2008). In order to reduce the toxicity of gadolinium; its interaction within the body and to increase the speed with which it clears the body, gadolinium is bound to a chelating agent (Bushong, 2003). There are two structurally distinct categories of gadolinium-based contrast media, namely linear and macrocyclic contrast media. The pharmaceutical solutions of some of these gadolinium complexes, such as the linear compounds, have excess chelate to ensure the absence of toxic free gadolinium ions (Gd^{3+}) in the solution. In macrocyclic chelates, the Gd^{3+} is caged in a pre-organised cavity of the ligand and has no excess chelate (Bellin & Van der Molen, 2008). Macrocyclic chelates are the least likely to release free ions through a process called transmetallation. It is a process in which Gd^{3+} exchange occurs with endogenous ions from the body, usually copper and zinc (ibid.). Linear chelates are more likely to release free Gd^{3+} in the body due to the excess chelate included in the solution (Kurtkoti, Snow & Hiremagular, 2008).

**Adverse reactions to gadolinium-based contrast media**

A great deal has been written in the literature with regard to the incidence of adverse reactions to gadolinium-based contrast media and they are generally considered to be safer
than iodinated contrast media (Dillman, Ellis, Cohan, Strouse & Jan, 2007; Elias Jr, Dos Santos, Koenigkam-Santos, Nogueira-Barbosa & Muglia, 2008; Li et al., 2006; Murphy, Brunberg & Cohan, 1996). The mean dose of IV gadolinium-based contrast administered during MRI examinations is 10-20 ml, which is 5-to 15-fold lower compared to contrast media used in CT examinations (Elias et al., 2008).

Gadopentetate dimeglumine (Magnevist, Bayer Schering Pharma AG) was first regarded as a potential contrast medium for MRI more than 25 years ago (Nelson, Gifford, Lauber-Huber, Gross & Lasser, 1995). Gadopentetate dimeglumine was shown to be more sensitive and specific than if no contrast enhancement was used and was confirmed to be safe and well tolerated in patients (Niendorf, as cited in Nelson et al., 1995). In 1988 gadopentetate dimeglumine became the first paramagnetic contrast media marketed in the United States for clinical use. Nelson et al. (1995) conducted a study to evaluate the rate of adverse reactions associated with the use of gadopentetate dimeglumine. The authors determined that 15,496 patients received gadopentetate dimeglumine between April and September 1992. Three hundred and seventy-two patients (2.4%) reported at least one adverse reaction during that study period (Table 1). None of the reactions were serious; they were all transient. In 185 (49.7%) of those patients adverse reactions occurred within 30 minutes of contrast administration. One hundred and sixty-seven patients (44.9%) had an allergic reaction more than one hour after contrast administration. The delayed reactions reported were similar to those that had occurred within the first hour after the contrast was injected.

Table 1: Adverse reactions encountered with gadopentetate dimeglumine (Nelson et al., 1995)

<table>
<thead>
<tr>
<th>Adverse reactions</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea</td>
<td>71</td>
</tr>
<tr>
<td>Headaches</td>
<td>68</td>
</tr>
<tr>
<td>Dizziness</td>
<td>29</td>
</tr>
<tr>
<td>Injection site reaction</td>
<td>28</td>
</tr>
<tr>
<td>Paresthesia</td>
<td>26</td>
</tr>
<tr>
<td>Vomiting</td>
<td>23</td>
</tr>
<tr>
<td>Asthma</td>
<td>19</td>
</tr>
<tr>
<td>Rash</td>
<td>14</td>
</tr>
<tr>
<td>Vasodilation</td>
<td>11</td>
</tr>
<tr>
<td>Urticaria</td>
<td>11</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>372</strong></td>
</tr>
</tbody>
</table>
However, Jordan and Mintz (1995) reported the case of a 67-year old woman who had a fatal reaction to gadopentetate dimeglumine. She had no drug allergies and had a prior contrast-enhanced CT examination without any difficulties; yet she had a history of severe chronic obstructive pulmonary disease and required home oxygen therapy. The patient became very short of breath within one minute of contrast medium administration and did not respond to immediate emergency treatment and died despite cardiopulmonary resuscitation (CPR). The cause of death was presumed as an anaphylactic reaction with associated bronchospasm. This was the first reported case in which the rapid onset of symptoms and subsequent cardiovascular arrest after the administration of gadopentetate dimeglumine has suggested a cause-and-effect relationship.

In a study by Murphy et al. (1996) 21,000 patients in their institution received gadolinium-based contrast media over a 57-month period. Ninety-eight percent of the patients received gadopentetate dimeglumine, 1.77% received gadodiamide (Omniscan) and 0.23% received gadoteridol (ProHance). Thirty-six patients (0.17%) experienced adverse reactions within 30 minutes of IV injection. Mild, non-allergic reactions such as nausea and vomiting occurred in 15 of the 36 patients. Mild allergic-like skin reactions such as hives, erythema and skin irritations occurred in 12 patients. Moderate reactions resembling an allergy with a respiratory component occurred in seven patients. Two more patients experienced severe reactions requiring transfer to the emergency department for prolonged observation and management. Two of the patients in this study had a prior history of allergic reactions to gadolinium-based contrast media and received both prophylactic treatments to prevent recurrence. One of the two patients still suffered a breakthrough reaction; the other patient received a different gadolinium-based contrast medium from the one administered previously without any complications.

A study conducted by Li et al. (2006) reported a reaction rate of 0.48% in 9,528 patients who received gadolinium-based contrast media in their institution (Table 2). The one patient that had an anaphylactic reaction had no previous history of asthma, allergies, or prior reactions to contrast media. The patient was successfully resuscitated and later discharged uneventfully.
Table 2: Adverse reactions to gadolinium-based contrast media found by Li et al. (2006)

<table>
<thead>
<tr>
<th>Adverse reaction</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea/vomiting</td>
<td>18</td>
</tr>
<tr>
<td>Urticaria/rash</td>
<td>15</td>
</tr>
<tr>
<td>Vasovagal attack</td>
<td>3</td>
</tr>
<tr>
<td>Dizziness</td>
<td>2</td>
</tr>
<tr>
<td>Palpitations</td>
<td>2</td>
</tr>
<tr>
<td>Dyspnoea</td>
<td>2</td>
</tr>
<tr>
<td>Confusion</td>
<td>1</td>
</tr>
<tr>
<td>Chest discomfort (transient)</td>
<td>1</td>
</tr>
<tr>
<td>Anaphylactic shock</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

Dillman et al. (2007) carried out a research study at their institution over a period of five years to determine the frequency and severity of acute allergic-like reactions to gadolinium-based contrast media. Over the study period 78,353 IV injections were performed: 65,009 were adults and 13,344 were paediatric patients. A total of 54 (0.07%) acute allergic-like reactions were recorded: six (0.04%) reactions for paediatric patients and 48 (0.07%) for adult patients; however, one patient experienced three acute allergic-like reactions on three different occasions during that time. Forty (74%) of the documented reactions were classified as mild, ten (19%) as moderate and four (7%) as severe (Table 3).

Table 3: Adverse reactions to gadolinium-based contrast media found by Dillman et al. (2007)

<table>
<thead>
<tr>
<th>Adverse reaction</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mild:</strong></td>
<td></td>
</tr>
<tr>
<td>• Urticaria</td>
<td>23</td>
</tr>
<tr>
<td>• Transient throat symptoms (itching)</td>
<td>4</td>
</tr>
<tr>
<td>• Rash</td>
<td>3</td>
</tr>
<tr>
<td>• Transient breathing difficulties</td>
<td>3</td>
</tr>
<tr>
<td>• Sneezing and nasal congestion</td>
<td>3</td>
</tr>
<tr>
<td>• Mild perioral/periorbital edema</td>
<td>2</td>
</tr>
<tr>
<td>• Mild facial edema</td>
<td>2</td>
</tr>
<tr>
<td><strong>Moderate:</strong></td>
<td></td>
</tr>
<tr>
<td>• Breathing difficulties (transfer to ED)</td>
<td>5</td>
</tr>
<tr>
<td>• Throat symptoms (transfer to ED)</td>
<td>3</td>
</tr>
<tr>
<td>• Facial angioedema (transfer to ED)</td>
<td>1</td>
</tr>
<tr>
<td>• Bronchospasm</td>
<td>1</td>
</tr>
<tr>
<td><strong>Severe:</strong></td>
<td></td>
</tr>
<tr>
<td>• Hypoxia</td>
<td>2</td>
</tr>
<tr>
<td>• Laryngeal edema</td>
<td>1</td>
</tr>
<tr>
<td>• Respiratory distress</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>54</strong></td>
</tr>
</tbody>
</table>
Any adverse events to the gadolinium-based contrast media such as nausea, vomiting, altered taste; perspiration, warmth, flushing, and anxiety were considered physiological side-effects. They were not thought to be allergic-like since they did not typically require medical management. No gadolinium-based contrast media-related deaths occurred during the study period. Fifty percent of the patients who experienced an adverse reaction had one or more identifiable presumed risk factors. The risk factors included a history of previous adverse reaction to gadolinium-based contrast media, iodinated contrast media, and substances other than gadolinium-based contrast media or iodinated contrast media.

More studies have been published with regard to the incidence and severity of adverse reactions to gadolinium-based contrast media (Bleicher & Kanal, 2008; Abujudeh, Kosaraju & Kaewlai, 2010; Forsting & Palkowitsch, 2010; Ishiguchi & Takahashi, 2010). When comparing all the studies, the frequency of acute allergic-like reactions were 0.93% (Ishiguchi & Takahashi, 2010); 0.9% (Forsting & Palkowitsch, 2010); 0.16% (Abujudeh et al., 2010); 0.76% (Bleicher & Kanal, 2008); 0.07% (Dillman et al., 2007); 0.48% (Li et al., 2006); 0.17% (Murphy et al., 1996); and 2.4% (Nelson et al., 1995). The most frequent reported reactions in those studies were nausea and vomiting, followed by urticaria. However, Dillman et al. (2007) did not include nausea and vomiting in their study, whereas the others had. Nevertheless, the frequency of adverse reactions is found to be consistent between the various studies with regard to gadolinium-based contrast media.

Comparison of adverse reactions between iodinated contrast media and gadolinium-based contrast media

Cochran, Bomyea and Sayre (2001) reported on the incidence and severity of adverse reactions to both iodinated and gadolinium-based contrast media. Data collected from their institution revealed that between 1985 and 1999, iodine-based contrast media were administered to 90,473 patients with 391 (0.4%) adverse reactions observed. Between 1993 and 1999; 28,340 doses of gadolinium-based contrast media were administered with 19 (0.07%) adverse reactions recorded.

Hunt, Hartman and Hesley (2009) did a retrospective review of all intravascular doses of low-osmolality iodinated contrast and gadolinium-based contrast media administered
between 2002 and 2006 in a single centre. A total of 456,930 doses of contrast media were administered. Among those, 298,491 doses were of low-osmolar iodinated contrast media and 158,439 of gadolinium-based contrast media. A total of 522 adverse reactions were recorded: 458 (0.153%) were associated with iodinated contrast media and 64 (0.04%) were related to gadolinium-based contrast media (Table 4).

Table 4: Comparison of the severity of adverse reactions between iodinated contrast media and gadolinium-based contrast media (Hunt et al., 2009)

<table>
<thead>
<tr>
<th>Severity</th>
<th>Iodinated contrast media (Number of patients)</th>
<th>Gadolinium-based contrast media (Number of patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>374</td>
<td>49</td>
</tr>
<tr>
<td>Moderate</td>
<td>69</td>
<td>11</td>
</tr>
<tr>
<td>Severe</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Total:</td>
<td>458</td>
<td>64</td>
</tr>
</tbody>
</table>

One death occurred during the study period associated with the use of iodinated contrast media. The patient experienced sudden cardiovascular collapse within less than 20 minutes after the contrast medium was administered and subsequent attempts at resuscitation were unsuccessful. No deaths were related to gadolinium-based contrast media.

Gadolinium-based contrast media remain one of the safest drug groups and are less nephrotoxic than iodinated contrast media on a volume level (Bongartz, 2007). MRI contrast media were originally introduced as ‘safe’ alternatives to iodinated contrast media in patients with renal impairment (Steen & Schwenger, 2007). However, gadolinium-based contrast media can bring on CIN if high doses are used; that is ≥0.3 mmol/kg of body weight instead of the recommended 0.1 mmol/kg (Weinreb, 2008). Therefore, the ‘carefree days’ of the medical community thinking that they had at least one imaging modality wherein contrast media could be used nearly risk-free in renal-failure patients, are in the past (Steen & Schwenger, 2007).

**Nephrogenic systemic fibrosis (NSF)**

This entity was first recognised in several patients in 1997 but only first described in the literature in 2000 (Broome et al., 2007). In 2000 the dermatologist Shawn Cowper
published a report of a new disease as described in 15 patients who had been either on chronic dialysis or who had received kidney transplants (Canavese et al., 2008; Issa et al., 2008). All the patients developed painful, erythematous, firm papules and plaques with geographic borders on the extremities and associated joints. The histopathologic findings demonstrated a unique fibrosing disorder that had not been described previously and for which the term nephrogenic fibrosing dermopathy (NFD) was proposed (ibid.). According to Canavese et al. (2008) approximately 50 papers were published between 2000 and 2005, mainly from dermatologists, pathologists, rheumatologists and nephrologists, describing more cases and adding further insights into the disease in terms of epidemiology, clinical features, histopathology and pathogenesis.

It was found that the disease occurred almost exclusively in patients with kidney failure of different degrees, on haemodialysis or peritoneal dialysis, or who were renal transplant recipients. It could occur in patients with advanced chronic kidney disease or acute renal failure not requiring dialysis (ibid). The disease affected both sexes with a reported age range of 8–87 years and had no race predilection (Cowper, as cited in Mendichovszky, Marks, Simcock & Olsen, 2008). Clinically patients presented with thickening and hardening of the skin with a *peau d’orange* appearance or textured plaques, overlying the extremities (from ankles to mid-thighs and from wrist to mid-upper arms) and sometimes involved the trunk but sparing the neck and face (Canavese et al., 2008; Mendichovszky et al., 2008). Later autopsy results of the disease demonstrated systemic manifestations including fibrosis of the skeletal muscle, bone; lungs, pleura; pericardium, myocardium; kidney, muscle; bone, testes and dura; therefore leading to a change toward a newly invented term: nephrogenic systemic fibrosis (Broome et al., 2007). Severely affected patients might be unable to walk because skin tightening and musculotendinous involvement result in joint contractures, which could reduce the range of motion of joint (Broome et al., 2007). Eventually, those patients would undergo fatal complications due to pulmonary involvement as well as mobility impairment leading to falls, fractures and clotting complications (Canavese et al., 2008).

However, it was the nephrologist Thomas Grobner, who in 2006, first reported an association between NFD/NFS and gadolinium-based contrast media after five out of nine
gadodiamide-exposed haemodialysis patients developed NSF within two to four weeks after exposure to it (Canavese et al., 2008). As a result, the medical community was informed in the following year that gadodiamide (Omniscan) was not only contraindicated in patients with end-stage renal disease (ESRD); but also in pre- or postoperative liver transplantation patients; and new-borns and infants up to one year old due to their renal-organ immaturity (Steen & Schwenger, 2007). Since gadolinium chelates are mostly eliminated through the kidneys, renal impairment will prolong the presence of these agents in the body and facilitate the release of toxic free Gd³⁺ by dissociation from its chelate (Bellin & Van Der Molen, 2008). The released Gd³⁺ ions form hydroxides and phosphates and these are probably engulfed by phagocytic cells, which might affect the reticuloendothelial system; inhibiting the activity of certain enzymes with consequent foreign body and fibrous reactions (Harpur et al., as cited in Mendichovszky, 2008). Though there is no reliable or successful treatment for NSF, improving the renal function appears to slow or arrest the development of NSF with gradual reversal of the process over time (Cowper, 2011). Treatments that have been tried and continue to be investigated are oral steroids (prednisone), Cytoxan; thalidomide, pentoxifylline; photopheresis, plasmapheresis; ultraviolet therapy, physical therapy, and renal transplantation (ibid.).

A number of retrospective studies followed that supported Grobner’s findings (Table 5).

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of patients diagnosed with NSF</th>
<th>Gadolinium-based contrast media used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broome et al., 2007</td>
<td>12</td>
<td>Gadodiamide</td>
</tr>
<tr>
<td>Collidge et al., 2007</td>
<td>14*</td>
<td>Gadodiamide</td>
</tr>
<tr>
<td>Moreno-Romero et al., 2007</td>
<td>3</td>
<td>Gadodiamide</td>
</tr>
<tr>
<td>Pryor et al., 2007</td>
<td>6</td>
<td>Not documented</td>
</tr>
</tbody>
</table>

*One patient developed biopsy-proven NSF without prior exposure to gadolinium-based contrast media

Almost all the patients developed NSF after the exposure of gadolinium-based contrast media and all of them had some form of renal insufficiency. Gadodiamide is excreted renally; therefore it has a noticeably prolonged half-life in patients with renal failure (Marckmann et al., 2006). The half-life of gadodiamide in healthy volunteers is 1.3 hours, 34.3 hours in patients with ESRD, 2.6 hours in haemodialysis patients, and 52.7 hours in
peritoneal dialysis patients (Joffe, Thomsen & Meusel, as cited in Marckmann et al., 2006). However, not all the dialysis patients exposed to gadodiamide in the study by Broome et al. (2007) developed signs of NSF; therefore suggesting that gadodiamide by itself was not a sufficient cause and that other factors had to play a role as well. One patient developed biopsy-proven NSF without prior exposure to gadolinium-based contrast media, suggesting that the contrast media in isolation does not cause NSF (Collidge et al., 2007).

Since numerous case reports implied a strong association of NSF with exposure to gadolinium-based contrast media in the setting of ESRD, Broome (2008) reviewed the medical literature reporting NSF cases in where the patients were specifically exposed to gadolinium-based contrast media. Up until February 1, 2008 Broome reported a number of 190 biopsy-proven cases of NSF published in the peer-reviewed literature (Table 6):

<table>
<thead>
<tr>
<th>Gadolinium-based contrast media used</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gadodiamide (Omniscan)</td>
<td>157</td>
</tr>
<tr>
<td>Gadopentetate dimeglumine (Magnevist)</td>
<td>8</td>
</tr>
<tr>
<td>Gadoversetamide (OptiMARK)</td>
<td>3</td>
</tr>
<tr>
<td>Unspecified cases</td>
<td>18</td>
</tr>
<tr>
<td>Confounding cases</td>
<td>4</td>
</tr>
<tr>
<td>Definitely no exposure</td>
<td>5</td>
</tr>
</tbody>
</table>

No NSF cases reported in the literature had been linked to gadoteridol (ProHance) yet. Since 2010, the United States Food and Drug Administration (FDA) have required that all gadolinium-based contrast media carry new warnings on their labels regarding the risk to NSF if administered to certain patients with kidney disease (FDA, 2010). This includes patients with acute or chronic severe renal insufficiency (glomerular filtration rate [GFR] < 30 ml/min/1.73m²); patients with acute renal insufficiency of any severity due to hepatorenal syndrome; or in the perioperative liver transplantation period (Issa et al., 2008). Gadodiamide, gadopentetate dimeglumine, and gadoversetamide are described as unsuitable for these patients. Table 7 demonstrates the estimated number of gadolinium-based contrast media (approved in the United States) that were administered worldwide as
of 2007 (Abu-Alfa & Weinreb, as cited in Broome, 2008). These figures do not include the administration of gadolinium-based contrast media that have been approved outside the United States. More than 15 million patients also received Dotarem (gadoterate dimeglumine), Gadovist (gadobutrol), Vasovist (gadofosveset trisodium) and Primovist (gadoxetic acid) (ibid.).

**Table 7: Worldwide estimated total number of gadolinium-based contrast media administrations as of 2007**

<table>
<thead>
<tr>
<th>Gadolinium-based contrast media</th>
<th>Estimated total number of administrations</th>
<th>Date of USA approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnevist (gadopentetate dimeglumine)</td>
<td>79.7 million</td>
<td>1988</td>
</tr>
<tr>
<td>Omniscan (gadodiamide)</td>
<td>36.5 million</td>
<td>1993</td>
</tr>
<tr>
<td>ProHance (gadoteridol)</td>
<td>12.5 million</td>
<td>1992</td>
</tr>
<tr>
<td>MultiHance (gadobenate dimeglumine)</td>
<td>2.1 million</td>
<td>2004</td>
</tr>
<tr>
<td>OptiMARK (gadoversetamide)</td>
<td>1.5 million</td>
<td>1999</td>
</tr>
</tbody>
</table>

As of June, 27, 2011, the International Center for Nephrogenic Systemic Fibrosis Research (ICNSFR) has identified 335 cases of NSF on their registry (Cowper, 2011). However, not all NSF cases have been triggered by the use of gadolinium-based contrast media (Collidge et al., 2007). Wahba, Simpson and White (2007) similarly reported two cases of solid-organ transplant recipients in whom NSF developed without previous exposure to gadolinium-based contrast media. Neither patient ever had a MRI examination and denied any exposure to gadolinium-based contrast media. However, these contrast media are used in more than just MRI and MRA examinations. Kay (2008) described the use of gadolinium-based contrast media by radiologists in other fluoroscopy examinations such as angiography, venography, fistulography and CT in patients for whom the use of iodinated contrast media is contraindicated. Therefore a patient with chronic kidney disease might have received these contrast media even if no MRI examination had been performed. The mechanism of NSF is speculative and the exact role of gadolinium-based contrast medium is unclear; because even though gadolinium appears to be necessary, it is not sufficient to trigger NSF. It is advised that all gadolinium-based contrast media should be used only after a careful assessment regarding risks and benefits to patients with renal impairment.
(Agarwal et al., 2009). If a contrast-enhanced MRI examination is absolutely necessary in a patient with ERSD or advanced chronic kidney disease, a gadolinium-based contrast medium other than gadodiamide, gadopentetate dimeglumine, and gadoversetamide should be used in the lowest dose possible (FDA, 2010; Issa et al., 2008).

**Summary**

Compared to the UK, role development in New Zealand has been slow to progress. MRTs believe that their skills and knowledge are not used to their full potential and they are capable of more. The non-medical prescribing of gadolinium-based contrast media by MRI technologists has potential for an extended role. Non-medical prescribing took years to develop in the UK and was met with much resistance from the medical professions. The implementation of nurse practitioner prescribing in New Zealand was not much different from the UK experience. The incidence of gadolinium-based contrast media reactions is very low and therefore should be ‘safe’ to be prescribed by MRI technologists. More to the point: prescribing of contrast media by radiographers in the UK has been happening for years and there is no reason why it cannot happen also in New Zealand.
CHAPTER 3

The Research Process

This chapter will provide an explanation of the research process of this project; that is the reasons why the specific methodology was chosen, the choice of data collection methods, how data were analysed, ethical considerations, the role of the researcher, and an evaluation of the research process.

Methodology

This study has combined quantitative research methods with a primarily qualitative study in order to investigate prescription rights as a possible extended role for MRI technologists in New Zealand. Ryan (1991) states that quantitative research describes a phenomenon in terms that can be counted or statistically expressed; however, there is a loss of human perspective. This may be compensated for when combined with qualitative research in order to understand the world from the perspective of those in it. Merriam (1998) defines qualitative research as “an umbrella concept covering several forms of inquiry that help us to understand and explain the meaning of social phenomena with as little disruption of the natural setting as possible” (p. 5). Merriam (1998) states that the key concern here is understanding the phenomenon of interest from the participants’ perspectives and not the researcher’s. Therefore, the product of a qualitative study is richly descriptive and is likely to include data in the form of the participants’ own words to support the findings of the study. With qualitative research, the researcher is the primary instrument for data collection and analysis, which differentiates the human researcher from other data collection instruments, for example the researcher is responsive to the context, can adapt techniques to the circumstances; process data immediately, can clarify and summarise as the study evolves, and can explore anomalous responses (Guba & Lincoln, 1981, as cited in Merriam, 1998). This form of research builds toward rather than tests existing theories from observation and intuitive understandings gained in the field (Merriam, 1998). Therefore, qualitative research findings are often in the form of themes and categories that
have been inductively derived from the data (ibid). In order to best meet the objectives of the research topic, it was decided that a case study approach would be the most suitable.

**Case study research**

Yin (2003) gives a technical definition of the case study as a research strategy and states that it is an empirical enquiry that “investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (p. 13). Merriam defines case study research in terms of its end-product; that is “an intensive, holistic description and analysis of a single instance, phenomenon, or social unit” (p. 27). Merriam (1998) adds that the case study design is selected to gain an in-depth understanding of a situation and its meaning for those involved. Smith (1978, as cited in Merriam, 1998) asserts that case studies are differentiated from other types of qualitative research given that they are intensive descriptions and analyses of a single unit or bounded system. Yin (2003) further explains that because the boundaries between phenomenon and context are not always discernible, “there will be many more variables of interest than data points” (p. 13). To overcome this, he proposes the triangulation of multiple sources of evidence that can be based on any mix of quantitative and qualitative evidence. Yin (ibid.) believes that selection of the appropriate unit of analysis occurs when the primary research questions are accurately specified. Therefore, if the questions do not lead to the favouring of one unit of analysis over another, the questions are probably too vague or numerous; making it difficult to conduct the case study. Merriam (1998) suggests in order to assess the boundedness of the topic, one needs to ask how finite the data collection would be; that is if there is a limit to the number of people involved. If there is no actual or theoretical limit, the phenomenon is not sufficiently bounded to constitute case study research.

Merriam (1998) characterises case study research by the following special features:

- **Particularistic** because it focuses on a particular situation or phenomenon. This makes it an especially good design for practical problems, questions, situations or puzzling occurrences from everyday practice.
- **Descriptive** because the end product is a rich description of the phenomenon under study that illustrate the complexities of a situation and the fact that not one but many factors contributed to it.
• *Heuristic* because the case study illuminates the reader’s understanding of the phenomenon under study and evaluates, summarises, and concludes, therefore increasing its potential applicability.

My study is therefore well-suited to the case study methodology since the situation being investigated is a well-bounded unit that focuses on a particular phenomenon in a present day situation: that being prescription rights as an opportunity for role extension in New Zealand for MRI technologists. The subsequent discussion and analysis of the results meet the characteristics as defined previously.

The design of the research is a single case design since it is confined to a particular group of people; that is MRI technologists in New Zealand. While radiologists are included to give more depth to the study, they do constitute an additional form of data collection within the parameters of the study. Yin (2003) states that one of the rationales for the single case is the representative or typical case where “the objective is to capture the circumstances and conditions of an everyday or commonplace situation” (p. 41) and that “the lessons learned from these cases are assumed to be informative about the experiences of the average person or institution” (ibid).

Yin (2003) maintains that the case study is particularly appropriate when ‘why’ and ‘how’ questions are being investigated. The following questions are therefore suitable for using this method:

• **How** often do New Zealand MRI technologists encounter patients experiencing adverse reactions to the gadolinium-based contrast media used and **how** well are the MRI technologists equipped to deal with these reactions?
• **Why** would MRI technologists find themselves in a position without a radiologist to prescribe the contrast medium?
• **Why** would it be beneficial for MRI technologists to have prescription rights and would they want them?
• What would prevent them from obtaining prescription rights and **why**?
• **How** supportive are radiologists of MRI technologists obtaining prescription rights?
Because it is anchored in real-life situations, Merriam (1998) once again emphasises the result of the case study as a rich and holistic account of a phenomenon that offers insights and illuminates meanings that expand the readers’ experiences. However, three issues need to be addressed here: validity, reliability and generalisation. According to Merriam (1998) internal validity deals with how congruent the findings are with reality. She believes that internal validity is a strength of qualitative research in the sense that people are the primary instrument of data collection and data analysis, and that the interpretations of reality are accessed directly through their observations and interviews. Merriam (ibid.) suggests some strategies to enhance internal validity, such as triangulation of data, member checks, and researcher biases. In this study different data collection methods have been used to gather the results so that the findings could be cross-referenced to support and validate the findings. Interview transcripts were returned to participants for them to check for accuracy. Researcher biases are addressed later in this chapter.

