Diagnostic Imaging Ordering Practices by Referring Physicians: A Qualitative Approach

by

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B.A., University of Victoria, 2009

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

MASTER OF SCIENCE

in the School of Health Information Science

Supervisory Committee

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Abstract

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The diagnostic imaging (DI) literature identifies that unnecessary examinations are occurring. However, there is a gap in the research literature: little is known about how physicians order DI examinations and what efforts need to be undertaken to reduce the number of inappropriate orders made by physicians. Such research is needed in order to promote patient safety and improve utilization of limited health care resources

Purpose: The purpose of this study is to explore how physicians order DI services, and what efforts could be made to reduce inappropriate DI ordering.

Participants: 12 English speaking, non-radiologist physicians (general practitioners and specialists) participated in this study.

Methods: Semi-structured key informant interviews were conducted with participants. Data from these interviews were analyzed using a grounded theory approach.

Results: DI ordering practices (both appropriate and inappropriate) emerged as the dominant theme in this research, specifically in the context of prevalence, decision-making, information support, contributing factors, and solutions. Particularly, the majority of participants felt that DI is overused in the medical field and identified contacting physicians (colleagues, specialists, or radiologists) and consulting the literature (using UpToDate® or Google Scholar) as their top methods of information support used in challenging clinical scenarios. Meanwhile, participants suggested factors that contribute to inappropriate ordering: patient demand, legal liability, and duplicate ordering. The majority of participants believed education could reduce inappropriate

ordering. Participants also identified increasing communication about requisitions and restricting DI ordering authority as potential solutions to reduce inappropriate ordering.

Conclusion: From the interviews, ordering (both appropriate and inappropriate ordering) emerged as the overarching theme. Findings were compared and contrasted to the current literature. Overall, this study revealed how human factors, such as patient demand, influence how a physician orders DI. As well, the majority of participants relied on the patient to recall patient DI history; however, literature suggests this method is unreliable. This study also offers unique insight into the physician's perspective of what would be effective for reducing inappropriate ordering. These findings contribute to the field of health informatics as any technology developed to reduce inappropriate ordering (such as a clinical decision support system) needs to consider these human factors to support user acceptance. Through findings from this study, further research gaps emerged that can guide future research.

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Acknowledgments

I would like to acknowledge my supervisory committee for their enthusiasm and dedication to the field of health informatics. Particularly, I would like to express my deepest gratitude to my supervisor, Elizabeth Borycki, for her invaluable guidance, support, and encouragement. I also wish to thank my committee member, Andre Kushniruk, for his support, and expertise.

Chapter 1: Introduction

While the diagnostic imaging (DI) literature reveals why unnecessary examinations are occurring, how physicians order DI examinations and what efforts can be made to reduce inappropriate orders remains unclear. Such questions probe ways of promoting patient safety and using limited resources responsibly. Examining the ordering practices of physicians who refer patients to diagnostic imaging services comes at a critical time with an alarmingly high estimation of unnecessary examinations performed annually in Canada and the USA. These unnecessary examinations not only place stress on human and financial resources, but they also raise concerns for patient safety. Legal liability, patient demand, and guideline familiarity all contribute to inappropriate ordering, according to the literature review. Enforcing standards, distributing guidelines, educating physicians, and introducing decision support systems could help to reduce unnecessary DI. Although several clinical decision support system (CDS) pilot studies highlight an interest in the technology, more research needs to be conducted to fill the knowledge gap on how to best support physicians in their decision making practices. Using grounded theory, this qualitative research seeks to understand how physicians order DI examinations to inform ways of reducing inappropriate ordering.

Diagnostic Imaging

For the purpose of this study, diagnostic imaging refers to medical examination techniques using x-ray, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, nuclear medicine, and positron emission tomography (PET) technologies. X-ray examinations expose a patient to a small amount of ionizing radiation to construct images of the body (Radiological Society of North America, 2012). Using advanced x-

ray equipment and computer technology, CT scans capture images from multiple angles to produce cross-sectional images of various body structures (Canadian Association of Radiologists [CAR], 2004a). MRI examinations use "magnetism and radio waves to build up a series of cross sectional images" (Royal College of Radiologists [RCR], 2012, para. 5). Meanwhile, ultrasound uses high frequency sound waves which echo off different layers of tissue. These echoes are detected by an ultrasound probe and displayed on a monitor for interpretation (RCR, 2012). Nuclear medicine refers to images that are "developed based on the detection of energy emitted from a radioactive substance given to the patient either intravenously" or orally (CAR, 2004b, para. 1). PET scans are a type of nuclear medicine "examination that involves the acquisition of physiologic images based on the detection of positrons. Positrons are tiny particles emitted from a radioactive substance administered to the patient" (CAR, 2004c, para. 1). This definition of DI excludes image guided procedures and screening, focusing on the diagnostic feature of these imaging techniques.

Increases in Use

With recent increases in DI use in the past decade, examining physician DI ordering behaviours has become crucial. For example, between 2003 and 2011, CT utilization increased from 2,767,849 to 4,326,904 (56%) in Canada. Similarly, MRI use increased from 768,302 to 1,594,097 (107%) (Canadian Institute for Health Information [CIHI], 2011). In the USA, approximately 80 million CT examinations are performed annually; this is in contrast to about 3 million in 1980 (Brenner & Hricak, 2010). These figures continue to climb 10% per year in the USA, with the population growth at less

than 1% (Mettler et al., 2009). These escalating figures demand further investigation of DI ordering practices.

Inappropriate Ordering

Inappropriate ordering can refer to several circumstances. First, when a different modality (CT, MRI, ultrasound, x-ray, nuclear medicine or PET) is indicated, the order may be deemed inappropriate. For example, if a CT examination was ordered where an MRI could have been performed, the order is inappropriate. This is because CT examinations expose a patient to radiation, unlike MRIs. Next, duplicate orders of examinations are inappropriate. Here, a specialist physician may order an examination, not knowing that the patient has already had this examination requested by another physician. Another type of inappropriate ordering refers to cases where the examination is not required for patient management; whether the examination results are positive, or negative, patient treatment is unaffected. Performing examinations too early is also a form of inappropriate ordering. For example, a patient may receive an examination, but the disease will not have progressed enough to affect the treatment (CAR, 2005a). These scenarios are all examples of inappropriate DI ordering.

Prevalence

CAR suggests that up to 30% of DI could be inappropriate (CAR, 2005b; CAR, 2010). Meanwhile, another CAR reference states that between 10-20% of DI examinations are not necessary (CAR, 2009a). However, a couple of CAR members believe that "in the absence of critically reviewed data, it is premature to suggest that up to 30% of Canadian CT scans are "inappropriate"" (Mayo & Munk, 2010, p. 250). Indeed, in these three CAR references, none mention how these inappropriate ordering

percentages were derived. Meanwhile in the USA, research suggests inappropriate ordering could be between 20 and 40%, estimated by comparing CT data against clinical guidelines (Brenner & Hricak, 2010).

Factors Contributing to Inappropriate Ordering

Understanding the root causes of inappropriate ordering could inform ways to minimize its prevalence. Several forces contribute to inappropriate ordering practices, as found through a literature search: concern for legal liability, the demands of patients, and lack of guideline familiarity.

Legal liability. Researchers believe that concern for legal liability drives physicians to order DI in unnecessary circumstances (Butler & Stolberg, 2004; De Campo, Lau & Phan, 2006; Dillon & Slanetz, 2010; Health Council of Canada [HCC], 2010). In other words, pursuing certainty could encourage physicians to order DI examinations that are not necessary for diagnosis or patient management.

Patient demand. Physicians may submit to patients who demand DI examinations without clinical indications (Dillon & Slanetz, 2010). The extent of this as a contributing factor to inappropriate ordering, though, is unknown. Butler and Stolberg (2004) also wonder "whether a patient's desire for reassurance and confidence should alter the determination of whether or not a test is appropriate" (p. 176) and therefore performed.

Guideline familiarity. Some physicians may not be familiar with their jurisdiction's guidelines (DeCampo et al., 2006; Bautista et al., 2009). In the USA, the American College of Radiology (ACR) manages Appropriateness Criteria (ACR-AC) for physicians to reference. It is available as a booklet, PDF, CD-Rom, webpage, and file

available to download to a personal digital assistant (Sistrom, 2005). However, many observe that the inconvenience of these formats could be a major barrier to their adoption (Bautista et al., 2009; Dillon & Slanetz, 2010; Logie, Smith & Nagy, 2010); the ACR-AC could be in a more user-friendly format to encourage greater adoption (Blackmore & Medina, 2006; Logie et al., 2010). Similarly in Canada, the CAR guidelines are available as a booklet and PDF (CAR, 2009a). However, CAR (2010) recognizes the need for seamless incorporation.

Guidelines and appropriateness criteria may not be widely incorporated into the referring physician's workflow; in a survey of 126 physicians, only 2.4% used the ACR appropriateness criteria (Bautista et al., 2009). Thus, perhaps a more seamless approach to incorporating guidelines into a physician's routine would prove beneficial.

Consequences

Inappropriate ordering can lead to many consequences. Most notably, patient safety can be compromised with unnecessary examinations. Additionally, financial and human resources are strained when health care services are not used responsibly.

Safety. As inappropriate ordering rates increase, several consequences threaten patient safety. First, unnecessary CT, nuclear medicine, PET, and x-ray examinations expose patients to radiation (CAR, 2005a). As well, inappropriate ordering introduces opportunities for type I and II errors to occur (Butler & Stolberg, 2004). Observing patient safety could motivate jurisdictions to consider ways to reduce inappropriate ordering.

Radiation. Inappropriate ordering can be harmful to a patient's health (Brenner & Hall, 2007). For example, a CT of the abdomen or pelvis exposes a patient to around

4.5 years of background radiation (CAR, 2005a), warranting the need for appropriate DI ordering. Although the clinical benefits often outweigh the radiation exposure risks, CT examinations could be replaced with MRI or ultrasound when applicable, which does not expose the patient to any radiation (CAR, 2005b). For example, certain CT examinations increase one's risk of developing a malignancy by ~0.05% (Gerber et al., 2009). Although this figure may seem low, it is coupled with one's lifetime risk of developing a malignancy: 21% in the USA (USA National Institutes of Health, 2005; Gerber et al., 2009). Many researchers note safety as the primary concern for inappropriate DI ordering (Bautista et al., 2009; Butler & Stolberg, 2004; Czembirek, Fruhwald, Imholf, Kainberger, & Pokieser, 2002; Schueler, 2008; Sistrom, 2005).

Radiation exposure can be especially harmful to children. Children are naturally more sensitive to radiation exposure "because they have a larger proportion of dividing cells than adults" (Brenner, 2010, p. 65). As radiation-induced cancers can take decades to appear, exposure to radiation early in one's life affords a greater risk of developing cancer. Around twenty years ago, 500,000 CT pediatric examinations were performed in the USA annually. The slower technology at this time required children to be sedated during the CT examination. However, newer and faster technology does not require sedation, a contributing factor in the growing number of pediatric CTs performed per year (5 million currently in the USA) (Brenner, 2010). Thus, appropriate ordering also needs to be examined with regards to medical radiation exposure to children.

Although the "lifetime cancer risk estimate associated with an abdominal CT scan on a 25 year old is 0.05% which is 1 in 2000" (Brenner, 2010, p. 66) may seem small, the escalating number of CT examinations is concerning on a population level. Estimates

from data between 1991 and 1996 indicate DI-induced cancer could account for around 0.4% of all cancers in the USA. To account for the increase in CT usage, this estimate could rise to approximately 1.5 to 2%. Eliminating inappropriate DI examinations and lowering the radiation dose where possible are two ways to support population health (Brenner, 2010).

Type I and II errors. Unnecessary examinations present opportunities for false negative and false positive diagnoses (Butler & Stolberg, 2004). For example, a patient may be wrongly diagnosed, or feel falsely reassured of her/his health. This "detection and pursuit of 'pseudo-disease,' with its attendant costs and worry" (Butler & Stolberg, 2004, p. 176), is not a desirable practice.

Financial costs. The Canadian health care system spends approximately $2.2 billion on DI annually (CAR, 2010). If even 1% of imaging were eliminated, the savings would be around $22 million. If this number is scaled to reflect the savings of the inappropriate ordering that CAR estimates (30%), this would represent $660 million.

Human resources. Not only does inappropriate ordering place financial stress on the health care system, it also strains human resources—which are already limited. Butler (2009) maintains that machines could be run for longer each day, but "funding for technical time to run the machines longer" (p.14) is not available. Similarly, CAR "remains concerned about the increasing workload and the staffing levels needed to keep pace with the growth in the number of scanners" (HCC, 2010). Thus, obtaining new equipment is not a complete solution to address DI demands. In summary, ordering inappropriate DI examinations comes with consequences such as reduced patient safety

(i.e. radiation exposure and incidental findings), as well as increased pressure on financial and human resources.

Solutions

Concerns for patient safety, as well as limited human and financial resources warrant investigating solutions to mitigate inappropriate ordering. Current literature reveals several suggestions for supporting the appropriate use of DI services including imposing standards, improving access and awareness of guidelines, educating physicians and medical students, and using technology such as CDSs.

Standards. A need to develop standards is a common theme in DI research (Bautista et al., 2009; Kahn & Tjahjono, 1999; Czembirek et al., 2002). This includes developing common nomenclature for ease of communication and to support computer programming (Sistrom, 2005; Sistrom & Honeyman, 2002). In 2005, CAR produced the *Diagnostic Imaging Referral Guidelines: A guide for physicians*. These guidelines are currently being updated and expanded (CAR, 2010; HCC, 2010). Additionally, wait-times are also reported differently in all but four provinces, inhibiting proper data comparison (HCC, 2010).

Distribution of guidelines. Not only is there a need for standards, but also a need for effective distribution and implementation of guidelines into work practices. Kahn and Tjahjono (1999) make the distinction between the development and implementation of guidelines; they argue more focus needs to be placed on distribution, utilization, inspection, and problem identification.

Improving access and awareness is critical for effective guideline use—especially in such a quickly changing field (Bautista et al., 2009). This could be done by making

appropriateness criteria available through the most popularly reported sources of information: Google internet searches, specialty journals, continuing medical education, meetings, and "UpToDate (an evidence-based, peer-reviewed medical information resource)" (Bautista et al., 2009, p. 1581). The guidelines need to be seamlessly incorporated into a physician's workflow to promote their use (Czembirek et al., 2002). Many researchers note the efficiencies that technology could offer for successful distribution, including that of CDSs (Bautista et al., 2009; Czembirek et al., 2002; Kahn & Tjahjono, 1999; Sistrom, 2005; Sistrom & Honeyman, 2002). Offering physicians a more seamless approach to guideline distribution could promote appropriate ordering.

Education for physicians. Czembirek et al. (2002) contest that the publication and distribution of guidelines alone will not make an impact; though, education and training could promote the use of appropriate DI ordering (Bautista et al, 2009; Czembirek, 2002; Dillon & Slanetz, 2010; Logie et al., 2010). However in the USA, "only 21.4% of medical schools require radiology clerkships" (Dillon & Slanetz, 2010), a possible factor contributing to inappropriate examinations. Again, when asked for their top three choices of radiological guidance, only 2.4% (3/126) of physicians considered consulting the ACR-AC in an American study (Bautista et al., 2009). Similarly, a study on current medical students found that 96% (214/228) were not aware of the ACR-AC (Dillon & Slanetz, 2010). However, after students attended periodic education sessions, many expressed interest in using this in the future as a resource (Dillon & Slanetz, 2010). Thus, education and training on appropriate ordering could prove beneficial.

Training "can be accomplished in several ways such as making the appropriateness criteria readily available at work stations, dedicating conferences to

specifically address imaging decision support and introducing new residents to the appropriateness criteria very early in training" (Logie et al., 2010). In fact, Czembirek et al. (2002) suggest that appropriateness criteria be discussed in medical ethics classes. However, Solomon et al. (1998) maintain that education by itself will not change ordering behaviour for the long term.