Hinds (2000) states that reliability refers to matters such as consistency, in other words, what the likelihood is of the same results being obtained if the procedures are to be repeated. However, reliability in a social study is problematic since human behaviour is never static (Merriam, 1998). Lincoln and Guba (1985, as cited in Merriam, 2003) suggest that one should instead reflect on the dependability and consistency of the results obtained from the data collected and that it makes sense; rather than if the same outcomes will be achieved again. To ensure that results are dependable, Merriam (1998) suggests the following techniques: An explanation of the investigator’s position; triangulation; and keeping an audit trail. In the first chapter the assumptions and theory behind the study that prompted this research topic was explained, which was then placed into context with the literature review. The selection of participants and the reasons for their inclusion in the study will be discussed shortly. As mentioned previously, different data collection methods were used to gather results and the data triangulated to support the findings. The aim throughout the process is to be logical and transparent that the reader will come to the same conclusions as the researcher.

Generalisation or external validity is concerned with the extent to which the findings of one study can be applied to other situations (Merriam, 1998). She suggests that one should
employ a ‘rich, thick description’ as to provide sufficient material for readers in order for them to determine how closely their situations match the research situation and whether findings can be transferred. However, Tellis (1997) comments that it is a frequent criticism of case study research that the results are not widely applicable in real life. Stake (1995, as cited in Tellis, 1997) on the other hand, expects that data generated by case studies “would often resonate experientially with a broad cross section of readers” (p. 2 ¶ 7) and subsequently assist in a greater understanding of the phenomenon.

Data collection

Yin (2003) states that the major strength of case study data collection is the opportunity to use many different sources of evidence; therefore the resultant findings or conclusions in case study research is going to be more convincing and accurate than those that rely on only single sources of information. The data collection methods for this research study included two questionnaires, critical incident reporting and six interviews.

MRI technologist questionnaire

According to Brink and Wood (1994), questionnaires are familiar to most people and are relatively inexpensive for obtaining data from a large population covering a wide geographical area. They state that an added advantage of questionnaires is that the subjects feel a greater sense of anonymity and are more likely to express controversial opinions when compared with interviews. Walonick (2004) believes that questionnaires reduce bias since the researcher’s own opinions will not influence the respondents to answer questions in a certain manner. However, Cohen, Manion, and Morrison (2000) caution against leading questions that may suggest to respondents that there is only one acceptable answer and that other responses might gain disapproval.

For the first phase of data collection a postal questionnaire was developed and piloted on four MRI technologists. Three had already completed their master’s degrees and had many years of experience in MRI. The other was a trainee with limited work experience. Two of the MRI technologists also had prior experience in conducting research projects and were able to give valuable advice on improving some of the questions. After some adjustments,
the questionnaire (Appendix Four) was mailed to all MRI technologists in New Zealand with either a scope of practice or a training scope of practice in MRI.

An e-mail that contained a covering letter (Appendix Three) was sent to all MRI team leaders working in either the public or private sector. It outlined the purpose of the study; the voluntary nature of the participation; and contact details of both the supervisors overseeing the research project and my own. Team leaders were initially asked if they could provide the names of the MRI technologists working in their department or practice; however, some thought it would leave them vulnerable despite the assurance of total anonymity. It was agreed then to provide only the number of MRI technologists working in each practice and the corresponding number of questionnaires were sent to the departmental or practice address. MRI team leaders, who did not respond to the e-mail, were phoned and asked if they were interested in participating in the research study. A total number of 157 MRI technologists (excluding myself) were identified.

The one major disadvantage of postal questionnaires is the possibility of a low response rate that can lower confidence in the results if the response rate is too low (Walonick, 2004). Cohen et al. (2000) estimate that a well-planned postal survey should obtain at least a 40% response rate. Of the 157 questionnaires sent, 99 questionnaires were completed and returned, which represents a response rate of 63.1%.

The questions were divided into five sections. The first section dealt with demographics. Polgar and Thomas (2008) suggest that demographic questions serve as a warm-up for the questions to follow. The purpose of the questions was to provide information such as the academic qualifications and clinical experience of the participants. The second section’s questions were related to the participants working practices in MRI. The third section contained questions with regard to the participants’ past experiences with gadolinium-based contrast media, for example patients who had an adverse reaction and how the participants dealt with those. The fourth section included questions regarding the prescription of gadolinium-based contrast media and the need for MRI technologists to have limited prescription rights. The final section dealt with the issue of training and the reasons that might prevent participants from doing the training.
**Critical incident technique**

Chell (1998, as cited in Gremler, 2004, p. 66) defines the critical incident technique as a qualitative interview procedure that “facilitates the investigation of significant occurrences (events, incidents, processes, or issues) identified by the respondent, the way they are managed, and the outcomes in terms of perceived effects.” This manner of reporting is also inexpensive and can provide rich information since the data collected are from the perspective of the participant (Gremler, 2004).

Attached to the questionnaire of each MRI technologist was a critical incident technique form (Appendix Five) and participants were invited to share any experiences, for example incidences that had occurred where it might have been helpful to have prescription rights or other practical areas that could give more insight into the research topic. One of the only drawbacks is that this manner of critical incident reporting relies on the memory of the participant to give an accurate and truthful report (Gremler, 2004). This technique requires respondents to take some time and effort to describe events in ample detail and therefore a low response rate is likely (Johnston, 1995, as cited in Gremler, 2004). That was unfortunately reflected in this study as only six respondents returned their critical incident reports.

**Radiologist questionnaire**

The radiologists’ participation was also an essential element in the research project since their opinion and support would be important should MRI technologists want to make a case for limited independent prescription rights. A questionnaire (Appendix Six) was developed and piloted on two radiologists with one radiologist working in the public sector and the other in the private sector.

The same approach was followed as with the distribution of the MRI technologists’ questionnaires. The team leaders were informed in the e-mail sent earlier of the necessity of the radiologists’ part in the study. A second covering letter (Appendix Three) addressed only to radiologists involved with MRI, was included. Via e-mails and follow-up phone calls a total of 173 radiologists were identified. Sixty-nine questionnaires were completed and returned; representing a response rate of 39.9%. However, because a number of
radiologists worked at both public hospitals and private practices simultaneously, they could have received the questionnaire twice. Therefore, only one completed copy would have been returned. A couple of blank questionnaires were received with a note that the respondent had already completed one.

Interviews

Cohen et al. (2001) state that the interview allows participants to express how they regard situations from their perspective. In this study the interview was used in conjunction with the questionnaires and critical incident technique to follow up results and to go deeper into the motivations and reasons for the way respondents replied.

I intended to interview four MRI technologists: two with work experience in the public sector (one qualified and one trainee) and two in the private sector (also one qualified and one trainee). At the time I thought this would form a good representation of my group of participants. However, I was not sure how to select the participants and altered my strategy slightly. On the last page of the MRI technologist questionnaire I included a tear-off slip that any interested individual could complete and return if they wanted to be interviewed by me. Thirteen respondents returned their slips and after follow up e-mails, the number I needed were prepared to be interviewed. They represented three MRI technologists working in the private sector and one in the public sector. Three of them were qualified with a combined work experience of 35 years in MRI amongst them and one trainee (private sector) who had four years’ experience in MRI.

Initially I was unsure whether I should interview any radiologists; however, one of the radiologists on whom I piloted the questionnaire said that more dialogue was needed on the topic and was willing to be interviewed. Despite the questionnaires being anonymous, one radiologist returned it signed with his name and place of employment. After discussion with my supervisor, I decided to contact the radiologist and asked him if he would be interested to do an interview with me, which he accepted. The two radiologists had a combined work experience of 38 years between them with 25 of those years related to MRI.
The interviews were face-to-face and the list of questions based on those used in the questionnaire (Appendix Seven and Eight). The interviews were conducted by myself in a semi-structured format to allow interviewees to share their experiences and to express their opinions and feelings on the research topic. At the same time it allowed me to respond to the situation at hand, for example exploring new ideas that the interviewee presented at the time. To increase the validity of the research, transcripts were returned to the interviewees so that they could check for the accurate transcriptions of their answers.

**Data analysis**

Anderson (1998) proposes two approaches to analysing data in case study research. The first is an analytical strategy that takes the literature and the background of the case and employs it as an organisational framework. The second approach is to organise the data into descriptive themes as they emerge throughout the data collection and preliminary analysis. These two approaches could be combined by organising the data into emergent themes and then extending the analysis to the context of the existing literature and theory (ibid.). Data collected from the questionnaires, critical incident reports and interviews were predominantly analysed qualitatively. It involved the search for common threads (cross-sectional thematic analysis) that extended throughout the data collection as proposed by Morse and Field (1995). However, data collected from the questionnaires that were compliant to quantitative analysis, were analysed using descriptive statistics. The quantitative data acquired supported the qualitative thematic analysis and strengthened the validity and reliability of the research interpretations.

**Ethical considerations**

Anderson (1998) has identified a number of ethical standards. Those that I believed were relevant to my study were put forward to the Unitec Research Ethics Committee (UREC) for consideration:

**Informed and voluntary consent**

An information sheet was attached to both the MRI technologist and radiologist questionnaire that stated the purpose of the research. It included a statement that
participation was strictly voluntary and anonymously (Appendix Three). A participant information sheet was also provided to all parties interested in being interviewed, stating that the interview would be recorded (Appendix Three). This included a form that the interviewees had to sign prior to conducting the interview (Appendix Three).

Confidentiality
All returned questionnaires, critical incident reports, and interview transcripts remain confidential. They will be kept locked away for five years after which they will be destroyed. To ensure that no participants could be identified (directly or indirectly) when analysing and reporting the data, the following techniques were employed: responses to both the questionnaires were coded; pseudonyms were used for interviewees, and codes for the critical incident reports.

Debriefing
Participants were invited to contact the researcher if they had any questions regarding the topic. Transcripts were returned to interviewees to check for accuracy.

Right to discontinue
Participants had the right to discontinue by not returning their questionnaires. Interviewees had up to two weeks to withdraw once the interviews were conducted.

Ethics approval was obtained from the Unitec Research Ethics Committee (UREC) in January 2010; UREC Registration Number 2009-1034 (Appendix Nine).

The role of the researcher in qualitative research
Yin (2003) warns that the demands of case study research are far greater than any other research study in terms of the researcher’s intellect, ego and emotions. Because the researcher is the primary data collector, he/she can take full advantage of opportunities to produce meaningful information (Merriam, 1998). Due to the lack of structure in qualitative research, Merriam (ibid.) compares the researcher’s role to that of a detective: time and patience are required to examine large amounts of data in order to piece the puzzle together. She suggests three traits or skills necessary for the qualitative researcher. The
qualitative researcher must have an enormous tolerance for ambiguity, be sensitive to the
information being gathered, and be aware of any personal biases and how they may
influence the investigation (ibid.). Yin (2003) agrees with this and recommends the
following qualities as well: to ask good questions, to be a good listener, to adapt and be
flexible; to have a grasp of the issue being studied, and to be unbiased to preconceived
ideas.

Certainly as a MRI technologist myself I had my own preconceived ideas; however, I quickly
realised that the case study approach was not to substantiate my theory but rather to
contribute to my topic. Because I was conscious of any personal biases, I knew to be open-
minded to views different from my own and rather to grasp the opportunities to explore
them more in-depth. I am of the opinion that I have analysed, interpreted, and recorded
the data collected in an accurate manner that will be reflected in the recommendations with
the latter being derived from the data analysis and not my preconceived concepts as
researcher. In addition, the reliability and validity of the findings have been strengthened
by the triangulation of multiple data sources.

**Evaluation of research methods**

As pointed out earlier, Merriam (1998) proposes that the qualitative researcher has to
possess an enormous tolerance for ambiguity. This is not made any easier due to the lack of
set procedures or protocols; however, it allows the researcher to adapt to unforeseen
circumstances and allow directional change in pursuit of meaning (ibid.). Merriam (1998)
suggests that it therefore places the researcher in a largely unchartered ocean but with the
promise of adventure and discovery. At times I did find the process a bit frustrating and
overwhelming but with encouragement from my supervisors, I was able to overcome those
periods. Without doubt, the case study approach was the best suited to my research topic.

I did encounter some issues along the way. The first issue was related to the MRI
technologist’s questionnaire (Appendix Four). At the time I piloted the questionnaire, it was
suggested that I add some questions regarding NSF and I did. However, in the original
questionnaire, participants were given the option to skip some questions if they believed
the questions were not relevant to their situation: they could go from Question 25 straight
to Question 29. In the new questionnaire I mistakenly indicated to participants they could go from Question 28 to Question 33. Regrettably, it should have been Question 32 since it was relevant to all MRI technologists. However, of the 36 respondents that could have skipped that question, twenty chose to respond to it. I am of the opinion that even if the other 16 responses were either affirmative or negative, it would not have altered the views of the majority of the respondents (see Chapter 4).

Secondly, it was a major disappointment that the staff of Auckland and Wellington Hospitals did not participate in the research project. I was told that the MRI technologists at Auckland Hospital had no interest in the study. No indication was given for the lack of interest from the MRI technologists at Wellington Hospital. That was a total number of 12 MRI technologists between the two hospitals that did not participate.

The third issue concerned the critical incident reports. The response rate was very low with only six completed forms returned; but was not unexpected since this manner of reporting takes more time and effort on the side of the respondent. However, these results have been integrated into the study for the reason that they enhance the understanding of the participant’s perspective and gives strength to the recommendations suggested.

Finally, the interviews took much longer to complete than I anticipated; mainly because the participants were spread over a wide geographical area and it took very fine planning to accommodate each one at a time and place suitable to them. Simultaneously I had to make sure they did not clash with my work commitments! Fortunately, I was in a position to travel to each one of them. It was also the first time that I had conducted interviews and while I was initially anxious; with the help of the question framework, I had some very interesting discussions along the way. In retrospect, I may have missed certain key issues and some questions I asked did not add any useful information. On the other hand, I believe that I have improved my skills with every interview.

Even though the whole process was often challenging, I found it overall interesting and enjoyable at times. In the future I may consider undertaking further research if the
opportunity presents itself. It is my hope that the findings of my research will contribute to the role development and profession of MRI technologists in New Zealand.

Summary
This chapter provided an explanation of the research process and the choice of case study research as the methodology. It gave an overview of the data collection strategies, data analysis and ethical considerations. The next chapter represents the findings of the first method of data collection utilised in the study, namely the postal questionnaires sent to the MRI technologists and radiologists.
CHAPTER 4

Results

This chapter represents the results of the data collected from the participants of the study. Four methods were used: one postal questionnaire was sent to MRI technologists; a second questionnaire was sent to radiologists involved with MRI reporting; a critical incident form was sent to MRI technologists to complete, and individual interviews with four MRI technologists and two radiologists were conducted. Results of the two questionnaires will be reported in this chapter; whereas the data from the critical incidents and the interviews will be integrated and discussed in Chapters Five and Six.

MRI technologist questionnaire

A questionnaire approach was selected for the first phase of data collection in order to seek specific information from the respondents (Polgar & Thomas, 2008). A postal questionnaire (Appendix Four) was mailed to all MRI technologists in New Zealand with either a scope of practice or a training scope of practice in MRI.

An e-mail was sent to all MRI team leaders working in both the public and private sector. A covering letter (see Appendix Three) outlined the purpose of the study (which was sent to each individual as well with the questionnaire), the voluntary nature of the participation, and contact details of both the supervisors overseeing the research project as well as my own. Team leaders were initially asked if they could provide the names of the MRI technologists working in their department or practice; however, some thought it would leave them vulnerable despite the assurance of total anonymity. It was agreed to provide only the number of MRI technologists working in each practice and the corresponding number of questionnaires were sent to the departmental or practice address. MRI team leaders who did not respond to the e-mail were phoned to ask if they were interested in participating in the study. A total number of 157 MRI technologists (excluding myself) were identified. Ninety-nine questionnaires were completed and returned, which represents a
response rate of 63.1%. Returned questionnaires were traced numerically to allow follow up via e-mail with departments and practices which had low response rates. That resulted in only a marginal increase in the initial number of responses.

The questionnaire consisted of 48 questions partitioned into five sections. The format of the questionnaire was mainly of a closed-response type; however, participants could make comments freely after the majority of questions. Because respondents were supplied with predetermined response options, it made the encoding and analysis of the data easier (Polgar & Thomas, 2008); yet those who wished to comment were given the opportunity to provide more insight into the topic or perhaps to introduce new ideas. That allowed for the collection of both quantitative and qualitative data.

Results are reported as per question. Qualitative comments are reported thematically where needed and in order of decreasing frequency if appropriate.

**Section 1: About yourself**

The first two questions were integrated into one graph.

**Question 1 & 2: Gender and age**

![Figure 1: Gender and age](image)

Of the 99 responses received, 83 represented females and 14 were males. There were two non-respondents.
Question 3: In what year did you qualify as a medical radiation technologist?

Answers to this question were grouped into 10-year intervals to help make analysis easier.

**Figure 2: Year qualified as MRT**

![Bar chart showing the number of respondents qualified in different years.]

Question 4: What is your highest medical imaging qualification?

**Figure 3: Highest medical imaging qualification**

![Bar chart showing the number of respondents with different qualifications.]

Sixty-nine respondents provided additional information on their qualifications obtained:

- Postgraduate Diploma in Health Science (MRI) – 48
- Master’s Degree in Medical Health Science (MRI) – 18
- Postgraduate Diploma in Diagnostic Medical Ultrasound – 1
- Postgraduate Certificate (MRI) – 1
- Competency-based assessment (MRI) – 1
**Question 5:** *What modalities do you currently work in?*

**Figure 4: Modalities currently working in**

Of the ninety-eight respondents:

- Fifty-two work in MRI only
- Thirty work in both MRI and general
- Nine work in MRI, CT, and general
- One works in both MRI and CT
- One works in MRI, CT, general, and ultrasound
- One works in MRI, general, and mammography
- Two work in MRI, general, and PACS
- One works in MRI, CT, general, and PACS
- One works in both MRI and nuclear medicine.
Question 6: Have you completed or are you currently studying in a postgraduate MRI course?

Figure 5: Postgraduate study undertaken

Section 2: About your MRI practices

These questions are a combination of respondents’ MRI experiences and work practices.

Question 7: How long have you been working in MRI?

Figure 6: Number of years in MRI
**Question 8:** How many hours per month do you work in MRI?

Figure 7: Hours per month in MRI

Three respondents work more than 160 hours a month in MRI.

**Question 9:** Is your MRI scanner a (options given to respondents to where their scanner is located):

Figure 8: Location of MRI Scanner

Of the 99 respondents:
- One works at both a public hospital scanner and a private practice scanner within a public hospital
• One works at two private practice scanners of which one is situated within a public hospital and the other within a private hospital
• Nine work at both private practice scanners within a public hospital as well as private scanners outside a hospital environment
• Twelve work at both private practice scanners within a private hospital as well as private scanners outside a hospital environment

Of the four respondents who indicated that they work at other locations, only one specified that she works at a university scanner.

**Question 10:** How many MRTs are rostered on at any time in your MRI department/practice?

**Figure 9: Number of MRTs rostered on at any time in MRI**

![Bar chart showing the number of MRTs rostered on at any time in MRI. The majority of respondents indicated a range of 1-2 MRTs.](image-url)
**Question 11:** Do you do any intravenous cannulation in MRI?

*Figure 10: Intravenous cannulation done*

Two MRI technologists indicated that they do not perform any IV cannulations; however, they do administer contrast media. Two more indicated that they perform IV cannulations but do not administer any contrast media.

**Question 12:** Do you administer any gadolinium-based contrast media in MRI?

*Figure 11: Administration of MRI contrast media done*
**Question 13:** If you answered no to the previous two questions, please indicate who performs this role.

Respondents could select more than one option for this question.

*Figure 12: Other staff members performing this role*

![Pie chart showing distributions for MRI colleague, Nurse, and Radiologist]

**Question 14:** Do you administer any other contrast media in any of the other modalities?

*Figure 13: Contrast administration in other modalities*

Seventeen respondents indicated that they administer contrast media in CT also.
Question 15: Do you administer any other drugs, for example Buscopan, in MRI?

Figure 14: Administration of other drugs

Respondents indicated that they administer the following drugs also:

- Buscopan – 44
- Glucagon – 4
- Ativan/lorazepam (oral) – 5
- Hypnovel – 3
- Fentanyl – 1
- Glyceryl trinitrate (GTN) – 1
- Midazolam (oral) – 1
- Maxolon (oral) – 1
**Question 16:** If you answered no to the previous question, indicate who administers it

Respondents could select more than one option for this question.

*Figure 15: Other staff members administering drugs*

Of the three respondents that selected the fourth option:

- One indicated that an MRI colleague administers the drugs
- One indicated that they do not use any other drugs than contrast media in MRI
- One did not specify.

**Section 3: Your experiences with gadolinium-based contrast media**

**Question 17:** Indicate the gadolinium-based contrast media used in your department.

*Figure 16: Gadolinium-based contrast media used*

Four respondents indicated that they use Gadovist as well in their department.
**Question 18:** Do you keep record of adverse reactions caused by the administration of gadolinium-based contrast media?

**Figure 17: Record of adverse reactions being kept**

![Pie chart showing the distribution of responses: 94 respondents indicated Yes, 3 respondents indicated No, and 2 respondents indicated No response.]

Respondents indicated that records are kept in the following manner:

- Through the Comrad Radiology Information System (RIS) – 65
- Alerting the associated drug company – 18
- In the patient/MRI register – 17
- Incident form – 14
- Alerting the Centre for Adverse Reactions Monitoring (CARM) – 10
- Drug register – 4

One respondent also pointed out that it has been noted on a Medic Alert bracelet of a patient with known contrast media allergies.
**Question 19:** How often do you encounter a patient experiencing an adverse reaction to gadolinium-based contrast media?

**Figure 18: Frequency of adverse reactions to MRI contrast media seen (MRI technologists)**

Of the 97 respondents:

- Fifteen have never encountered an adverse reaction
- Seven have encountered a reaction once before; however, one of these was a needle-phobic patient who passed out and could not be proven as a definite contrast media reaction
- Seven had rarely encountered an adverse reaction before
- Three stated they encounter an adverse reaction one or twice per year
- Two said they encounter a reaction two to three times per year
- Two estimated they encounter a reaction three to four times per year
- Two respondents had encountered reactions once over three years
- Five respondents had encountered reactions once over five years
- Five respondents had encountered reactions once over ten years
- One respondent had encountered three adverse reactions over 12 years
- One respondent had encountered six adverse reactions over 16 years
- One respondent had encountered five adverse reactions over 17 years.
**Question 20:** Do you know what to do if a patient has an adverse reaction to gadolinium-based contrast media?

**Figure 19:** Know what to do in the event of an adverse reaction

Fifteen respondents indicated that:

- They would get the radiologist or a doctor to assist – 9
- They would follow department protocol – 3
- It would depend on the reaction – 3

**Question 21:** Indicate the reaction(s) you have encountered before in patients with the administration of gadolinium-based contrast media.

**Table 8: Reactions and frequency of reactions encountered by MRI technologists**

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Frequency</th>
<th>Reaction</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea</td>
<td>72</td>
<td>Vomiting</td>
<td>48</td>
</tr>
<tr>
<td>Warmth</td>
<td>24</td>
<td>Flushing</td>
<td>10</td>
</tr>
<tr>
<td>Perspiration</td>
<td>10</td>
<td>Altered taste</td>
<td>45</td>
</tr>
<tr>
<td>Rash</td>
<td>39</td>
<td>Hives</td>
<td>30</td>
</tr>
<tr>
<td>Itching</td>
<td>26</td>
<td>Mild eye/facial swelling</td>
<td>13</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>4</td>
<td>Bronchospasm</td>
<td>8</td>
</tr>
<tr>
<td>Convulsions</td>
<td>1</td>
<td>Unresponsiveness</td>
<td>1</td>
</tr>
<tr>
<td>Severe respiratory distress</td>
<td>1</td>
<td>Cardiopulmonary arrest</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Other reactions respondents had experienced included:

- Sneezing – 3
- Altered smell – 2
- Asthma – 2
- Altered blood pressure – 1

**Question 22: Have any of your patients ever required medical intervention after the administration of gadolinium-based contrast media?**

**Figure 20: Medical intervention required**

Respondents indicated that the treatment that had been required to treat adverse reactions included the administration of:

- Antihistamine – 20 patients
- Adrenalin – 4 patients
- Steroids – 2 patients
- Antiemetic – 2 patients
- Oxygen – 2 patients
- Ventolin – 1 patients
- Cream for rash – 1 patient

Two patients had to be admitted to the emergency department for treatment: one to be treated for bronchospasm and the other for observation due to a combination of vomiting, mild rash and a feeling of being generally unwell.
**Question 23:** Nephrogenic systemic fibrosis (NSF) has been associated with the use of gadolinium-based contrast media. Do you know which patients are at risk or have a potential risk for developing NSF?

**Question 24:** Do you know how to identify patients who are at risk for developing NSF?

**Question 25:** Does your department have a protocol in place for the use of gadolinium-based contrast media in patients who are at risk or have a potential risk for developing NSF?

The results of these three questions have been integrated into one graph and responses will be reported together as the same issues recurred across the three questions.

![Figure 21: Nephrogenic systemic fibrosis (NSF)](image)

Respondents identified the following patients to be at risk or who have the potential risk for developing NSF:

- Patients with acute or chronic renal insufficiency/renal failure – 90
- Age-related – 21
- Patients with low eGFR of less than 30 ml/min/1.73m² - 19
- Patients who have had recent vascular trauma such as surgery or post-hepatic transplants – 14
- Some diabetic patients – 11
- Patients with high creatinine levels, i.e. >120 – 9
- Patients on haemodialysis – 9
- Patients who have gadolinium-based contrast media administered frequently and in high doses – 4
- Children – 4
- Patients with cardiac problems – 1

Respondents indicated that all patients who may be at risk of developing NSF would have a blood test prior to the MRI examination to check the creatinine levels and the estimated glomerular filtration rate (eGFR). Some respondents also indicated that sometimes the patient’s urine would be tested to determine more accurate GFR levels. Most departments would automatically subject patients to a blood test if patients are over the age of 60 to check their creatinine levels and eGFR; other departments require a blood test if the patient is over 65. The consensus is however that gadolinium-based contrast media are not to be given to patients with an eGFR of less than 30ml/min/1.73² unless the radiologists think it absolutely necessary and the benefits outweigh the risks. It is then up to the radiologist to explain to the patient the necessity of having the contrast medium administered and the risk associated with NSF. Informed consent is then obtained from the patient and the ‘safer’ gadolinium-based contrast medium is administered. If the eGFR is between 30 – 60ml/min/1.73m², the radiologist would review the form to decide whether contrast is required or not. Contrast is always given if the eGFR is greater than 60ml/min/1.73² and the MRI examination requires it.

Most respondents indicated that MultiHance is the contrast medium of choice when it needs to be administered to patients with an eGFR of less than 60ml/min/1.73m² and then the lowest dose possible. However, it varies as some respondents indicated that their departments prefer to use Dotarem in these patients.
Section 4: Prescription of gadolinium-based contrast media

Question 26: Do you have specific prescribing parameters in place to know when a patient requires contrast media, for example post-surgery, tumours, infections etc.?

![Figure 22: Prescribing parameters in place (MRI technologists)](image)

Some of the respondents indicated that contrast media are required in the following circumstances:

- Post-surgery examinations – 11
- Tumours – 8
- Infections – 5
- Suspicious lesions – 2
- Lumps – 1
- Pituitary – 1
- Liver – 1
- Renal – 1

Twenty respondents did however indicate that the decision to give contrast is made on a case-by-case basis.
**Question 27:** Do you get the radiologist to assess each case individually and make a decision whether contrast is required or not?

![Radiologist assessing every case](image)

Twelve respondents indicated that they would give contrast when routine protocols require its use. Seven respondents indicated that they would ask the radiologist to review each patient who is likely to need contrast. Five respondents indicated that the radiologist has to chart the contrast prior to injecting and therefore always check the scan images. However, two respondents admitted that the radiologist is often not available to them during MRI examinations in which case they would administer the gadolinium-based contrast media to clear out cases and get the prescription signed in retrospect. Two respondents indicated that the radiologist would be consulted if they were unsure about a case. Two respondents also indicated that most examinations are standard and are not shown to the radiologist unless unexpected pathology is revealed. One respondent revealed that because of NSF, cases are always checked by the radiologist to make a decision on whether contrast is required.
**Question 28:** Do you ever find yourself in a situation without a radiologist available to prescribe the contrast media?

*Figure 24: Radiologist available to prescribe contrast media*

Eight respondents indicated that it could be problematic to find someone to prescribe contrast media after hours and over weekends. Six respondents indicated that the situation is being avoided by having booked sessions for patients that would require contrast media. Five respondents indicated they could not administer contrast media unless the radiologist is on-site and the patient would be rebooked. Alternatively, five respondents indicated they would ask other doctors to assist them. One respondent indicated they would make the call to inject if the radiologist is not on-site. Respondents, who answered ‘No’ to this question, were given the option to skip the next four questions and were directed to Question 33 (However, respondents should have gone to Question 32 if an error was not made).

**Question 29:** Do you have to rely on other doctors to be available to prescribe the contrast media?

*Figure 25: Relying on other doctors to prescribe MRI contrast media*
Seventy-four respondents chose to answer this question. In addition, five respondents indicated that they would have to recall the patient if the radiologist was not available. Two respondents indicated that the only other doctors entitled to prescribe and administer contrast media are the anaesthetists responsible for the general anaesthesia (GA) sessions in their department. Two respondents indicated that they would consult another radiologist if the duty radiologist was unavailable. However, one respondent stated that if it was a particular radiologist’s list, they could not ask another doctor to prescribe the contrast. Two respondents indicated that often they have to ask other doctors to prescribe the contrast, which the doctor would do reluctantly. One respondent indicated that the MRI technologists would make the decision to administer contrast but another radiologist, who is not ‘MRI trained’ would prescribe.

**Question 30:** Do you ever have difficulty in locating a doctor to prescribe the contrast media when needed?

**Figure 26: Difficulty in locating a doctor to prescribe MRI contrast media**

Seventy-four respondents answered and the following comments were included: three respondents indicated that they would try to avoid the situation by scheduling contrast examinations to radiologists’ availability. Three more respondents indicated that the availability of doctors was a problem after hours. Two respondents indicated that if the radiologist was unavailable, the patient would be recalled for the post-contrast studies. One respondent indicated that staff shortages of radiologists were a problem. Another
respondent indicated that sometimes the radiologist would prescribe the contrast media prior to the booking of the patient. One respondent indicated that they often have a problem over lunch time to get contrast medium prescribed, especially for oncology patients who do not have a RMO specifically responsible for the patient.

**Question 31:** Do you encounter other doctors (other than radiologists) that are not familiar with gadolinium-based contrast media administered in MRI?

**Figure 27:** Frequency of encountering doctors unfamiliar with MRI contrast media

Seventy-six respondents replied. Ten respondents added comments and indicated that the doctors they encounter who are unfamiliar with contrast media are:

- Non-radiologist doctors – 4
- Anaesthetists – 2
- RMOs – 2

Two respondents indicated that they would not expect any other doctor than a radiologist to prescribe the contrast media.
Question 32: Do you think it is desirable for New Zealand MRI technologists with the appropriate training and supervision, to be permitted to prescribe gadolinium-based contrast media?

Figure 28: MRI technologists to be permitted to prescribe contrast media

Eighty-two respondents chose to answer this question. Four included comments: one respondent indicated that some private hospitals in New Zealand already prescribe. Two respondents indicated it could be appropriate for certain indications, such as acoustic neuromas and post-op discectomies. One respondent questioned the legal implications or consequences for such a step.

Question 33: Do you think it is desirable for New Zealand MRI technologists with the appropriate training to prescribe and administer gadolinium-based contrast media without a radiologist or any other doctor present in the radiology department within a hospital with a resuscitation team?

Figure 29: MRI technologists to be permitted to prescribe and administer contrast media with access to a resuscitation team
Respondents opposed to the suggestion indicated that their reasons were:

- MRI technologists are not trained to deal with emergency situations if patients should react to the contrast media – 5
- Radiologists should always be around to give guidance and avoid unnecessary contrast given to the patient – 3
- Radiologists are ultimately responsible for any contrast reactions – 2
- Medico-legal implications – 1
- Support and financial remuneration - 1

Respondents in favour of the suggestion indicated that:

- The resuscitation team endorses this role extension and is available to provide support – 2
- It should be limited to certain indications and pathologies – 2
- The senior MRI technologist should be willing to absorb any associated risk – 1
- MRI technologists are supported – 1
- Training would be provided and recognition given – 1
- It should be in an advanced practitioner level only – 1

Respondents unsure of the suggestion indicated that their reasons included:

- Medico-legal implications – 2
- Dependant on the situation and level of training regarding adverse reactions – 2
- Lack of radiologist support – 1

One respondent also indicated that each site would need assessing and certifying as to the effectiveness of the resuscitation team and their ability to deal with the MRI environment. Another respondent thought if the patient had had no previous contrast reactions; it might possibly be okay to administer the contrast medium.
Question 34: Do you think it is desirable for New Zealand MRI technologists with the appropriate training to prescribe and administer gadolinium-based contrast media without a radiologist or any other doctor present in a radiology practice situated outside a hospital environment?

Figure 30: MRI technologists to be permitted to prescribe and administer contrast media outside a hospital

One respondent stated that it would not be worth the risk if a patient should have an adverse reaction, even if they are rare. Three respondents indicated that MRI technologists are not trained to deal with emergency situations and that the present CPR training is inadequate. Back-up of a resuscitation team or a doctor is needed.

Question 35: Do you think there is a need for New Zealand MRI technologists to gain certain prescription rights, for example, limited independent prescription rights to prescribe gadolinium-based contrast media?

Figure 31: Need for MRI technologists to gain prescription rights
One respondent commented that the decision on whether someone needs a drug or not should be in the hands of doctors because they have experience and knowledge that a MRI technologist does not have. Even a technologist with extensive MRI experience should not have the same responsibility and liability as doctors. Therefore, the respondent thought it unnecessary to prescribe independently of a doctor’s opinion. This was supported by another respondent commenting that since MRI technologists do not report scans it is debatable whether they need prescribing rights. Three other respondents’ comments were that it would be helpful; however there should be documented proof of the technologist’s competence to do so and under the supervision of a radiologist.

**Question 36:** Would you want prescription rights after the appropriate education and training?

*Figure 32: MRI technologists wanting to have prescription rights*

**Question 37:** Do you think all MRI technologists should have prescription rights?

*Figure 33: Prescription rights to all MRI technologists*
Four respondents indicated only if technologists are appropriately and fully trained, should they have prescription rights. One respondent thought it would depend on the level and experience of the technologist whereas another respondent commented that some technologists would not be keen on having this responsibility.

**Question 38:** *If you answered no to any of the previous two questions, state the reasons why you believe MRI technologists should not be allowed to prescribe.*

Sixty-five respondents chose to comment and included the following reasons:

- It should be based on radiologists’ need for more information – 13
- MRI technologists should not have that responsibility – 11
- MRI technologists’ level of experience and knowledge is insufficient – 10
- MRI technologists do not have the relevant training to deal with emergencies – 8
- Patients will end up having contrast media unnecessarily – 8
- Concerns over how far role extension will be going – 4
- MRI technologists are not paid for the responsibility – 3
- The training would be considerable – 3
- Suggestion to train as a doctor if MRI technologists want to prescribe – 3
- Not trained to prescribe other medications if adverse reactions should occur – 2
- Appropriate bookings should be done when radiologists are around – 2
- Concerns over medico-legal implications – 2
- It would stop radiologists from being present for any examinations – 1
- Gadolinium is not prescribed if part of the protocol for a particular examination – 1
- MRI technologists are already prescribing for routine post-surgeries – 1
**Question 39:** How useful would it be to be able to prescribe gadolinium-based contrast media in your department?

**Figure 34: Usefulness of prescribing MRI contrast media**

**Question 40:** Please specify what other drugs you think would be useful for MRI technologists to prescribe.

Fifty-three respondents replied to this question. The drugs they specified included:

- Buscopan – 47
- Oral sedation – 8
- Glucagon – 5
- Hypnovel (midazolam) – 2
- Phenergan – 1
- Ativan (lorazepam) – 1
- Drugs to counteract any adverse reactions – 1
- Painkillers – 1
**Question 41**: Would it improve your workflow should you be able to prescribe?

**Figure 35: Improved workflow**

Twenty respondents, who chose to comment on this question, indicated that:

- It might make a difference in some departments – 5
- It would not make a difference in other departments – 4
- It has made a difference in a few departments that are already doing it – 3
- MRI technologists would not have to spend time to find a radiologist to sign a prescription form which the technologists have filled out for them – 3
- Scans requiring contrast/sedation/Buscopan have to be booked on a ‘radiologist day,’ which limits accessibility to the patient – 1
- It would allow convenient imaging of outpatients with unexpected findings without having to recall patients for post-contrast studies – 1
- There would be no hold-ups for busy radiologists – 1
- It would be good for on-call – 1
- It has to be under the supervision of a radiologist – 1
**Question 42:** Would it optimise patient continuity should you be able to prescribe?

*Figure 36: Improved patient continuity*

Seven respondents chose to comment. One respondent was of the opinion that the patient would prefer a doctor making the decision whether contrast medium has to be administered or not; however another respondent stated that the patient only has contact with the MRI technologist and therefore would make the process more efficient in most cases requiring contrast media. One respondent indicated that if protocols are in place the question is irrelevant; yet another respondent stated that it would optimise patient continuity if specific protocols are followed. Two respondents indicated that it would optimise patient continuity marginally. All has to be under the supervision of a radiologist according to one respondent.

**Question 43:** Would it increase your job satisfaction should you be able to prescribe?

*Figure 37: Improved job satisfaction*
Fifteen respondents commented on this question. They indicated that:

- With extra responsibility there should be extra remuneration, which is highly unlikely in today’s public health climate – 3
- It should be a radiologists’ role – 2
- The work would be less frustrating if they did not have to “hunt” for a radiologist – 2
- Not interested in the responsibility – 1
- It would not make a difference – 1
- Maybe it would make a difference – 1
- It already does make a difference – 1
- It would make a difference with the appropriate training and department backing – 1
- Doing the training in order to prescribe would be satisfying, though not personally interested in doing the prescribing – 1
- It should be under supervision – 1
- It would improve the job satisfaction of those who chose to do it – 1

Section 5: Training

**Question 44:** What should the minimum requirement/qualification be before MRI technologists could undertake training to prescribe?

![Figure 38: Minimum qualification required to prescribe contrast media](image)
Four respondents could not make a decision whether a postgraduate diploma or a master’s degree should be the minimum qualification required to undertake training. One respondent could not choose between an undergraduate degree and a postgraduate certificate, however did indicate that in the UK prescribing is being incorporated into the undergraduate degree. One respondent could not choose between a postgraduate certificate and a postgraduate diploma while five respondents were strongly of the opinion that only a medical degree would ever be sufficient.

**Question 45: In your opinion, when should training to prescribe be undertaken?**

Of the 87 respondents that answered the question:

- Fifty-four indicated that it should be undertaken only after completion of a postgraduate MRI qualification
- Sixteen indicated that it should be incorporated into the postgraduate MRI training
- Seventeen were unsure.

Twenty-six respondents opted to add further comments and included that:

- Training should be separate from postgraduate MRI training and be a standalone course – 7
- Technologists should have extensive experience in MRI – 4
- It should not be happening at all – 4
- After the completion of a medical degree – 2
- After the MRI scope of practice has been obtained – 1
- When technologists report scans – 1
- When needed – 1
- It should be department and radiologist driven – 1
- It should only be by choice – 1
- Each step should be taken progressively – 1

One respondent indicated that she undertook the training while in the UK. Another respondent thought she might forget by the time she finished the training since it took her four years to do the postgraduate MRI training.
**Question 46:** Would you be willing to undertake the additional training to become a prescribing MRI technologist?

**Figure 39: MRI technologists willing to undertake additional training**

Fourteen respondents commented on this question. Ten indicated that they would be willing to undertake the training if:

- It is work funded – 3
- There is still backup of a radiologist or resuscitation team – 2
- Depending on the training required – 2
- Depending on the duration of the training required – 1
- Depending on the cost of the training required – 1
- It is a requirement – 1
- There is a financial incentive – 1

Two respondents indicated that they would be more interested in image reporting and one respondent stated that she was not interested in the responsibility. Another respondent would like to extend her knowledge but it would be of no benefit to her because of the department she works in.
**Question 47:** If you answered no to the previous question, please indicate the reason(s):

Respondents could select more than one option. Thirty-seven participants opted to answer this question. They indicated that:

- They would worry that they would make the wrong prescriptive decision – 19
- The duration of the course might be too long – 8
- They would not have the time to complete the training – 6
- To some it would be too late in their careers to undertake the training – 3
- Due to financial reasons – 2

Twenty-three cited other reasons as well and they included:

- Not interested in doing it – 5
- Not interested in taking on the responsibility – 5
- It is something radiographers should not do – 4
- MRI technologists should have full medical training to prescribe – 3
- It would not bring any job enhancement – 2
- It would not be of any benefit – 1
- It is not required from MRI technologists yet – 1
- The patient has a right to have a doctor’s input when having a scan – 1
- It would cause more stress and frustration as booking times would have to be increased – 1
- Uncertainty of what the overall acceptance would be from the radiological community – 1
- Prefer other role extension activities such as image reporting – 1
- Already prescribe to an extent due to very good scan protocols – 1
- There is no need – 1

One respondent indicated that she was still newly qualified and inexperienced; however, might consider it in the future.
**Question 48**: Please include any other general comments you would like to make on this subject.

Forty-two respondents included general comments with recurring themes being identified and grouped as such.

Respondents opposed to this role extension activity indicated that:

- Radiographers should stick to being radiographers and not try to be pseudo-radiologists – 2
- MRI technologists should go to medical school if they want the same responsibility as a doctor; at least then they will get the respect and monetary reward – 2
- They would rather study something that would be more financially rewarding – 2
- They would not want the medico-legal responsibilities – 2
- Most departmental protocols cover the appropriate use of contrast media and therefore prescribing not necessary – 2
- It would be a huge educational and financial responsibility for limited time savings at work – 1
- Drug administration is too much of a minefield with the potential for disaster – 1
- Had prior bad experience with a patient reacting to contrast media – 1
- The minimum training acceptable in order to prescribe contrast media would be equivalent to a radiologist’s training – 1
- Only when technologists report, they could make the decision on contrast – 1
- Contrast may be given unnecessarily – 1

Respondents unsure of this role extension activity indicated that:

- A profound knowledge and experience would be needed – 2
- Too much training in image interpretation would be needed in order to prescribe – 2
- There would be need for prescribing other drugs that could counteract adverse reactions – 2
- There are concerns regarding medico-legal aspects – 2
- They would not administer contrast without a radiologist in the department – 2
- Radiologists are moving away from giving MRI contrast – 1
• Increased responsibility not worth without financial recognition – 1
• MRI reporting is a more attractive option – 1

Respondents in favour of this role extension activity indicated that:
• Some radiologists do not like the idea of MRTs expanding their role – 2
• It will enhance the running of the department – 2
• Comprehensive training in contrast reaction treatment is essential – 2
• Experienced MRI technologists working in a hospital with a resuscitation team will be capable of doing this – 1
• If the UK can do it as they have been for years then New Zealand can – 1
• Bookings would be simpler – 1
• It should be voluntary – 1
• There should be a financial incentive – 1

One respondent specified that prescribing rights should be given only under strict guidelines, suggesting the following:
• It should be protocol-specific, for example contrast-enhanced liver scanning; buscopan for pelvic examinations
• It should be specific drugs relevant to MRI only
• Education on the drugs being administered in MRI including side-effects and drug interactions
• Intensive resuscitation training – not just CPR; however, resus team should still be available in an emergency.

Another respondent commented that in their department gadolinium-based contrast medium is not signed for by a doctor and is more or less given as required by the MRI technologists. The system has been working well and according to the respondent he could not recall a case where a MRI technologist has given contrast media when it was not required. In fact, the respondent recalled several cases where radiologists requested contrast where it turned out not to have been required. Even though IV cannulation and contrast administration by MRI technologists are an acceptable practice in most
departments across New Zealand, one respondent stated that they still have to address this issue.

Radiologist questionnaire

The same approach was followed as with the distribution of the MRI technologists’ questionnaires. In the first e-mail sent to the team leaders of the various MRI departments/practices, they were informed of the necessity of the radiologists’ part in the study as well. A second covering letter (Appendix Three) addressed only to radiologists involved with MRI, was included. Through e-mails and follow-up phone calls a total of 173 radiologists were identified. Sixty-nine questionnaires were completed and returned, representing a response rate of 39.88%. However, because a number of radiologists worked at both public hospitals and private practices simultaneously, they may have received the questionnaire twice. Therefore, only one completed copy was returned.

The questionnaire consisted of 27 questions that were partitioned into four sections. The format of the mainly closed-response questions was similar to the MRI technologist’s questionnaire. However radiologists were free to make comments if they considered it appropriate. Results are reported as per question.

Section 1: General

The questions in this section were aimed at radiologists’ work experiences.

Question 1: Number of years as a consultant radiologist.

To make analysis easier, answers to this question were grouped into five year intervals.
**Question 2:** In what environment do you practice?

![Figure 41: Work environment](image)

**Question 3:** Approximately how many radiologists are employed in your practice?

For ease of the analysis to this question, answers were grouped into denominations of five.

![Figure 42: Number of radiologists employed](image)
**Question 4:** Approximately how long has MRI been your area of speciality?

![Figure 43: Number of years specialising in MRI](image)

**Question 5:** Do you do any off-site reporting through Telemedicine for some of your MRI examinations?

![Figure 44: Off-site reporting done](image)
Section 2: Adverse reactions to gadolinium-based contrast media

The questions in this section are aimed at the radiologists’ knowledge and experience as related to gadolinium-based contrast media.

**Question 6:** How often do you encounter a patient with an adverse reaction to the gadolinium-based contrast media administered to a patient?

**Figure 45: Frequency of adverse reaction to MRI contrast media seen (Radiologists)**

It was indicated by 32 of the respondents that:

- Fifteen had never encountered a reaction before
- Six had rarely encountered a reaction before
- Eight estimated that they would encounter a reaction less than once per year
- Three estimated that they would encounter a reaction once every two years
- One respondent would encounter a reaction three times per year
- One respondent encountered a reaction twice in five years
- One respondent encountered a reaction twice in seven years
- One respondent encountered a reaction twice over ten years.
**Question 7:** Indicate the reaction(s) you have encountered before in patients with the administration of gadolinium-based contrast media.

**Table 9: Reactions and frequency of reactions encountered by radiologists**

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<td>Severe respiratory distress</td>
<td>3</td>
</tr>
<tr>
<td>Cardiopulmonary arrest</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
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</tbody>
</table>

Seventeen respondents added comments. Nine respondents indicated that they had not encountered any reactions before. The other eight encountered the following reactions:

- Hypotension – 3
- Persistent bradycardia – 1
- Anaphylaxis – 1
- Vasovagal reaction – 1
- Local burning/extravasation reaction – 1
- Nephrogenic systemic fibrosis – 1

**Question 8:** Do you know if any of your patients have ever required medical intervention after the administration of gadolinium-based contrast media?

**Figure 46: Medical intervention required after the administration of MRI contrast media**

![Pie chart showing medical intervention required after the administration of MRI contrast media](image)
Respondents, who chose to be specific, indicated that the following treatment was required:

- Antihistamine – 11
- Steroids – 4
- Resuscitation – 7 (anaphylaxis[4]; cardiopulmonary collapse[2]; unresponsiveness[1])
- Hospital admission – 4
- Adrenaline – 2
- Anticonvulsant treatment – 1
- Oxygen – 1
- Observation for bradycardia and hypotension, which resolved – 1

One respondent indicated treatment for a patient with NSF; however, he did not elaborate on the treatment.

**Question 9:** Have you ever been directly involved in any medical intervention required after the administration of gadolinium-based contrast media?

**Figure 47: Direct involvement in medical intervention**

Six respondents indicated that they had to:

- Administer antihistamine – 4
- Administer IV steroids – 1
- Call on a resuscitation team to resuscitate a patient – 1
In addition, one respondent indicated that one of their patients had to be observed for some time after the contrast medium was administered, while another patient needed a consultation to assess the condition of the patient. One respondent again indicated treatment for NSF but it is unlikely that he actually administered any treatment to the patient because NSF only makes its appearance weeks or months after the contrast media were administered.

**Question 10:** Do you believe a radiologist (or any other doctor) should always be present in the radiology department when gadolinium-based contrast media is administered to patients?

![Figure 48: Radiologist required in department when MRI contrast media is administered](image)

Twenty-one respondents chose to make comments on this question. Ten respondents indicated that:

- The radiologist should always make the decision to prescribe contrast media or not – 2
- Reactions are usually unpredictable – 2
- There should be qualified medical help available to treat extreme adverse reactions – 2
- A radiologist should always be available for any MRI examination – 1
- There is always a potential for error since this is given IV – 1
- IV drugs have a rapid response but may also have rapidly progressive adverse reactions – 1
• It is legally negligent not to have somebody medically responsible present – 1

This is in contrast with what eight other respondents stated:
• As long as a radiologist or medical team is within the building and accessible, it is accepted – 6
• Reactions are predictable – 1
• Reactions are usually mild and require no intervention – 1

Five respondents indicated that an alternative would be to have support/cover from another speciality for questions or any reactions, e.g. Accident and Emergency cover or access to a resuscitation team.

**Question 11**: Are you aware of any departments administering gadolinium-based contrast media to patients without having any doctors present in the radiology department?

**Figure 49: Departments administering MRI contrast media without a doctor present in the department**

Four respondents commented on this question. The first respondent stated that he was not aware of any cases in New Zealand where MRI contrast media were administered without a doctor present in the department; however, he knew it was being done in Europe and the
USA. The second respondent was aware of it being done in CT but not MRI. The third respondent stated that it was not something occurring within his practice. The fourth respondent indicated that though contrast media were administered without a doctor in the radiology department, staff still had access to a medical team.

Section 3: Contrast media prescription

Question 12: Do you assess each MRI examination individually to decide whether contrast media is required or not?

Figure 50: Radiologist assessing each MRI examination to assess need for contrast media

Eighteen respondents added further comments:

- Most MRI examinations are protocol driven and signed for by the radiologist – 12
- Usually MRI technologists know when it is required and will only check for approval – 2 (comments made that MRI technologists are good in seeing which cases need contrast, often better than the doctors)
- Some examinations reviewed during scan and decision made then – 3
- It is used in line with RANZCR guidelines – 1
Question 13: Do you have specific prescribing parameters in place for the MRI technologist to know when contrast media are required?

Figure 51: Prescribing parameters in place (Radiologists)

Fourteen respondents added more comments. They included:

- Radiologists would prescribe contrast as part of protocolling scan – 4
- There are set protocols with some including contrast media – 4
- There are contrast protocols for some types of examinations but many are for review prior to giving contrast – 3
- Some MRI technologists are trained to know specific indications but are only parameters – 2
- Radiologist would protocol procedure at start of examination and check it while scanning – 1
**Question 14:** Are you always available to prescribe the contrast media for the MRI technologist when needed?

**Figure 52: Radiologist availability to prescribe MRI contrast media**

Twenty respondents chose to comment on this question:

- Usually a radiologist/consultant/registrar would be available – 12
- Contrast is not ‘prescribed’ on paper, it is a verbal ‘prescription’ to MRI technologists – 3
- Forms are protocolled in advance and contrast prescribed – 2
- A radiologist is not always available for after-hours examinations – 1
- Patients told to return for contrast media if there is an unexpected lesion and radiologist is unavailable – 1
- Prescription of contrast could be either verbal or written – 1
- Standing order is used to pre-prescribe contrast media – 1
Question 15: Do you know if MRI technologists have difficulty to locate any other doctors to prescribe the contrast media if you are unavailable, for example after-hours?

Figure 53: Difficulty in locating other doctors to prescribe MRI contrast media

Fifteen respondents added more comments. One respondent was of the opinion that a well-organised department should not have this problem of locating a doctor to prescribe contrast media. Other comments included:

- Examination would be stopped and patient recalled for contrast examination – 4
- Radiologist/registrar would always be available – 3
- It would sometimes cause minor delays to find someone – 2
- After-hours are always a problem – 2
- On occasion it is a problem – 2
- Would make arrangements in advance prior to a procedure starting – 1
- It is a verbal prescription; therefore MRI technologists do not have that problem – 1 (indicating that MRI technologists are administering contrast media without a doctor present?)
Section 4: Role extension activities for MRI technologists

Question 16: Do you have any experience working with MRI technologists undertaking the following role extension activities in New Zealand?

a. IV Cannulation

Figure 54: Radiologists' experience with MRI technologists doing IV cannulation

b. Contrast administration

Figure 55: Radiologists' experience with MRI technologists administering contrast media
Question 17: Do you think it is desirable for New Zealand MRI technologists with the appropriate training and supervision, to be permitted to prescribe the gadolinium-based contrast media when needed?

Figure 56: MRI technologists prescribing contrast media (Radiologists)

Twenty respondents opted to comment on this question. They indicated that:

- The need for contrast media should be determined by a radiologist – 5
- MRI technologists could prescribe within well-defined protocols, e.g. breast imaging, peripheral angiograms etc. – 5
- Radiologists are comfortable with MRI technologists administering contrast media but not prescribing – 4
- MRI technologists are trained well and have a very good knowledge regarding usage of contrast media – 2
- However, a medical doctor should still be available in case of an emergency – 2
- Prescribing is a non-event like deciding which scanning sequence or parameters to use – 1
- It would be convenient for MRI technologists to prescribe and they are responsible; however a MRI technologist should not be placed into a position of being responsible for something a doctor should do; that is responsibility versus ability – 1
- Only if the public are aware they carry appropriate personal medico-legal insurance – 1
**Question 18:** Do you think it is desirable for New Zealand MRI technologists with the appropriate training to prescribe and administer gadolinium-based contrast media without a radiologist/other doctor present in the radiology department within a hospital with a resuscitation team?

Figure 57: MRI technologists prescribing and administering contrast media with access to a resuscitation team (Radiologists)

Eleven respondents decided to comment on this question. One respondent questioned how/why a MRI technologist should ever get into a situation of doing a scan requiring contrast where none has been prescribed. Other respondents indicated that:

- Technologists should have access to medical assistance or a resuscitation team willing to cover – 3
- Technologists could administer the contrast media without the presence of a doctor in the department; just not prescribe it – 2
- MRI technologists would need training in order to recognise signs and symptoms of allergies – 1
- It should be done by experienced MRI technologists only – 1
- It is something that could be done within a hospital – 1
- It could be done if the supervising radiologist is not available – 1
- It would be convenient – 1
- In some circumstances it is desirable but not all – 1
Question 19: Do you think it is desirable for New Zealand MRI technologists with the appropriate training to prescribe and administer gadolinium-based contrast media without a radiologist/other doctor present in a radiology practice situated outside a hospital environment?

Figure 58: MRI technologists prescribing and administering contrast media without access to a resuscitation team (Radiologists)

Eight respondents commented on this question. Comments included:

- It could be considered in low risk patient – 2
- There should be access available to a resuscitation team – 2
- It is the doctor’s responsibility to deal with a potential complication – 1
- Contrast reaction to gadolinium is highly unlikely and if the MRI technologist is trained in resuscitation then it is acceptable – 1
- It would be no different if it was a radiologist administering; CPR would still be done in the same way – 1
- It would not be defensible if there is a reaction – 1
**Question 20:** Do you think there is a need for New Zealand MRI technologists to gain certain prescription rights, for example limited independent prescription rights?

![Figure 59: The need for New Zealand MRI technologists to gain prescription rights (Radiologists)](image)

Twelve respondents made comments to this question. One respondent questioned the need for independent prescribing rights if every MRI department/practice is supposed to have a supervising radiologist. Other respondents indicated that:

- With direct supervision it would be unnecessary – 2
- In peripheral centres it might be useful – 2
- Prescription of gadolinium should always be under auspices of a radiologist – 2
- It would not increase efficiency or safety if good clinical flow processes are in place – 1
- Not needed in well-staffed hospitals – 1
- There are reservations on the level of ‘appropriate training’ refer to – 1
- This could be achieved under standing orders – 1
- MRI technologists do not have the appropriate medical background to prescribe – 1
**Question 21:** Do you think it would optimise patient care and continuity should MRI technologists be able to prescribe?

*Figure 60: Improved patient care and continuity*

![Pie chart showing responses to Question 21.]

- Yes: 37
- No: 22
- Unsure: 8
- No response: 2

**Question 22:** Do you think it would make MRI technologists more proficient in their work should they be able to prescribe?

*Figure 61: Improve proficiency of MRI technologists*

![Pie chart showing responses to Question 22.]

- Yes: 31
- No: 23
- Unsure: 4
- No response: 11
**Question 23:** Would you be supportive of an initiative to present a case for New Zealand MRI technologists to obtain limited independent prescription rights?