Clinical decision support systems. CDSs can take various forms including clinical pathway diagrams and question formats (Government of Western Australia, 2007; Ontario Ministry of Health and Long Term Care, 2009). As well, some can be incorporated into a computerized order entry system or electronic health record (EHR) (Massachusetts General Hospital [MGH], n.d). Different methods of reasoning can be used in CDSs such as artificial neural networks, Bayesian principles or rule-based techniques, for example (Musen, Shahar, & Shortliffe, 2006). CDSs used in health care can improve the efficiency of tasks, facilitate learning and increase patient safety. Ultimately, CDSs are used to support users in their decision-making processes (HCC, 2010).

Many researchers note the potential for CDSs to promote appropriate ordering (Bautista et al., 2009; CAR, 2010; Czembirek et al., 2002; Kahn & Tjahjono, 1999; Sistrom & Honeyman, 2002; Sistrom, 2005). For example, a CDS used at MGH bent the utilization curve from a 12% annual increase for CT and MRI examinations to 1% and 7%, respectively (Rosenthal et al., 2006). Meanwhile, several pilot studies have been conducted in Canadian settings (Atlantic Health Sciences Centre [AHSC], CAR & Medicalis, 2005; CAR, 2007; Government of Saskatchewan, 2007). Of this research, no

study mentioned how physicians reach a decision or what methods of decision support are sought when faced with a challenging clinical scenario.

Parallels and lessons learned from other CDSs in health care. Without concrete evidence of how CDSs impact DI ordering practices, researchers can draw parallels to other CDSs used in health care to better explore this option. Computerized provider order entry (CPOE) systems act as a widely used example of decision support for health care. CPOEs are electronic prescribing platforms designed to increase efficiency and reduce errors. One way in which CPOEs can reduce errors is through imbedded decision support. This can alert a prescriber or pharmacist of medication interactions, allergies, and duplicate ordering, for example (Campbell, Guappone, Sittig, Dykstra, & Ash, 2009). However, the promises CDSs bring to prescribing practices are not guaranteed; many factors need to be considered for CDS adoption, as was learned through several CPOE CDS implementations (Seidling et al., 2011).

First, human factors need to be considered when designing and implementing a CDS. This includes the timing of advice and considering the workflow. Research suggests that to "optimize current and future systems, knowledge of human factors and esthetics as well as the psychological aspects of human-computer interaction should be included in the development process" (Seidling et al., 2011, p. 483). For example, a CDS needs to account for human factors such as timing the advice early in the system "instead of retrospective warnings after users have invested time entering the information in question" (Nanji et al., 2011, p. 6). As well, one CPOE required that the patient be admitted as an inpatient before a prescription could be ordered. This disturbed workflow for a physician who wanted to order a prescription for a patient who was being

transferred from the emergency department to an inpatient setting. Here, the system would not allow for advanced ordering and as a consequence, this impacted workflow (Campbell et al., 2009). Similarly, in a DI CDS pilot study, physicians noted workflow interruptions such as having to log into the system, the inconvenient physical location of the equipment, and the time to use the system added 2-3 minutes to each consultation (AHSC et al., 2005). Overall, human factors need to be considered when designing and implementing a CDS system, as demonstrated through CDSs used in CPOE.

Nanji et al. (2011) maintain that accounting for human factors can be done by incorporating the end-user into the development and testing stages of a CDS. As well, field experts should be consulted with regards to the content of the CDS and its alerts (Nanji et al., 2011). This helps to ensure that the information incorporated is appropriate as well as supports end-user buy-in.

However, even if the content is accepted by end-users, important alerts can be overridden and ignored. In fact, according to Weingart, Toth, and Sands (2003), 90% of alerts could be overriden. Although a CDS could be developed whereby an alert is not allowed to be ignored, end-users may refuse to use the system, or rely too much on the system and become complacent (Seidling et al., 2011). Thus, implementing a CDS without considering the factors that relate to end-user acknowledgement of alerts can lead to resistance. Seidling et al. (2011) note two factors affecting alert acceptance: the quality of the content provided in the alert, and the presentation of the alert. Knowing what factors influence alert acceptance can inform future developments of CDSs.

Overall, several ways to promote the appropriate use of DI resources are presented in the literature. These include imposing standards, more effectively

distributing guidelines, educating physicians and using CDSs. As literature surrounding CDS implementations for DI is limited, parallels can be drawn from other CDSs used in health care (such as CDSs included in prescription medication ordering systems). These solutions could help to promote patient safety and reduce strains on financial and human resources.

Summary of Current Literature

Literature published thus far largely describes factors contributing to inappropriate ordering: legal liability, patient demand, and unfamiliarity with guidelines. However, the literature does not describe the processes involved in ordering DI. It is indeed important to probe deeper into why inappropriate ordering is occurring, how a decision is made, and what methods of decision support a physician would use when ordering DI. Gaining insight into ordering practices could inform efforts to reduce inappropriate ordering, thereby increasing patient safety and decreasing unnecessary spending.

Current literature also suggests inappropriate ordering could be reduced by developing standards of practice, distributing guidelines in a more user-friendly format, educating physicians, and implementing CDSs. In fact, CDSs have been implemented in jurisdictions around the world—including several pilot studies in Canada; however, available literature only discusses post-implementation feedback from participants regarding the technology. Thus, examining DI ordering behaviour and beliefs regarding decision-making with a health informatics lens could inform how technology could be developed to suit user needs and promote appropriate ordering.

Research Questions

This research investigated the patterns of ordering DI services by physicians. Particularly, semi-structured interviews were conducted in an effort to answer the following research questions: How do physicians make decisions regarding DI during challenging clinical scenarios (where the physician is unsure whether a diagnostic imaging examination would be appropriate, or unsure which modality would be better)? What methods of information support do physicians seek when presented with a challenging clinical scenario? How do physicians determine if a DI examination has already been performed or is scheduled to take place? Do physicians feel inappropriate DI ordering is occurring in the medical field, and if so, to what extent? What could aid physicians in their DI decision making process? What could help to reduce inappropriate ordering (i.e. CDSs, guidelines, education, or other methods)? All of these questions aim to gain a better understanding of how physicians order DI services, and what efforts could be made to reduce inappropriate DI ordering.

By exploring DI ordering practices, other researchers can discover ways to reduce inappropriate ordering. Particularly, this research could inform the field of health informatics on CDS development. As pilot studies have revealed, CDSs can interrupt workflow and offer poor timing of advice (AHSC et al., 2005). Understanding how a physician decides on an order could inform the design of a system that suits workflow and physician decision-making activities. More generally, gaining the physician's perspective regarding the aforementioned research questions could also inform other efforts to reduce inappropriate ordering such as through guidelines, education, or other methods. Overall, these research questions are intended to help researchers gain a better

understanding of how physicians order DI and what efforts could be made to reduce inappropriate ordering—a gap in the DI literature.

Chapter 2: Methods

Research was conducted using a qualitative approach. This research included key informant interviews to gain a more rich understanding of the experiences and processes of ordering DI. This qualitative method allows for a more in-depth analysis of DI ordering than is possible with quantitative research alone. Grounded theory was applied in an effort to "develop a theoretical account that facilitates discussion of the general features of the topic under study and is firmly based or grounded in the data" (Martin & Turner, 1986, p.142). In other words, grounded theory was employed in order to generate theory from the data.

Participants

Key informant interviews were conducted with English speaking physicians who are permitted to refer patients to DI services in their jurisdiction. As part of the inclusion criteria, these physicians also needed to be currently practicing in Canada. However, radiologists were excluded because of their assumed greater knowledge of the radiology field.

Recruitment. Given that physician recruitment can be difficult, this research used four methods to contact physicians. First, the researcher's supervisors sent email invitations to contacts (who met the inclusion criteria) from previous University of Victoria research. Although the researcher's supervisors would know the physicians that were sent invitations, they would not know who has responded with interest to the researcher. This limit to confidentiality is addressed through an email letter of invitation to participate [Appendix A: Letter of Invitation to Participate], as well a verbal consent form [Appendix C: Verbal Consent Form for Participants] where potential participants

are informed that they should not feel obliged to participate based on any professional relationship with the researcher's supervisor.

In the second method of recruitment, the researcher sent physicians who are adjunct faculty members to the School of Health Information Science at the University of Victoria an email invitation. As with the first method of recruitment, the letter of invitation to participate [Appendix A] and verbal participant consent form [Appendix C] were the same as above, informing potential participants not to feel obliged to participate based any professional relationship with the researcher's supervisor. Similarly, the researcher's supervisor would not know who has agreed to participate.

Third, an email letter of invitation to participate [Appendix A] was sent to the email list for current University of Victoria Health Information Science graduate students by the department's graduate secretary. Although this invitation was sent to all graduate students (not specifically students who are physicians), the invitation explained the eligibility criteria; participants needed to be currently practicing non-radiologist physicians who are able to order DI services in their jurisdiction. Those interested were instructed to contact the researcher directly. Again, the email invitation to participate [Appendix A] and the verbal participant consent form [Appendix C] were the same as the first two methods of recruitment; students were informed that they should not feel obliged to participate on the basis of a professional relationship with the researcher's supervisor. Also, the researcher's supervisor would not know who has agreed to participate.

Last, a different email invitation to participate [Appendix D: General Letter of Invitation to Participate] was emailed to physicians who have their email addresses listed

on publicly available websites. This included the personal websites of physicians, as well as associations and societies. Physicians associated with other institutions (i.e. universities or research institutes) could only be contacted if the researcher had permission from the Human Research Ethics Board of the particular institution. To avoid confusion, physician participants contacted through this method were read a different consent form [Appendix E: General Verbal Consent Form for Participants] that excluded the information regarding participation based on a professional relationship with the researcher's supervisor.

Interviewed physicians were asked to recommend another physician who might be interested in being interviewed. This snowball method of recruitment was performed until the research reached saturation—the point when "data collected from new participants simply confirms previously collected data rather than adding new information" (Jackson & Verberg, 2007, p. 153). This is generally accomplished with five to ten participants (Borycki, E., lecture, September 28, 2010).

All physicians were contacted through an informative invitation by email [Appendix A and D]. The researcher's contact information included a phone number and an email address to support different preferences in communication styles.

As described in the email invitations, the researcher asked for 30 minutes of the participants' time to conduct the interviews. As physician time is indeed valuable and limited, recruitment was difficult. To overcome this limitation, more physicians were contacted than were needed. As well, information explaining the importance of this study was provided in both invitation letters [Appendix A and D].

Setting

Individuals who participated in the study were from across Canada. Therefore, all of the interviews were conducted over the telephone. To accommodate the physician's demanding schedule, telephone interviews were performed at the physician's convenience.

Methods

Data collection. The interviews were semi-structured in nature to ensure the most relevant topics were covered, while allowing for some flexibility. With permission, the interviews were recorded for the researcher to review. This was done using a telephone recording adaptor which connects a landline telephone to a digital voice recorder. One researcher conducted all of the interviews. The researcher wrote brief notes during the interview using a pen and paper, but was primarily engaged in the interview process. Immediately after each interview was completed, the researcher reflected on the interview and wrote more detailed notes. Additionally, the researcher transcribed and reviewed the recorded sessions to produce more comprehensive notes.

As the interview questions were regarding the DI ordering practices of physicians, the researcher wanted to ensure that participants did not feel judged on their responses. To mitigate this as a barrier, the researcher was very clear about the purpose of the study, provided a neutral atmosphere, and assured the participants that the interviews were anonymous and confidential.

Demographic data. Participants were asked to complete a short demographic questionnaire followed immediately by the semi-structured interview. The demographic questionnaire is tabled, below:

Demographic Questionnaire	
Screen for eligibility	
1.	Are you able to order diagnostic imaging examinations in your jurisdiction?
General demographic information	
2.	How long have you been a practicing physician?
3.	Do you have a specialty?
4.	What country did you do your medical education in?
5.	How many diagnostic imaging orders do you typically place in a week?
6.	What percentage of those orders do you feel are routine (routine as in non-challenging clinical scenarios; or commonplace)?
7.	What type of imaging modalities do you most typically order?

Table 2.1 Demographic Questionnaire

Semi-structured interview data. Key informant interviews were conducted based on a set of semi-structured questions. Participants were not given these questions in advance. These questions addressed the research objectives, outlining the decision-making activities of physicians when presented with a challenging clinical scenario as well as methods to reduce inappropriate ordering. Participants were given a definition for inappropriate ordering (see Chapter 1) before beginning the interview. These semi-structured interview questions are tabled, below:

Key Informant Interview Questions	
1.	Can you describe your thought process when presented with a challenging clinical scenario, where you are unsure whether a diagnostic imaging examination would be appropriate, or unsure which modality would be better. (In other words, how do you proceed if you are unsure whether the examination is of clinical value?)
2.	Can you give me a couple of examples where you were unsure of whether an examination was of clinical value? (In other words, can you walk me through the situation and describe the steps you took?)
3.	Can you indicate your top three methods of obtaining information to support your decision when presented with a challenging clinical scenario?
4.	How do you determine if an examination has already been performed or is scheduled to take place by another physician?
5.	To what extent do you feel appropriate diagnostic imaging ordering is occurring in the medical field?
6.	Do you think examinations are being ordered unnecessarily? If yes, to what extent do you think this a problem, please describe.
7.	What do you think could aid physicians in deciding whether to order an image, and which type of imaging modality to select?
8.	Do you think inappropriate ordering could be reduced by the introduction of: CDSs, guidelines, education, other methods (please describe).

Table 2.2 Key Informant Interview Questions

After completing a short demographic questionnaire, participants discussed DI ordering practices based on semi-structured interview questions (tabled above and also shown in Appendix B).

Data Analysis

Data was analyzed throughout the data collection process using the constant comparative method. Here, "data collection and analysis are interrelated processes" (Corbin & Strauss, 1990, p. 6). In other words, data analysis is a continuous process, beginning during data collection. First, data was coded according to patterns found in the

interview transcripts. In other words, similar findings were grouped together for further analysis. At the first level of coding, data were examined by the researcher using notes taken during the interview, immediately following the interview, and while transcribing the recordings. These notes were examined to identify words or themes. Using a more Straussian approach, open coding was used to "give the analyst new insights by breaking through standard ways of thinking about or interpreting phenomena reflected in the data" (Corbin & Strauss, 1990, p. 12). The second level of coding compares level one coding against each other in an attempt to condense similar words or themes into categories. Finally, level three coding involved recognizing core variables—a conceptual element that "focuses the theory and accounts for most of the variation in a pattern of behaviour that is both relevant and problematic for the participants involved" (Jackson & Verberg, 2007, p.175). Basic social psychological processes are also identified in this stage. These often reflect "the title given to the themes that emerge from the data" and that happen "over time and that involve changes over time" (Jackson & Verberg, 2007, p. 175).

After the three stages of concept formation, concept development occurs if further data analysis is not required. Concept development required reduction, selective sampling of the literature, and selective sampling of data to support the core variable. In reduction, the researcher compared the categories and noted any relationships that could be identified under a more general or unifying category. Selective sampling of the literature usually occurs in grounded theory data analysis. Here, the researcher reviewed literature pertaining to the topic and used this information to inform the emerging theory. In this study, however, the researcher already performed a literature review. This step

was used to identify more current research that was not available at the time of the first literature search. After the researcher identified key concepts, selective sampling of the data was performed to "develop the hypothesis statements further, to identify the properties of the main variables, and to ensure saturation of the categories" (Jackson & Verberg, 2007, p. 177). After these three stages were complete, a core variable surfaced (Jackson & Verberg, 2007).

The constant comparative method involves another level of data analysis/comparison (theoretical coding) whereby unused or misaligned concepts are reintroduced to the theoretical findings and compared. After this, theoretical memorandums—which have been developed throughout the research process—are collected and integrated into the research. While the length of a memorandum varies, the purpose remains stable: to scribe "categories, properties, hypotheses, and generative questions" that emerge from the process of data collection and analysis (Corbin & Strauss, 1990, p. 10). These memorandums helped fasten concepts together to produce the grounded theory. Thus, a theory emerged from the data.