**Figure 62:** Number of radiologists supportive of an initiative for MRI technologists to obtain prescription rights

Seven respondents decided to add further comments to this question. Three respondents against the initiative indicated that:

- MRI is a high-tech and a high-expense technology. Independent implies the decision to proceed with a scan and the benefits of administering contrast outweighs the risk. These decisions are to be made by the supervising radiologist
- There is support for cannulation and administration to be done under standing orders but not otherwise
- Prescribing is a very limited undertaking and there are probably more rewarding areas to challenge and extend such a highly trained capable group of professionals.

Two respondents unsure of supporting such an initiative indicated:

- It should be restricted to places with limited radiologist input where contrast medium is essential to make a diagnosis
- The need to see the detail involved in such an initiative.

Two respondents claiming that they would be supportive of this initiative stated:

- If it is limited to certain examinations
- If it is deemed necessary to achieve a level of autonomy.
Question 24: If you answered no to the previous questions, do you think gadolinium-based contrast media could be administered under a standing order?

Figure 63: Administration of MRI contrast media under a standing order

Forty-four respondents answered this question. Nine added further comments. One respondent stated that all standing orders have to be authorised and countersigned by a doctor. It should be a scenario for where doctors would protocol scans but omit to sign for contrast.

Three respondents against standing orders reasoned that:

- Administration of gadolinium has to be planned individually as cases differ
- The radiologist needs to be involved in the whole scan process
- Medical staff need to be on-site and available to treat reactions.

Two respondents unsure of standing orders indicated that:

- It would depend on the definition of ‘standing order’
- It might be useful in certain circumstances.

Three respondents supportive of standing orders indicated that:

- It has been done that way for years, the same as in CT
- It should be strictly controlled
- In selected circumstances, for example peripheral angiograms.
**Question 25:** If you are of the opinion that MRI technologists should not have limited independent prescription rights, would you be supportive of collaborative prescribing (i.e. to prescribe under the supervision of an authorised prescriber)?

Fifty-one respondents answered this question with two persons adding further comments, both of whom are against collaborative prescribing:

- One could not prescribe under supervision and expect someone else to take responsibility for decisions made by the collaborative prescriber
- Failure to see how this could increase safety or efficiency.

**Figure 64: Number of radiologists supportive of collaborative prescribing**

- 23 respondents answered “Yes”
- 18 respondents answered “No”
- 3 respondents answered “Unsure”
- 2 respondents added comments

**Question 26:** Do you think that with the appropriate training and supervision, MRI technologists could prescribe the following drugs as well:

- a. Muscle relaxants, such as buscopan for certain pelvic examinations
- b. Mild sedatives, such as oral diazepam for claustrophobic patients
Answers to these two questions have been integrated into one graph for ease of comparison.

**Figure 65: Prescription of other drugs by MRI technologists**

Seven respondents added comments regarding the prescription of buscopan. Two respondents indicated that it would not be advisable because of the high risk profile of buscopan and also the risk of severe reactions. Two other respondents indicated that it could be done under direct supervision of the radiologist and with the appropriate medico-legal insurance. Three respondents were uncertain, indicating that:

- Standing orders might be more appropriate
- One has to take into account the side effects and interaction of buscopan with other medications
- A radiologist or doctor has to be present.

Twelve respondents commented regarding the prescription of oral diazepam. The objections raised by some of the respondents were:

- Potentially dangerous drugs which require direct medical supervision – 2
- Have to look at the requirements of New Zealand Society of Anaesthetists (NZSA) on sedation – 2
- Slight risk of people being over sedated and requiring medical support – 1
- Risk of respiratory depression – 1
- It is not a mild sedative – 1
- It should be prescribed by someone who knows the patient, for example a GP – 1
One respondent pointed out not to “be dumb” while two other respondents indicated that it could be done under standing orders with adequate supervision. Another respondent was of the opinion that diazepam should not be issued at all because its half-life is 40 hours. He recommended a shorter acting benzodiazepine such as midazolam.

**Question 27:** Please indicate any other general comments you would like to make on this subject.

Twenty-six respondents added their over-all comments. Respondents, who were generally against MRI technologists prescribing, remarked:

- Prescribing is a matter for a doctor – 3
- There would be no advantages to the patient and only significant disadvantages – 2
- Prescribers need to have extensive medical knowledge surrounding the acute and chronic effects of such drugs and their management; therefore a checklist approach could be dangerous – 2
- There is a marked medico-legal risk in the prescription of drugs – 2
- It would lead to the unnecessary utilisation of gadolinium – 2
- It might not be given when needed – 1
- Gadolinium is expensive and its usage should be controlled carefully, not written into standard protocols – 1
- Prescribing is not an intellectual or practical exercise to challenge or stimulate one’s career in a meaningful way – 1
- It lies outside the current scope of practice of MRI technologists – 1
- MRI technologists do not have the background in physiology and pharmacology – 1
- MRI technologists could prescribe once they have undertaken a six-year medical course – 1
- Failure to see any benefits in such initiatives – 1
- It would not improve a system which is already efficient – 1
- The radiologist or medical doctor needs to be around when administering IV drugs – 1
• It is not a requirement (in some places) to prescribe gadolinium; it would be indicated on the request form but not formally written up as a specific prescription – 1

Respondents who were unsure of this role extension activity, indicated:
• Standing orders might be more appropriate under clear guidelines – 2
• Decision to give contrast should generally be made by a radiologist – 1
• Drug prescription is a doctor’s job and they should be available or find a way to fulfil their responsibility rather than hand it to someone else; that is MRTs should not have to do a job because the doctor finds it inconvenient or are too lazy to do it. If MRTs take on the role of drug prescription it has to be guaranteed that the doctors would back them up for their decisions and not ‘pass the buck’ when something goes wrong.

Respondents who were supportive of this role extension commented:
• It would give the team more professionalism, confidence and improve moral in the department – 2
• Full support; however, would depend on the level of additional training undertaken – 2
• Most MRTs have the ability to prescribe for the population who has no other medical history or problems and could be trained appropriately for such – 1
• Experience with MRTs who have delegated prescribing rights in the UK have proven to be very successful (prescribing gadolinium- and iodine-based contrast media) – 1

Three respondents added comments regarding IV cannulation and contrast administration. One respondent indicated that some of their MRI technologists had acquired these skills, which had been helpful with workflow. Another respondent commented that their MRI technologists are IV trained and give contrast; however, they would call the radiologist to administer buscopan and IV sedatives after the MRI technologist had cannulated the patient. It was suggested by the respondent that it would be ideal if MRI technologists could give everything themselves within set protocols. They can do it once they have
discussed the case with the radiologist and checked that a radiologist or resuscitation team is on-site. The third respondent questioned the practices of MRI technologists inspecting the drugs and whether they check it with another health professional as are the standard practices with nurses.

The results of this chapter will now be integrated with the data collected through the interviews and the critical incidents in the following two chapters.
Chapter 5

Current practices and experiences of MRI technologists in New Zealand

Hardy and Snaith (2006) have stated that role extension is often dictated by and limited to the needs and demands of a department to optimise service delivery by maximising the flexibility of the staff base. An excellent example is that of IV peripheral cannulation and contrast media administration by MRI technologists. Until approximately the late 1990s most radiology practices in the United States required those tasks to be performed by a physician (Colletti, 2008). However, policy changes allowed trained technologists to perform venepuncture under the indirect supervision of the physician, which released the physician’s attention from the physical process of gadolinium-based contrast media administration. At the same time there was an increasing demand for radiographers in the UK to perform IV injections as well (Patterson, as cited in Keenan, Muir & Cuthbertson, 2001) and by 2007 this practice was well established in most hospitals (Smith & Reeves, 2009). In New Zealand this practice was also adopted at a number of MRI sites, which improved workflow greatly in those departments (Sinclair & Yielder, 2007). It is from this point that the discussion will be launched.

Intravenous peripheral cannulation and contrast media administration in MRI

Of the 99 respondents to the MRI technologist questionnaire, 86.7% (86/99) are performing IV cannulation and contrast media administration. Fifteen have indicated that they perform this role elsewhere as well (CT – 12; intravenous urograms – 4; isotopes in nuclear medicine – 1). However, IV cannulation and contrast media injection appear to have become integrated into the role of the MRI technologist. When asked if they do any role extension activities, one interviewee responded:

They probably do not consider it role extension anymore but I do IVs.       Amy
In a research study that investigated role development and career progression for MRTs in New Zealand, Yielder et al. (2008) found that undertaking IV cannulation and contrast media administration in MRI have impacted on workflow directly. No longer did MRI technologists have to wait for a radiologist or nurse to perform this task with the added benefit of improved continuity for the patient. One study in the UK found that radiographers performing IV injections had a reduction in waiting times of up to 30 minutes per patient (Smith & Reeves, 2009).

Interviewees were then asked what sort of formalised training they underwent in order to prepare them for the task:

Anyone and everyone can do the one at the hospital and it is only just a two hour session where you get to practise on a few dummies and when they are happy with that you can go practise on each other and then off you go and cannulate. In-house we do expect them to do 20 cannulations supervised and then they get a list of 40 cannulations and once they have done 40 cannulations we sign them off and say that they are competent and able to continue.

Michael

There was a whole big bunch of us and they gave us little fake arms and we put little lines in it and things like that and then we had to get a doctor to supervise us doing three of them and then we were certified as competent, and started doing it from then.

Amy

We did the cannulation course that our hospital offers and then we practised on staff members for quite a while until we felt we were proficient enough to start practising on the public at which point we went ahead and did our prescribed 10 supervised cannulations. Once we had done those we were signed off by a person who was a dedicated supervisor who could specifically sign us off.

Mary

Compare the training these MRI technologists obtained to the training one interviewee received while she worked in the UK:
In the UK there are two ways you can do it. You do it in the hospital but then it stays in the hospital and if you move hospitals you don’t take it with you; you can’t. Or you do it through the University, which is what I did and means you take the qualification wherever you go because you have got it. It is a two day course: You do the first day and they give you all the papers before you arrive. They give you a whole booklet with all the anatomy and contrast media products and stuff and you go there and you get the lectures as well. You’ve got to write an exam at the end of the day of the following week and only once you have gotten through that and they give you the results, can you start the practical side of it, which is the injecting and a log book you’ve got to fill out. You’ve got to get someone who has been injecting for longer than three years or a doctor to supervise you. There is quite a lot to the course that I have done because I have mentioned it here and they say “Really, you have done all that?” and I say “Yes, I have done all of that”.

Sue

Most radiologists have experience with MRI technologists performing IV cannulations and contrast administration (95.7% [66/69] and 98.6% [68/69] respectively). One interviewee mentioned though that at her current place of employment some doctors are hedging a little because they are unsure whether her qualification is ‘sufficient’ for this country, especially by one doctor:

I am not quite sure why he is not happy for me to inject... The charge radiographer injects and he is happy for her to inject. She did her one day course here in the hospital and that is all she has done.

Sue

However, some practices are willing to accept a UK qualification in venepuncture and contrast media administration:

I have got a friend who has recently arrived from the UK who also did her injecting certificate over there and they are quite happy for her to carry on and inject here.

Sue

Responses suggest that training occurs mainly in-house and lacks standardisation across the country. One interviewee considers that a formalised qualification through a tertiary institution would be more beneficial:
It might be a good idea, just purely because then it doesn’t matter if you move around
to say a different hospital. Then you can actually say you’ve got a New Zealand
qualification rather than a hospital qualification or whatever. I see that there would be
greater advantage to that.  

Mary

Most in-house cannulation courses solely assess cannulation competency and appear to be
more aimed at nurses as part of their curriculum. Therefore Marshall and Kasap (2010)
recommend that MRTs undertake an endorsed national certificate in IV cannulation that
also considers the implications of the different contrast media. National accreditation will
ensure consistency and a high level of service standard, which sequentially increases
professional prestige and allows transferability (White & McKay, 2004). Since contrast
media appears to be an unscheduled substance, there is probably no restriction on MRTs
administering it (McNab, 2003; Toh, Reed & Robinson, 2007). Then again maybe IV
cannulation, contrast handling, and administration should be formally recognised within the
MRI technologist’s scope of practice by the MRTB. This raises the next point to be
addressed; that is contrast reactions.

**Adverse reactions encountered with contrast media**

Numerous studies were conducted to investigate the frequency and characteristics of
contrast media reactions encountered with the use of gadolinium-based contrast media
(Dillman et al., 2007; Li et al., 2006; Murphy et al., 1996). Studies were also carried out to
compare adverse reactions between gadolinium-based and iodinated contrast media
(Cochran et al., 2001; Hunt et al., 2009). The studies concluded that even though adverse
reactions due to gadolinium-based contrast media were less frequent than those due to
iodinated contrast media, 0.07% and 0.4% respectively (Cochran et al., 2001), and 0.04%
and 0.153% respectively (Hunt et al., 2009); the reactions associated with them were more
often deemed severe and necessitated more aggressive treatment. MRI technologists were
asked to indicate the frequency of reactions they had encountered with gadolinium-based
contrast media. Fifteen respondents have answered that they have never experienced a
reaction to date; 32 respondents have experienced a reaction once per year; 12 have
experienced a reaction more than once per year; and the rest of the respondents have
experienced reactions infrequently. The same question was submitted to the radiologists
with 15 who have indicated they have never experienced any reactions to date; one radiologist encounters at least one reaction monthly; 26 at least once per year; 10 experience reactions more than once per year; and the rest will experience reactions intermittently. Both groups have indicated that the most common reactions encountered are nausea and vomiting (77.8% and 48.5% respectively for MRI technologists as well as 50.7% and 26% respectively for radiologists), which are the reactions most frequently reported in the literature review. These are followed by rash, hives, itching and flushing (39.4%, 30.3%, 26.3% and 14.5% respectively for MRI technologists compared to 29%, 27.5%, 14.5% and 17.4% respectively for radiologists). Another reaction frequently encountered by MRI technologists is that of altered taste (45.5% and 11.6% by radiologists). Little has been mentioned in the literature with regard to this reaction to gadolinium-based contrast media; however, a metallic taste in the mouth has been associated with IV administration of iodinated contrast media (Siddiqi, 2010). Moderate reactions such as bronchospasm and dyspnea have been experienced at a lesser rate (8.1% and 4% respectively for MRI technologists and 7.2% and 5.8% for radiologists). In addition, two cases of asthma have been reported by MRI technologists. Severe reactions such as unresponsiveness, severe respiratory distress and convulsions appear to happen infrequently (1%, 1% and 1% respectively for MRI technologists and 4.3%, 4.3% and 2.9% respectively for radiologists). Cardiopulmonary arrest happens rarely and has only been experienced by 2.9% of the radiologists (2/69). Interviewees were asked about their experiences with regard to the use of contrast media:

There have been a couple of fainty-type responses but probably more vasovagal reactions to needles than to the contrast agent. But we did have one case where the patient vomited, which is pretty rare. **Michael**

I think one or two may have thrown up but it may be nerves more than anything. The two who did were very, very nervous but most of them are fine. **Sue**

Mainly what we would get is nausea and vomiting with Multihance; nausea and vomiting with Omniscan and rashes with Omniscan. And once, I probably would call it a
borderline anaphylaxis with MultiHance, where the patient became short of breath and red in the face. But I have only seen one person vomited with Dotarem.  

Amy

She then elaborated more on this reaction encountered:

The patient vomited... She stopped vomiting on her own, probably about 10 minutes after. She looked quite horrid for a while and we just kept her there... for half an hour afterwards to make sure she was alright.  

Amy

Other interviewees also shared their experiences (or lack of) regarding gadolinium-based contrast media:

Over the years we have had one or two patients reacting. We had one patient that went into a full-blown, what appeared to be an anaphylactoid reaction, until we told the patient that they hadn’t had an iodine-based contrast at which point they recovered quite quickly – psychosomatic. Other than that I have had a couple of patients that have vomited. One a few years ago was a patient that had come for a carotid angiogram and prior to that a very old man who had had a tumour on his uvular; we gave him gadolinium and he vomited. In those days I think it was Magnevist and he vomited quite strongly after that. Certainly with the patient for the carotid angiogram we spoke to the radiologist afterwards and he felt that it was more just the volume of contrast and the rapidity of which it went in that actually caused him to vomit rather than the contrast itself.  

Mary

You know, I have been doing MRI from 1992, so it’s now for almost 18 or 20 years and I don’t recall any single incident happening for contrast reaction. And you know that over time there has been a lot of improvement in the quality of contrast. It has become much much less harmful to the patient and to the human being because there are much less side effects than before.  

James (Radiologist)

We’ve not had any significant adverse responses to gadolinium. We’ve had a few cases of nausea but that has been few and far between.  

Rick (Radiologist)
From the critical incident reports, two MRI technologists described separate episodes of patients who developed rash and hives after the administration of the contrast media. Antihistamine was administered to one patient and though the other patient complained of dizziness in addition to the rash, no further treatment was required. These comments support the literature that adverse reactions to gadolinium-based contrast media occur rarely and that the most common reactions are vomiting and nausea followed by minor skin reactions. An interviewee shared her experiences related to iodinated contrast media:

I actually had two but they were a bit odd: I was doing an IVU, both times actually. I had injected the first patient and was talking to him the whole time; come back, talk to him, come back, talk to him. It was 20 minutes into the examination and he had a grand mal seizure. They were not sure if it was triggered by the contrast or whether it was a previous experience because he was a refugee and they thought he might have been tortured or something and his way of getting out of it was to have seizures. I went “Hmmm... okay” but it left me standing in the corner with my eyes big as saucers watching what was going on... He was hitting and thrashing his head on the table; his legs were flying everywhere. There were a lot of people in the room. That was the first one. The second one we had was pretty much after we had started the injection. It was also kind of a fit. Because of the first one, I knew this one was going funny on me when I talked to him. So we got to him a bit quicker but he also had a similar kind of thing; he just went off, had a seizure or a fit sort of thing, not funny.           Sue

This raises the issue if MRI technologists know how to recognise and treat any adverse reactions patients may suffer. Most respondents indicated that they would “call the doctor.” Unfortunately, the questionnaire failed to address the level of training MRI technologists have received in recognising and treating reactions. When asked if they received specific training in how to deal with patients experiencing adverse reactions to the contrast medium, one interviewee said:

No. In a word “no.” We did get CPR training and we were given strict protocols as to how to call the crash team and things like that if something happened. If it was a mild
reaction we’d usually try and ring the radiologist first. But no, we weren’t given any
formal training with that. 

Amy

From another critical incident report, one MRI technologist described how stressful such it
could be on the MRI technologist if a patient reacts. In this instance a patient who was
booked at the end of the day had to get contrast media for a lumbar spine examination,
which the radiologist administered. After the first post-contrast scan, the lady began
sneezing but said she was fine. However, at the end of the next scan she started to itch and
the MRI technologist removed her from the scanner and then attempted to locate the
radiologist. By then all the radiologists had left to go home:

None of the radiologists were within the department and I was unsure whether or not
the lady’s symptoms were going to escalate. Locating the radiologist on his mobile
phone took some time and this was very stressful... I also had no training to administer
any antidote.

Another incident was described concerning a patient who had a scan for a Morton’s
neuroma and was administered contrast media. When the MRI technologist went into the
room after completion of the scan, she noticed the patient was coughing a bit:

I said: “Are you alright?” and she said “Oh yes, I just have a bit of a cough.” I said “But
you were not like that before” and I noticed that her neck was all red... We managed to
get a registrar over from the hospital that came and administered some oral
antihistamines. 

Amy

When questioned if it would have made a difference to the situation if she was trained to
administer antihistamine to the patient herself, she answered:

Yes. It would have. It would have been nice to have the freedom, in a way to use what
was on the emergency trolley to actually get on top of the situation before we had to
ring around and find a doctor to come and see her.

Amy

Another interviewee who had her training in the UK said:
We were given a breakdown of all the drugs that could be used and what they could be used for but we were not allowed to administer them. So we were given what the drugs were for but that was all we were allowed to do.  

Sue

Thirty-seven of the MRI technologists indicated that their patients required some form of medical intervention because of adverse reactions experienced after the administration of gadolinium-based contrast media. Antihistamines were the most common drug being administered to patients (54.1%). It was followed by adrenalin (10.8%), steroids (5.4%) and antiemetics (5.4%). Other measures included oxygen (5.4%), Ventolin (2.7%) and creams for rash (2.7%). A survey in the United States found that the most common type of drug administration is IV injections of radiopharmaceuticals and contrast media (Tortorici & Mixdorf, 1997). However, it was found that only 17.3% of the institutions permitted technologists to administer medication to counteract any contrast media reactions. As a result, even though the technologists perform the contrast media injections, they have to locate someone else to administer medications in circumstances where the patient has a reaction (ibid.). Obviously, this process could be time-consuming and, in rare instances, could threaten the recovery of the patient. The results of the survey by Yielder et al. (2008) have shown that there is support from radiologists to a certain extent (14 out of 26 respondents) for prescribing pharmaceuticals relevant to a procedure (such as glucagon and antihistamine) and reasonable support for administering these pharmaceuticals (16 out of 26 respondents). When questioned how comfortable they, that is the MRI technologists, would feel about prescribing and using drugs from an emergency drug trolley, interviewees responded:

My first impression of something like that would be “no.” You wouldn’t really want to go there because once you are talking about delving into an emergency trolley – there are things in there that you don’t really want to be responsible for giving... I think I would be uncomfortable with that because to go down that track: Then it is going to be okay you give adrenalin but what do you do to a patient that is actually allergic to adrenalin and so it goes on.  

Michael
However, some interviewees were of the opinion that with the necessary training they would administer drugs from the emergency trolley quite confidently:

I said before it would be helpful to know a little bit more about the goings-on of the emergency trolley... if it was an emergency and I had to give someone something now, I would be quite comfortable giving someone an emergency drug.  

Amy

Absolutely; with some proper training so that you are not floundering around: You have some insight into what the drug does, why it does, how it reacts with other drugs, side-effects and that sort of thing. I feel that I would definitely need some form of qualification in that direction I think before I took on a lot of other drug administration.  

Mary

One interviewee even questioned the possible use of EpiPens in a situation where a patient experiences an adverse reaction to contrast media:

That is what you give somebody when they have a reaction. You then just stab them in their thigh and anybody can do that in a home setting. They teach people how to do that if your child has got a peanut allergy or something like that... Could that be a possibility? I had a friend whose daughter is very allergic and she showed me how to use them. I was like “Oh that is not so hard.” People who are allergic to bees carry them around in case they are stung because they have to use it straight away.  

Sue

It is uncertain if this method may be a possibility for MRI technologists to use epinephrine in the treatment of patients with severe contrast reactions. In the UK there is a deliberation whether radiographers should be allowed to inject intra-muscular adrenalin under a patient group directive where it is evident that an allergic reaction is resulting in anaphylactic shock (Marshall & Kasap, 2010). On the other hand, IV administration of epinephrine is preferred over subcutaneous or intramuscular injections in cases of severe anaphylactoid reactions in patients with poor circulation, due to more consistent delivery of precise amounts of the drug into the central circulation (Collins, Hunt & Hartman, 2009). It has been stated that the immediate management of severe adverse reactions begins with a brief but directed assessment of the patient by the radiologist on site, prompt initiation of supportive
measures such as the administration of oxygen and isotonic fluid, and simultaneous calling of a code (ibid.). Rarely IV epinephrine hydrochloride is indicated and then mostly for laryngeal edema.

Twenty-seven radiologists indicated that their patients required the following medical intervention: antihistamine (40.7%); resuscitation (25.9%); steroids (14.8%); hospital admission (14.8%); adrenaline (7.4%); oxygen (3.7%); anticonvulsant (3.7%); and observation (3.7%). One radiologist suggested the following in order to enable MRI technologists to expand their role:

Image interpretation or awareness of images influence on interpretation is important. The other critical thing is an understanding of the physiology and pathophysiology of drug reactions and renal function and also resuscitation. I think they should be as skilled as any practising doctor at resuscitation and that would be a level seven resuscitation, which is not problematic – it is not a difficult thing. I think the ability to do CPR and to administer defibrillation shocks is critical. That would probably be a level five or something – I am not familiar with all the different qualifiers for different levels – but some form of resuscitation qualification that enables them to provide advanced life support would be essential. You couldn’t operate without that.  

Rick (Radiologist)

Data suggest that most of our MRI technologists are not comfortable in dealing with patients experiencing adverse reactions. This could be because either CPR training is inadequate or because the rarity of such events leaves MRI technologists hesitant to act or both:

You do need extra training now and again in some things and it is good to go over things sometimes because you will remember things one year; and the next year you will remember something different. So it might be a good idea to revisit a few things every now and again just to make sure you have still got the same knowledge stuck up there somewhere.

Sue

The proof of the pudding is always in the eating. I guess if you go over the CPR training regularly and that sort of thing you hope that it is well gelled in your mind but often you
only ever know how well you deal with an emergency situation once you are stuck in one.

Mary

Experience is the thing that gives people confidence. The chances of an allergic reaction are so rare... so it is all kind of role played and this is what you would do in the event of but no one actually ever had experienced the event – just one or two unfortunate people. It is very rare. I have never experienced an adverse reaction to any contrast media, whether it is iodinated contrast or gadolinium-based contrast in the 20 years that I have been a radiographer. If that event is something that occurs in less than a 20-year event in your working life-span it is going to be less than twice in your life that you experienced it. Because of that lack of experience you have no confidence in your ability to actually work in a situation because it just doesn’t occur to you. Michael

One interviewee said that even something as simple as giving oxygen to a patient was a form of prescribing:

That’s what I found in the UK: I was “What? Oxygen is prescribing?” You’re not allowed to give it unless you’ve been told to give it. Oxygen is prescribing; you would think it’s oxygen, what are you going to do to the patient? But in the UK they had this funny thing about oxygen as well. We used to do it anyway. Sue

According to the BNF (as cited in Dodd et al., 2000), oxygen (used in the treatment of hypoxemia) may be lethal and should therefore be considered a drug and be prescribed. Yet doctors often fail to prescribe it and its administration is left unsupervised (Small et al. as cited in Ganeshan, Quen Hon & Soonawalla, 2006). Ganeshan et al. (2006) advise that all health professionals should know how to use oxygen. Correct administration of it is vital to obtain optimal therapeutic benefits; however, inappropriate usage can lead to a detrimental outcome. In their study to determine if health care professionals could prescribe oxygen correctly, Ganeshan et al. (2006) found that a quarter of the doctors and half of the nurses were unable to select the correct dosage and method of administering oxygen in the event of a cardiorespiratory arrest. Oxygen was also wrongly prescribed in various clinical scenarios that dealt with respiratory failure by the majority of the participants. This study did not address the issue of oxygen administration; therefore it is not known if MRI
technologists are capable of administering oxygen correctly according to the requirements of patients with respiratory disorders.

Approximately 75.4% (52/69) of radiologists are of the opinion that a doctor should always be present in the radiology department when a patient is administered gadolinium-based contrast medium. This group of radiologists believe that even if the risks of contrast reactions are minimal, qualified medical help should always be at hand in the department in case of an anaphylactic reaction. One radiologist responded:

I believe a radiologist should always be present in the department for any MRI examinations regardless of whether gadolinium is used or not.

The remainder of the radiologists (24.6%) do not think it is necessary for a doctor to be physically present in the radiology department when contrast media are administered, so long as there is medical support available, for example a cardiac arrest team to assist if required. One radiologist commented that in places like the United States and Europe, gadolinium-based contrast media are being administered without a doctor having to be present in the department. One interviewee said:

I think a person with resuscitation skills needs to be close at hand. They don’t need to be immediately in the environment. For example, we’ve got a CT practice in private that doesn’t have a radiologist associated with it because it is a satellite clinic but there is a GP practice associated with it so there is that ability to call on a physician if necessary.  

Rick (Radiologist)

Adverse reactions to gadolinium-based contrast media are rare and the vast majority of them are of a minor nature. Nevertheless, the ACR (2007, p. 2) states that “training and proficiency in cardiopulmonary resuscitation are recommended for those who attend to patients undergoing contrast-enhanced examinations.” This would include the MRI technologist administering gadolinium-based contrast media as well. A review of the training needs of MRI technologists would be helpful to determine, for example if more
theoretical and practical training are needed with regard to the signs and symptoms to look for when presented with a reaction and the treatment thereof.