Chapter 3: Results

In this chapter, the results from the key informant interviews are presented. After reviewing participant demographics, appropriate ordering—the dominant theme that emerged from this study—will be discussed. Again, for the purpose of this study, appropriate ordering refers to useful investigations whereby "the result—positive or negative—will alter clinical management and/or add confidence to the physician's diagnosis" (CAR, 2005a, p. 8). Appropriate ordering is further analyzed by investigating what methods of information support a physician would seek when presented with a challenging clinical scenario. In contrast, this section explores the factors that contribute to inappropriate ordering: patient demand (including poor health literacy, patient anxiety, and the threat of patients leaving one's practice), legal liability, and duplicate orders. To support appropriate ordering, a summary of solutions that were suggested by participants will also be presented. These include CDSs, guidelines, education, requisition communication, and restricting access to DI examinations. Overall, appropriate ordering emerged as an overarching theme in this study.

Participants

Using the four methods of recruitment outlined in chapter 2, a total of 273 physicians were contacted by email to participate. Seven email delivery failure notifications were received by the researcher, reducing the total number of potential participants contacted to 266. Of those physicians who were contacted, 13 responded with interest in participating and 12 carried through with participating in the interviews; thus, the response rate was 4.5%. A study examining the response rates of health care professionals on internet-based surveys found response rates between 9% and 94%

(Braithwaite, Emery, de Lusignan, & Sutton, 2003). However, no studies are present in the literature that examine the response rates for recruiting physicians by email to participate in key informant interviews. Therefore, comparing response rates to other studies is difficult. Email invitations were sent to physicians over a seven week period. Emails were sent to physicians who had emails posted on publicly available websites (when permission was granted by the Human Research Ethics Boards of institutions where faculty members' email addresses were posted on publicly available websites). Overlapping with recruitment, interviews were conducted over an eight week period, until saturation was reached.

Participants included four general practitioners, two geriatricians, two neurologists, one rheumatologist, one respirologist, one hepatologist, and one emergency physician. The participants completed their medical education at universities in Canada (7), the United Kingdom (3), New Zealand (1), and Lebanon (1). Years of experience varied among participants with a range between 4.5 and 35 years. Years of experience is further described with measures of central tendency: mean (20.33), mode (27) and median (22). Years of experience is presented in the Table 3.1 (below). In summary, most participants (9/12; 75%) had over 15 years of experience. Also, physicians were mostly educated in Canada (58%) and the United Kingdom (25%) for varying specialties and in general medicine.

	Years of Experience
Range	4.5 to 35
Mean	20.33
Mode	27
Median	22

Table 3.1 Participant Years of Experience Practicing as a Physician

Demographic Questionnaire Results

As part of the demographic questionnaire, participants were asked to recall how many diagnostic imaging orders they would typically place in a week. As some participants responded with a range, those results were analyzed using the mean of the two numbers. This ranged from 1.5 to 85 requisitions being placed in a week. This can be further described with measures of central tendency: mean (23.58), mode (15, 20, and 25), and median (18.75). These results are highlighted in Table 3.2:

	Requisitions/Week
Range	1.5 to 85
Mean	23.58
Mode	15, 20, 25
Median	18.75

Table 3.2 Number of Diagnostic Imaging Orders Placed in a Week

Physician participants were also asked to ascribe a percentage to how many DI requisitions placed in a week were routine (i.e. a non-challenging clinical scenario). The responses ranged from 0 to 80% with a mean of 48.83%. Meanwhile, the median was 55 and the mode was both 50 and 80. These findings are represented in table 3.3, below:

	Non-challenging DI orders
Range	0 to 85%
Mean	48.83%
Mode	50%, 80%
Median	55%

Table 3.3 Percentage of Non-challenging Diagnostic Imaging Orders Placed Each Week

During the demographic questionnaire, participants identified the DI modalities that they most typically used. Most participants listed more than one modality, in no particular order. Interestingly, participants listed using x-ray (9/12; 75%), CT (9/12; 75%), ultrasound (7/12; 58%), MRI (6/12; 50%), and PET (1/12; 8%) most typically. This is represented in Table 3.4, below:

Imaging Modality	Frequency
X-Ray	9 (75%)
CT	9 (75%)
Ultrasound	7 (58%)
MRI	6 (50%)
PET	1 (8%)

Table 3.4 Diagnostic Imaging Modalities Physicians Most Typically Order

In summary, the majority of participants (75%) had over 15 years of experience in various specialties and general medicine. As well, most participants completed their medical education in Canada (58%) or the United Kingdom (25%). Although the number of DI orders placed in a week ranged from 1.5 to 85, the mean was 23.58. Meanwhile, the mean for non-challenging DI orders was 48.83%. Participants also listed their most typically ordered DI modalities: x-ray, CT, ultrasound, MRI, and PET. Thus, the results of the demographic questionnaire showed the participants' experience, country of medical study, number of DI orders placed in a week, percentage of routine DI orders, and types of imaging modalities most typically ordered.

Interview Results

The overarching theme that emerged from the interviews was ordering (both appropriate and inappropriate ordering). Again, appropriate ordering, refers to cases "in

which the result—positive or negative—will alter clinical management and/or add confidence to the physician's diagnosis" (CAR, 2005a, p. 8). Meanwhile, inappropriate ordering occurs in situations where the most ideal imaging is not selected, when imaging would not change or support patient management, when the examination is performed too early, or when a duplicate order is placed (CAR, 2005a). This dominating theme of appropriate and inappropriate ordering is highlighted throughout this section.

Particularly, the interview data includes whether participants felt appropriate DI ordering was occurring in the medical field. As well, what methods of information support a physician would seek when presented with a challenging clinical scenario to ensure that their decision of whether to order DI and if so, which type of modality to select is most appropriate. In contrast, the interviews helped to identify several factors that influence appropriate ordering: patient demand, legal liability, and duplicate orders. This is juxtaposed with possible solutions to support more appropriate ordering: education, guidelines, CDSs, increased communication on requisitions, and restricting access to certain DI modalities.

Appropriate ordering. During the key informant interviews, participants were asked to what extent they felt appropriate ordering was occurring in the medical field. Of the twelve participants interviewed, eleven addressed this question (n = 11). Interestingly, ten participants (10/11; 91%) described an overuse of DI examinations in the medical field in general. The extent to which participants felt the overuse of DI was occurring was varied, with some participants using descriptive words, and others ascribing percentages or values to the number/amount of appropriate orders. Meanwhile,

one participant (1/11; 9%) commented on how DI was generally appropriate, but limited the comment to this participant's specialty field. This is represented in table 3.5:

Is Appropriate Ordering Occurring in Medical Field?	Frequency
No	10 (91%)
Yes	1 (9%)

Table 3.5 Occurrence of Appropriate Ordering in the Medical Field, in General, as described by participants

This finding is further demonstrated through excerpts from the interviews. First, participants described the overuse of DI with various levels of intensity as demonstrated through their word choices:

> Most of it is inappropriate. There is no extent...I think it is way overdone and a lot of it is inappropriate—a big chunk of it is inappropriate. (Participant 10, Line 121-124)

> I think people do the radiology things just because it's there…they've stopped thinking anymore. I mean, it's all tests. I mean, people don't even ask patients anymore what's wrong with them, or what is the complaint. They look at the blood test, they do a scan or an imaging or whatever and then they just move on…I can guarantee you there are more [CT] scans that are being done with all the radiation and whatever than ever before. I just can't believe the amount that goes on. (Participant 11, Line 127-150)

> Well, in general, I would think it's largely inappropriate…I think it's a problem to a large extent…I despair of it. (Participant 01, Line 24-30)

Meanwhile, some participants ascribed a percentage or a value to demonstrate the extent to which they felt appropriate ordering was occurring in the medical field:

> 10% inappropriate based on those criteria. (Participant 05, Line 44)

> To what extent. I would say only half of it is appropriate…If we follow evidence-informed clinical decision-making, things like the Ottawa Ankle Rule and a couple other things that have been well published, we wouldn't be doing half of the x-rays that we do. (Participant 04, Line 90-93)

> If I were to give a guesstimate, I think there's 10-15% of the time, I think there's inappropriate of scans and x-rays and things. (Participant 11, Line 151-152)

Overall, ten participants (10/11; 91%) felt DI was inappropriately used to some extent. This finding is supported by excerpts from the key informant interviews. In summary, the majority of participants thought inappropriate ordering was occurring in the medical field.

Thought process during challenging clinical scenarios. During the interviews, physicians were asked to describe their thought process when presented with a challenging clinical scenario: a scenario where they were unsure whether to order DI, or unsure which modality would be most beneficial. Participants were also asked to provide an example of a time when they were unsure whether to order DI, or which modality to select. The purpose of these questions was to understand how a physician proceeds when faced with a difficult clinical scenario—a key piece missing from the literature to date (see Chapter 1, above). Common to all interviews (n = 12) were descriptions of how participants would order imaging if they foresaw it as changing patient management, used for diagnosis, or used it for both patient management and diagnosis. In fact, six participants described how DI was ordered to help reach a diagnosis (n = 6; 50%). Meanwhile, three participants explained that DI would be ordered in circumstances where the results of a DI examination would support patient management (n = 3; 25%). As well, three participants indicated that they would use DI for both diagnosis and patient management (n = 3; 25%). Using DI to reach a diagnosis is illustrated in the following interview except:

> Will it help me with my pathway to hopefully make a diagnosis? These are obviously not routine ones. Will I utilize the result in a decision point? (Participant 05, Line 2-3)

In this excerpt, the participant explains the use of DI to support patient management:

> The thought process would be whether a specialty test would alter a clinical decision. That means, if I order a specific test x, would it change my management? (Participant 06, Line 1-2)

Meanwhile, the following quotation represents how DI is used for both diagnosis and patient management:

> Well, the first thing is, is imaging going to help answer a question that will affect management? So, that's the first question I want to ask, is this going to help in the diagnosis or the management? (Participant 09, Line 1-3)

Thus, each participant described questioning the utility of the examination when ordering DI, whether it was to reach a diagnosis, to support patient management, or both. Figure 3.1 illustrates how a physician's thought process influences decision-making with respect to appropriate ordering.

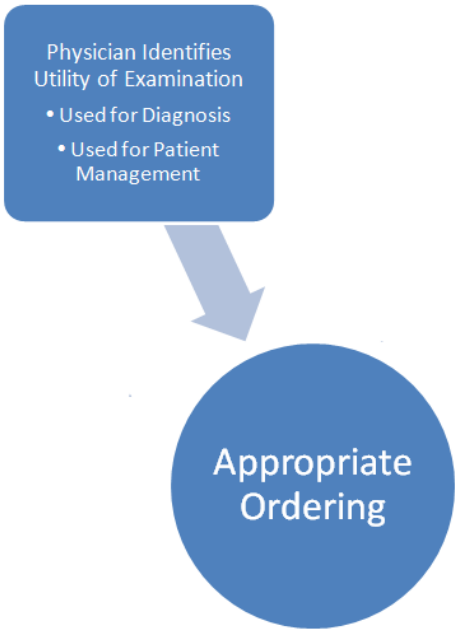

Figure 3.1 Physician Thought Process Influences Decision-Making with Respect to Appropriate Ordering

Information support. To support appropriate ordering, physician participants were asked to indicate their top methods of obtaining information support when they were presented with a challenging clinical scenario. This excluded clinical information that the individual patient presents such as clinical history and physical examinations. Clinical history refers to "a collection of information obtained from the patient and from other sources concerning the patient's physical status and psychologic, social, and sexual functions. The history provides a data base on which a plan for management of the diagnosis, treatment, care, and follow-up may be made" (Mullins, 1986, p. 512). Meanwhile, a physical examination refers to "an investigation of the body to determine its state of health, using any and all techniques of inspection" (Mullins, 1986, p. 880). In summary, physician participants identified their top method of obtaining information to support a decision when faced with a challenging clinical scenario.

In this study, one participant did not disclose any methods of information support (n = 11). Here, participants indentified their top methods of information support, including consulting a radiologist (4/11; 36%). Meanwhile, several participants (3/11; 27%) reported using UpToDate®, a decision support system that uses "current evidence to answer clinical questions quickly and easily at the point of care" (UpToDate®, 2012). Several other participants (3/11; 27%) identified consulting a colleague/specialist for information support. Last, one participant (1/11; 9%) reported using Google Scholar, "a search engine for a wide range of academic fields. It searches for scholarly publications, including peer-reviewed articles, theses, books, and abstracts from academic publishers, professional societies, pre-print sources, and universities" (Anders & Evans, 2010, p. 578-579). Overall, participants most often stated that consulting a radiologist, consulting a colleague/specialist, and using UpToDate® were used as information support in a challenging clinical scenario. These findings are reported below in Table 3.6:

Top Method of Information Support	Frequency
Consult Radiologist	4 (36%)
Consult Colleague/Specialist	3 (27%)
UpToDate®	3 (27%)
Google Scholar	1 (9%)

Table 3.6 Top Method of Obtaining Information Support

These findings are further supported with the following excerpts from participant interviews. First, one physician explains about consulting a radiologist as a top method of obtaining information support:

> I go straight to the radiologist usually. I find them very helpful and much more informed, and if they can give me an answer quickly, grand. (Participant 09, Line 5-17)

Another participant explained the convenience of consulting colleagues when involved in a challenging clinical scenario, below:

> Discussion with colleagues: we work in a specialty clinic, but there's usually several other clinicians in the same area. So, often we have off-the-cuff discussions. (Participant 02, Line 20-21)

Last, another physician briefly explains using UpToDate® as a method of information support:

> I usually use UpToDate®. We have it in our office, I use that a lot. (Participant 02, Line 16)

Findings can be further analyzed by grouping similar information support modalities together. Specifically, consulting a radiologist, colleague, or specialist could be grouped together as all these methods require consulting another physician. Using UpToDate® and Google Scholar could be grouped together as both literature-based methods require searching, reading, and synthesizing information. Using these condensed groupings, 7/11 (64%) participants would seek information support from another physician. Similarly, 4/11 (36%) participants would conduct some form of literature search as their top method of information support. This is illustrated Table 3.7, below

Top Method of Information Support	Frequency
Consult Physician: • Consult Radiologist • Consult Colleague/Specialist	7 (64%)
Literature Search: • Use UpToDate® • Use Google Scholar	4 (36%)

Table 3.7 Top Method of Information Support Condensed Into Categories

Reducing the top reported methods of information support into two categories—Consult Physician and Literature Search—displays the overarching types of information sought by participants in challenging clinical scenarios. Figure 3.2 expresses how information support relates to the broader theme of this study: appropriate ordering, below:

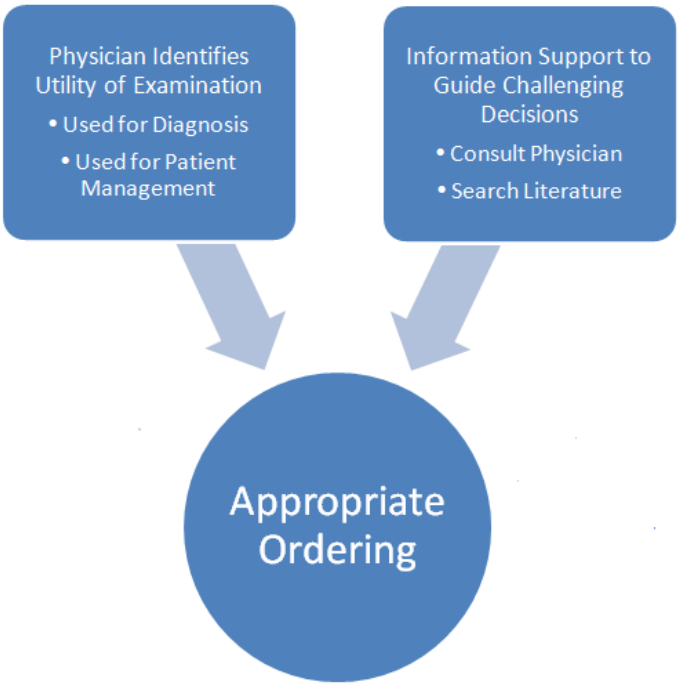

Figure 3.2 Methods of Information Support Used for Decision-Making in a Challenging Clinical Scenario.

Contributing factors to inappropriate ordering. Participants identified a number of factors that lead to inappropriate ordering. This was usually in response to the interview question that asks participants whether they believe DI examinations are being ordered unnecessarily, and if so, to what extent they thought this was a problem. The

interview data suggests that surrendering to patient demand, protecting oneself from legal liability, and not knowing if an examination has already occurred are three reasons that physicians may not order appropriately. This subsection outlines these findings in further detail.

Patient demand. All but one participant (n=11) commented on how patient demand can influence a physician's decision to order DI services. After the first few participants mentioned patient demand, the interviewer began to prompt participants to comment on patient demand for the remaining interviews. According to physician participants, patients may demand imaging based on lack of health literacy—the "degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" (Ratzan and Parker, 2000, p. ix). Participants also noted that physicians may surrender to requests for imaging to alleviate the patient's anxiety. Similarly, some participants feared that patients would leave one's practice to consult another physician. The following section will describe the physician's perception of patient health literacy, anxiety, and the threat of a patient leaving to see another physician as contributing factors in the decision-making process for ordering DI.

*Health literacy***.** Again, health literacy describes the ability of individuals "to access and use health information to make appropriate health decisions and maintain basic health" (Canadian Council on Learning, 2007, p. 4). In this study, seven participants (7/11; 64%) identified how patients demand DI services based on information from unreliable sources such as the media, internet, or from family and friends. As well, participants described how patients can have unrealistic expectations

about what DI can detect. Similarly, patients may also request to have imaging performed earlier or more frequently than what the physician considers appropriate. Here, the role of health literacy in the physician-patient consultation is highlighted through this sub-section.

As described by participants, patients may demand imaging based on information found on the internet or through other media such as the television or radio. Patients may also request imaging based on hearsay from their friends or family. Using information from unreliable sources is exemplified in the following participant quotes:

> A lot of people look-up and Google things and look things up, and 95% of the things people look-up I would say are garbage. The internet is a very dangerous place. (Participant 10, Line 128-130)
>
> There's a sort-of standard, well fairly standard, perception in the general population that's driven by media and the internet and hearsay saying, "oh, you should have an x-ray, or you should have that." So, a lot of people actually ask for an imaging investigation and I actually spend a fair amount of my time actually dissuading people from these things. But, it's difficult; a fairly big proportion of imaging things are done because they're driven by patient requests, what I would consider unnecessary. (Participant 10, Line 4-10)
>
> People come in and say "I think I need an MRI" or, you know, "I've been reading about such and such test, do you think that I need that?" and I think, again, usually I try to only order things that are going to change the management of the patient or that I agree is appropriate. (Participant 02, Line 39-42)
>
> Generally, it's the daughter from Toronto: "How could you possibly have that if you didn't have a [CT] scan?" (Participant 01, Line 42-43)

Similarly, several participants also disclosed their concerns about patients who have unrealistic expectations about what DI can detect. The following quotes illustrate this:

> There are certain things that we don't have tests for. But, [doctors], instead of explaining that to the patient, they just keep on doing more tests. And so the patients think that unless you check on the scan today again, you're going to miss the problem, and that's not the case. (Participant 11, Line 84-87)
>
> But, unfortunately, patients say, "well I'd like to have an x-ray anyway because it might be something else." And I say, "well, I'm pretty sure it isn't." "Yea, I

> know, but let's do one anyway." So, you get coerced into doing it, even though you know it isn't necessary. So, a lot of that goes on, too. (Participant 10, Line 89-92)
>
> Patients will demand or have definite expectations [that] they want a total body MRI just to be safe. (Participant 05, Line 57-58)

Participants also noted how patients request DI services earlier, or more frequently than is deemed clinically indicated by their physician, as exemplified below:

> For example, if there was a plan to follow-up on some finding in 6 months, the patient request might be "why can't it be done next week, or in three weeks?" And usually that involves an explanation on what's being followed; if it's going to change, it's not going to change fast enough to make this worthwhile, in which case, you've just had the radiation exposure without any realistic chance of it showing anything new. So, not unexpectedly, their anxiety might lead to know answers faster and it won't necessarily help. (Participant 03, Line 85-90)
>
> Because of increased patient expectations, there's more awareness of health issues and a more consumer-type where people [will say] "well, I want to know an answer like now today" and the patients are less willing to wait. Then, imaging is being ordered more frequently. (Participant 07, Line 79-81)

In summary, patients may demand DI examinations based on unreliable information sources found through the media and internet, and from family and friends. Patients may also demand DI examinations based on unrealistic expectations of what the imaging technologies can detect. Similarly, participants described how patients may request DI examinations earlier or more frequently than what is deemed necessary, according to the physician. The previous interview excerpts all contain elements of how health literacy is influencing patient demand.

Patient anxiety. Patients who exhibit anxiety, as perceived by the physician, may persuade physicians to order in situations where DI may not be most appropriate. Anxiety refers to "a state or feeling of apprehension, uneasiness, agitation, uncertainty, and fear resulting from the anticipation of some threat or danger" (Mullins, 1986, p. 78).

In fact, five participants (5/11; 45%) identified how physicians may order DI services in an effort to mitigate a patient's anxiety. This is highlighted through the following excerpts:

> Sometimes, if there's a significant amount of patient anxiety, or yea, if they are not going to rest until that happens, then, I think, sometimes probably imaging is done in that case, unnecessarily. (Participant 02, Line 45-46)

> But there is a sway in the sense that patient anxiety around a specific condition that sometimes a test was done to alleviate their anxiety. That means, even though it was derived that we shouldn't have done the test based on best evidence that sometimes the personal aspects of the patient interaction are such that we would be swayed into doing a test just simply to reduce worry and anxiety and so forth. (Participant 06, Line 6-11)

Patient anxiety, as perceived by the physician, was noted to be a contributing factor to inappropriate ordering. The previous examples illustrate how DI may be ordered to reduce the patient's anxiety.

Threat of patients leaving. A couple of participants (2/11; 18%) also described the threat of patients leaving to see another physician as an influencing factor with respect to decision-making and DI. In other words, physicians feared that refusing to order DI examinations may provoke a patient to leave the care of his/her current physician for another physician. The following quotes illustrate this pressure:

> If they come and see you and they don't like what you say they can turn around and see somebody else the next day or even the same day, right. So they are the biggest driver and they are not the smartest driver because they don't know anything about guidelines or clinical decision support, but they do drive you because it is, unfortunately, a business, and they're forcing you to do things that are inappropriate. (Participant 10, Line 72-78)

> I've lost some patients over the years because I've said, "no we're not going to do that because we don't need to." And if they really want it, then they'll have to find someone else who will do it. (Participant 05, Line 59-61)

These examples highlight how physicians are aware that unsatisfied patients may leave to consult with other physicians. Interestingly, these two participants expressed different ordering outcomes. Specifically, participant 10 suggested that this threat forces physicians to order inappropriately. Meanwhile, participant 05 states that patients would have to find another physician who would be willing to order the DI. However, both participants identified how denying patient requests is at the risk of losing the patient to another physician.

With the exception of one, all participants described the role of patient demand in decision making surrounding DI. For example, as noted by participants, patients may demand imaging based on poor health literacy. Participants also identified how patient anxiety can influence a physician's decision to order DI. Likewise, participants also noted the risk of dissatisfied patients leaving to seek another physician. This was a factor that influenced their decision-making. A summary of these findings is displayed in Table 3.8, below:

Patient Demand	Frequency
Patient Demand	**10 (91%)**
Health Literacy	7 (64%)
Patient Anxiety	5 (45%)
Threat of Patients Leaving	2 (18%)

Table 3.8 Patient Demand as a Contributing Factor to Inappropriate Ordering. Patient Demand is Further Broken-Down into Health Literacy, Patient Anxiety, and Threat of Patients Leaving. Some Overlap Occurs.

In summary, patient demand was described as a factor that influenced physician participants' DI ordering.

Legal liability. Although not prompted by the interviewer, participants noted that sometimes physicians will order DI examinations in situations that may not be the most appropriate because of concern about legal liability. That is, some physicians indicated they feared being sued and ordered DI defensively. Interestingly, 6/12 participants (50%) described how legal liability influences physicians to order DI examinations. This finding is tabled, below:

Legal Liability Contributed to Inappropriate DI Ordering	Frequency
Agree	6 (50%)
Disagree	1 (9%)
Did Not Mention	5 (41%)

Table 3.9 Legal Liability as a Contributing Factor to Inappropriate DI Ordering

Meanwhile, the following excerpts are illustrative of this finding:

> I would definitely say that some of my decision making around imaging is to document normality given certain warning symptoms. And so, even though I know that the likelihood of the test being abnormal is low, I feel that it is necessary to actually show that, in case of the rare situation where it wasn't. So, I would say, medico-legally, that's in the back of my mind. (Participant 02, Line 50-54)

> So, a lot of [doctors] will in turn cover their ass and order an MRI. That's inappropriate in my mind. You need to have a [doctor] with the confidence in their clinical capabilities they won't need as much imaging. And I think as we are evolving, imaging is becoming an abused diagnostic tool. (Participant 05, Line 53-56)

> But, if you do [imaging] anyway, and it is partly defensive medicine, in other words, for medico-legal things or where you say, if you don't do an investigation you might be accused of being incomplete, so that's a driving force, or another factor. (Participant 10, Line 20-23)

In contrast, one participant (1/12; 8%) described feeling confident in only ordering medically necessary examinations because of protection from the Canadian Medical

Protective Association (CMPA). The CMPA "provides its physician members with medico-legal advice, risk management education and legal assistance related to their clinical practice" (n.d., para. 1). This participant's perspective is presented below:

> But at least we're confident that from a medico-legal standpoint, if the patient did decide to sue us, then we could say clinically that it's not justified and that would probably be upheld…I think we feel quite confident—I mean it is always at the back of our mind—but, I think in general, the Canadian Medical Protective Association for physicians, we feel quite confident in. (Participant 07, Line 144-149)

In summary, half of the participants reported how physicians may order DI examinations to protect themselves from legal liability. Meanwhile, one participant denied feeling this pressure; the physician expressed confidence in her/his DI decision-making, based on protection from the CMPA. Overall, however, more participants (6/12; 50%) identified how physicians order DI for fear of litigation.

Duplicate ordering. Duplicate ordering refers to repeating DI examinations which have already been performed (CAR, 2005a). During the key informant interviews, participants were asked how they determine if an examination has already been performed or is scheduled to take place by another physician. Interestingly, 8/12 participants (67%) noted that asking the patient would be the top method for determining if an examination has already been performed or scheduled to take place. The remaining four participants (4/12; 33%) stated they used a Picture Archiving and Communication System (PACS), or other electronic systems to determine if a DI examination has already been performed. PACS is an "information technology tool that has emerged as a key enabler of improved access and patient care delivery in Canada today. PACS enables a diagnostic imaging service to manage, store, and distribute digital images from [DI

technologies] such as CT, MRI, x-ray, and ultrasound" (CAR, 2009b). However, all participants who identified using these imaging services noted that this would be for internal use only (i.e. within a health care organization); in other words, these physicians can only determine whether a DI examination has occurred within the network or hospital that the imaging service serves. The following table (Table 3.10) lists the methods participants used to determine if a DI examination had already taken place:

Method to Determine if DI was Already Performed or Scheduled	Frequency
Ask the Patient	8 (67%)
Look at PACS or Electronic System	4 (33%)

Table 3.10 Duplicate Ordering: Participants Determine Whether a DI Examination has Already Been Performed or is Scheduled to Take Place.

This finding is also highlighted in the interview transcript excerpts. Below are excerpts from participants who asked the patients if a DI examination had already been ordered or performed:

> The easiest way is to actually ask the patient, you know, "has someone else ordered this test?" And they may or may not know. (Participant 06, Line 92-93)

> The most reliable thing is probably still asking the patient. (Participant 07, Line 56)

> That's a very good question, and it's almost impossible. The flow of information between doctors or between institutions like hospitals and physicians and between specialists and GPs is almost non-existent. A lot of the time, the only thing you have, most of the time, you wouldn't have anything and you wouldn't know if something has been done, other than just by asking the patient…so really, the patient would be the number one source of information. (Participant 10, Line 50-56)

The previous examples illustrate how participants ask patients about prior DI examinations. Meanwhile, the following quotes illustrate how physicians use PACS or

other electronic systems to verify if DI has already been performed or has been scheduled to take place:

> So, if it's happened before, and it's in our health district, it will show up on our diagnostic imaging database. (Participant 03, Line 60-61)

> If it's already been performed, I can find out because I can log into our electronic system…It has everything from within the Province. (Participant 09, Line 41-42)

These excerpts illustrate how some participants used PACS or other systems to discover whether their patients have already had specific DI examinations within their given jurisdiction.

Overall, to determine if an examination has already been performed or is scheduled to take place by another physician, the majority of participants (8/12; 67%) expressed that they would ask the patient. However, the other third of participants (4/12; 33%) would consult an electronic system used in their jurisdiction such as PACS, or another database.

Conclusion to contributing factors to inappropriate ordering. Participants explained that several factors contribute to inappropriate DI ordering. These factors include surrendering to patient demand. Particularly, poor health literacy may lead patients to request DI examinations. Meanwhile, patient anxiety and the risk of patients leaving to see another physician also influence a physician's decision when ordering DI. Ordering DI defensively to avoid legal liability, and not knowing if an examination has already been performed are two other reasons that physicians may order inappropriately. In conclusion, several factors were identified by participants that contribute to inappropriate ordering. These are summarized in figure 3.3 in relation to the other study findings.

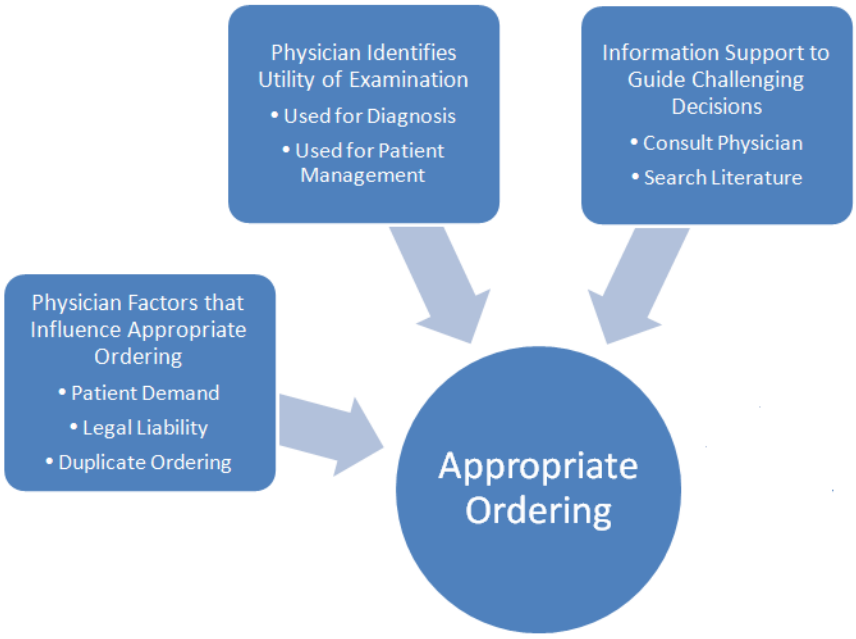

Figure 3.3 Contributing Factors to Inappropriate Ordering Placed in Relation to Other Study Findings

Solutions to inappropriate DI ordering. During the key informant interviews, participants identified ways that more appropriate ordering practices could be supported in response to the last two interview questions. For example, CDSs, which refer to "any computer program designed to help healthcare professionals to make clinical decisions" (Musen et al., 2006, p. 701), were discussed as a means of minimizing inappropriate ordering. Participants were also prompted to comment on whether they believed guidelines, or education would reduce inappropriate DI ordering. Without prompting by the interviewer, several participants discussed how greater communication on requisitions, and restricting ordering authority for DI examinations to certain physician

specialities could reduce inappropriate ordering. These proposed solutions are discussed in further detail in this section.