**Administration of other drugs in MRI**

MRI technologists were questioned on whether they are administering any other drugs in addition to contrast media in MRI with 47.5% (47/99) of respondents admitting that they have. Drugs that are being administered by MRI technologists included: buscopan (44.4%); Ativan/lorazepam (5.1%); glucagon (4%), hypnovel/midazolam (4%), fentanyl (1%), maxolon (1%), and glyceryl trinitrate (1%). Buscopan or hyoscine-N-butylbromide is an antispasmodic and its property as a smooth muscle relaxant is helpful when performing pelvic MRI examinations that require the bowel to be paralysed (Dyde, Chapman, Gale, Mackintosh & Tolan, 2008). It is usually being administered through a parenteral route. However, it is not clear what the level of training and if any, the MRI technologists have received in order to administer the drug. There are concerns regarding cardiac side-effects when patients are being administered buscopan with tachycardia as the main cardiovascular side-effect (Dyde et al., 2008). One interviewee experienced the following:

One of the radiologists absolutely refuses to let us administer buscopan because he had a patient that nearly had a cardiac arrest from one injection of buscopan. He just said that as far as he is concerned it is not a safe drug for us to be injecting; so he won’t let us inject at all. I have been in radiography a long time and I have never seen anybody react to buscopan ever. 

Sue

However, there has been little evidence to directly implicate buscopan as a cause of cardiac complications during radiological procedures, and it is believed other factors like age may be more important (Dyde et al., 2008). Buscopan is also contraindicated in myasthenia gravis (an autoimmune disease resulting in muscle weakness), porphyria, megacolon, and patients who have demonstrated prior hypersensitivity to the drug (Dyde et al., 2008; New Zealand Medicines and Medical Devices Safety Authority [Medsafe] 2010). Glucagon also acts as a diagnostic aid in radiologic examinations since it relaxes the smooth muscles of the gastrointestinal tract when diminished intestinal motility would be beneficial (Eli Lilly & Company, 2005). However, glucagon also increases the blood glucose concentration and is
therefore used in the treatment of hypoglycaemia. In patients with a history suggestive of insulinoma (tumour of the pancreas) and pheochromocytoma (tumour of the adrenal gland) glucagon should be administered with caution. It could cause hypoglycaemia and a sudden increase in blood pressure respectively (ibid.).

Ativan (generic name lorazepam) and hypnovel (midazolam) both belong to a group of drugs known as benzodiazepines and are used to treat anxiety disorders (Cerner Multum, Inc., 2010; Monson, 2007). They are also classified as Class C5 drugs and require a doctor’s prescription (Medsafe, n.d.). They are often prescribed for claustrophobic patients undergoing MRI examinations to relieve anxiety. Ativan is usually administered orally; however, hypnovel can be administered either orally or IV. Hypnovel has a short duration of action and has the ability to cause memory loss for a few hours. It gives patients the sensation of being under GA but without the risk of GA or the need for a hospital setting (Monson, 2007). Some of the interviewees explained how they approached patients that might be claustrophobic:

Mostly our patients get phoned and asked about metal in their eyes, heart valves and claustrophobia. If they say maybe a little bit then we talk to them further just to try and figure out how much claustrophobia they have actually got. If we find out it is going to be just slightly claustrophobic then we give them oral sedation. If they say they are really, really bad then we book them for IV sedation... We've got 7.5mg hypnovel tablets at work. We get the patient to arrive an hour earlier and we give them the tablet.  

Sue

All our patients go through the MRI booking clerks: They ring and go through a simple safety check list with them to make sure they are ‘MRI compatible’ and talk to them about the scan... If they are concerned about them from a claustrophobic perspective, they will encourage them to go to their general practitioner and get their GP to prescribe oral sedation. It is quite variable the degree of oral sedation they are given but it has reduced the amount of IV sedation that we give quite remarkably. We got a 62% reduction in the need for IV hypnovel by giving the patient the option to take oral sedatives... We encourage them to come sedated and we ask the GP to provide them with enough sedation to get them through for a two hour period so if there is a delay...
they have got enough sedation to help them through for an extended period. It has been quite successful.

Michael

Fentanyl is an opioid analgesic as well as a sedative and a dose of 0.1 mg is approximately equivalent to 10 mg of morphine or 75 mg of pethidine (Medsafe, 2003). One of the indications for administering fentanyl is the induction and maintenance of anaesthesia (ibid.). Results of this study have indicated that one MRI technologist is in fact administering this sedative. Yielder et al. (2008) found that 16 out of 26 radiologists would allow their MRI technologists to administer glucagon and hypnovel with varying degrees of supervision. The remainder of the radiologists indicated that the MRI technologist should not be responsible for administering sedation. However, it was admitted by two of the radiologists in this study that their MRI technologists are performing this task. One interviewee knew about a MRI technologist performing IV sedations:

I know of someone working up in this department that was actually doing IV sedation. We all went: “You’re doing what?” and she said: “Yeah, I am doing it.” We said: “Are you serious?” and she said: “Yes.” We said: “Where is the doctor?” She said: “He is around there.” She’s been doing it for ages. She didn’t realise that none of us were doing it. We said that our doctors won’t even let us near it. We could put needles in and that is as far as it gets. Our doctors won’t let us do IV sedation. But she was quite happy doing it but “None of us were allowed to do it, how come you’re managing to do it?” She said: “He just let me do it. I never asked any questions, so I did it.” We were like: “Well, you shouldn’t be doing that.” She was a bit shocked I think... This is the semester I did last year and there was a whole group of us and she just came out with it... She didn’t realise that no one else was doing IV sedation.

Sue

For these MRI technologists already administering sedation, either orally or IV, there needs to be a recognised training course available with regard to the pharmacological actions of these drugs: the pharmacokinetics and –dynamics; indications and contra-indications; dosages and administration, and precautions with these substances.

Oral maxolon is an antiemetic and used to treat nausea and vomiting (New Zealand Consumer Medicine Information, 2010) that could potentially be administered to patients
presenting with these symptoms after the administration of gadolinium-based contrast media. However, it may interfere with other medications such as anxiolytic drugs, sedatives, codeine, morphine, and paracetamol (ibid.).

Glyceryl trinitrate relaxes the vascular smooth muscle to relieve angina in patients by reducing systolic, diastolic and mean arterial blood pressure (Medsafe, 2003). It is usually sprayed under the tongue but is also available as an IV infusion (Medsafe, 2008). Severe hypotension may occur even with small doses of glycerol trinitrate and severe and persistent headaches are commonly reported side effects (Medsafe, 2003).

The results of the study have indicated that approximately 16% of MRI technologists are administering these drugs; they are hypnovel, lorazepam, fentanyl, maxolon, and glyceryl trinitrate to patients. However, the study does not address the issue on how familiar MRI technologists are with the systemic pharmacology of these medications.

**Nephrogenic systemic fibrosis (NSF)**

NSF can be classified as a delayed reaction to gadolinium-based contrast media because it is a disorder that could develop within two to eleven weeks up and to a year after exposure (Broome et al., 2007; Pryor et al., 2007 & Collidge et al., 2007). This rare but potentially debilitating fibrosing condition most often affects the skin as well as multiple organs (Broome et al., 2007; Canavese et al., 2008). The disease has been found to occur in patients with varying degrees of kidney failure, patients on haemodialysis or peritoneal dialysis, renal transplant recipients, and pre- and postoperative liver transplant patients (ibid.). Results of the study revealed that most MRI technologists possessed reasonable knowledge with regard to NSF and were able to identify those patients at risk for potentially developing this disease. Respondents identified that the foremost risk factors are acute and chronic renal failure due to decreased renal function (91.8%). Other risk factors respondents included are patients who have had major vascular surgery or organ transplants (14.3%) and patients on haemodialysis (9.2%). Diabetes (11.2%), in addition to high and repeated doses of gadolinium-based contrast media administered (4.1%) were also included. Respondents (21.4%) included age also; the reasoning that a patient’s renal
function decreases with age but that children are at risk also due to immature renal function.

Juluru et al. (2008) advise that an institutional policy should first be used to identify patients who may have renal insufficiencies and indicate that this is achieved through a screening questionnaire, which investigates the patient’s past medical history of renal problems. This may require further testing to obtain creatinine values and eGFR. The use of gadolinium-based contrast media should be avoided in patients with acute renal failure since the creatinine values and eGFR are inaccurate. The FDA has determined that the risk for NSF is the greatest if the eGFR is less than 30 mL/min/1.73m² (Juluru et al., 2008; Shellock & Spinazzi, 2008). Respondents have indicated that all their patients who may be at risk for NSF will have a blood test prior to MRI to obtain creatinine values and eGFR. In some departments patients over the age of 60 are automatically subjected to a blood test, others over the age of 65. An interviewee elaborated on this:

> Primarily we go through our questionnaire. One of the flags or one of the major questions is that we ask if they have had any renal disease and people will say things like kidney stones. For me, kidney stones would be a flag to say right: We possibly need to look further before we go ahead. I might then just do the routine scan and then get their eGFR tested. Our age criteria basically mean that anybody under 60 years of age does not get their eGFR and creatinine tested unless they’re coming for an angiogram or liver scan or they have a history of things like kidney stones. That sort of thing would be a flag to me to get their blood tested and bring them back to complete their examination. All patients over 60 years of age are routinely given a laboratory form, which I’ll request that they have their eGFR and creatinine tested prior to coming to MRI.

Mary

Juluru et al. (2008) and Marshall and Kasap (2010) referred to the introduction of point-of-care devices in MRI departments in the UK. These devices allow quick, low-cost measurement of eGFR and serum creatinine levels with small blood samples obtained from a finger stick. Not only does this increase safety and efficiency for those patients in whom a recent blood test and eGFR has not been obtained (Marshall & Kasap, 2010) but the frustration and logistic difficulties associated with traditional testing could be avoided.
(Juluru et al., 2008). In addition respondents indicated that gadolinium-based contrast media are not given if the eGFR is less than 30mL/min/1.73m² unless absolutely necessary and then the responsibility are with the radiologist to explain the risks and benefits of the contrast medium to the patient and to obtain consent. Usually the type of gadolinium-based contrast medium used is determined by the eGFR of the patient, for example MultiHance and Dotarem will be used for patients with an eGFR of less than 60 mL/min/1.73m².

Of the five gadolinium-based contrast media used in New Zealand departments, MultiHance appears to be utilised more frequently (71.7%); followed by Omniscan (46.5%); Dotarem (40.4%); Magnevist (28.3%); and Gadovist (4%). In the literature the majority of NSF cases have been associated with Omniscan followed by Magnevist (Broome, 2008). Five cases of NSF identified in the Auckland region were all exposed to Omniscan (Kendrick-Jones, Voss & De Zoysa, 2011). To date no literature has been found about unconfounded cases with MultiHance or ProHance (Shellock & Spinazzi, 2008). There have been reports of confounded cases with MultiHance and Dotarem; however, those patients were also exposed to Omniscan (Broome, 2008). Omniscan, Magnevist and OptiMARK are contraindicated for use in patients at risk of NSF but the other gadolinium-based contrast media like MultiHance and Dotarem may be given to those patients if regarded as clinically essential (Shellock & Spinazzi, 2008). Afterwards they should then be followed up for at least one year to identify any symptoms or signs suggestive of NSF (ibid.). The emergence of NSF has also had an influence on the utilisation of gadolinium-based contrast media here in New Zealand as well. One MRI technologist commented in the questionnaire “since NSF we always check whether or not a patient needs gad.” One interviewee remarked:

We only give Omniscan to our patients and we only do ambulant or outpatients. We hardly ever do hospital patients – we don’t have a hospital contract – so we never come across patients who have kidney problems and even if we do on the rare occasion, we refer them straight back to hospital because we would rather not risk taking on all that added NSF and all that kind of stuff.  

Sue
Prescription of gadolinium-based contrast media

Seventy-six percent (73/96) of MRI technologists indicated that they have specific protocols in place for patients that will require contrast media, for example patients who have had surgery to their spines, patients with known or suspected tumours, infections; suspicious lesions, lumps, imaging of the pituitary gland and liver, and contrast-enhanced angiograms. Of the radiologists, 66.7% (46/69) indicated that they have protocols in place for specific examinations. However, 62.5% (60/96) of MRI technologists claim they still get the radiologist to assess each case individually before the contrast medium is administered. The reason is that every radiologist has personal preferences with regard to administering contrast media, for example some radiologists will not request contrast medium for prostate imaging while other radiologists do. Therefore the majority of MRI technologists will confirm with the radiologists if contrast media are in fact required. One responded explained:

Some indications require contrast; however, some may or may not require contrast and it is up to the radiologist on duty to check the pre-contrast imaging and decide on whether it is required.

The radiologists indicated that 76.8% (53/69) of them assess each MRI examination to determine the need for contrast media. However, one radiologist made the comment:

Usually the MRI techs know – often better than the doctors (radiologists) to give gad – but still check it off for approval.

This remark was supported by one of the interviewees:

It doesn’t need a rocket scientist to come in and say: “Yes, that needs contrast.” You guys are probably ninety-nine times out of a hundred just as able as we are to recognise the situation that needs contrast. Rick (Radiologist)

Gadolinium-based contrast media are administered by injection and are therefore classified as prescription-only medicines or drugs (Thorp, 2008). The ACR (Kanal et al., 2007, p. 1458)
states that “No patient is to be administered prescription MR contrast agents without orders from a duly licensed physician.” The Irish Institute of Radiography and Radiation Therapy ([IIRRT] 2007, p. 5) declares:

> It is a legal requirement that all prescription-only medicine (POMs) be ordered by a registered medical practitioner in writing, using indelible ink. Such requirements must be fulfilled by a medical doctor inserting administration details of any such substances in writing on the request card in advance of the procedure. This can also be done using a group administration protocol, locally agreed and signed by the line manager, and hospital management.

The administration details have to include the patient’s name and hospital number; the name; strength and dosage of the contrast media; and the route of administration (IIRRT, 2007). Numerous responses were received regarding the prescription of contrast media and varied between departments. There were radiologists that indicated that they did not ‘prescribe on paper’ and would give the MRI technologists a verbal prescription, even by telephone if necessary. Other radiologists would pre-prescribe the contrast media at the time of the booking. Some departments have standing orders in place for the contrast media to be administered. One of the radiologists interviewed admitted that:

> I have to prescribe the contrast media for the patient but I think there is room for improvements. I don’t think that it is a practical way and it is time consuming because I may be busy with other procedures that may make it difficult for me to leave in the middle of the procedure to talk to the MRI technologists or to advice on contrast.

James (Radiologist)

The following interviewee explained there were options available with regard to how contrast media could be prescribed:

> You can either do it intermittently (get the radiologist to prescribe contrast), which obviously has its inefficiencies associated with it while you wait and try to find someone or you get that same person to dedicate an hour a week to go through your forms and protocol them and prescribe at that stage... It’s just convincing the person that an hour
a week is sensible use of their time rather than constant interruptions. The other alternative is to have standing orders where you’re allowed to prescribe in situations that are pre-prescribed, for example tumour follow-up or post-back surgery or an obvious abnormality on the images that you’ve obtained prior to contrast. So two options: Standing orders or getting it signed off by a doctor proactively or reactively.

Rick (Radiologist)

The latter could be a solution to departments with a shortage of radiologists; however one interviewee said:

The radiologists don’t protocol our forms. The off-site guys would like to protocol all our forms but it’s logistically difficult. Our on-site radiologist I don’t believe has the technical know-how to do that.

Mary

Some of the MRI technologists commented that a protocol form would be attached to the referral form stating if contrast media would be required. In those cases the radiologist would not review the pre-contrast images and the MRI technologist would go ahead and administer the contrast media. In the majority of cases the radiologists would chart the contrast media when required in their opinion; however, there would be deviations from that:

Often our radiologist are not available to us in MRI in which case we will administer Gad in clear out cases and get the prescription signed in retrospect.

Interviewees were asked how contrast media were prescribed in their departments:

It is just a verbal. We will speak to the radiologist and say for example that it is a lumbar spine, has had a discectomy; we go ahead and give them contrast and they will give it the okay. Previously, we never used to do anything like that but since the kind of raise of the NSF we just make sure we have spoken to the radiologist and write down “spoken to radiologist” and who the sign-off radiologist is but it is not formally charted.

Michael
We have got a separate contrast form that the patient fills out and it covers things like myasthenia gravis I think is the one thing on it and all sorts of different things and at the bottom either we or the radiologist signs it and puts the dose on. Then it gets recorded in another file with the contrast batch number.  

Sue

The former interviewee also commented on what a colleague had told her with regard to the contrast prescription in her (the colleague’s) place of employment:

The MRTs are not allowed to do anything until the radiologists have signed it off. So if you can’t find a radiologist, you cannot give contrast media to the patients. I know that is what they do there but we don’t seem to do it where we are. At the bottom it says MRT or radiologist signature so either one of us can sign.  

Sue

We have to get our prescription signed off prior to giving the contrast. If there is not a radiologist on-site then we’ve gotten hold of either the consultant or the house surgeon or the registrar to that consultant to come and sign off the contrast media so that we can administer it. Failing all of those, we have been getting a doctor from the emergency department – just so that there is somebody there if things should go wrong.  

Mary

The following interviewee shared her experiences with regard to contrast media prescription in her former place of employment:

We always had contrast consent forms and we put the batch number and the signature of the person who gave it and all that sort of record keeping. But just to give you an example: I had a woman who came in – it was a couple of years ago now – who had a huge tumour in her knee that was unexpected. She came for query meniscal tear. The one radiologist that we had happened to be away and I couldn’t get hold of anybody – so I gave gad. It just had to be that way. She had a tumour that needed looking at and there was no one else to make the decision. And that actually happened quite frequently: All my colleagues and I used to basically prescribe the contrast media.  

Amy

The results from the study indicate that identical to IV cannulation training, there is also no standardised practice on how contrast media are being prescribed, for example in some
places a verbal prescription would be sufficient whereas other departments would require a written prescription. The indications for administering contrast media are also varied between sites, for example prostate imaging that might require contrast media or not. One interviewee compared it with coil testing:

> It is like with QA on the coils at the moment: Everyone I have contacted is doing something different!  
>  
> Sue

Keenan et al. (2001) stated that the signature of the delegating radiologist must be recorded as evidence of the radiologist’s availability during cannulation and the ensuing examination. MRI technologists were asked if they ever found themselves in a situation without a radiologist available to prescribe the contrast media. Sixty-three percent (62/98) of MRI technologists admitted they had found themselves in a situation without a radiologist and 39.2% (29/74) of MRI technologists indicated that they had to rely on other doctors to prescribe the contrast media. Yet 76.1% (51/67) of radiologists claimed to be always available to prescribe the contrast media with 30% (16/67) of radiologists mindful of MRI technologists having difficulty to locate other doctors to prescribe when they are unavailable. Some MRI technologists indicated that they would ask doctors from the emergency department to cover for them when there is not a radiologist available to prescribe for them. One MRI technologist remarked:

> Sometimes doctors cannot be found and we either have to make the call to inject or tell patients that they may be recalled if the doctor deems it necessary.

One MRI technologist commented that they were without a radiologist certain times of the week and would try not to book any contrast examinations:

> We try not to book contrast exams during these times but this does not work out most of the time and we often have to cast about for someone to prescribe the contrast.

Another MRI technologist mentioned that this was a situation she had faced regularly in her previous employment and had found it to be a ‘horrid situation.’ Sometimes it would
happen that the radiologist allocated to MRI is not available and the MRI technologists cannot ask any other doctors to assist because ‘it is the protocol.’ Often periods of ‘waiting’ are required until a radiologist becomes available. Only 6.8% (5/74) of MRI technologists would frequently encounter difficulty in locating a doctor to prescribe the contrast media; 71.6% (53/74) would sometimes have difficulty in locating a doctor, and 21.6% (16/74) would never encountered such difficulties. However, some MRI technologists indicated that they would administer contrast media if they thought it to be necessary and the patient consented.

Approximately 62.1% of MRI technologists had at some stage encountered doctors not familiar with gadolinium-based contrast media, such as anaesthetists, research doctors, and RMOs. A similar scenario was encountered by Macaulay and Saunder (2008). The authors reported on MRTs performing after-hours CT examinations in Hawke’s Bay Regional Hospital and the impact it had on them. One of the changes in the MRTs responsibilities were that they no longer had the direct support of a radiologist to consult with on protocols and contrast media administration. Junior medical staff were often sent to supervise the IV contrast administration and frequently they had no experience with regard to the contrast media and were unaware of its potential risks; therefore leaving the responsibility to the MRT to educate them. MRI technologists have the same responsibility to alert doctors to possible adverse reactions the patient may experience; however, sometimes their explanations to the doctor may have an unexpected outcome as reported by one respondent:

> I once had a paediatric registrar refuse to give the contrast – we ended up having to call in the consultant.

This raises the question whether it is fair to expect a doctor ignorant of gadolinium-based contrast media to prescribe and supervise the IV administration thereof. One interviewee remarked:

> To be honest with you, the knowledge of our technologists is far better than the RMO about the contrast because they are working in the field. They know what the indications, the contraindications are; what the usage of it is. I believe that if the
technologist’s able to administer the contrast and decide about it, it’s much easier and
is more logical rather than the RMO.

James (Radiologist)

When questioned on the ability of MRI technologists to make decisions with regard to the use of contrast media and to deal with consequent reactions, the answer was:

I think that the MRTs are well graduated and they know what they are doing – especially if you talk about an experienced person. So I think they will know how to deal with these cases; yes.

James (Radiologist)

Summary
The findings of this chapter suggest there is a need for more formalised training regarding IV cannulation and contrast media administration. In addition it has been identified that there is a need for advanced CPR on a more regular basis than the current CPR training allows for. It has been found that MRI technologists are progressively administering drugs that do not lie within their scope of practice without any concrete evidence of training they received in the pharmacology of these drugs; for example buscopan and hypnovel. It has also become evident that the prescription of gadolinium-based contrast media is happening rather haphazardly across New Zealand. Though the majority of departments have protocols in place regarding the prescription of contrast media with certain indications and examinations, MRI technologists will often seek radiologists’ advice and approval first before administering the contrast media. However, it has become evident that MRI technologists will sometimes make decisions independently to administer contrast media if a radiologist cannot be found, and it will prove to be beneficial to the patient’s clinical management. Also occurring is that MRI technologists are signing off contrast forms without them realising that they are in actual fact ‘prescribing:’

I didn’t really think of it as prescribing because I didn’t think that was what I was doing.

It was just part of my job I was doing.

Sue

In the light of these findings, the next chapter will focus on the possibility of extending prescription rights to MRI technologists.
Chapter 6

Non-medical prescribing for MRI technologists – Moving forward

In 1999 the Royal College of Radiologists presented a guidance document, *Skills Mix in Clinical Radiology* (as cited in Forsyth & Robertson, 2007), which set out the advantages and potential pitfalls of skill mix. It was advocated that radiographers, given adequate education and training, could undertake protocol led activities that have traditionally been carried out by radiologists. In response to the Crown Report, *The Review of Prescribing, Supply and Administration of Medicines* that recommended an extension of prescribing rights to other groups of health professionals; the SCoR set up a working party to investigate opportunities for their radiographers to prescribe (SCoR, 2001). The SCoR (2003) published a report, *Role Development Revisited: The Research Evidence 2003* and found that radiographers had to involve doctors or prescribe under PGDs to remain within the existing law. Evidence suggested that it hindered the smooth running of the department and that services to the patient would be improved if radiographers were able to operate as supplementary and/or independent prescribers (ibid.). A specific example was given of radiographers giving contrast media during diagnostic procedures such as CT, MRI and ultrasound. In response, tertiary providers incorporated pharmacology and prescribing into their undergraduate courses to prepare radiographers for that role within radiotherapy and/or diagnostic imaging departments (City University London, 2005). The issue has been raised in the previous chapter that MRI technologists in New Zealand are probably already prescribing drugs without them realising the fact. Therefore, this chapter will explore the need for MRI technologists to extend their role into the area of prescribing and to remain within the law. The opinions of both MRI technologists and radiologists regarding this topic were investigated.

Prescribing as a role extension activity

Prescribing as a role extension activity was addressed in both the questionnaires sent to MRI technologists and radiologists. Of the MRI technologists that responded to the question,
59.8% (49/82) thought that it would be desirable for them to be permitted to prescribe gadolinium-based contrast media with the appropriate training and supervision; 17.1% (14/82) did not think it would be desirable; whereas 23.8% (19/82) were unsure. One respondent indicated that MRI technologists were already prescribing contrast media in some private hospitals across New Zealand. Some respondents thought it would be appropriate in instances where patients present with definite clinical indications such as acoustic neuromas and disectomies. The legal implications and consequences of taking such a step were questioned; including the requirement of indemnity insurance and who would be paying for it. The need for further training and strict guidelines that include stringent emergency procedures and protocols were also important. One interviewee remarked:

Just as long as you have the backup support of a protocol to follow that clearly identifies that gadolinium is required in those cases and you have the medical support if anything should go wrong. Michael

Fifty-three percent (35/66) of the radiologists thought it would be desirable for MRI technologists to be permitted to prescribe gadolinium-based contrast media when needed; provided they have the necessary training and supervision; 43.9% (29/66) were against it; and 3% (2/66) were unsure. Two radiologists were unclear on what ‘prescribe’ meant in the context of the questionnaire:

I am not clear what you mean by ‘prescribing’ IV contrast. If you mean actually making the decision that the MRI exam needs post Gad sequences, then I feel that should be left to the supervising radiologist who will be reporting the exam.

The general consensus amongst radiologists against MRI technologist prescribing gadolinium-based contrast media was that the need for contrast media should be determined by a radiologist, and not be written into standard protocols. Radiologists should be the ones making the decision with regard to the usage of contrast media because they have the training and experience to interpret images and the knowledge in the treatment of adverse reactions. In all probability one could not argue the fact that most radiologists
would know better than the MRI technologist on how to recognise and treat adverse reactions; however, two respondents shared their insight. One of the interviewees explained:

> When I had those two patients seizing on me, I used the red button in the IVU room that called the radiologist to the room. I had one of them wandered down going: “Ah... what’s going on then? What do you need me for? Oh no, I don’t know how to do that.” And I was like: “You are the doctor in the department; you are supposed to be here in case of an emergency and you are wandering around going ‘Ah, I don’t know what I am supposed to do.’” That is really comforting! Sue

The results of an Australian study within four teaching hospitals demonstrated a deficiency in the acute management of anaphylactic reactions in radiology departments by both consultants and trainees (Bartlett & Bynevelt, 2003). The most important single medication in the treatment of anaphylaxis is adrenaline that when administered, lead to peripheral vasoconstriction, cardiac contractility and bronchodilation (ibid.). Bartlett and Bynevelt (2003) found that 57% of the answers given by radiologists regarding the dosage of adrenaline to be administered in the management of an anaphylactic reaction were incorrect. In addition it was more likely to be an overdose (66%) than an underdose (33%). This is of great concern because an overdose of adrenaline has significant side effects; in particular hypertensive crisis and myocardial ischaemia (ibid.). Only 26% of the participants were able to name the correct dose for IV histamine. Sixty-two percent were able to name the correct dose of atropine in the treatment of profound bradycardia and 64% knew the CPR rates for sufficient cardiac output. Only 45% knew the emergency telephone number in their institution to summon help. More concerning was the fact that only 26% of the participants in the study had completed a resuscitation course within the past two years and 52% one in the past five years. It was not mentioned in the article the frequency of resuscitation courses the remainder (22%) had received. Since anaphylactic reactions are rare with the current use of gadolinium-based contrast media, experience in its management can only come from regular compulsory training in resuscitation.
Another MRI technologist shared her experience in the critical incident report and described an episode in which a patient had a contrast-enhanced angiogram. The patient complained of immediate nausea at the time of the injection and then developed two large raised welts on his arm. The technologist considered that the patient was having an adverse reaction and called on the help of the radiologists. Unfortunately, she had difficulty in finding a radiologist interested in helping out and even then it took a great deal of discussion amongst the radiologists determining the urgency of the situation before they decided upon ‘watchful waiting.’ An hour later the patient was dismissed without further treatment needed. Idiosyncratic reactions begin either during or immediately after the injection of contrast media (Bartlett & Bynevelt, 2003) with more severe reactions occurring within 20 minutes of contrast media administration (ACR, 2010). With advanced and regular training MRI technologists would be able to assess those situations and how to deal with them appropriately; for example deciding on the best treatment option instead of wasting unnecessary time in finding a radiologist free to help. However, guidelines and an understanding with other specialities, for example the emergency department, should be in place so that the technologist could call on medical assistance if needed in case of more severe reactions.

Since the incidence of NSF, the concern amongst radiologists is that MRI technologists will make incorrect prescriptive decisions and administer gadolinium-based contrast media to at risk patients. This would not necessarily be the case as seen in an interview with one of the MRI technologists:

I think that most of us are cautious about giving gad and I think we probably try and steer gently away from it. These days I’d probably try an extra sequence or two before I would give gad. This is where extra knowledge comes in and I think we can improve it and we would be very good at it and be very accurate.  