Clinical decision support systems. Participants were prompted to discuss their thoughts regarding whether a CDS would be an effective method for reducing inappropriate ordering. Again, CDSs include "computerized tools that aim to improve patient care by putting best-practice recommendations directly onto computer and hand-held devices for physicians. Features might include up-to-date clinical practice guidelines, automated reminders for preventive screening, software that flags drug interactions, or guidelines for appropriate diagnostic imaging referrals" (HCC, 2010, p. 37). Nine participants (n = 9) answered the interview question about whether they thought inappropriate ordering could be reduced through the introduction of a CDS. The responses were mixed; four participants (4/9: 44%) were undecided as to whether CDS could reduce inappropriate ordering. Next, three participants (3/9; 33%) thought CDS could potentially reduce inappropriate DI ordering. Last, two participants (2/9; 22%) responded with comments suggesting that they did not think CDS would reduce inappropriate ordering. Overall, the topic of CDS with regards to reducing inappropriate ordering was met with mixed responses. The following table (Table 3.11) presents these findings:

Could CDS be an Effective Method to Reduce Inappropriate Ordering?	Frequency
Undecided	4 (44%)
Yes	3 (33%)
No	2 (22%)

Table 3.11 CDS Could Help to Reduce Inappropriate Ordering

To support these findings, the following excerpts illustrate how some participants were undecided as to whether CDS would reduce inappropriate ordering:

> I think decision support will aid in efficiency of improving wait-times. But, I don't think decision support will aid in ordering the right test, necessarily. Certainly, decision support is a complex thing…I'm not entirely sure it would [reduce inappropriate ordering]. Now, it can do a whole host of other things, but, I'll sit on the fence on that. (Participant 06, Line 108-112)

> I'm sort of a bit hot and cold about those sorts of things because we have been, we've spent quite a bit of time trying to develop decision support aids like that are electronic, or perhaps not even electronic, and they have not been met with overwhelming enthusiasm and they're not always used. (Participant 08, Line 58-61)

> So we can put in business rules to decrease duplication. We can put in some business rules to say another imaging modality that is more sensitive and specific, so you should probably order that. But, in the end, there may have to be some fiscal things. (Participant 08, Line 117-120)

> The success of assisting decisions with algorithmic approaches depends on how complex the question is. So, a simple question is well suited to it; a more complicated one is less well. One concern is always that complex situations tend to get punched into simple boxes, because that's where the algorithm is, where it may not apply. So, yea, I think there is potential to streamline ordering where point of care ordering may request additional information, to make that additional step and ask people to ensure to that to sort of consider all the pieces that should be there. But, there's always an alternative side to many—complex situations aren't easy to break into those steps. So, the wrong application could still apply even though, you know, may be applied to the wrong situation. (Participant 03, Line 94-101)

Meanwhile, the following interview excerpts are indicative of the thoughts of participants who expressed that CDS could be used to reduce inappropriate ordering:

> As long as [the CDS] is user-friendly and isn't a barrier. (Participant 09, Line 45)

> Out of all of those ones [that interviewer prompted with], the one that would work the best is the decision support one…you almost have to create a decision analysis, it's almost like a fuzzy logic, where it will give you the chances of a certain diagnosis versus another one. (Participant 11, Line 196-201)

In contrast, the below quotes from interview transcripts indicate how some physicians do not think that CDS could reduce inappropriate ordering. The first example describes how the time needed to enter information into a CDS would be a barrier to adoption:

> No, I would spend too much time—I would imagine I would have to put in data, build a scenario to allow a computer [to come up] with an algorithm to give me some hints or some suggestion. And it would probably come back to me, already knowing my options. (Participant 05, Line 76-79)

Next, the following excerpt voices the concern that perhaps CDS would not address the underlying issues surrounding inappropriate ordering:

> Your question was could some sort of a CDS reduce inappropriate ordering, and I think no because you would still have the patient…So, the answer is no, the CDS would not significantly reduce inappropriate ordering. Because, we already know that, that a lot of the things are really unnecessary. (Participant 10, Line 69-98)

In summary, participants had mixed responses when asked about whether a CDS could reduce inappropriate DI ordering. Specifically, four participants were undecided regarding CDS as a means to reduce inappropriate ordering. Meanwhile, three participants believed that CDS could reduce inappropriate DI ordering; however, the remaining two participants were not convinced that CDS could aid in minimizing inappropriate ordering. Thus, responses were varied among physician participants. The majority of physicians remained undecided as to whether CDS could reduce inappropriate ordering.

Guidelines. Similar to the previous sub-section regarding CDSs, participants were asked whether they thought guidelines could help to reduce inappropriate ordering. For the purpose of this research, guidelines refer to "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances" (Field & Lohr, 1990, p.38), which is consistent with the definition

provided by CAR (2005a) in their *Diagnostic Imaging Referral Guidelines: A guide for physicians*. Again, nine participants addressed this question during the key informant interviews (n = 9). Here, seven participants (7/9; 78%) suggested that guidelines would not be an effective tool to decrease inappropriate ordering. However, two participants (2/9; 22%) thought that guidelines would minimize inappropriate ordering. Overall, the majority of participants did not think guidelines would aid in reducing inappropriate ordering. The following table (Table 3.12) summarizes these findings:

Could Guidelines be an Effective Method to Reduce Inappropriate Ordering?	Frequency
No	7 (78%)
Yes	2 (22%)

Table 3.12 Guidelines to Reduce Inappropriate Ordering

These findings are also illustrated through the following examples from the interview transcripts. First, the majority of participants did not think that guidelines would be effective in reducing inappropriate ordering:

> Guidelines are tough to do because they're written with the evidence that guideline makers have which may not fit the patient that's sitting in front of you. So guidelines were not written for that patient like that, they were written for a whole bunch of people that look like this. So when it comes down to the individual level, guidelines may not hold and so, everybody then all of the sudden becomes the exception to the guideline and it drives the clinician nuts. (Participant 04, Line 126-131)

> I would never read them. Guidelines are arbitrary; they change. You can have guidelines for so many things that it's impossible to keep up. (Participant 05, Line 81-82)

> Various societies have brought out guidelines for just about every disease under the sun and it's rarely been shown to impact physician habits. So, I don't think guidelines, per se, are particularly helpful. (Participant 09, Line 46-48)

In contrast to the previous excerpts, the next set of excerpts represents the two participants who thought that guidelines could help to decrease inappropriate ordering:

> I think it's helpful to if you have rules for when you don't have to order things because that kind-of pressure of needing to reassure yourself and the patient is decreased if you know that there's like specific patterns you are looking for before you have to order a certain imaging study. (Participant 02, Line 61-64)

> I think guidelines would be more likely to modify practice, yes, than decision support. (Participant 06, Line 113)

As reflected in the interview transcripts, seven participants (7/9; 78%) did not think that guidelines are an effective tool for reducing inappropriate ordering. This is in contrast to the two participants (2/9; 22%) that believed decreasing inappropriate ordering could be accomplished through guidelines. Thus, the majority of participants did not think that guidelines would minimize inappropriate ordering.

Education. As with CDSs, and guidelines, the interviewer asked whether participants thought inappropriate ordering could be reduced through education (either in medical school or through continuing medical education). Of the twelve participants, ten addressed this question (n = 10). Interestingly, eight participants (8/10; 80%) suggested that inappropriate DI ordering could be reduced through education. However, two participants (2/10; 20%) did not believe education would minimize inappropriate ordering. Overall, the majority of participants viewed education as a viable means for reducing inappropriate ordering. The following table (Table 3.13) demonstrates this finding:

Could Education be an Effective Method to Reduce Inappropriate Ordering?	Frequency
Yes	8 (80%)
No	2 (20%)

Table 3.13 Education to Reduce Inappropriate Ordering

These findings are further supported in the following interview excerpts. The first set of quotations is in support of education for reducing inappropriate ordering:

> Education, I think, is key to reducing any overuse. All of the examples that I cited to you previously are things that we're now taught in residency or medical school. But, with any new guideline, it takes several years probably to go from being published to actually making it into clinical use. (Participant 07, Line101-104)

> I think [education] is essential and it's an ongoing thing. It's in parts of the curriculum in medical schools but then for continuing professional education it's very important. (Participant 08, Line 80-82)

> I think overall, yes, education is key. And I think in terms of the undergraduate curriculum across the country (with [school name] as the exception) I think in the amount of exposure to diagnostic imaging is really quite limited and it's almost more restricted to residency in learn-as-you-go and the residents are being taught by their supervisors who may not be up-to-date on the best diagnostic image to be requesting or whether or not they should be. So, I think education should be at all streams. (Participant 09, Line 53-58)

The previous examples can be compared to the following excerpts where participants do not think education would reduce inappropriate DI ordering:

> I don't think CME [Continuing Medical Education] is going to be effective to change inappropriate radiology ordering; it would require more of a quality management approach at a local level. (Participant 04, Line 43-44)

> Education is a nice thing, but there are few people who can teach that part and you are much better off to, literally, this is an experience thing. Every time you look at something, you improve your experience in making that decision. (Participant 11, Line 205-207)

Overall, the majority of participants stated that education would be effective in reducing inappropriate DI ordering.

Requisition communication. Three participants (3/12; 25%) independently identified that requisition communication could reduce inappropriate ordering of DI. Excerpts from the key informant interviews are provided below. The first excerpt describes how an electronic order entry system has improved communication in contrast to the former paper system. This participant explained how hand-written requisitions are difficult to interpret and any missing information would need to be obtained by contacting the referring physician.

> We're improving communication through the order entry tool because there is no longer this hand-written thing that is difficult to decipher and the radiologist has some basic information and extra information that they may not need to call for, all electronically now. (Participant 04, Line 66-69)

The next participant used a requisition form that could be hand-written, or typed and printed-off. However, this format restricted the amount of information a referring physician can provide. Thus, communication is curbed by the limited space on the requisition. The following excerpt illustrates this finding:

> Unfortunately, [the requisition] is a paper one. And even the one that I sometimes use is a, it generates paper, so even if I type it, it generates paper and there's a restriction to the amount of wording I can put in that text area. (Participant 11, Line 39-41)

Similarly, the following excerpt highlights the importance of providing adequate information in a requisition in order for the radiologist to make informed decisions. In this participant's jurisdiction, the physician could provide information on a requisition and have the radiologist decide which imaging examination would be most suited to the

patient's condition. For the radiologist to make this decision, the referring physician must provide sufficient information. Thus, communication through requisitions is important for ordering the most appropriate DI examination, as described below:

> And sometimes as a clinician, you're not sure, in which case the request for the imaging would specify, for example "I want a CT scan of the chest, this is the information I want from it" and then you'd want the diagnostic imaging consultant to decide how to do the scan to best do that. Rather than tell them what way to do it, if it's the wrong way. [So on the requisition, you can choose to either fill out what area specifically, or leave it up to the radiologist?] Yes. So the general investigation may be straightforward. So, I might want a [CT] scan of the chest, but there are many different ways that can be done, depending on what you want to get out of it. And the amount of radiation to the patient can be hugely different. What you don't want to do is do the most risky for the patient for the least yield. You want to get the most yield with the least risk. So, if you're not sure for what you're really looking for, how to best do that, then we'd write on the request form: "want the [CT] scan to look for the following items, or answer the following questions." And then [the radiologist] would determine how they'd do the [CT] scan to best do that. So you pass on to the people with the most expertise, what's the most effective way to do it. (Participant 03, Line 47-59)

Three participants (3/12; 25%) identified communication through DI requisitions as a method for reducing inappropriate ordering. Specifically, the first excerpt (from participant 04) described how an electronic order entry system is used for improved requisition communication in comparison to a paper-based format. The next quote (from participant 11) expressed how paper-based requisitions (whether typed or hand-written) can restrict the amount of information a referring physician is able to provide. This is supported further by participant 03's emphasis on using the requisition as a communication tool between the referring physician and radiologist to order the most appropriate examination. Thus, several participants mentioned how communication through radiology requisitions could be used to reduce inappropriate ordering.

***Restricting ordering authority*.** Another three participants (3/12; 25%) suggested that restricting ordering for specific imaging modalities to certain specialist physicians could help to reduce inappropriate ordering. These three participants raised the topic of restricting access to DI without prompting from the interviewer. Excerpts are presented (below) to highlight this finding. The first excerpt demonstrates how restricting access to DI examinations by requiring a radiologist's approval is an effective method of reviewing the appropriateness of DI requisitions:

> So there are several tests that we can order, but they won't be done until they're approved by the radiologist. So, we can order it all we want, but nothing will happen until it's approved, which is a way of controlling the use of the test, that way you have to speak with the radiologist to justify why you want a given test. So, especially if you're in a large institution with many people, with many different skill levels and different levels of education and that's a very effective way of policing what gets ordered. (Participant 07, Line 116-121)

The next participant describes how accessing certain DI modalities could be restricted to specific physician specialties (in the future) to reduce inappropriate ordering:

> I think inevitably there's probably going to be a need for more blanket things like I think they will exist like "you can't order this particular test unless you are a particular specialist." (Participant 08, Line 82-84)

Last, this participant describes how restricting access to DI to certain physician specialties is already being practiced as a method to reduce inappropriate ordering:

> You can restrict access to various modalities. I mean, that's already being done certainly in our jurisdiction, and only certain physicians can order PET scans. Only specialists can order MRIs, so restricting access is one way which is being utilized. (Participant 09, Line 68-70)

In conclusion, three participants mentioned restricting access to DI examinations in the key informant interviews. Restricting access can be done by requiring approval

from a radiologist, or by only allowing certain physician specialties to order certain DI examinations. Overall, three participants (3/12; 25%) indicated that restricting access to DI could be an effective method for minimizing inappropriate ordering.

Conclusion to solutions to inappropriate ordering. During the key informant interviews, participants identified possible solutions to reduce inappropriate ordering. Particularly, the interviewer prompted participants to address whether CDS, guidelines, and education could be used to reduce inappropriate ordering. Unprompted, several participants also identified how communication about DI requisitions (3/12; 25%) and limiting what certain physicians can order (3/12; 25%) could help to reduce inappropriate ordering. Overall, the most dramatic results were with respect to guidelines and education: 7/9 participants (78%) did not value guidelines as an effective method to minimize inappropriate ordering; meanwhile, 8/10 participants (80%) believed education could help to reduce inappropriate ordering. These findings are summarized in figure 3.4 in relation to the other study findings surrounding appropriate ordering.

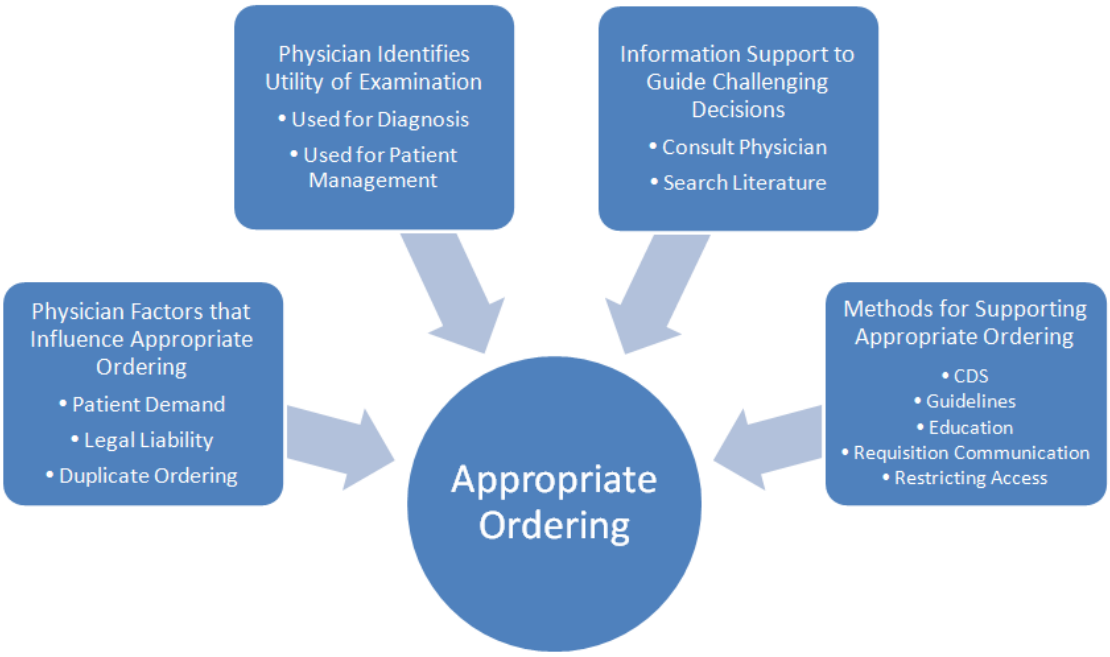

Figure 3.4 Solutions to Reduce Inappropriate Ordering are Added in Relation to the Other Study Findings with Respect to Appropriate Ordering

Conclusion to results. In general, results from the key informant interviews were largely focused on appropriate DI ordering, or lack thereof. Particularly, the majority of participants felt that DI is overused in the medical field. Participants also identified contacting physicians (colleagues, specialists, or radiologists) and consulting the literature (using UpToDate® or Google Scholar) as their top methods of information support used in challenging clinical scenarios. Meanwhile, participants suggested factors that contribute to inappropriate ordering: patient demand (including poor health literacy, patient anxiety, and the threat of a patient leaving to seek another physician), legal liability, and duplicate ordering. Of the solutions prompted by the interviewer (CDS, guidelines, and education), the majority of participants believed education could reduce inappropriate ordering. Participants also identified increasing communication about

requisitions and restricting access to certain DI modalities to particular specialties as potential solutions to reduce inappropriate ordering. Overall, themes of appropriate and inappropriate ordering are highlighted throughout the interviews, specifically in the context of prevalence, decision-making, information support, contributing factors, and solutions.

Chapter 4: Discussion

Appropriate ordering was the overarching theme in the participant interviews. Several subthemes also emerged. They included the thought processes of physicians and information support physicians would seek during challenging clinical scenarios. As well, contributing factors (such as patient demand, legal liability, and duplicate ordering) and solutions (including CDS, guidelines, education, requisition communication, and restrictions to access of DI services) to inappropriate DI ordering were also concepts that emerged under the theme of DI ordering. These concepts are all discussed with respect to findings present in the literature. As well, how these findings address the research objectives are also discussed. Next, limitations to this study are identified and discussed. Additionally, contributions to the field of health informatics are highlighted, as well as how these findings can be generalized to other areas in health care. Last, future directions are discussed with particular attention to areas that require more research. In this discussion chapter, the research will discuss the following: how the results align with current research, how the research questions were addressed, limitations involved, contributions to field of health informatics, the generalizability of this research, and recommendations for future research.

How Study Results Align with Literature Review Findings

Using grounded theory, the researcher consulted the literature to examine what is already known about the concepts that emerged from the data (Jackson & Verberg, 2007). This included revisiting information from the literature review as well as performing new searches, mainly through online journal databases (i.e. Medline and Pubmed). In this step, "the literature is used to fill the gaps in the emerging theory and to

add completeness and clarity to the theoretical description" (Jackson & Verberg, 2007, p. 177). Thus, results from this study are compared and contrasted with other findings present in the literature.

In this section, each finding from the results section (Chapter 3) is analyzed with respect to what is present in the literature. Specifically, the thought processes and information support used when a physician is presented with a challenging clinical scenario will be analyzed with support from the current literature. Additionally, contributing factors (such as patient demand, legal liability, and duplicate ordering) and solutions (including CDS, guidelines, education, requisition communication, and restrictions to access of DI services) to inappropriate DI ordering will also be discussed through findings from the literature.

Thought process during a challenging clinical scenario. As described previously (see Chapter 3), each participant considered the utility of a DI examination when presented with a challenging clinical scenario. Particularly, participants questioned how DI would affect diagnosis, or patient management or both. This largely resembles CAR's definition of an appropriate investigation: "one in which the result—positive or negative—will alter clinical management and/or add confidence to the physician's diagnosis" (CAR, 2005a, p. 8). In addition to considering how a DI examination will affect diagnosis and patient management, Western Australia's Department of Health suggests that physicians should consider the risks associated with particular DI examinations (such as ionizing radiation) (Government of Western Australia, 2011). Interestingly, none of the participants mentioned patient safety as a factor when trying to decide whether to order DI, and if so, which type of modality to select when presented

with a challenging clinical scenario. Thus, more research surrounding the referring physicians' consideration of patient safety with regards to DI ordering is indicated. Overall, participants considered how a DI examination would affect diagnosis and patient management which is consistent with CAR's definition of an appropriate investigation.

Information support. As noted in the results section, participants identified their top methods of obtaining information support for DI decision making. More specifically, participants identified consulting a radiologist (4/11; 36%), using UpToDate (3/11; 27%), consulting a colleague/specialist (3/11; 27%), and using Google Scholar (1/11; 9%) as means of obtaining information to support decision-making activities regarding DI. This is similar to another study whereby researchers surveyed 126 physicians (resident and attending physicians) at a 500-bed university medical centre (Bautista et al., 2009). In the study by Bautista et al. (2009), participants were asked to rank their top three methods of information support when deciding which imaging modality would be best for their patient. Participants selected their top three methods based on a list of 11 sources, including an open-ended "other" choice. Adding together the top four choices of information support in the study by Bautista et al. (2009), participants identified consulting a radiologist, using UpToDate®, searching a specialty journal, and using Google's search engine. These findings are similar to those from the current study, with consulting a radiologist as the top method, closely followed by using UpToDate®. However, consulting a colleague/specialist (the third top choice identified by participants in the current study) was not an option in the study by Bautista et al. (2009); thus, this item cannot be identically evaluated because the study by Bautista et al. (2009) does not

include consulting a colleague/specialist as an option for participants to select. Overall, however, the results are similar.

In the results chapter, findings from the current study were further analyzed by grouping similar information support methods together. Specifically, consulting a radiologist, colleague, or specialist were grouped together as all these methods require consulting another physician. As well, using UpToDate® and Google Scholar were grouped together as both literature-based methods require searching, reading, and synthesizing information. Thus, the top types of information support were, broadly, consulting a physician and searching the literature. Similar to the current study, the top identified sources of information support in the study by Bautista et al. (2009) could also be broken-down into themes of consulting a physician, and searching the literature. Again, though, without the inclusion of consulting a colleague/specialist in the study by Bautista et al. (2009), comparisons are difficult. Overall, the current study is largely consistent with Bautista et al. (2009). This is particularly evident with the top two sources of information support being consulting a radiologist and using UpToDate® in both studies.

Contributing factors to inappropriate ordering. Several factors that may contribute to inappropriate DI ordering emerged during the key informant interviews. First, patient demand was discussed in the large majority of interviews. Particularly, poor health literacy, a physician's perception of a patient experiencing anxiety, and the risk of losing a patient to another physician were all discussed as influencing factors. However, available literature surrounding patient demand is indeed limited. Meanwhile, half of the participants noted that legal liability contributed to inappropriate ordering. While

physicians may feel more comfortable ordering this way, patients may be unnecessarily subjected to risks associated with DI such as radiation exposure and incidental findings. Last, the majority of physician participants determined if a DI examination had already been performed or was scheduled to take place by asking the patient directly whether s/he recalls having a DI examination or scheduling an appointment for one; however, relying on patients to recall their DI history has proven to be unreliable. In the literature review (see Chapter 1), lack of guideline familiarity was noted as a contributing factor to inappropriate ordering; however, none of the participants mentioned this during the interviews. Overall, patient demand, legal liability, and duplicate ordering all emerged as factors contributing to inappropriate ordering.

Patient demand. As mentioned in the results section (see Chapter 3), participants expressed patient demand as a contributing factor to inappropriate ordering. More specifically, participants discussed how poor health literacy, a patient's anxiety surrounding one's health, and the fear of a losing a patient to another physician are all patient demand factors that influence how a physician reaches a DI decision. While accounts of patient demand influencing DI ordering are available in the literature, they are largely anecdotal.

In the absence of concrete studies regarding patient demand for DI examinations, parallels could be drawn from studies investigating patient demand with respect to prescription medication and other treatments or examinations. For example, one study noted that "nearly half of all incidents [studied] of patient pressure to prescribe resulted in the patient being prescribed the medication they requested. Of these incidents, two-thirds were deemed by the prescriber to be inappropriate requests" (Lewis & Tully, 2011, p. 7).

Meanwhile, another study described physician opinions in Finland regarding patient requests. Particularly, more than half of physician participants (53%) reported receiving requests from patients for specific treatments or examinations "very often" or "often" (Toiviainen, Vuorenkoski, & Hemminki, 2005). The majority of those physician participants (76%) noted that requests for laboratory or other procedures, prescription medications, and surgical or other procedures have increased in recent years (Toiviainen et al., 2005). Thus, studies of how patient demand influences physicians' decisions for prescription medications, treatments, and examinations could offer insight into DI ordering practices. In this subsection, the researcher describes how patient demand acts as a factor influencing inappropriate DI ordering. Specifically, health literacy, patient anxiety, and the threat of patients leaving were all identified by participants to affect DI ordering practices.

Health literacy. Throughout the key informant interviews, the majority of participants (7/11; 64%) described patients who demand DI examinations based on unreliable information sources found through the media and internet, and from family and friends. Participants also described patients who have unrealistic expectations of what DI technologies can detect, and request imaging in unnecessary circumstances or more frequently than is clinically indicated. Though, this finding is only present in the DI literature anecdotally. Research from other areas in health care, such as prescription medication ordering, that is currently available in the literature largely focuses on how socio-economic factors affect one's health literacy. This finding is not necessarily a function of one's socio-economic status, as none of the participants described this as a contributing factor during the key informant interviews. Regardless, the current study

identifies a gap in the literature with respect to how patients obtain and synthesize information as well as present this information to their physician. Similarly, the literature on health literacy does not examine how physicians respond to such requests. Thus, this study identifies the need for more research regarding health literacy for all patients, not solely those with a low socio-economic status. This is not only necessary for DI ordering practices, but many situations where a patient is unreliably informed, or has unrealistic expectations (such as patients requesting prescription medication or referrals to specialists). As well, further research is required to determine how physicians handle such requests and expectations during the consultation.

Patient anxiety. Patient anxiety, as perceived by the physician, was noted to be a contributing factor to inappropriate ordering for five participants (5/11; 45%). Interestingly, the physician's perception of a patient experiencing anxiety was not present in the literature. However, a study highlighting patient demand for prescriptions identified how physicians may succumb to emotion (for example, a patient crying) (Lewis & Tully, 2011). Thus, further research on how a patient's worry or anxiety may affect the physician's decision on whether to order DI may reveal insight into how to curb this phenomenon. As well, this could be studied in the broader context of submitting to emotion, as described by Lewis and Tully (2011). Overall, the physician's perception of a patient experiencing anxiety was described as a contributing factor to DI ordering.

Threat of patient leaving. In the current study, two participants (2/11; 18%) identified how denying patient requests is at the risk of losing the patient to another physician. Although anecdotal, other journal articles note the threat of patients leaving to

seek the consult of another physician as an influencing factor for surrendering to patient requests (Schattner, 2009; Bernardy et al., 2009). In lieu of DI-focused studies on this subject, parallels can be drawn from research on patient requests for prescription drugs. Based on direct to consumer advertising (for example, a television advertisement for a prescription medication that is targeted towards the patient, not necessarily towards the physician), 818/2988 participants (27.4%) admitted to requesting prescription medication. Of these participants, 196 (24%) were denied the particular medication by the physician. Of those participants who were denied the requested medication, 27 (13.9%) switched physicians (Lee & Begley, 2011). Therefore, future research regarding the threat of patients leaving with a particular focus on DI requests from patients is indicated. This would be especially interesting to note differences between the Canadian and American health care system models. In summary, two participants suggested that denying patient requests comes at the risk of losing the patient to another physician. Without concrete studies on this topic, more research is necessary to determine the extent of this as an influencing factor.

Patient demand was identified during the key informant interviews by the majority of participants (10/11; 91%). This was further broken down into three subcategories: health literacy, patient anxiety, and threat of a patient leaving. To date, literature surrounding health literacy, generally, is largely focused on how one's socio-economic status influences one's health care. More research could be conducted to examine how patients obtain and synthesize information, as well as present information to their physician. How physicians respond to such requests and expectations would also help to address this gap in the literature.

Legal liability. During the interviews, six participants (6/12; 50%) mentioned that legal liability may influence a physician to order DI. This is in contrast to one participant (1/12; 8%) who described feeling confident in only ordering medically necessary examinations because of support from the CMPA. The other five participants did not comment on this subject. Although mostly anecdotal, findings from the literature review conducted at the beginning of this study (see Chapter 1) also suggest concerns about legal liability influencing inappropriate ordering. Using a model that demonstrates the expected gains and risks for physicians and patients with respect to ordering DI as defensive medicine, researchers in one study conclude that "defensive testing necessarily reduces the overall quality of patient care" (DeKay & Asch, 1998, p. 19). In other words, these researchers argue that ordering DI to protect oneself against legal liability is in the physician's interest at the expense of the patient's interest (DeKay & Asch, 1998). Therefore, solutions to defensive DI ordering could be minimized through efforts to reduce the fear of litigation. DeKay and Asch (1998) suggest this could be done by limiting the liability of physicians in scenarios where physicians are tempted to order DI defensively. As some physicians may not consider the potential risks associated with unnecessary DI examinations (i.e. radiation exposure and incidental findings), educating physicians on the implications to patient care may help to reduce this type of ordering (DeKay & Asch, 1998). More recent research on physicians ordering DI for protection against legal liability could offer more focused solutions, including research in a Canadian setting.

Duplicate ordering. Again, to determine whether a DI examination has been performed or is scheduled to take place, two thirds of participants (8/12; 67%) indicated

asking the patient directly. Meanwhile, the remaining participants (4/12; 33%) described using PACS or an electronic database to determine if an examination has already been performed or ordered. Hendee et al. (2010) agree with the majority of participants stating that "physicians should encourage patients to describe the imaging examinations they have undergone previously to help ensure that duplicate studies are not performed" (p. 244). However, a study by Baumann et al. (2011) highlights how patients may not know if they have had imaging examinations previously. Specifically, emergency department patient participants with acute abdominal pain were asked to recall if they had undergone a CT examination in the past five years. Interestingly, 365 participants (31%) reported not having a CT scan performed in the past five years; however, researchers discovered by consulting the hospital's electronic medical record that of these participants, 142 (39%) had indeed had a CT scan in the past five years (Baumann et al., 2011). Therefore, relying on patients to recall information—which the majority of participants identified as using in the current study—may not be the most dependable method.

The other third of participants (4/12; 33%) identified using PACS or an electronic database to determine if an examination has already been performed or ordered. This is similar to another study whereby 73.5% of physician participants who refer patients to DI services either moderately agreed or strongly agreed that "PACS has reduced the number of exams reordered because the exams were not available (lost or located elsewhere)" (MacDonald, 2008, p. 271). Thus, participants in both studies implied using PACS or an electronic database to determine if a duplicate order had been placed or performed.

Although qualitative studies suggest that PACS can reduce unnecessary duplicate DI orders, the impact of this remains unclear. For example, an empirical study in Ontario found modest reductions in duplicate x-ray ordering after PACS was introduced. Specifically, duplicate x-ray examinations that occurred within 7 days, 30 days, and 60 days were recorded with absolute reductions of 0.2%, 0.6%, and 0.9%, respectively. Meanwhile, duplicate CT examination orders increased within 30 days and 60 days, both by 0.05%; duplicate CT examinations ordered within 7 days remained unchanged (You, Yun, & Tu, 2008). More studies regarding PACS or other electronic systems as a means to reduce unnecessary duplicate DI examinations would clarify its effectiveness.