Amy

Four radiologists indicated that they were comfortable with MRI technologists administering the contrast media, just not prescribing it. One radiologist did question the confidence and ability of MRI technologists in treating adverse reactions until the arrival of a resuscitation team. On the other hand two radiologists did comment that their MRI technologists were
well trained and had a very good knowledge regarding the usage of contrast media. Therefore, contrast prescription was seen by some as a non-event like deciding which scanning sequence or parameters to use. A number of radiologists considered that prescription of contrast media by MRI technologists could be appropriate in a proportion of cases and might well be predicted, for example contrast-enhanced angiograms and breast imaging. One radiologist stated that even though MRI technologists were responsible and able to prescribe contrast media, the concern was that should it lead to a disaster, for example a patient experiencing an adverse reaction, a MRI technologist should not be put into a position of being responsible for something a doctor should do; that is responsibility versus ability. Overall the consensus amongst radiologists not opposed to MRI technologists prescribing contrast media, was that they (MRI technologist) might well be able to do so within well-defined protocols but medical assistance should also be available if needed.

**Medical assistance: A necessity**

Questions regarding the prescription and administration of gadolinium-based contrast media concerning two different situations were presented to the respondents. Firstly, their opinions were sought on contrast media being prescribed and administered to patients by MRI technologists without any doctors being present in the radiology department but within a hospital environment. Those MRI technologists would have access to a resuscitation team to back them up if needed. Secondly, they were presented with a scenario where MRI technologists in a radiology practice outside a hospital environment might not have the same support. In the first scenario, 42.4% (42/99) of MRI technologists thought it would be suitable for them to prescribe and administer contrast media to patients; as long as they have the backup of a resuscitation team. They believed that within the right supported environment this could work, provided training and recognition are given. Some MRI technologists felt that it should be limited to certain indications and pathologies because they do not have the same knowledge of pathological processes as a radiologist. One respondent stated that the role should be an advanced practitioner’s role only. However, 39.4% (39/99) of MRI technologists thought it not to be desirable because even with the backup support of a resuscitation team they think a radiologist should be around to give specific guidance during MRI examinations and to rule out the unnecessary use of contrast media. They believe that if a patient should develop a major anaphylaxis, the resuscitation
team would be minutes away, which would be too long and therefore the radiologist is needed. With minor reactions such as hives, the MRI technologist only needs a doctor to assess the patient, not a resuscitation team. It was believed that ultimately the responsibility is with the radiologist. Approximately 18% (18/99) of MRI technologists were undecided. They were questioning the level of support they would get, for example: What would happen if a patient has an adverse reaction and the radiologist disagrees that contrast medium was necessary? Would the MRI technologist have the appropriate training to make the right decision in an emergency? In the second scenario an overwhelming 85.6% (83/97) of MRI technologists were opposed to prescribing and administering contrast media to patients without any form of medical backup. Three percent (3/97) of MRI technologists thought it to be possible, with another 13.4% (13/97) undecided. Ultimately it comes down to the fact that even though reactions are rare, they do happen and the MRI technologist is not trained to deal with these emergency situations; especially with the existing CPR training for MRI technologists seen as inadequate. They maintained that it would not be worth the risk and to be responsible and liable if something should go wrong would not be fair on the staff nor the patient. Radiologists on the other hand are seen by some MRI technologists as experts in the field of contrast reactions, trained for it in medical school and through experience are able to deal with medical emergencies.

Of the responses received by radiologists, 47.7% (31/65) thought that MRI technologists could prescribe and administer contrast media without them being in attendance, provided a resuscitation team would be at hand. In contrast, 47.7% (31/65) of radiologists were against MRI technologists performing this activity with 4.6% (4/65) undecided. Radiologists thought that it could be done within a hospital where MRI technologists would have access to medical assistance to provide support to the MRI technologist if the supervising radiologist was not available. However, the requirement would be for MRI technologists to have training in order to recognise signs and symptoms of allergies and for it to be preferably performed by experienced MRI technologists.

In the second scenario, 82.1% (55/67) of radiologists were against MRI technologists prescribing and administering contrast media in a radiology practice outside a hospital environment that may not have the backup of a resuscitation team at hand. Reasons were
that legally it would not be defensible if there happens to be a complication, and it should be a doctor’s responsibility to deal with a potential complication. Nine (13.4%) radiologists thought it could be considered in low risk patients since adverse reactions to gadolinium-based contrast media are highly unlikely and it would acceptable if the MRI technologist is trained in resuscitation. One opinion was that it would be no different to a radiologist administering the contrast because “CPR would still be done in the same way.” Three (4.8%) radiologists were undecided. Interestingly the results have revealed that some radiologists are comfortable with the MRI technologists administering contrast media without a doctor in the department, just as long as they do not prescribe.

**The need to gain prescription rights for MRI technologists**

Both groups were asked whether they thought there was a need for MRI technologists in New Zealand to gain prescription rights to a certain extent, for example limited independent prescription rights to enable MRI technologists to prescribe gadolinium-based contrast media. Of those MRI technologists who responded to the question, 41.8% (41/98) thought there was no need; 32.7% (32/98) thought there was a need, and 25.5% (25/98) were undecided. One respondent felt very strongly that the decision on whether a patient needed a drug or not should be left in the hands of doctors because they had the experience and knowledge MRI technologists lacked. The belief was that even a MRI technologist with extensive experience and knowledge should not have the same responsibility and liability as a doctor. Therefore, the respondent deemed it unnecessary for MRI technologists to prescribe independently from a doctor’s opinion. One respondent thought it was debatable whether MRI technologists did need prescription rights because they were not reporting the scans. Others thought it would be helpful, on the condition that there was documented proof of the MRI technologist’s competence to do so and to do it under the supervision of a radiologist. Approximately 63.2% (43/68) of radiologists thought there was no need for MRI technologists to gain prescription rights; 29.4% (20/68) thought there was a need; and 7.4% (5/68) were undecided. The need for independent prescribing was questioned because every MRI department/practice should have a supervising radiologist and therefore would be unnecessary. It was commented that MRI technologists did not have the appropriate medical background to prescribe and there were reservations on what the level of ‘appropriate training’ referred to. Prescription of
gadolinium-based contrast media should always be under the auspices of a radiologist and rather than having MRI technologists prescribe contrast media, it could be achieved under standing orders. Although the view was that contrast prescription by MRI technologists was not needed in well-staffed hospitals, some radiologists admitted that in peripheral centres it might be useful. One radiologist commented “in the provinces they are not as lucky as we are.”

Approximately 45.5% (45/99) of the MRI technologists indicated that they would want prescription rights after the appropriate education and training; 32.2% (32/99) were not interested; and 22.2% (22/99) were undecided. However, 61.6% (61/99) thought that it was not to be a privilege for all MRI technologists; 16.2% (16/99) were in favour of all MRI technologists having prescription rights, and 22.2% (22/99) were undecided. It was indicated that only if MRI technologists were appropriately and fully trained should they earn the right to prescribe. For example, it would require a certain level of experience and understanding of the information required through the use of contrast media – something a new staff member in MRI might lack:

I think prescribing contrast is definitely something that needs to be left to a senior technologist. If it was going to be done it would probably need to be done at the tail end of a postgraduate qualification so that the person knows how to scan and have the necessary background. I also think it would be really good for someone to be buddied up with a radiologist for a while and be basically taught how to look at a scan.  

Amy

Therefore, prescribing should be performed only by MRI technologists with proven competency since not “all MRI techs are equal.” A number of MRI technologists would probably not be interested in extending their role into this area or be interested in the added responsibility. Reasons that stated why MRI technologists should not be prescribing or why not all MRI technologists should be prescribing contrast media, were: prescribing had to be based on radiologists’ need for more information (20%); it was not a responsibility that MRI technologists should have (16.9%); the level and experience of MRI technologists were insufficient (15.4%); MRI technologists did not have the relevant training to deal with emergencies (12.3%); patients would end up having contrast media unnecessarily (12.3%);
concerns regarding the boundaries of role extension that seemed to be never-ending (6.2\%); MRI technologists were not paid for the responsibility (4.6\%); training would be too much for some (4.6\%); MRI technologists could be retrained as doctors if they so desperately wanted to prescribe (4.6\%); MRI technologists would be unable to prescribe drugs to counteract adverse reactions (3.1\%); appropriate bookings should be done when the radiologist was around (3.1\%); concerns regarding medico-legal implications (3.1\%); believe that it would stop radiologists from being present for any examinations if MRI technologists prescribe (1.5\%); not necessary to prescribe gadolinium if it was part of the protocol for a particular examination (1.5\%); and MRI technologists were already prescribing for routine post-surgeries (1.5\%). One MRI technologist commented in the questionnaire:

To know if gad is required needs greater knowledge of anatomy and pathology and image interpretation than most MRTs have. In the last 15 years I have met more MRTs incapable of ever knowing when to give gad than those who do.

One respondent declared that it would corrupt MRI technologists if they were allowed to prescribe, something only doctors had the right to do:

I’m an MRT, not a doctor. Ultimate power corrupts absolutely. I can answer for myself but in some hands a little power can go a long way.

However, one interviewee had the following to say in support of role extension in the area of limited prescription rights for MRI technologists:

I think in theory it is common sense. You don’t need someone (radiologist) with 15 years training to say: “Yes, this mass – that you have identified for me – needs contrast.” That is just a no-brainer.                        Rick (Radiologist)

Another driving factor behind the need for MRI technologists to gain prescription rights is the shortage of radiologists in certain areas. One MRI technologists stated that New Zealand has a bit of a problem because radiologists either want to work in the big centres like Auckland, which may have more interesting cases, or they want to work in places like
Tauranga with its nicer climate. Hence, the less desirable areas are the ones that miss out and where MRI technologists are more likely to struggle to get hold of a radiologist. However, it should be an option made available to MRI technologists interested in extending their roles and willing to take up the responsibility.

**Prescription of contrast media and other drugs**

MRI technologists were asked if it would be of any use to them if they were able to prescribe gadolinium-based contrast media and they responded as follow: 25.5% (25/98) indicated that it would be very useful in their department; 37.8% (37/98) thought that it would be somewhat useful; 27.6% (27/98) said it would not be useful to them at all, and 9.2% (9/98) were undecided. Fifty-three respondents indicated that besides prescribing contrast media in MRI it would be helpful to prescribe the following as well: buscopan (88.7%); oral sedation (15.1%); glucagon (9.45%); hypnovel (3.8%); phenergan (1.9%); lorazepam (1.9%); drugs to counteract adverse reaction (1.9%); and painkillers (1.9%). One of the MRI technologists commented that there were no drugs she could think of prescribing that would be useful in their practice; however she did state:

> We already prescribe buscopan after going through a questionnaire with the patient and gaining consent. We only check with a doctor if there are any contraindications.

Another comment included that buscopan should be prescribed by MRI technologists in New Zealand as it has been done successfully in the UK. One MRI technologist declared that they would decide when to give buscopan to patients but would check that the radiologist was on site. One interviewee stated that they do not routinely use buscopan for pelvic examinations. They would first try and scan without it and then use it if it was a problematic situation:

> The MRI technologist would come to us and say: “We’ve got this situation; we believe buscopan is going to help” and robotically we (radiologists) would fill out a piece of paper and the technologist would go and cannulate and administer.  

**Rick (Radiologist)**
Approximately 51% (34/67) of the radiologists indicated that MRI technologists should not be allowed to prescribe muscle relaxants such as buscopan; 41.8% (28/67) were in favour of MRI technologists prescribing it; and 7.5% (5/67) were uncertain. Two radiologists stated that due to its high risk profile and the risk of adverse reactions it would not be advisable for MRI technologists to prescribe buscopan. One of the earlier studies conducted by Lee (1982) regarding the routine use of buscopan in DCBE examinations claimed that no side effects were observed with IV buscopan; not even in elderly patients. However, in a later DCBE study involving 109 patients, Goei, Nix, Kessels and Tusscher (1995) found five patients complaining of blurred vision after the administration of IV buscopan. Treweeke and Barrett (1987) reported the case of a 66-year old male patient with a history of asthma that developed shortness of breath after the administration of IV buscopan as part of a barium meal examination. More recently Misra and Dwivedi (2007) reported that no adverse effects were observed in 94 patients receiving IV buscopan during colonoscopy procedures; although significant tachycardia were detected in those patients compared to patients receiving a placebo. Milner (2010) reported a near-fatal outcome in an 18-year old female after IV buscopan was administered during a gastroscopy. She had no previous reactions to IV buscopan and it could be speculated that the side effects might have increased with the simultaneous administration of other anticholinergic agents and centrally acting drugs such as sufentanil, midazolam, and propofol. Dyde et al. (2008) state that allergy to buscopan is rare and that only a few cases have been reported. The authors concluded that buscopan is safe to use in imaging, particularly in abdominal and vascular radiology. However, one radiologist felt that it would be more appropriate for MRI technologists to administer buscopan under standing orders than for them to prescribe it. One could only speculate if the management of adverse reactions to buscopan would be different under a standing order than from it being prescribed by a MRI technologist. When interviewees were asked if the prescription of buscopan could become part of the MRI scope of practice for MRI technologists, one radiologist responded:

We are not talking about contrast media; so it’s a little bit different because now we are talking about medical drugs. You need special training and study for that and I think it’s better to be under the supervision of a radiologist or any other doctor than the technologist.  

James (Radiologist)
However, another radiologist believed it was not such an issue:

I think we’re talking about one additional drug, which is well utilised safely in a radiology environment. It’s not a big deal. It’s not the thin edge of the wedge as far as I am concerned. The radiographer can quite happily ask the same safety-related questions as the radiologist would with respect to glaucoma and diabetes. I don’t see an issue if you upskill any individual who is open and aware and intelligent. It doesn’t matter what qualification hangs above their desk.  

Rick (Radiologist)

It was also suggested by some of the MRI technologists that they could prescribe sedation as well since they were already administering it (as was found in the previous chapter); however, medical assistance should be immediately available if required. Radiologists were asked if MRI technologists could prescribe oral sedatives, for example diazepam for claustrophobic patients. Approximately 77% (53/69) of the radiologists were against it; 17.4% were in favour of it; and 5.8% (4/69) were uncertain. Two suggested though that it could be done under standing orders. Those radiologists not in favour of MRI technologists prescribing oral sedatives perceived them as potentially dangerous drugs with a small risk of people becoming oversedated, including the risk of respiratory depression. One radiologist stated that oral sedatives should be prescribed by someone that knows the patient and their medical history, for example their general practitioner. However, it has been found that one MRI practice has oral midazolam (7.5mg) in stock and requests that a claustrophobic patient come in an hour earlier to be given the tablet. The MRI technologist would then question the patient to see if there is anything that might prevent them from receiving the midazolam. One of the interviewees thought that MRI technologists could potentially prescribe diazepam and sketched the following scenario:

If patients travel a great distance to get their scans done and they turned out to be claustrophobic, we could potentially prescribe the tablets; get the tablets dispensed to the patient and juggle our workload to do their scan that same day. I believe that we would and could manage having a limited prescription right very well.  

Mary
One radiologist stated that diazepam should in fact not be issued as its half-life is 40 hours and that a shorter acting benzodiazepine would be more appropriate, for example midazolam. Datasheets reveal that the elimination half-life of midazolam ranges between 1.5 to 2.5 hours in healthy volunteers (Medsafe, 2008) whereas the terminal half-life of diazepam is one to two days (Medsafe, 2010). Therefore, diazepam would influence the patient’s ability to operate any vehicle and would require other means of transport unless there is a designated driver that could take the patient back home. Although the half-life of lorazepam is shorter than diazepam, that is between 10-20 hours (Medsafe, 1999), it probably would be best avoided and not given to claustrophobic patients. Though one MRI technologists did make an interesting comment during his interview:

Every Tom, Dick and Harry is out there taking diazepam or lorazepam or one of the -azepam drugs – they are as commonly taken as an antidepressant. Sure you can say: “Here, have a couple of pills and go sit in the corner and wait there until we are ready to go.” There is no difference: You give people anti-anxiety medication and it works and it works well. As far as role extension goes, with the proper training, why couldn’t you prescribe anxiolytic drugs? Michael

It has been suggested that MRI technologists could prescribe IV sedation as well, for example IV hypnovel and phenergan. One interviewee questioned on the topic said:

If you are giving IV hypnovel, it’s no different to a radiologist giving it. You know there is an anexate available to reverse it; you know how many milligrams you are allowed to per kilo of weight; you have got rules in place about patient weight and sleep apnoea and those things. It is all just a matter if you are going to train someone into the role. As long as they are properly trained into it, there is probably no difference with any of the other drugs. Michael

One radiologist has suggested that this proposal would require anaesthetic opinion and the presumption is that the NZSA would most likely not be supportive of such an endeavour. This opinion is based on the NZSA’s resistance to the consultation document, namely Implementing Nurse Practitioner Prescribing (Ministry of Health, 2005) regarding the prescription of anaesthesia by nurse practitioners. The NZSA’s position is that prescribing
and administration are in most instances of clinical care separate tasks (Bukofzer, n.d.). It is because of this separation that a margin of safety is provided in which drugs can be checked and balanced by the dispenser; something that cannot occur in anaesthesia where drugs are ‘prescribed’ and given almost simultaneously and its effect then monitored (ibid.). The NZSA does not believe that just because there are nurse anaesthetists in the UK and the USA performing this activity that it necessarily means it is acceptable to do the same in New Zealand. The NZSA support the statement of the NZMA in that “the minimal training necessary for prescribing medications other than those deemed safe enough to be available over the counter, should be a basic medical degree” (Bukofzer, n.d., p. 4). One MRI technologist commented in her interview:

One of our doctors is a bit heavy-handed with the IV sedation and he does knock the patients out quite often and then has to administer additional drugs to wake them up. Another doctor does it so lightly that it doesn’t work very well. Sue

It could be argued that if some radiologists, despite their basic medical training, struggle to administer the correct dosages of IV sedation; how could it then be expected that MRI technologists are able to do it correctly? Perhaps this could be accomplished by training interested MRI technologists under the professional guidance and supervision of supportive anaesthetists. Nevertheless, it would probably be a very contentious issue if it is to be raised with the NZSA and the radiologists.

With regard to the proposal of one MRI technologist that the prescription of pain-medication would be helpful, one interviewee shared her thoughts on it as she experienced in the UK:

Sometimes you get patients that come in and they ask you what sort of painkillers they could take because they’ve had an examination and they are in a bit of pain. That’s, where they were looking at the prescribing element of it: Once your patient had an examination and were in pain you could prescribe them Panadol or something they could take for the pain and sometimes antibiotics after a HSG (hysterosalpingogram). But you had to do training for it and were limited to certain medications. Sue
From the results of this study it does not appear that there is a definitive need for MRI technologists to prescribe sedation and painkillers; however, another study may be more accurate where technologists can be questioned specifically on the prescription of these drugs. However, if MRI technologists could prescribe gadolinium-based contrast media, one has to investigate the possibility for them to prescribe drugs that will counteract the effects of any adverse reactions to the contrast media.

**Advantages of MRI technologists prescribing contrast media**

If there is a need for prescription rights for MRI technologists, one has to determine if there is any advantages to such a role extension activity. Therefore, technologists were questioned on improved workflow; patient continuity; and job satisfaction if they were allowed to prescribe. In the first instance, 51.5% (51/99) of MRI technologists believed it would improve their workflow; 36.4% (36/99) were of the opinion it would make no difference; and 12.1% (12/99) were unsure. Three respondents remarked that it had made a difference in the workflow of departments where technologists were already prescribing contrast media. Others believed it would save time since the MRI technologists would not have to waste it finding a radiologist to sign off a prescription form that the MRI technologists have filled out for them. As a result there would be no hold-ups for busy radiologists. It was stated that opportunities are limited if patients needing contrast media or buscopan could only be booked on a ‘radiologist day.’ Furthermore, it would allow convenient imaging of outpatients presenting with unexpected findings without having to recall them for post-contrast studies. This was supported by one of the critical incident reports where a patient was booked for a routine brain examination. Unfortunately a tumour was identified by the MRI technologist but since the radiologist and his registrar were unavailable to prescribe the contrast medium, the patient had to be sent home and rebooked for another day in order to complete the post-contrast studies. In another critical incident a patient was booked for a routine lumbar spine examination on a ‘protocol day.’ It was not mentioned in the MRI request that the patient had previous back surgery, which is an indication for contrast media depending on the number of years since the patient had the surgery. Some practices might not give contrast media for example, if the surgery was more than 10 years ago, whereas others might not give it after five years. In this instance the patient did require gadolinium-based contrast media but because there was no
radiologist on site that day, the MRI technologists had no choice but to rebook the patient. That resulted in the pre- and post-contrast scans not running through together, delays in getting the scan reported in a timely manner, and the inconvenience of an additional trip for the patient. One MRI technologists stated:

If the UK can do it as they have been for years then NZ can. There is proof from the UK that it does not increase the incidence of side effects etc. It improves workflow and means we can scan more patients per day and reduce the waiting lists.

The results of the study demonstrated that 49.5% (49/99) of MRI technologists thought that it would optimise patient continuity were MRI technologists able to prescribe; 39.4% (39/99) did not believe that it would, and 11.1% (11/99) were unsure if it would improve patient continuity. It was the opinion of one respondent that patients would prefer that a doctor make the decision to administer gadolinium or not and if protocols were in place it would make patient continuity irrelevant. Yet one respondent thought that the MRI technologist was often the only contact the patient had in the MRI department and for that reason would make the process more efficient in cases requiring the patient to have gadolinium administered. Therefore, non-medical prescribing by MRI technologists will have its advantages in some places:

I know that finding a radiologist in a busy public hospital where a lot of work is going through is never easy. If it is going to make the clinical decision making a lot easier for the patient’s consultant then it makes sense that you could go ahead and give the gadolinium in situations where it is required but there isn’t a radiologist available.

Michael

Sometimes they want to finish what they are doing first before they have a look for you and then they will forget. It would certainly tidy up some of the workflow in that regard – just being able to make that decision yourself and making you a better technologist as well.

Amy

When asked if it would in fact increase their job satisfaction, only 34.3% (34/99) of technologists were certain that it would make a difference. The majority, which is 42.4%
of MRI technologists, responded negatively with 23.2% (23/99) of them being uncertain. Three respondents indicated that with added responsibility there should be extra remuneration, which they felt would be highly unlikely in the present public health climate. Some believed that doing the training in order to prescribe would be satisfying and that it would improve the job satisfaction of those who chose to do it. It would make the work less frustrating if technologists did not have to ‘hunt’ for radiologists. One respondent said that it had increased her job satisfaction since she had started to prescribe. Others were still of the opinion that it should be a radiologist’s responsibility only, lack of interest expressed by others. One interviewee said:

I think I have a high level of job satisfaction and that I really enjoy what I do and that is why I go to work every day. I don’t know if prescribing would necessarily improve my job satisfaction but it would definitely impact on our workflow. It would also mean not to miss out on things like our lunch breaks.  

Mary

Of the radiologists, 32.8% (22/67) thought it would optimise patient care and continuity if technologists were able to prescribe; 55.2% (37/67) did not think it would and 11.9% (8/67) were unsure. When asked if it would make MRI technologists more proficient in their work, 35.4% (23/65) of radiologists believed that it would; 47.7% (31/65) did not think so, and 16.9% (11/65) were unsure. When asked if they would be supportive of an initiative to present a case for New Zealand MRI technologists to obtain limited independent prescription rights, 36.2% (25/69) of radiologists said that they would be supportive; 46.4% (32/69) declined, and 17.4% (12/69) were undecided. One radiologist thought that prescribing is a very limited undertaking and that there were more rewarding areas to challenge and extend “such a highly trained capable group of professionals.” One can only speculate as to what these areas might be that they referred to since they did not elaborate on what might challenge and extend MRI technologists. Perhaps one of these areas might be the reporting of MRI scans since a number of MRI technologists expressed their interest in this area. One interviewee remarked:

To do radiology reporting as a role extension would definitely give MRI technologists the ability to prescribe because they would understand what they are looking at and
whether the actual use of gadolinium in that situation is going to alter their impression of what they are seeing. If you ask me whether I would be interested in that role then I would have to say definitely!  

Michael

One radiologist observed that MRI is a high-tech and a high expense technology and that the decision to proceed with a post-contrast scan (after taking into account that the benefits of giving the contrast media outweigh the risks), is a decision that can only be made by a radiologist. In support of MRI technologists, one radiologist said in his interview:

I would much rather be able to sit there and get through 15 MRI reports than to be interrupted five times looking at sequences, which I’m not actually engaged in otherwise or whether contrast is appropriate. It would be much more efficient to let someone else make those decisions within reason and for me to get on with what I am paid to do, which is to report.  

Rick (Radiologist)

Some radiologists stated that in order for them to support such an initiative it should be limited to certain examinations, and be restricted to areas with limited radiologist input where contrast medium would be essential to make a diagnosis.

Overall the majority of MRI technologists believed that limited independent prescription rights would improve their workflow and it would enhance patient continuity but it would not necessarily give them more job satisfaction.

Standing orders and collaborative prescribing

Fifty percent of radiologists thought that gadolinium-based contrast media could be prescribed under a standing order rather than have MRI technologists doing it. It would be acceptable in selected circumstances, for example peripheral angiograms. The definition of a standing order according to the Ministry of Health (2006, p. 2) is:

... a written instruction issued by a medical practitioner or dentist, in accordance with the regulations, authorising any specified class of persons engaged in the delivery of health services to supply and administer any specified class or description of
prescription medicines or controlled drugs to any specified class of persons, in circumstances specified in the instruction, without a prescription.

However, this does not enable a person who is not a medical practitioner to prescribe, only to supply and/or administer prescription drugs. These persons must be engaged in the delivery of a health service for example registered nurses, pharmacists, paramedics, optometrists, and physiotherapists (ibid.). Since MRI technologists are delivering a health service too, they will be able to administer prescription drugs under standing orders. The standing order has to list what drugs may be supplied or administered, the indications for which it is to be administered and the recommended dose; contra-indications, the route of administration, and the documentation required (ibid.). In the case of the MRI technologists, they would then have to chart the contrast media administered and then have to get the issuer of the standing order; that is the radiologist, to countersign the order within a certain time period, for example within 24 hours after administration. Radiologists against standing orders stated that the administration of gadolinium-based contrast media has to be planned because individual cases differ and they have to be involved in the whole scan process. One MRI technologist’s view on standing orders was as follows:

It just involves somebody signing a whole lot of paper after the fact, doesn’t it? I would have to go with limited independent prescribing as being the best way because MRI is not a constant. MRI is not something that works well with a standing order. There’s always going to be another way to do it or another sequence that shows the nature of a pathology or a situation where giving gad would be better than another similar situation. I suppose that’s what we love about MRI: that it is always changing.  

Amy

Since MRI technologists cannot prescribe independently at this point in time and because of the fact that standing orders have to be countersigned within a specified time period, perhaps a more flexible policy would be appropriate such as collaborative prescribing. It can be broadly defined in this way:
Collaborative prescribing is where a non-medical health practitioner, after authorisation from their registration authority, may prescribe under the supervision of an authorised prescriber (Ministry of Health, 2007, p. 2).

The reason for allowing the development of collaborative prescribing has been that in many cases there are highly competent practitioners who may not be competent enough to prescribe autonomously, but are competent enough to prescribe in a collaborative relationship with an authorised prescriber (ibid.). Therefore, collaborative prescribing should not be seen as a form of independent prescribing but rather prescribing in partnership with an authorised prescriber. Forty-nine percent (25/51) of radiologists were supportive of MRI technologists to be allowed to prescribe collaboratively; 45.1% (23/51) were not supportive, and 5.9% (3/51) were unsure. One radiologist gave his view that one could not prescribe under supervision and expect someone else to take responsibility for the decisions made by the collaborative prescriber. However, the solution to the problem would be to set a framework in place that allows MRI technologists to prescribe in partnership with the radiologist.

Prerequisites for training

It should be determined what the minimum qualification ought to be before MRI technologists could undertake the necessary training to become prescribers. Approximately 7% (6/84) of technologists indicated that an undergraduate degree would be sufficient; 13.1% (11/84) thought that a postgraduate certificate would be adequate; the majority, which is 51.2% (43/84), believed that a postgraduate diploma had to be the minimum requirement, and 15.5% (13/84) thought a master’s degree to be more appropriate. Seven percent (6/84) could not make a definitive decision and indicated a couple of options with the majority opting between a postgraduate diploma and a master’s degree. Six percent (5/84) were of the strong opinion that the minimum requirement acceptable would be a medical degree. Furthermore, 62.1% (54/87) of MRI technologists indicated that training to prescribe should only be undertaken after the completion of a postgraduate MRI qualification; 18.4% (16/87) thought it could be incorporated into the postgraduate training while 19.5% (17/87) were unsure. It was pointed out that such training should be a
separate course from the other MRI courses and those technologists undertaking such an endeavour had to have extensive experience in MRI.

However, some considered that prescribing should not be a role undertaken at all by any MRI technologist. Despite the negativity of some, 50.5% (49/97) of MRI technologists would be willing to take on the additional training in order to prescribe; 29.9% (29/97) were not interested or willing, and 19.6% (19/97) could not decide. Interested parties did stipulate though that their decisions would depend on the training required, if it would be work-funded, and if there would be a financial incentive. A survey in Australia found that 94.4% of Australian radiographers felt that they should be appropriately rewarded for performing IV contrast media injections (Toh et al., 2007). This research study did not address whether New Zealand MRI technologists are financially rewarded for performing IV cannulations; however, taking on non-medical prescribing does equate to taking on an additional task and responsibility with increased medico-legal implications. One interviewee shared her perspective:

I think we all certainly feel that we don’t earn enough for what we do. I have never received extra pay for a new piece of paper that has said that I have some new skills. I would love that to happen! In reality, certainly at this stage, I think it probably would not be a goer. Perhaps it would be something that unions could work towards in the future.

Mary

Marshall and Kasap (2010) are of the opinion that MRI technologists are well placed in that they can contribute to the establishment of departmental policies for the safe use and administration of gadolinium-based contrast media, specifically under PGDs as currently carried out in the UK.

**Barriers to developing the role of non-medical prescribing for MRI technologists**

Analysis of the data revealed that there were certain factors or barriers that played a part in restricting MRI technologists from extending their role into the area of non-medical prescribing. The three major barriers that were identified, that is radiologist resistance, resistance from MRI technologists, and medico-legal implications will be further discussed.
Freidson (as cited in Lewis, Heard, Robinson, White & Poulos, 2008) reasoned that medicine occupies a central position in health care due to a thoroughly controlled monopoly over its field of work. Therefore, it is in a powerful position to control growth of a division of labour in health care. Two examples of how the medical profession can exercise its authority over other health professionals are through direct supervision and limitation or exclusion (Adamson, as cited in Yielder, 2006). Prescribing used to be the exclusive domain of medical practitioners and dentists but legislative changes have allowed prescribing by members of the health care professions who are not ‘medically’ qualified such as nurse practitioners (Thorpe, 2008). However, it took several years to develop non-medical prescribing in the UK; first for nurses and then for other health professional groups (Hogg et al., 2007). In Australia the medical profession strongly voiced their opposition to the expansion of nursing practices into areas that are traditionally the domain of medicine, particularly prescribing. It was on the basis that “nurse practitioners do not have the educational preparation or clinical expertise to provide a standard of care and treatment equivalent to that provided by their medical colleagues” (Elsom, Happell, & Manias, 2009, p.9). In New Zealand nurse practitioners also experienced resistance from their medical colleagues (Moller & Begg, 2005[a]). Therefore it comes as no surprise that so many radiologists are resistant to MRI technologists extending their role into this area. They maintain that only radiologists have the necessary skills and training in image interpretation and as a result prescribing is a matter best left to a doctor; thereby retaining their hierarchical position. However, we are only talking about limited independent prescription rights, not a generic one. One interviewee expressed his opinion:

Now I have not prescribed generic medicines for 15 years but I am still entitled by law to prescribe anybody anything and that is nonsensical. Why should I be able to prescribe a high dose of IV steroids or antibiotics when I’ve got no idea about their pharmacology or indication? To suggest that you are stepping outside your bounds of training is missing the point really. I suspect they either feel threatened by it or they don’t understand the reasons behind the thought process.     

Rick (Radiologist)
It is the opinion of some radiologists that there would be no advantages to the patient and only significant disadvantages where patient safety may be compromised if MRI technologists should be able to prescribe. However, one radiologist believes it is not going to undermine the role or the responsibility of the radiologists should MRI technologists be able to prescribe. The reason for doing this would be to improve efficiencies, particularly in situations where access to radiologists is problematic and to make interruptions fewer and far between for radiologists. Some radiologists are still of the opinion that MRI technologists have no idea how to utilise gadolinium-based contrast media and that it may lead to issues such as over or under prescription of the contrast medium. Under prescription is a non-entity in the opinion of some radiologists and the patient is simply brought back if required. With reference to MRI technologists over prescribing contrast media one could ask the same with regard to radiologists. It appears that some radiologists would request contrast media unnecessary. An example was with regard to MRI of the prostate: some radiologists prefer post-contrast images whereas others feel it does not add any diagnostic value to the examination when compared to the pre-contrast images. There is no evidence that the number of unnecessary contrast media administrations would increase should MRI technologists prescribe contrast media. The more experience MRI technologists possess, the more likely they are to recognise abnormalities and the more likely they are to ‘get it right’ as compared to radiologists who ‘get it right’ every time or administer gadolinium when it is unnecessary.

Another misconception amongst radiologists is that prescription rights would be ‘handed out’ to MRI technologists, which is not the case. They would be trained into the role and this is where radiologists would have the chance to give valuable input into the design of these courses. However, some radiologists will maintain the status quo that “if MRI technologists want to prescribe they should go to medical school.” However, being the ‘slightly lesser’ qualified person does not necessarily disadvantage the MRI technologist in being able to prescribe contrast media effectively when needed, especially when they are trained into the role and know how to deal with adverse events. In the past there was opposition to technologists doing IV cannulation but now it is happening as one interviewee remarked:
I think it is just a generational attitude thing. Things change with time. With new blood you get a delusion of static staid opinion. I think with common sense debate you can articulate the reasons for or against a development and make a decision. It’s based on practicalities.

Rick (Radiologist)

**Resistance from MRI technologists**

Even though it would be the choice of individuals whether they want to take up the role of non-medical prescribing, a number of technologists whole-heartedly agree with those radiologists who maintain the stance that “if someone wants to prescribe they should go to medical school.” There is the opinion that MRI technologists “should stick to being radiographers” and leave the responsibility to a qualified medical practitioner. For someone to become a medical practitioner in New Zealand, they have to complete a double degree, that is the Bachelor in Medicine and the Bachelor in Surgery, which requires six years of full-time study (The University of Auckland, n.d.). To be registered as a MRI technologist, one has to complete a bachelor’s degree requiring three years of full-time study plus another two years of full-time study if a MRI technologist decides to complete a master’s degree. If another year of full-time study in pharmacology and physiology is added to that, it can be argued that the tuition required to prepare MRI technologists for prescribing is almost as extensive as for medical practitioners; especially if they should practise at an advanced level as suggested by one respondent, requiring even more study. However, some MRI technologists would respond negatively to such a suggestion. One responded expressed her opinion:

The role of the radiographer is being so narrowed by the MRTB, penalising MRTs who advance their skills in MRI to take away their general scope, which is my original qualification, but then wanting to super-specialise within the narrow scope. Cutting up and super-specialising does not give me job satisfaction and then having the added responsibility of prescribing makes my role even more difficult or enjoyable. I trained as a radiographer and that is what I want to do, not be a pseudo-radiologist.

However, this statement is inaccurate since many MRI technologists (43.9%) have dual scopes of practice in MRI and diagnostic imaging. One respondent has scopes of practice in diagnostic imaging, MRI and ultrasound. To continue practising in multiple scopes, one
needs a minimum of 360 hours of patient contact for each scope over three years (MRTB, 2011).

Some MRI technologists are also not interested in doing more studying for what they consider as limited time savings. They have already done the minimum qualification required by the MRTB to practise in the scope of MRI and do not want to waste extra time on something that is not an absolute requirement in their role. This gives the impression that they are reluctant to step outside their prescribed clinical responsibilities. One interviewee raised her point of view:

I think to a lot of people this is just a job and they want to go in, do it, get out and leave it there. A lot of them are kind of balking at the fact that the CPD and the learning just keep getting more and more.  

Amy

Some would rather pursue something they perceive as more meaningful like image reporting. Others totally disagree with the concept of any MRI technologist having prescription rights and fail to see any benefits to such an undertaking. These perceptions may be seen by others as patch protection as observed by one MRI technologist:

They are always concerned about “What will happen if someone else is allowed to do this and this?” You see it just in a training perspective: Some people will learn, learn, learn but they will never teach, teach, teach. They are worried about the person coming up behind them and may end up knowing more than they do and then where do they fit in?  

Michael

Unfortunately, this is not how a place functions best. MRI is an area that constantly grows and changes and technologists have to keep up with it; though it is a personal choice as some people will never do any more or any less than what they are required to do.

Medico-legal implications

Support from radiologists is an issue that has been raised by MRI technologists that may prevent them from taking up this role, especially with some radiologists biased to MRTs
extending their role. In addition, the level of support MRI technologists will receive from the RANZCR is questionable. MRI technologists also queried the support they will receive from medical teams, for example the resuscitation teams, and from their MRI colleagues. They have raised their concerns regarding patients experiencing an adverse reaction to gadolinium-based contrast media and the radiologist happening to disagree with them that contrast media were necessary. MRI technologists are worried that it will leave them vulnerable and open to litigation. It has to be taken into account that the primary role of the MRT is to provide the best care and management to patients while performing diagnostic procedures (Alderson & Hogg, 2003). In order to succeed in a clinical negligence claim the patient must establish that: The defendant owed a duty of care; there was a breach of that duty of care; and that the patient suffered harm because of that breach of duty (Alderson & Hogg, 2003; Dimond, as cited in Yielder et al., 2008). The standard of care is judged by what has become known as the Bolam test:

A doctor is not guilty of negligence if he has acted in accordance with a practice as accepted by a responsible body of medical men [sic] skilled in that particular art...

Putting it the other way around, a doctor is not negligent if he [sic] is acting in accordance with such a practice, merely because there is a body of opinion that takes a contrary view (Alderson & Hogg, 2003, p. 306).

Therefore, in the UK a radiographer will be judged by the standards for radiographers and the actions are judged by a responsible body of professional opinion (Alderson & Hogg, 2003). In New Zealand, acts of negligence are more likely to result in disciplinary action by an employer or the professional body, rather than court action against the individual (Yielder et al., 2008). The Accident Compensation Corporation (ACC) legislation in New Zealand has a no-fault liability provision that provides compensation for accidental personal injury (ibid.). Even if the MRT were liable for personal negligence, the organisation; that is the DHB/hospital would be sued as the employer; this is referred to as vicarious liability (ibid.). Nevertheless, it is of the essence that a framework of care and management is set in place to protect both patients and MRI technologists as much as possible against harmful outcomes.
Summary

The findings in this chapter conclude that more than half of the MRI technologists and radiologists (59.8% and 53% respectively) in New Zealand think that it would be desirable to permit MRI technologists to prescribe gadolinium-based contrast media if they have the appropriate training and supervision. Yet less than 33% of MRI technologists and 30% of radiologists think there is a definitive need for technologists to gain limited prescription rights. Approximately 45.5% of MRI technologists are interested in taking up this role extension and believe it will improve their workflow and continuity for the patient. However, it will depend on the length of training required, if it is going to be funded by the employer, and if there is going to be any financial incentive. In areas which have limited access to radiologists, there is certainly some gain in an initiative like this but it will require a strong desire for advancing this role; especially with resistance encountered from both radiologists and MRI technologists. If the MRTB and NZIMRT are supportive of such an initiative, a proposal could be put forward to the Ministry of Health to extend non-medical prescribing to MRI technologists.

The next chapter will summarise the findings from this thesis and provide an overview of the key findings of the study with recommendations for the future.
Chapter 7

Conclusions

The aim of this research study has been to provide a case for MRI technologists to obtain limited independent prescription rights that could be presented to the Ministry of Health. This research project set out to investigate the views of both MRI technologists and radiologists in New Zealand towards extending the role of the MRI technologist into the area of non-medical prescribing, specifically gadolinium-based contrast media. In addition the opinions with regard to administering contrast media without the presence of medical assistance in the MRI department were pursued.

Staying true to the nature of case study research, data were collected from multiple sources to strengthen the validity of the results. In the first phase of data collection an e-mail approach to MRI Team Leaders was utilised in order to identify the number of MRI technologists and reporting MRI radiologists in each department. The relevant number of questionnaires were sent to each department and distributed amongst the staff members. The questions were designed to get an overall impression of the state of affairs in MRI departments across New Zealand with regard to their prescription practices, the availability of radiologists, the frequency and treatment of adverse reactions to gadolinium-based contrast media, the need for MRI technologists to prescribe the contrast media, and to identify barriers that may prevent this role development from happening. Of the 157 questionnaires sent to MRI technologists, 99 were returned representing a 63.1% response rate. Of the 173 questionnaires sent to radiologists, 69 were returned representing a 39.9% response rate. A critical incident form was attached to the questionnaire of each MRI technologist to provide the second source of data. Participants were invited to share their experiences with regard to gadolinium-based contrast media and the benefits that prescribing might have for MRI technologists. Even though only six responses were received, the results were incorporated into the study because they provided a rich description of events that happened. The third and final source of data was from interviews. Four MRI technologists and two radiologists were interviewed to provide more
in-depth information regarding their views towards role extension activities, adverse reactions experienced with the contrast media, the decision-making process involved in administering contrast medium to a patient, the necessity for MRI technologists to extend their role into non-medical prescribing, and training requirements.

The data revealed that MRI technologists and radiologists were of the opinion that there was no definitive need for MRI technologists in New Zealand to gain prescription rights (41.8% and 63.2% respectively). On the other hand 59.8% of MRI technologists and 53% of radiologists thought that they could be permitted to prescribe gadolinium-based contrast media with the appropriate training and supervision. However, 75.4% of radiologists indicated contrast media could not be administered without a medical practitioner present in radiology. Approximately 45.5% of MRI technologists did express their interest in undertaking the relevant training that is required in order to prescribe; not just MRI contrast media but buscopan as well. This could be included in the MRI advanced practitioner scope of practice. However, the evidence suggests that MRI technologists deciding on taking up this extended role can expect resistance from the radiologist community and from some of their MRI colleagues.

**Key findings**

The study has demonstrated that activities previously seen as role extension, for example peripheral IV cannulation and administration of gadolinium-based contrast media have become well integrated into the role of the MRI technologist. The IV cannulation courses available to MRI technologists appear to be happening in-house and rather casually across the country. The wish for a more formal qualification such as a national certificate, which is specifically aimed at MRI technologists, has been expressed.

The questionnaires revealed that most MRI technologists and radiologists have experienced to some extent a patient reacting to gadolinium-based contrast media used. Fortunately most of those reactions were mild with vomiting and nausea encountered most frequently. Moderate and severe reactions were seen, although rarely. There were no gadolinium-based contrast media-related deaths reported. The study did not address the level of training MRI technologists have received to enable them to deal with adverse reactions.
One participant admitted that “MRI technologists do not have the medical background to act on a reaction; that is CPR.” Clearly there is a need for undertaking advanced CPR on a more regular basis than the current training allows for.

An interesting key finding of the study was that besides gadolinium-based contrast media, 47.5% of MRI technologists administered a range of other drugs with muscle relaxants such as buscopan being the most common, followed by benzodiazepines. All these drugs have pharmacodynamic interactions; not only with the body but with other drugs as well. The administration of these drugs lies outside the MRI scope of practice. It is unknown how familiar MRI technologists are with the use of these drugs and the level of training (if any) they have received to assist a patient in case of an adverse reaction. Nevertheless, 53.5% of MRI technologists indicated that it would be useful for them to prescribe these sorts of drugs; especially buscopan and to a lesser extent glucagon, benzodiazepines, and analgesics. The majority of radiologists were not so supportive of MRI technologists prescribing either buscopan or sedatives (51% and 77% respectively).

It became evident from the questionnaires that the prescription of gadolinium-based contrast media is happening haphazardly across New Zealand. Most departments have protocols set as to when the contrast media are to be administered and often MRI technologists will first seek the approval of radiologists before administering the contrast medium. However, sometimes MRI technologists will make the decision to give the contrast medium independently if it will benefit the clinical diagnosis of the patient and the radiologist is unavailable. Depending on the protocols of the various departments, the prescription of contrast media could be verbal, be written down on the patient’s consent form, or not at all as seen with the following comment made by one of the participants:

Gadolinium is not signed for by a doctor and is more or less given as required by the MRT. This system works very well and there are few cases (none comes to mind) where a MRT has given it and it was not required. In fact, several cases of radiologists requesting gad when it turned out not to be required comes to mind.
Without the written prescription from a radiologist some MRI technologists would sign off the contrast media themselves after they had administered it to a patient – not realising that they were in actual fact ‘prescribing.’ It was identified that at least one MRI technologist is already prescribing gadolinium-based contrast media in New Zealand.

MRI technologists thought that the foremost advantage for them would be an improved workflow (51.5%); followed by patient continuity (49.5%) if they were able to prescribe gadolinium-based contrast media. Patients will have to be recalled less often for post-contrast scans and it will reduce time delays in reporting the scans. Only 34.3% of MRI technologists thought that it would give them more job satisfaction. However, one MRI technologist claimed that ever since she started prescribing MRI contrast media it has made a difference to the workflow in their practice and that it has increased her job satisfaction. Certainly in areas with limited access to radiologists initiatives like these would be an advantage to both the patient and the MRI technologist.

Alternative ways in which gadolinium-based contrast media could be issued when were presented to the radiologists. Fifty percent of radiologists admitted that they would rather have the contrast media administered under a standing order than allowing MRI technologists to prescribe them. Forty-nine percent showed some support for collaborative prescribing.

The study revealed that the largest barrier for MRI technologists wanting to develop their role into the area of non-medical prescribing would be resistance encountered from both radiologists holding onto their hierarchical position; and to a lesser extent from their MRI colleagues who are unwittingly supporting the monopoly of medicine over MRTs. However, prescription rights are not going to be ‘handed over’ to MRI technologists opting for this extended role. It will only be granted once they have completed the necessary training and then preferably in an advanced practitioner status.

**Recommendations**

In the light of these findings, the following are recommended:
Introduction of an IV national certificate for MRI technologists

The results of the study have revealed that most IV cannulation courses for MRI technologists are occurring in-house and rather ad hoc. It appears that the training is more based on the competency of the MRI technologist to cannulate and does not consider the implications of administering the actual contrast medium. The desire for an official qualification aimed at MRI technologists by an approved tertiary provider has been expressed. The introduction of a national accredited course will ensure consistency and a high level of standard across New Zealand. Preferably it should also be introduced within the MRI scope of practice, which will increase the professional status of the MRI technologist. Another benefit of having an endorsed national certificate is that it will allow transferability between different hospitals.

Improvement of the current CPR training for MRI technologists

Based on the results of the study, claims have been made that MRI technologists cannot prescribe gadolinium-based contrast media because “we are not trained to deal with emergency situations, which doctors train for at med school and by experience.” Yet the same MRI technologists have no reservations about administering the contrast media despite them not having the knowledge, experience or competency to deal with serious adverse reactions. According to the RANZCR guidelines (2009, p. 4) “nurses, radiographers and medical practitioners who administer intravenous contrast shall be trained in the recognition of contrast reactions, the procedures for treating these reactions, and resuscitation procedures.” Data from the study support the concept that a resuscitation qualification in advanced life support is essential when administering contrast media. MRI technologists admit that current CPR training they receive at their workplaces is inadequate. There is the potential for a patient to react at any time to any contrast media or other drug that are being administered by the MRI technologist. MRI technologists have to know how to recognise these signs and symptoms and how to deal with them swiftly, appropriately, and effectively. It is therefore recommended that serious attention is given to the level of CPR training that MRI technologists receive.
Investigation into the introduction of a framework teaching pharmacology to MRI technologists

Pharmacology is the science of drugs and their effects on biological systems (Thorp, 2008) and is not part of the curriculum of the New Zealand MRT. Based on the results, MRI technologists are administering a range of drugs in the MRI environment that could prove to be costly if they are not aware of the pharmacodynamics and pharmacokinetics of the drugs they are administering. They also have to be aware of their interactions with other drugs. One of the arguments against MRI technologists prescribing has been because of their lack of knowledge regarding pharmacology. It is proposed that the three tier framework suggested for teaching pharmacology to potential nurse prescribers be investigated (Lim, Honey & Kilpatrick, 2007). The first tier of the framework consists of the principles of pharmacology, pharmacodynamics, and pharmacokinetics. The second tier relates to how pharmacological knowledge is applied to practice within a context. The third tier is decision making and relates to side effects and drug interactions that have to be taken into account when dealing with patients (ibid.). Recommendations can then be made as to how this framework can be adapted to suit the needs and training requirements of MRI technologists.

Introduction of non-medical prescribing as part of an advanced practitioner role

The study has found that prescribing is not a role extension activity that can be undertaken by all MRI technologists. This is because it requires a certain level of experience and knowledge as to when gadolinium-based contrast media are to be administered, something that new MRI technologists may lack. It is emphasised that only MRI technologists who have completed the necessary training will have the option of including non-medical prescribing within their practice. It is recommended that prescribing is introduced as part an advanced practitioner role in the MRI scope of practice. Approximately 36.2% of radiologists have indicated that they will give their support to an initiative for MRI technologists to gain limited independent prescription rights. However, a more acceptable alternative to the radiologist community may be the prescription and administration of gadolinium-based contrast media under PGDs as it is currently carried out in the UK. This may well include the prescription of drugs like buscopan under PGDs.
Future research
An area that may be worthy of further investigation is the administration of IV sedation by MRI technologists as a role extension activity. Even though it is perceived as an activity not to be performed by a MRI technologist, the study has revealed that it is in fact already occurring in New Zealand. The question is why some activities that are seen as out of bounds by one group of MRI technologists are totally acceptable practice for another group of MRI technologists? Perhaps this could be addressed in future research.

Conclusion
The research has investigated the views of both MRI technologists and radiologists with regard to gadolinium-based contrast media prescription as an extended role for MRI technologists in New Zealand. The research has showed that even though there is no definitive need for MRI technologists to gain prescription rights, there are MRI technologists eager to extend their roles into this area with the appropriate education, training and supervision. Therefore it is important to provide the opportunity for those willing to take on the extra responsibility. Not only will it enhance the professional status of MRI technologists in New Zealand but will allow them to keep up with international role developments. Non-medical prescribing for radiographers is an acceptable practice in the UK and there is no reason why it cannot be done in New Zealand. However, compared to the UK, New Zealand is still in its infancy with regard to non-medical prescribing for health professionals. At this stage it is a relatively new concept to MRI technologists and obviously a contentious issue that will provoke different opinions. One radiologist remarked that there was the same opposition to MRTs doing IV cannulations but now it is happening and has become an accepted practice for MRI technologists. Hence, the same can be expected with regards to MRI technologists wanting to take on prescribing. Support from the professional body, the NZIMRT, and the statutory body, the MRTB, is essential if a case is to be presented to the Ministry of Health to extend non-medical prescribing to MRI technologists. Irrespective of what the outcome may be, it is still vitally important that the issues of an endorsed IV certificate, CPR training, and basic pharmacology for MRI technologists are addressed. Once these issues are addressed, the benefits thereof may as a result lead to the improvement of service delivery to patients, enhancement of the
professional status of the MRI technologist, and subsequently the attraction and retention of staff to the MRI profession.
List of References


Irish Institute of Radiography and Radiation Therapy. (2007). *Intravenous administration by radiographers: Guidelines on best practice.* Retrieved March 17, 2009, from http://www.ranzcr.edu.au/documents/detail.cfm?ophilelngEditState=3&ophileintBase=1&ophileLibrary=29&ophilesrc=%28%28txtName%20like%20%27%25contrast%25%27%29%20or%20%28txtDescription%20like%20%27%25contrast%25%27%29%20or%20%28txtKeywords%20like%20%27%25contrast%25%27%29%20or%20%28txtKeyw


New Zealand Medicines and Medical Devices Authority. (n.d.). Benzodiazepines to be controlled drugs. Retrieved October 27, 2011, from Medsafe:


Appendix One

Schedules and classes of controlled drugs under the Misuse of Drugs Acts 1971 (UK)
Schedules and classes of controlled drugs under the Misuse of Drugs Act 1971

Controlled drugs are divided into five Schedules by the regulations:

- **Schedule 1**: Drugs of little use or no therapeutic use, for example cannabis, lysergic acid diethylamide (LSD)
- **Schedule 2**: Drugs of high abuse potential with medicinal use, opiates and major stimulants, for example amphetamines and cocaine
- **Schedule 3**: Drugs of lesser abuse potential with medicinal use, for example minor stimulants and barbiturates
- **Schedule 4**: Part 1 – Anabolic steroids and related hormones
  Part 2 – Most benzodiazepines and zolpidem
- **Schedule 5**: Drugs of low abuse potential because dispensed or formulated in small amounts, for example low doses of codeine, pholcodeine and morphine (Thorp, 2008).

These drugs are further classified according to the degree of danger that misuse of them presents and for determining penalties for offences under the Act:

- **Class A**: All opiates, hallucinogens, cocaine, injectable amphetamines, cannabinol and coca leaf
- **Class B**: Amphetamines, codeine, pholcodeine and barbiturates
- **Class C**: Milder stimulants and tranquilisers, benzphetamine benzodiazepines, cannabis, and anabolic steroids and related hormones (Thorp, 2008).
Appendix Two

The classification of controlled drugs under the Misuse of Drugs Act 1975 (New Zealand)
The classification of controlled drugs under the Misuse of Drugs Act 1975

The classification is as follows:

i. **Class A**: Drugs posing a very high risk of harm. They are limited to the most serious drugs requiring severe restrictions such as cocaine, heroin, LSD, thalidomide, amphetamine substances and methamphetamine (McNab, 2003).

ii. **Class B**: Drugs posing a high risk of harm. They are divided into three parts:
   - Class B1 drugs – processed substances, including opiates with both therapeutic and abuse potential such as morphine and cannabis preparations (resin and oil since the concentrated forms have a higher potency than the natural plant)
   - Class B2 drugs – stimulants with less dependence potential as B1 substances, including ecstasy and Ritalin
   - Class B3 drugs – drugs commonly used for medical purposes, including methadone, pethidine (ibid.).

iii. **Class C**: Drugs posing a moderate risk of harm. There are seven categories:
   - Class C1 – substances used illicitly rather than medically, including the leaf, fruit and seed of the cannabis plant
   - Class C2 – substances that could be prescribed for therapeutic purposes but have a moderate abuse potential such as codeine powder, codeine linctus and codeine syrup
   - Class C3 – partially exempted drugs that have less dependency potential such as pholcodine (cough suppressant)
   - Class C4 – barbiturates with medical uses
   - Class C5 – substances that have medical uses, less dependency and abuse potential than C4, including phenobarbital, diazepam and nitrazepam
   - Class C6 – exempted drugs such as codeine and paracetamol
   - Class C7 – controlled drug analogues or substances that have similar structures to controlled drugs such as designer drugs (ibid).
Appendix Three

Ethics
Participant Information Sheet (MRI Technologist Questionnaire)

Prescription rights for New Zealand MRI technologists: An opportunity for role extension

My name is Exelda Kruger and I am a MRI technologist/Staff MRT at Wanganui Hospital. I am currently enrolled as a student in the Master of Health Science at Unitec in Auckland and I want to conduct this research for my thesis. I have chosen this topic because it has not been investigated before in New Zealand. This is an invitation to all staff with either a scope of practice in MRI or a training scope of practice in MRI to participate in this study.

The anticipated objectives of my study are:

1. To investigate the views of MRI technologists in New Zealand towards extending their role in the area of gadolinium-based contrast prescription.
2. To develop a case to prescribe and administer the contrast media without requiring the presence of a doctor in radiology.
3. That the results of my research project may be used to optimise patient care and continuity especially in imaging departments with radiologist shortages.

What it will mean for you:

This research is being conducted to provide a case for MRI technologists in New Zealand to have certain prescription rights, for example limited independent prescription rights, which could be presented to the Ministry of Health by our statutory registration body, the Medical Radiation Technologists Board (MRTB).

The questionnaire is designed to gather information on your experiences as a MRI technologist regarding various aspects on gadolinium-based contrast media. I would appreciate approximately 30 - 45 minutes of your time to complete the questionnaire. Any
comments are welcomed but if your time is limited, complete it as best you can. In addition, I would like to ask you to write down a critical incident(s) that you can recall that might have made a difference if MRI technologists had prescription rights. An example of the format of a critical incident log is included with your questionnaire. However, you can send the questionnaire back independently from the critical incident log in case you have nothing you wish to report.