Overall, the majority of participants determined if a DI examination had already been ordered or performed by asking the patient. However, other research reveals that asking patients to recall their DI history is not always reliable. The remaining participants described using PACS or other electronic systems to determine if an examination had already been ordered or performed. However, more research is needed to determine the effectiveness of this as a means to reduce unnecessary duplicate ordering.

Conclusion to factors contributing to inappropriate ordering. During the key informant interviews, several concepts emerged that capture contributing factors to inappropriate ordering. Specifically, patient demand was reported by all but one participant. Although literature surrounding this topic is limited, some concepts were supported through parallels from laboratory, prescription medications, and surgical or other procedures. Half of participants identified legal liability as a factor contributing to inappropriate ordering; however, research suggests that the defensive ordering of DI

comes at the expense of patient care, as radiation exposure and the risk of incidental findings may be present. Last, duplicate orders may contribute to inappropriate ordering, although the extent of this is unknown. However, the majority of participants determined if an examination had already been ordered or performed by asking the patient. Other research suggests that asking patients to recall their DI history is often unreliable. In summary, patient demand, legal liability, and duplicate ordering all emerged as factors contributing to inappropriate ordering.

Solutions. Several solutions to inappropriate DI ordering surfaced during the key informant interviews. While CDS was met with mixed responses, other solutions (such as using guidelines and education to reduce inappropriate ordering) had stronger majorities. For example, the majority of participants did not believe guidelines would be effective in reducing inappropriate ordering. In contrast, the majority of participants believed education and training would reduce inappropriate ordering. Interestingly, several participants mentioned how communication to radiologists on requisitions could be improved to support more appropriate ordering. As well, several participants also suggested that restricting certain DI modalities to specific physician specialties may also help to promote more appropriate ordering. Overall, the majority of participants believed that inappropriate ordering could be reduced through education, but not through guidelines.

Clinical decision support systems. Using CDSs as a method to reduce inappropriate ordering was met with mixed reactions from participants. Specifically, when asked if participants thought CDSs would reduce inappropriate ordering four (4/9; 44%) were undecided, three (3/9; 33%) thought it could, and two did not think it could

(2/9; 22%). As described in the literature search (see Chapter 1), socio-technical factors are indeed important considerations when implementing technology into a health care setting. Thus, this question explored, very generally, participant impressions on whether CDS could reduce inappropriate DI ordering. Research by Venkatesh, Speier, and Morris (2002) suggests that "perceived usefulness had a very strong positive effect on intention to use information technology" (p. 311). While Venkatesh et al. (2002) are not specifically referring to the health care setting, perhaps their finding could be generalized to how physicians' preconceived attitudes affect acceptance of a CDS. In summary, physician participants had mixed responses with respect to whether CDS could reduce inappropriate ordering. Considering human factors (such as how physicians' attitudes may affect acceptance of a technology) are important to examine when introducing a new technology into the health care setting, as discussed in the introduction chapter of this thesis (see Chapter 1).

Guidelines. As highlighted in the results section (see Chapter 3), the majority of participants (7/9; 78%) did not believe guidelines would reduce inappropriate DI ordering. This is in contrast to two participants (2/9; 22%) who believed guidelines could minimize inappropriate DI ordering. This majority attitude may be reflected in the information support question in this study whereby participants were asked to provide their top method of obtaining information support (see Information Support section in Chapter 3). Here, participants did not mention using guidelines when presented with a challenging clinical scenario. Similarly, another study determining what methods of information support physicians would seek found that only two participants (2/126; 1.59%) used the American College of Radiology's Appropriateness Criteria as their top

method for decision-making (Bautista et al., 2009). Overall, the majority of physicians did not believe guidelines could reduce inappropriate DI ordering.

Interestingly, two of the excerpts (see the Guidelines section in Chapter 3) that do not support guidelines as an effective method to reduce inappropriate ordering suggested feeling burdened with guidelines from many sources, not just radiological. Perhaps this finding is a comment on the current format of guidelines. In fact, Czembirek et al. (2002) believe that guidelines need to be seamlessly incorporated into a physician's workflow for optimal adoption. Currently, the CAR recognizes that their Diagnostic Imaging Referral Guidelines (2005a) (available in a booklet or PDF) could be incorporated into a CDS to support greater adoption (CAR, 2009a). Thus, research on physician acceptance of guidelines in differing formats (such as in CDSs) could be studied through CAR's current efforts in this area.

Education. Again, the majority of participants (8/10; 80%) believed education—including medical school education and continuing medical education—regarding DI could help to reduce inappropriate ordering. Anecdotally, this belief is present in the literature; however, concrete examples of how education could support more appropriate ordering practices are scarce. With only 21.4% of medical schools in the USA requiring radiology clerkships, much opportunity is present for researchers to explore how education may affect DI ordering (Dillon & Slanetz, 2010). In fact, one study examined how a lecture-based session followed by group exercises based on the ACR Appropriateness Criteria during a radiology clerkship challenged medical students to think in a different way about radiology. As well, close to 90% of these medical students reported gaining "a solid understanding of the indications for the use of various imaging

tests for specific common clinical scenarios" (Dillon & Slanetz, 2010, p. 915). Results from another study suggest referring physician participants would be most interested in attending satellite seminars delivered over the internet because of its convenient format. Meanwhile, delivering information regarding appropriate ordering at annual meetings and grand rounds was met with less interest (DiLeo & Spinelli, 2006). Thus, although research in this area is limited, interest in education to reduce inappropriate ordering is present.

Requisition communication. During the key informant interviews, three participants (3/12; 25%) suggested that improved communication on DI requisitions could reduce inappropriate ordering. Cohen et al. (2006) agree that more information is necessary, stating that "an accurate history is essential if the radiologist is to be able to identify and answer the specific clinical questions that the referring clinician needs answered" (p. 239). However, in their study investigating the quality of x-ray requisitions in the intensive care unit, Cohen, Curtin, and Lee (2006) found that in 24% of the cases studied, the information provided was either insufficient or incomplete. This is supported by a radiology perspective whereby a study surveying radiologists found that 72% participants "reported that they frequently needed more clinical information about their patients than received" (Boonn & Langlotz, 2009, p. 359). Thus, focusing on how communication could be improved between the referring physician and radiologist through DI requisitions may support appropriate ordering. However, studies in this area are scarce, warranting the need for more research.

Restricting ordering authority. Several participants (3/12; 25%) suggested restricting access to DI examinations to certain physicians in order to reduce

inappropriate ordering. Restricting access, as identified by participants, can be done by requiring approval from a radiologist, or by only allowing select physician specialties to order certain DI examinations. Interestingly, MRI and CT examinations were previously only available for specialist physicians to order in Canada. However, authority for ordering MRI and CT examinations has changed, granting family physicians ordering privileges for these modalities given certain clinical indications in certain Canadian jurisdictions (HCC, 2010). More research is necessary to identify which jurisdictions restrict access to certain DI modalities, and its implications to appropriate DI ordering and patient care. Overall, several participants identified how restricting access to DI examinations may prove effective in trying to promote more appropriate ordering, suggesting an interest for further research on this topic.

Conclusion to solutions to inappropriate ordering. Through the key informant interviews, several solutions to inappropriate DI ordering emerged. Although mixed responses were discussed with respect to CDS, the majority of participants did not believe guidelines would reduce inappropriate ordering. However, participants believed that education would help to minimize inappropriate ordering. As well, several participants noted the potential that increased communication on DI requisitions could have on promoting more appropriate DI ordering. Last, several other participants thought that restricting access to certain DI modalities to specific specialties could also support more appropriate DI ordering. While the literature review (see Chapter 1) noted how introducing standards (such as common nomenclature for ease of communication and computer programming) could reduce inappropriate DI ordering, none of the participants mentioned this during the interviews. However, this could reflect the more

administrative nature of introducing standards. Overall, the majority of participants believed that education would reduce inappropriate DI ordering, while guidelines would not.

Conclusion on how the framework aligns with findings from the literature review. In summary, the researcher reviewed the literature to determine what is already known about the concepts that emerged from the data (Jackson & Verberg, 2007). This helped to address knowledge gaps and provide clarity in the research findings (Jackson & Verberg, 2007). Thus, research findings were analyzed with information available in the literature. Particularly, thought processes and information support used when a physician is presented with a challenging clinical scenario were considered with respect to current literature. As well, contributing factors (such as patient demand, legal liability, and duplicate ordering) and solutions (including CDSs, guidelines, education, requisition communication, and restrictions to access of DI services) to inappropriate DI ordering were analyzed using current literature. Thus, grounded theory was used to align research findings with information available in the literature.

Addressing the Research Questions

This research aimed to investigate several research questions through key informant interviews. First, this research examined how physicians make decisions during challenging clinical scenarios. Participants described questioning the utility of the examination when deciding if they should order DI, and if so which modality to choose. Next, this study focussed on the methods of information support physicians seek when they are presented with a challenging clinical scenario. During the interviews, participants described consulting a physician (a colleague, radiologist, or other

specialist), and performing a literature search (using UpToDate®, or Google Scholar). This study also asked physician participants how they determined if a DI examination had been performed or was scheduled to take place. The majority of participants relied on the patient to recall personal DI history. This study was also interested in gauging whether physicians believed appropriate ordering was occurring in the medical field, generally. In answering this, the majority of participants believed DI was inappropriately used to some extent. Similarly, this research was interested in the participant's perspective of methods that could potentially reduce inappropriate ordering (i.e. CDSs, guidelines, education, or other methods). The majority of participants believed education would and guidelines would not reduce inappropriate ordering. Two other methods of reducing inappropriate ordering were mentioned by several participants: increasing communication on DI requisitions, and restricting the ordering authority for DI to certain physician specialties. More generally, this study aimed to expand on the currently available literature regarding DI and appropriate ordering, including incorporating the physician's perspective. Overall, these research questions provided a framework to guide this qualitative research.

Limitations

While conducting this study, the researcher acknowledged several limitations. These included recruitment, time, and interview question limitations. This section describes these limitations in further detail. Overall, several limitations are identified that could be considered for future studies in this area.

First, recruiting physicians to participate in this study proved difficult. The researcher made revisions to the research proposal in order to recruit physicians who

have email addresses publicly available, in addition to the original methods of contacting adjunct faculty members to the school of Health Information Science at the University of Victoria, using contacts already established by the researcher's supervisor, and contacting Health Information Science students who are also physicians. While this new method allowed the researcher to contact many more physicians, recruitment rates (4.5% response rate) were still low; twelve physicians agreed to participate. Anticipating this low response rate, only radiologists were excluded from the inclusion criteria. Thus, the study included four general practitioners, two geriatricians, two neurologists, one rheumatologist, one respirologist, one hepatologist, and one emergency physician. Including participants from different specialties could act as a confounding variable, as perspectives from one specialty may not represent other specialties. However, this method enabled the researcher to contact more potential participants.

Additionally, the key informant interviews were kept to 30 minutes in an effort to respect physician time and promote recruitment. Due to this time constraint, each interview question was carefully selected. However, in several cases the interviewer wished to probe deeper into specific questions but time would not allow. Similarly, specific questions regarding consequences to inappropriate DI ordering such as patient safety, financial costs, and human resources were not explicitly included in the interviews due to anticipated time constraints. As well, consequences to inappropriate DI ordering are documented in the literature. However, gaining the referring physician's perspective on the consequences involved might offer insight into ways to promote appropriate ordering. Thus, time constraints affected the number of questions asked by the researcher.

As well, one of the questions asked participants to comment on whether CDS could help to reduce inappropriate ordering. Participants were given a brief definition of CDS; however, a brief verbal definition might not capture exactly what a working CDS encompasses. As described in the literature review (see Chapter 1), CDSs can take many forms and include different methods of reasoning. Thus, equipping participants with more background knowledge on CDS would potentially support participants in answering this question more thoroughly. Though, a more descriptive definition would take more time.

Overall, this study included several limitations surrounding recruitment, time constraints, and interview question structure. Particularly, participants were from various specialties, potentially presenting confounding variables. In an effort to promote participation, interviews were scheduled for 30 minutes, which limited the number of interview questions. Probing deeper in some cases was difficult given the time constraints. Last, participants were given a definition of CDS and asked whether it would be effective in reducing inappropriate ordering. The brevity of this definition may not have provided participants with enough background information on the subject of CDS. In summary, the researcher acknowledges several limitations to the current study that should be remedied in future studies.

Contributions to Health Informatics Practice

Throughout this study, several contributions to the practice of health informatics emerged. Quite generally, this study offered unique insight into physicians' perspectives of their thought processes when presented with challenging clinical scenarios as well as the methods of information support physicians would seek. As well, this study explored

the factors that contribute to and solutions to inappropriate ordering through the physician's lens.

More specifically, this research aimed to understand how physicians order DI examinations to inform ways of reducing inappropriate ordering, a perspective currently missing from the literature. Results from the key informant interviews suggest that patient demand influences how physicians order DI. Particularly, poor health literacy, patient anxiety, and the threat of patients leaving to seek the consult of another physician are all factors that affect how a physician orders DI. This finding contributes to the field of health informatics in that any technical innovation that is developed to mitigate inappropriate ordering needs to consider these human factors that are currently absent from the literature.

As this study suggests, patient demand can influence a physician to order DI inappropriately. Consumer health informatics (CHI) views patients as participants in their own health care. This includes how patients may seek information about their own health conditions (Brennan & Starren, 2006). However, patients may not always seek the most reliable information, as was suggested by participants in the current study (see Chapter 3). Thus, educating physicians on how to react to patients who demand DI during the patient visit could help to promote more appropriate DI ordering.

Another finding from this study was that the majority of participants relied on the patient to recall previous DI examinations. However, a study revealed that depending on the patient to recall their DI history is unreliable. Contributing to the field of health informatics, this study finding reveals a need for improved methods of determining if a DI examination has been ordered or performed—perhaps through an electronic order

entry system, CDS, PACS, EHRs or other health information systems. In fact, several participants used PACS or an electronic database to determine if an examination had already been performed; however, this was limited to DI examinations within the hospital, health authority or other jurisdiction. Therefore, greater interoperability of such systems could help to reduce unnecessary duplicate ordering. Overall, the process to which duplicate orders are identified could be supported through health informatics innovations.

As mentioned, this study is unique among the currently available literature because of its focus on the physician's perspective. Specifically, this study asked participants their opinions on whether CDS, guidelines, and education could help to reduce inappropriate DI ordering. Each of these methods requires significant planning, and resources. The majority of participants believed that education would and guidelines would not help to reduce inappropriate DI ordering; however, consensus was not reached with respect to CDS. Research suggests a positive correlation between the extent to which one perceives information technology to be useful and the intention of using it (Venkatesh et al., 2002). Thus, considering the end-user's perception before investing in a health informatics system like CDS may be beneficial. This study is the first of its kind to focus on physician perspectives regarding CDSs for DI before development.

Contributions to health informatics education can also be drawn from this study. Particularly, this study explores many solutions to reduce inappropriate DI ordering such as guidelines, education, and CDSs. This demonstrates the importance of exploring all options, not solely health informatics solutions. As well, this study serves as a reminder that human factors need to be considered when designing, developing, and implementing

a technology used in health care. Overall, this study supports health informatics education by reiterating the role of technology, and human factors in the health care field.

Similarly, this study contributed to health informatics research through several means. First, this study recognizes the importance of including the end-user's (in this case, the physician) perspective into health informatics research. Though much research has been conducted on inappropriate ordering, little has been done on how physicians order in the first place—a central angle in working with physicians pre-emptively rather than after-the-fact. Thus, the timing of the study is important, before major time and monetary investments have been made. Next, this research emphasizes the importance of considering human factors in health informatics. In summary, this research contributed to health informatics research by considering the end-user's perspective, the timing of the study, and human factors.