Your participation is strictly voluntary. You are not asked to identify yourself in any way on the questionnaire or critical incident log and all information received will remain confidential. You may note a number on the reply-paid envelope; however, there is no way that you may be identified by this number as a third party will separate the questionnaire from the envelope. The number will only be used to identify those requiring a reminder.

Should you be interested to be interviewed by me, please complete the tear-off slip at the bottom of the last page of the questionnaire. A third party will separate this from the questionnaire to ensure anonymity is maintained.

If you have any queries about the research or questionnaire, you may contact either my principal supervisor, Dr. Jill Yielder, Department of Medical Imaging, Unitec (jyielder@unitec.ac.nz) or myself (exelda.xtra.co.nz).

Please return the completed questionnaire before Friday, 16th April 2010 in the stamped self-addressed reply envelope. I thank you in anticipation for your time and cooperation to make this study possible. I hope you would find your involvement interesting.

UREC REGISTRATION NUMBER: 2009-1034
This study has been approved by the UNITEC Research Ethics Committee from 18 January 2010 to 17 January 2011. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Committee through the UREC Secretary (ph: 09 815-4321 ext 6162). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Participant Information Sheet (Radiologist Questionnaire)

*Prescription rights for New Zealand MRI technologists: An opportunity for role extension*

My name is Exelda Kruger and I am a MRI technologist/Staff MRT at Wanganui Hospital. I am currently enrolled as a student in the Master of Health Science at Unitec in Auckland and I want to conduct this research for my thesis. I have chosen this topic because it has not been investigated before in New Zealand. This is an invitation to all radiologists involved with MRI reporting to participate in this study.

**The aim of my study:**

This research is being conducted to provide a case for MRI technologists in New Zealand to have certain prescription rights, for example limited independent prescription rights, which could be presented to the Ministry of Health by our statutory registration body, the Medical Radiation Technologists Board (MRTB).

The questionnaire has been designed to gather your opinion regarding MRI technologists in New Zealand being able to prescribe gadolinium-based contrast media. I would appreciate approximately 20 - 30 minutes of your time to complete the questionnaire. Any comments are welcomed but if your time is limited, complete it as best you can.

I hope that the results of my research project may be used to optimise patient care and continuity especially in imaging departments with radiologist shortages.

Your participation is voluntary. You are not asked to identify yourself in any way on the questionnaire and all information received will remain confidential.
If you have any queries about the research or questionnaire, you may contact either my principal supervisor, Dr. Jill Yielder, Department of Health Science, Unitec (jyielder@unitec.ac.nz) or myself (exelda@xtra.co.nz).

Please return the completed questionnaire before Friday, 16th April 2010 in the stamped self-addressed reply envelope.

I thank you in anticipation for your time and cooperation to make this study possible. I hope you would find your involvement interesting.

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Participant Information Sheet (MRI Technologist – Interview)

*Prescription rights for New Zealand MRI technologists: An opportunity for role extension*

My name is Exelda Kruger and I am a MRI technologist/Staff MRT at Wanganui Hospital. I am currently enrolled as a student in the Master of Health Science at Unitec in Auckland and I want to conduct this research for my thesis. I have chosen this topic because it has not been investigated before in New Zealand and invite you to participate in this study.

*The anticipated objectives of my study are:*

4. To investigate the views of MRI technologists in New Zealand towards extending their role in the area of gadolinium-based contrast prescription.
5. To develop a case to prescribe and administer the contrast media without requiring the presence of a doctor in radiology.
6. That the results of my research project may be used to optimise patient care and continuity especially in imaging departments with radiologist shortages.

The proposed interview is designed to gather your opinion as a MRI technologist regarding:

1. Your experiences with gadolinium-based contrast media
2. The prescription of the contrast media
3. The prescription of other drugs related to the MRI environment
4. Your view on prescription rights as an opportunity for role extension in New Zealand.

I would appreciate it if you could meet with me for approximately one hour to talk about these topics. I could come either to your place of work or a place of your preference at a time convenient for you. I will tape the interview and will be transcribing it later. All features that
could identify you will be removed and the tapes used will be erased once the transcription is done.

If you agree to participate, you will be asked to sign a consent form. This does not stop you from changing your mind if you wish to withdraw from the project. However, because of my schedule, any withdrawals must be done within two weeks after I have interviewed you.

Your name and information that may identify you will be kept completely confidential. All information collected from you will be stored on a password protected file and only you, myself and my supervisors will have access to this information.

If you have any questions regarding the interview or need more information about the research topic, you may contact either my principal supervisor, Dr. Jill Yelder, Department of Medical Imaging, Unitec (jyielder@unitec.ac.nz) or myself (exelda@xtra.co.nz).

UREC REGISTRATION NUMBER: 2009-1034
This study has been approved by the Unitec Research Ethics Committee from 18 January 2010 to 17 January 2011. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Committee through the UREC Secretary (ph: 09 815-4321 ext 6162). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Participant Information Sheet (Radiologist - Interview)

Prescription rights for New Zealand MRI technologists: An opportunity for role extension

My name is Exelda Kruger and I am a MRI technologist/Staff MRT at Wanganui Hospital. I am currently enrolled as a student in the Master of Health Science at Unitec in Auckland and I want to conduct this research for my thesis. I have chosen this topic because it has not been investigated before in New Zealand and invite you to participate in this study.

The anticipated objectives of my study are:
This research is being conducted to provide a case for MRI technologists in New Zealand to have certain prescription rights, for example, independent prescription rights which could be presented to the Ministry of Health by our statutory registration body, the Medical Radiation Technologists Board (MRTB).

The proposed interview is designed to gather your opinion as a consultant radiologist regarding gadolinium-based contrast media prescription. I would appreciate it if you could meet with me for approximately one hour to talk about these topics. I could come to your place of work at a time convenient for you. I will tape the interview and will be transcribing it later. All features that could identify you will be removed and the tapes used will be erased once the transcription is done.

If you agree to participate, you will be asked to sign a consent form. This does not stop you from changing your mind if you wish to withdraw from the project. However, because of my schedule, any withdrawals must be done within two weeks after I have interviewed you.
Your name and information that may identify you will be kept completely confidential. All information collected from you will be stored on a password protected file and only you, myself and my supervisors will have access to this information.

If you have any questions regarding the interview or need more information about the research topic, you may contact either my principal supervisor, Dr. Jill Yelder, Department of Medical Imaging, Unitec (jyelder@unitec.ac.nz) or myself (exelda@xtra.co.nz).

UREC REGISTRATION NUMBER: 2009-1034
This study has been approved by the UNITEC Research Ethics Committee from 18 January 2010 to 17 January 2011. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Committee through the UREC Secretary (ph: 09 815-4321 ext 6162). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Participant Consent Form (Interview)

Prescription rights for New Zealand MRI technologists: An opportunity for role extension

I have had the research project explained to me and I have read and understand the information sheet given to me.

I understand that I do not have to be part of this if I do not want to and may withdraw at any time prior to the completion of the research project.

I understand that everything I say is confidential and none of the information I give will identify me and that the only persons who will know what I have said will be the researcher and her supervisors. I also understand that all the information that I give will be stored securely on a computer at Unitec for a period of five years.

I understand that my discussion with the researcher will be taped and transcribed.

I understand that I can see the finished research document.

I have had time to consider everything and give my consent to be part of this project.

Participant Signature ……………………………………Date ……………………………

Project Researcher………………………………………………………..Date…………………………..
Appendix Four

Prescription rights for New Zealand MRI technologists

- Questionnaire
About yourself

1. What is your gender?
   □ Male
   □ Female

2. Age
   □ 20 – 29
   □ 30 – 39
   □ 40 – 49
   □ 50 – 59
   □ 60 +

3. In what year did you qualify as a medical radiation technologist? _____________

4. What is your highest medical imaging qualification?
   □ Diploma
   □ Degree
   □ Postgraduate Certificate
   □ Postgraduate Diploma
   □ Master’s Degree
   □ Other (please specify) ________________________________

5. What modalities do you currently work in?
   □ None
   □ General radiography
   □ MRI
   □ CT
   □ Ultrasound
   □ Other (please specify) ________________________________
6. Have you completed or are you currently studying in a postgraduate MRI course?
   □ No
   □ Yes

About your MRI practices

7. How long have you been working in MRI?
   □ Less than 1 year
   □ 1 – 5 years
   □ 5 – 10 years
   □ 10 – 15 years
   □ 15 – 20 years
   □ More than 20 years

8. How many hours per month do you work in MRI?
   □ 40 hours or less
   □ 40 – 80 hours
   □ 80 – 120 hours
   □ 120 – 160 hours
   □ Other (please specify) ________________________________

9. Is your MRI scanner a:
   □ Public hospital scanner
   □ Private practice scanner within a public hospital
   □ Private practice scanner within a private hospital
   □ Private scanner situated outside a hospital environment
   □ Other (please specify) ________________________________

_____________________________________________
10. How many MRTs are rostered on at any time in your MRI department/practice?
__________________________________________________________________

11. Do you do any intravenous cannulation in MRI?
   □ No
   □ Yes

12. Do you administer any gadolinium-based contrast media in MRI?
   □ No
   □ Yes

13. If you answered No to the previous two questions, please indicate who performs this role
    (you may select more than one option).
   □ MRI colleague
   □ Nurse
   □ Radiologist
   □ Resident medical officer
   □ Other (please specify) __________________________________________
                                                                 ___________

14. Do you administer any other contrast media in any of the other modalities?
   □ No
   □ Yes (please specify) ____________________________________________
                                                                 ___________

15. Do you administer any other drugs, for example Buscopan, in MRI?
   □ No
   □ Yes (please specify) ____________________________________________
                                                                 ___________
16. If you answered No to the previous question, indicate who administers it (you may select more than one option)

□ Nurse
□ Radiologist
□ Resident medical officer
□ Other (please specify) ________________________________

Your experiences with gadolinium-based contrast media

17. Indicate the gadolinium-based contrast media used in your department:

□ Omniscan
□ Multihance
□ Magnevist
□ Dotarem
□ Other (please specify) ________________________________

18. Do you keep record of adverse reactions caused by the administration of gadolinium-based contrast media?

□ No
□ Yes (please specify how, for example register, computer etc.)

19. How often do you encounter a patient experiencing an adverse reaction to gadolinium-based contrast media?

□ Once a week □ More than once a week
□ Once a month □ More than once a month
□ Once a year □ More than once a year
□ Other (please specify) ________________________________
20. Do you know what to do if a patient has an adverse reaction to gadolinium-based contrast media?

□ No
□ Yes
□ Unsure
Any comment ____________________________________________________________
________________________________________________________________________
________________________________________________________________________

21. Indicate the reaction(s) you have encountered before in patients with the administration of gadolinium-based contrast media:

□ Nausea □ Vomiting
□ Warmth □ Flushing
□ Perspiration □ Altered taste
□ Rash □ Hives
□ Itching □ Mild eye/facial swelling
□ Dyspnea □ Bronchospasm
□ Convulsions □ Unresponsiveness
□ Severe respiratory distress □ Cardiopulmonary arrest
□ Other (please specify) ____________________________________________________
________________________________________________________________________
________________________________________________________________________

22. Have any of your patients ever required medical intervention after the administration of gadolinium-based contrast media?

□ No
□ Yes (please specify) ______________________________________________________
________________________________________________________________________
________________________________________________________________________
23. Nephrogenic systemic fibrosis (NSF) has been associated with the use of gadolinium-based contrast media. Do you know which patients are at risk or has a potential risk for developing NSF?
   □ No
   □ Yes
   □ Unsure
   If you answered Yes, please explain ______________________________
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________

24. Do you know how to identify patients who are at risk or have a potential risk for developing NSF?
   □ No
   □ Yes
   □ Unsure
   If you answered Yes, please explain ______________________________
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________

25. Does your department have a protocol in place for the use of gadolinium-based contrast media in patients who are at risk or have a potential risk for developing NSF?
   □ No
   □ Yes
   If you answered Yes, please explain ______________________________
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________
Prescription of gadolinium-based contrast media

26. Do you have specific prescribing parameters in place to know when a patient requires contrast media, for example post-surgery, tumours, infection etc.?

□ No
□ Yes
Any comment ______________________________________________

____________________________________________________________
____________________________________________________________

27. Do you get the radiologist to assess each case individually and make a decision whether contrast media is required or not?

□ No
□ Yes
□ Only if I am unsure
Any comment ______________________________________________

____________________________________________________________
____________________________________________________________

28. Do you ever find yourself in a situation without a radiologist available to prescribe contrast media?

□ No (go to question 33)
□ Yes
Any comment ______________________________________________

____________________________________________________________
29. Do you have to rely on other doctors then to be available to prescribe the contrast?

□ No
□ Yes

Any comment ______________________________________________________
____________________________________________________________
____________________________________________________________

30. Do you ever have difficulty in locating a doctor to prescribe the contrast media when needed?

□ Often
□ Sometimes
□ Never

Any comment ______________________________________________________
____________________________________________________________
____________________________________________________________

31. Do you encounter doctors (other than radiologists) that are not familiar with gadolinium-based contrast media administered in MRI?

□ Often
□ Sometimes
□ Never

Any comment ______________________________________________________
____________________________________________________________
____________________________________________________________

32. Do you think it is desirable for New Zealand MRI technologists with the appropriate training and supervision, to be permitted to prescribe gadolinium-based contrast media?

□ No
□ Yes
□ Unsure
33. Do you think it is desirable for New Zealand MRI technologists with the appropriate training to prescribe and administer gadolinium-based contrast media without a radiologist or any other doctor present in the radiology department within a hospital with a resuscitation team?

- [ ] No
- [ ] Yes
- [ ] Unsure

Any comment __________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

34. Do you think it is desirable for New Zealand MRI technologists with the appropriate training to prescribe and administer gadolinium-based contrast media without a radiologist or any other doctor present in a radiology practice situated outside a hospital environment?

- [ ] No
- [ ] Yes
- [ ] Unsure

Any comment __________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

35. Do you think there is a need for New Zealand MRI technologists to gain certain prescription rights, for example, limited independent prescription rights to prescribe gadolinium-based contrast media?

- [ ] No
- [ ] Yes
- [ ] Unsure
36. Would you want to have prescription rights after the appropriate education and training?
   □ No
   □ Yes
   □ Unsure

37. Do you think all MRI technologists should have prescription rights?
   □ No
   □ Yes
   □ Unsure

38. If you answered No to any of the previous two questions, state the reasons why you believe MRI technologists should not be able to prescribe.
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   _____________________________________________

39. How useful would it be to be able to prescribe gadolinium-based contrast media in your department?
   □ Very useful
   □ Somewhat useful
   □ Not useful
   □ Unsure

40. Please specify what other drugs you think would be useful for MRI technologists to prescribe ____________________________________________________________
   ____________________________________________________________
41. Would it improve your workflow should you be able to prescribe?
   □ No
   □ Yes
   □ Unsure
   Any comment ____________________________________________________________
   ________________________________________________________________

42. Would it optimise patient continuity should you be able to prescribe?
   □ No
   □ Yes
   □ Unsure
   Any comment ____________________________________________________________
   ________________________________________________________________

43. Would it increase your job satisfaction should you be able to prescribe?
   □ No
   □ Yes
   □ Unsure
   Any comment ____________________________________________________________
   ________________________________________________________________

**Training**

44. What should the minimum requirement/qualification be before MRI technologists could undertake training to prescribe?
   □ Undergraduate Degree
   □ Postgraduate Certificate
   □ Postgraduate Diploma
   □ Master’s Degree
45. In your opinion, when should training to prescribe be undertaken?

☐ It should be incorporated into the postgraduate MRI training
☐ Only after completion of a postgraduate MRI qualification
☐ Unsure

Any comment ______________________________________________________________

________________________________________________________________________

________________________________________________________________________

46. Would you be willing to undertake the additional training to become a prescribing MRI technologist?

☐ No
☐ Yes
☐ Unsure

Any comment ______________________________________________________________

________________________________________________________________________

________________________________________________________________________

47. If you stated No please indicate the reason(s)

☐ I would not have the time to complete the training
☐ The duration of the course might be too long
☐ I would worry that I may make the wrong prescriptive decisions
☐ It is too late in my career to undertake the training
☐ Financial reasons
☐ Other (please specify) ________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
48. Please include any other general comments you would like to make on this subject

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Thank you for your participation. Your answers will be treated in the strictest confidence.

Please return before **Friday 16th April 2010** in the stamped self-addressed reply envelope to:

**Exelda Kruger**
**PO Box 4309**
**Wanganui, 4541**
Interview

If you are interested in being interviewed for this research study, please complete the slip below. This page will be separated from the questionnaire by a third party to maintain the anonymity of your questionnaire.

I will send you an information interview sheet to have a read and make a decision.

Name: ________________________________________________________________

Place of work: _______________________________________________________

Contact number: _____________________________________________________

E-mail address: _______________________________________________________ 

Thank you for your participation.
Appendix Five

Critical incident technique form
Critical Incident Log

- The context of the incident (e.g. time of day, condition of patient, nature of the examination).

- What happened (in detail)?

- Why the incident was problematic.
• How a resolution was reached.

• What aspects were the most demanding about the situation?

• Any other comments you have about the situation
Appendix Six

Prescription rights for New Zealand MRI technologists
- Radiologist questionnaire
General

1. Number of years as a consultant radiologist
   □ Less than 5 years
   □ 5 – 10 years
   □ 10 – 15 years
   □ 15 – 20 years
   □ More than 20 years

2. In what environment do you practice?
   □ Public hospital only
   □ Private practice only
   □ Private and public hospital practice
   □ Other (please specify______________________________

3. Approximately how many radiologists are employed in your practice? _________

4. Approximately how long has MRI been your area of speciality?
   □ Less than 5 years
   □ 5 – 10 years
   □ 10 – 15 years
   □ 15 – 20 years
   □ More than 20 years

5. Do you do any off-site reporting, through Telemedicine for some of your MRI examinations?
   □ No
   □ Yes
Adverse reactions to gadolinium-based contrast media

6. How often do you encounter a patient with an adverse reaction to the gadolinium-based contrast media administered to a patient?
   □ Once a week  □ More than once a week
   □ Once a month  □ More than once a month
   □ Once a year  □ More than once a year
   □ Other (please specify) ____________________________________________

7. Indicate the reaction(s) you have encountered before in patients with the administration of gadolinium-based contrast media.
   □ Nausea  □ Vomiting
   □ Warmth  □ Flushing
   □ Perspiration  □ Altered taste
   □ Rash  □ Hives
   □ Itching  □ Mild eye/facial swelling
   □ Dyspnea  □ Bronchospasm
   □ Convulsions  □ Unresponsiveness
   □ Severe respiratory distress  □ Cardiopulmonary arrest
   □ Other (please specify) ____________________________________________
   ____________________________________________
   ____________________________________________

8. Do you know if any of your patients have ever required medical intervention after the administration of gadolinium-based contrast media?
   □ No
   □ Yes (please specify) ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
9. Have you ever been directly involved in any medical intervention required after the administration of gadolinium-based contrast media?

☐ No

☐ Yes (please specify) __________________________________________
  ____________________________________________________________
  ____________________________________________________________
  ____________________________________________________________
  ____________________________________________________________

10. Do you believe a radiologist (or any other doctor) should always be present in the radiology department when gadolinium-based contrast media is administered to patients?

☐ No

☐ Yes

Any comment ____________________________________________
  __________________________________________________________
  __________________________________________________________
  __________________________________________________________
  __________________________________________________________

11. Are you aware of any departments administering gadolinium-based contrast media to patients without having any doctors present in the radiology department?

☐ No

☐ Yes

☐ Unsure

Any comments ____________________________________________
  __________________________________________________________
  __________________________________________________________
  __________________________________________________________
  __________________________________________________________
Contrast media prescription

12. Do you assess each MRI examination individually to decide whether contrast media is required or not?
   □ No
   □ Yes
   □ Only if the MRI technologist is unsure
   Any comment ____________________________
   ____________________________
   ____________________________
   ____________________________

13. Do you have specific prescribing parameters in place for the MRI technologist to know when contrast media are required?
   □ No
   □ Yes
   Any comment ____________________________
   ____________________________
   ____________________________
   ____________________________

14. Are you always available to prescribe the contrast media for the MRI technologist when needed?
   □ No
   □ Yes
   Any comment ____________________________
   ____________________________
   ____________________________
   ____________________________
15. Do you know if MRI technologists have difficulty to locate any other doctors to prescribe the contrast media if you are unavailable to do so?

☐ No
☐ Yes
☐ Unsure

Any comment ________________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

Role extension activities for MRI technologists

16. Do you have any experience working with MRI technologists undertaking the following role extension activities in New Zealand?
   a. IV Cannulation
      ☐ No
      ☐ Yes
   b. Contrast administration
      ☐ No
      ☐ Yes

17. Do you think it is desirable for New Zealand MRI technologists with the appropriate training and supervision, to be permitted to prescribe the gadolinium-based contrast media when needed?

☐ No
☐ Yes
☐ Unsure

Any comment ________________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________
18. Do you think it is desirable for New Zealand MRI technologists with the appropriate training to prescribe and administer gadolinium-based contrast media without a radiologist/other doctor present in the radiology department within a hospital with a resuscitation team?

☐ No
☐ Yes
☐ Unsure

Any comment ________________________________________________
________________________________________________________________
________________________________________________________________

19. Do you think it is desirable for New Zealand MRI technologists with the appropriate training to prescribe and administer gadolinium-based contrast media without a radiologist/other doctor present in a radiology practice situated outside a hospital environment?

☐ No
☐ Yes
☐ Unsure

Any comment ________________________________________________
________________________________________________________________
________________________________________________________________

20. Do you think there is a need for New Zealand MRI technologists to gain certain prescription rights, for example, limited independent prescription rights?

☐ No
☐ Yes
☐ Unsure

Any comment ________________________________________________
________________________________________________________________
________________________________________________________________
21. Do you think it would optimise patient continuity and MRI workflow should MRI technologists be able to prescribe?

☐ No
☐ Yes
☐ Unsure

22. Do you think it would improve the MRI technologists’ job satisfaction should they be able to prescribe?

☐ No
☐ Yes
☐ Unsure

23. Would you be supportive of an initiative to present a case for New Zealand MRI technologists to obtain limited independent prescription rights?

☐ No
☐ Yes
☐ Unsure

Any comment __________________________________________________________
________________________________________________________
________________________________________________________
________________________________________________________
________________________________________________________

24. If you answered No to the previous question, do you think gadolinium-based contrast media could be administered under a standing order?

☐ No
☐ Yes
☐ Unsure

Any comment __________________________________________________________
________________________________________________________
________________________________________________________
________________________________________________________
25. If you are of the opinion that MRI technologists should not have limited independent prescription rights, would you be supportive of collaborative prescribing (i.e. to prescribe under the supervision of an authorised prescriber)?

□ No
□ Yes
□ Unsure

Any comment ______________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

26. Do you think that with the appropriate training and supervision, MRI technologists could prescribe the following drugs as well:

a. Muscle relaxants, such as Buscopan for certain pelvic examinations

□ No
□ Yes
□ Unsure

Any comment ______________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

b. Mild sedatives, such as Diazepam for claustrophobic patients

□ No
□ Yes
□ Unsure

Any comments ______________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
27. Please include any other general comments you would like to make on this subject.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Thank you for your participation. Your answers will be treated in the strictest confidence.

Please return before **Friday 16th April 2010** in the stamped self-addressed reply envelope

*Exelda Kruger*

*PO Box 4309*

*Wanganui, 4541*
Interview question guide (MRI technologist)
Sample Interview Question Framework

1. How long have you been a MRI technologist?
2. Have you completed or are you still enrolled in a postgraduate MRI programme?
3. What other modalities do you currently work in?
4. Do you do any intravenous cannulation and/or contrast media administration in MRI?
5. What gadolinium-based contrast media do you use in your department?

6. a) Have you ever encountered patients who reacted to the contrast media?
    b) What did these reactions involve?
    c) Did you know how to help these patients?
    d) Did any of these patients require medical intervention?
    e) Did you find it very demanding dealing with those patients?
    f) How do you keep record of any adverse reactions encountered?

7. a) How many radiologists are at your practice?
    b) Do you find it effortless to locate a radiologist to prescribe the contrast media?

8. a) Does your practice/department have set protocols in place for when MRI contrast media need to be administered?
    b) Do you think MRI technologists are experienced enough to make judgment calls on whether patients need contrast media to be administered or not?
    c) Does it happen sometimes that a patient needs to come back for additional scans with contrast media?
    d) Is it because the MRI technologist overlooked something or any other reason?

9. a) Do you think there is a need for MRI technologists being able to prescribe MRI contrast media?
    b) Do you think there is a need for MRI technologists being able to prescribe muscle relaxants, such as Buscopan, with certain MRI pelvic examinations?
    c) How do you deal with patients who are claustrophobic and require oral sedation? Who prescribe that?
    d) Do you think there is a need for MRI technologists to prescribe oral sedation?
    e) Are you able to think of any advantages of MRI technologists being able to prescribe?
f) Do you think MRI technologists are ready to take up the responsibility of limited independent prescribing?

g) Is there anything else, except MRI contrast media, you might think off that MRI technologists could prescribe as well, which would be helpful in the MRI environment?

h) Do you know if your radiologists would be supportive of you extending your role to radiographer prescribing?

10. a) Do you know if you will be prepared to undertake the appropriate training to gain prescription rights?

b) Do you think MRI technologists should do the training during their postgraduate training programme or once they have completed it?

c) Do you think your employer would be prepared to pay for these courses?

11. a) Do you work in any other modalities that require the administration of IV contrast media? What are they?

b) Do you think MRTs should be able to prescribe IV contrast media for those modalities as well?

c) Are you of the opinion that gadolinium-based contrast media are safer than the iodinated ones?

d) Do you think there may be medico-legal implications if MRI technologists are allowed to prescribe their own drugs?

e) Would it be best for MRI technologists to have limited independent prescription rights or collaborative prescription rights?

12. Do you have any other comments regarding this topic?
Appendix Eight

Interview question guide (Radiologist)
Sample Interview Question Framework

1. a) How long have you been a consultant radiologist?
   b) Have you been involved in MRI all of that time?
   c) How many other radiologists work with you?
   d) Are all of them involved with MRI reporting?

2. a) Do you do any administering of gadolinium-based contrast media?
   b) Who else does it?
   c) Have you encountered any allergic reactions in patients with the administration of gadolinium-based contrast media before?
   d) Do you recall if patients react more towards iodine-based contrast media than gadolinium-based contrast media?

3. Do you think that a doctor has to be present at all times when contrast media are being administered?

4. When do you assess MRI examinations in order to decide which ones require contrast media or not? For example, when asked by the MRI technologist or after the scan has already been done?

5. In what instances do you believe gadolinium-based contrast media always needs to be administered if possible?

6. a) Are you always available to prescribe the contrast media when needed?
   b) What happens if you are unavailable?
   c) Are you aware if the MRI technologists have difficulty to locate other doctors to prescribe if you are unavailable?
   d) Do you know if some of these doctors are inexperienced with the prescription of gadolinium-based contrast media?

7. a) How would you feel about MRI technologists prescribing the contrast media as well?
   b) Do you think there is a need for New Zealand MRI technologists to gain limited independent prescription rights?
c) Will you be supportive of an initiative to present a case for New Zealand MRI technologists to obtain limited independent prescription rights?

8. Will you be more supportive of MRI technologists administering contrast media under a standing order?

9. Will you be supportive of MRI technologists having collaborative prescribing rights?

10. Do you think MRI technologists could prescribe the following with the appropriate training and supervision?
   • Muscle relaxants, for example Buscopan
   • Oral sedatives, for example Diazepam

11. If you are of the opinion MRI technologists do not need prescription rights, what suggestions do you have to support MRI technologists that do not always have access to doctors to prescribe the contrast media?

12. Do you have any other comments regarding this topic?
Appendix Nine

Unitec Research Ethics Committee approval letter
Exelda Kruger
PO Box 4309
Wanganui 4541

25 February 2010

Dear Exelda

Your file number for this application: 2009-1034

Title: Prescription rights for New Zealand magnetic resonance imaging (MRI)

Technologists: Am opportunity for role extension

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: 18 January 2010
Finish date: 17 January 2011

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.

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

Yours sincerely

Lyndon Walker
Deputy Chair, UREC

c: Jill Yelder
Cynthia Almeida