Using grounded theory, several findings emerged from the interview data that contribute to the practice of health informatics. First, all but one participant described how patient demand affects how physicians order DI. Specifically, this includes the patient's health literacy, and the physician's perception of a patient experiencing anxiety and threat of a dissatisfied patient leaving to seek consult from another physician. This study reveals the presence of patient demand as a factor contributing to inappropriate DI ordering, which is largely missing from the literature. Considering human factors such as patient demand is important for developing health information technology. Next, the majority of participants relied on the patient to recall previous DI examinations. However, a study on patient recollection of DI examinations found this method unreliable (Baumann et al., 2011). The current study highlights the potential prevalence of this

method in Canada. As well, this study introduces the physician's perspective to methods of reducing inappropriate DI ordering. Specifically, this study identified the differing physician perspectives surrounding CDSs, important for implementing this technology. Finally, this study contributed to both health informatics research and education by considering the end-user's perspective, the timing of the study, and human factors. Overall, this study can be used when considering health informatics solutions for appropriate DI ordering.

Generalizability

This study reflects the views of physician participants from Canada regarding their DI ordering practices. Thus, generalizing this study to countries that have differing health care models may not be appropriate. Besides DI, other disciplines could expand on concepts that emerged from this study. For example, parallels were discussed between DI and prescription medication ordering (see Chapter 1). Perhaps other areas in health care that require ordering could also benefit from this research such as laboratory testing, and referring patients to specialists. As well, DI ordering practices may vary by disciplinary background; thus, nurse practitioner DI ordering practices would need to be further studied. Overall, concepts from this study could be generalized to other areas in health care.

Future Directions

Through findings from this study, further questions and research gaps emerged that can guide future research. Particularly, considerations for patient safety, patient demand, and legal liability all require further research with respect to DI ordering practices. Addressing conflicting research on whether PACS reduces duplicate orders is

also necessary. Meanwhile, CDSs, guidelines, education, requisition communication, and ordering authority measures need to be carefully studied to confirm their effectiveness as solutions to inappropriate DI ordering. Thus, this research presents several opportunities for future research.

First, whilst exploring physician participants' thought processes when presented with challenging clinical scenarios, none of the participants mentioned considering patient safety such as the radiation exposure involved in certain DI examinations. Thus, more research could be conducted in this area to determine whether physicians consider patient safety when ordering DI services.

Next, more research is indicated with respect to patient demand and appropriate DI ordering. Particularly, research surrounding patient demand and DI ordering is indeed limited. Researching patient demand as a contributing factor to inappropriate DI ordering is important for determining ways to reduce this phenomenon. For example, a CDS could be implemented to reduce inappropriate ordering; however, patient demand could still influence a physician's DI ordering practices, mitigating the benefits of the CDS. Thus, understanding how human factors, such as patient demand, affect a physician's decision could inform ways to reduce inappropriate ordering.

Another area for future research includes how legal liability may influence a physician to order DI examinations in situations that are not necessarily clinically appropriate. One study suggests that reducing the fear of litigation could help through limiting physician liability and educating physicians on the consequences of unnecessary DI examinations (radiation exposure and incidental findings) (DeKay & Asch, 1998). In summary, current research on physicians ordering DI for protection against legal liability

could offer more focused solutions. Research in Canada would also be important, given the differences between the Canadian and American health care models.

To determine if a DI examination has been ordered or performed, the minority of participants described using PACS or another electronic database. However, conflicting results are present with respect to the effectiveness of this method. Overall, more research is necessary to gain a clearer understanding on the effects of PACS and other electronic databases as a means to reduce unnecessary duplicate DI orders.

As participants' perceptions on whether CDSs could reduce inappropriate DI ordering were met with mixed responses, more research could be done to investigate the rationale behind each response. As mentioned (see Limitations section), perhaps a more detailed definition of what CDSs encompass would support participants with their comments. Although this interview question offered a preliminary finding on the physician's perceptions of CDS, it could be expanded in the future by encouraging participants to describe what features would be most important in a CDS for DI ordering. This would offer insight into user needs and acceptance before resources are invested into this technology. Overall, more research is needed to examine the physician's perspective of CDSs to evaluate user needs and acceptance of this technology.

Again the majority of participants did not believe guidelines could reduce inappropriate DI ordering. One study suggests that guidelines need to be seamlessly incorporated into the workflow of a physician to support user acceptance (Czembirek et al., 2002). CAR (2009a) agrees with this stating that computerized physician order entry and CDS "is the most effective way of implementing guidelines to ensure that DI resources are used most appropriately and effectively" (para. 4). However, this claim

needs to be substantiated by further research. Thus, more research could identify whether guidelines presented in different formats could be more effective in reducing inappropriate ordering.

As well, several participants mentioned how education, greater communication on DI requisitions, and restricting access to certain specialties for specific modalities could help to reduce inappropriate DI ordering. In all three of these areas, the literature is scarce. Thus, conducting more research on how education, requisition communication, and ordering authority could be used to promote appropriate ordering is necessary in the absence of available literature.

Last, research on how wait-times are affected by inappropriate DI ordering was outside of the scope of this study. Future studies could explore this as a consequence to inappropriate DI ordering, as well as a contributing factor to selecting the wrong modality (for example, a physician may order a CT scan instead of an MRI because of shorter wait-times). Thus, future research could expand on wait-times in relation to appropriate DI ordering.

In conclusion, this study presents opportunities for future research in several areas. This includes whether physicians consider patient safety when ordering DI examinations. As well, more research is necessary to evaluate how patient demand affects DI ordering practices, a piece currently missing from the literature. Similarly, more research is warranted with respect to legal liability in the current Canadian setting. Again, further research could determine whether PACS or other database systems help to reduce duplicate ordering. Meanwhile, more focused questions are necessary to examine physician perceptions of CDS. This would be particularly important for determining user

needs and acceptance of CDS before the design, development, and implementation of such a system. Although participants suggested that guidelines would not improve appropriate DI ordering, perhaps evaluating a different format would be more effective. Future research is also necessary with respect to how education, requisition communication, and ordering authority could help to promote appropriate ordering. As well, research on DI wait-times was outside the scope of this study; however, future research could benefit from its inclusion. Overall, this research highlights several areas to focus future efforts.

Conclusion

Research in DI ordering practices can help to eliminate inappropriate ordering and therefore promote patient safety and use limited resources responsibly. Although research relating to why physicians inappropriately order is present in the literature, how physicians order is still unclear: a key piece to better understanding DI ordering practices. This study aimed to fill this knowledge gap using a qualitative method. Particularly, grounded theory was applied to generate theory from the data. From the key informant interviews, ordering (both appropriate and inappropriate) emerged as the overarching theme. This included subthemes such as how a physician decides whether DI would be appropriate and what methods of information support a physician would use in a challenging clinical scenario. Subthemes also included contributing factors and solutions to inappropriate DI ordering. These subthemes were compared and contrasted to current literature. Limitations to this study were surrounding recruitment, time constraints, and interview question structure. This study revealed how human factors, such as patient demand, influence how a physician orders DI. As well, the majority of participants relied

on the patient to recall patient DI history; however, literature suggests this method is unreliable. This study also offers unique insight into the physician's perspective of what would be effective for reducing inappropriate ordering. These findings contribute to the field of health informatics as any technology developed to reduce inappropriate ordering (such as a CDS) needs to consider these human factors to support user acceptance. Findings from this study could be generalized to other areas in health care such as prescription medication and laboratory test ordering and specialist referrals. Through findings from this study, further research gaps emerged that can guide future research. Overall, appropriate and inappropriate ordering emerged as the central theme in this research. This included how physicians order and the methods of information support physicians use as well as contributing factors and solutions to inappropriate DI ordering. With recent increases in DI use (which place strains on human, and financial resources, and raise concerns for patient safety) understanding physician DI ordering practices is critical for developing ways to mitigate this phenomenon.

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Appendix A
Letter of Invitation to Participate

Research project:

Diagnostic Imaging Ordering Practices by Referring Physicians: A Qualitative Approach

Dear Mademoiselle, Madame, or Sir,

As a graduate student, I am conducting research as part of the requirements for a Masters of Science degree in Health Information Science at the University of Victoria. It is being conducted under the supervision of Elizabeth Borycki.

As you are a medical doctor, I would like to invite you to participate in a study exploring the diagnostic imaging ordering practices of physicians. Furthermore, this study employs the snowball sampling method of recruitment. If you know of a physician who might be interested in participating in this study, forwarding this invitation would be greatly appreciated.

Purpose of the Study:

The purpose of this research project is to explore the decision making activities of referring physicians when ordering diagnostic imaging services. Specifically, this research is interested in what methods of information support a physician will seek when presented with a challenging clinical scenario as well as how a physician reaches a decision.

Setting of the Study:

The study will be conducted by telephone at a time that is convenient for you.

Participants:

Physicians who meet the following criteria are being asked to participate:

(a) Are currently practicing
(b) Are permitted to order diagnostic imaging services in his/her jurisdiction
(c) Are not a radiologist
(d) Can speak English

Participation:

If you agree to voluntarily participate in this research, your participation will include a demographic questionnaire as well as nine interview questions. The interview should take approximately 30 minutes of your time. The interviews will be audio-recorded, with your consent.

Your participation in this research must be completely voluntary. You should not feel obliged to participate if you were recruited on the basis of a professional relationship with my supervisor (Elizabeth Borycki).

Risks and Benefits:

No known risks are anticipated to occur during this research; however, you may withdraw at any point. Similarly, you may answer all, some, or none of the demographic

and interview questions. Participation in this study may help researchers better understand the decision making processes involved in ordering diagnostic imaging services and inform ways to promote appropriate ordering.

Confidentiality:

All information collected will be kept strictly confidential. Thus, participant names, organizational affiliations, and any other identifying information will not be used in the research or study findings. Interview audio recordings (if you consent to recording the interview) will be stored in a secure, locked cabinet. Separate from this cabinet, the demographic information and interview notes will be securely stored on a password protected computer that only the researcher can access. If you are interested in this research, a copy of the findings can be sent to you upon completion of the study. Any published documents will not include any identifying information.

Your participation will help researchers better understand the ordering practices of diagnostic imaging services and inform ways to promote appropriate ordering. If you have any questions, or are interested in participating in this study, I can be contacted at x, or x.

Thank you for your consideration.

Sincerely,

Janessa Griffith

Appendix B
Demographic Questionnaire and Interview Questions

Demographic questionnaire

Screen for eligibility

1.) Are you able to order diagnostic imaging examinations in your jurisdiction?

General demographic information

2.) How long have you been a practicing physician?
3.) Do you have a specialty?
4.) What country did you do your medical education in?
5.) How many diagnostic imaging orders do you typically place in a week?
6.) What percentage of those orders do you feel are routine (routine as in non-challenging clinical scenarios; or commonplace)?
7.) What type of imaging modalities do you most typically order?

Interview questions

1) Can you describe your thought process when presented with a challenging clinical scenario, where you are unsure whether a diagnostic imaging examination would be appropriate, or unsure which modality would be better. (In other words, how do you proceed if you are unsure whether the examination is of clinical value?)

2) Can you give me a couple of examples where you were unsure of whether an examination was of clinical value? (in other words, can you walk me through the situation and describe the steps you took).

3) Can you indicate your top three methods of obtaining information to support your decision when presented with a challenging clinical scenario?

4) How do you determine if an examination has already been performed or is scheduled to take place by another physician?

5) To what extent do you feel appropriate diagnostic imaging ordering is occurring in the medical field?

6) Do you think examinations are being ordered unnecessarily? If yes, to what extent do you think this a problem, please describe.

7) What do you think could aid physicians in deciding whether to order an image, and which type of imaging modality to select?

8) Do you think inappropriate ordering could be reduced by the introduction of:

- Clinical decision support systems
- Guidelines
- Education
- Other methods. Please describe

9) Do you have any other comments or thoughts regarding diagnostic imaging and appropriate ordering or diagnostic imaging and information support?

Thank you

Appendix C
Verbal Consent Form for Participants

School of Health Information Science
University of Victoria, British Columbia

Verbal Consent Form for Participants

Diagnostic Imaging Ordering Practices by Referring Physicians: A Qualitative Approach

You are invited to participate in a study, entitled "**Diagnostic Imaging Ordering Practices by Referring Physicians: A Qualitative Approach**," that is being conducted by Janessa Griffith.

Janessa Griffith is a graduate student in the department of Department of Health Information Science at the University of Victoria and you may contact her if you have further questions by telephone or email.

As a graduate student, I am required to conduct research as part of the requirements for a Masters of Science degree in Health Information Science. It is being conducted under the supervision of Elizabeth Borycki. You may contact my supervisor at x.

Purpose and Objectives
The purpose of this research project is to explore the decision making activities of referring physicians when ordering diagnostic imaging services. Specifically, this research will examine what methods of information support a physician will seek when presented with a challenging clinical scenario as well as how a physician reaches a decision.

Importance of this Research
Research in diagnostic imaging ordering practices is important for eliminating inappropriate ordering and therefore promoting patient safety and using limited resources responsibly. Although research relating to why physicians inappropriately order is present in the literature, how physicians order diagnostic imaging services remains unclear. This study will aim to fill this knowledge gap using a qualitative approach. Particularly, grounded theory will be applied to discover theory in the data. Contributing to the field of health informatics, this research will help to inform how information technology can be developed to best support physician needs and ordering practices.

Participants Selection
You are being asked to participate in this study because you:

(a) Are a practicing physician
(b) Are permitted to order diagnostic imaging services in your jurisdiction
(c) Are not a radiologist
(d) Speak English

What is Involved
If you agree to voluntarily participate in this research, your participation will include:

1. Completing a short demographic questionnaire.

As part of the interview, the researcher will ask you some basic demographic information. You may answer all, some, or none of these demographic questions. This demographic questionnaire component should take approximately five minutes.

2. Interview questions.

The second component of this research involves a semi-structured interview. During the interview, a set of nine questions will be asked. Again, you may choose to answer some of the questions, all of the questions, or none of the questions. With your consent, the interview will be audio-recorded. This part of the interview should take approximately 25 minutes.

Inconvenience

Participation in this study may cause some inconvenience to you, including requiring approximately 30 minutes of your time. However, telephone interviews are intended to be scheduled at a time that is convenient for you.

Risks

There are no known or anticipated risks to you by participating in this research.

Benefits

The potential benefits of your participation in this research include contributing to the state of knowledge with respect to understanding how physicians order diagnostic imaging examinations. As well, informing ways to develop information technology to suit user needs in an effort to reduce inappropriate ordering may be beneficial to society.

Voluntary Participation

Your participation in this research must be completely voluntary. If you do decide to participate, you may withdraw at any time without any consequences or any explanation. If you do withdraw from the study your data will not be used and will be safely destroyed. If you were recruited on the basis of a professional relationship with my supervisor (Elizabeth Borycki), you should not feel obliged to participate.

On-going Consent

To make sure that you continue to consent to participate in this research, I will remind you of your right to withdraw from the study at any time without consequences or explanation.

Anonymity

In terms of protecting your anonymity, your name and any identifying information will not be used for any component of the research. The audio-recorded interview (if you give consent to be recorded) will be stored in a locked cabinet which only the researcher can access. The electronic interview note documents will have assigned numeric codes for the researcher to reference; all identifying information such as names and locations will be removed from these documents. This information will be stored in a separate electronic document from that of the participant names list. All electronic notes will be stored on a password protected computer, only accessible to the researcher.

Confidentiality

Your confidentiality and the confidentiality of the data will be protected by keeping the audio-recordings in a locked cabinet to which only the research can access. After written notes are

transcribed to a computer file, they will be shredded and discarded. Meanwhile, electronic notes will be stored on a password protected computer to which only the researcher can access.

Based on the recruitment method used in this study, some participants were sent a Letter of Invitation to Participate by my supervisor, Elizabeth Borycki. Thus, my supervisor will know some of the potential participants who were contacted. This limit to confidentiality will be addressed by ensuring that only the researcher knows who has participated (including all identifying information) by keeping all information on a password protected computer and locked cabinet to which only the researcher can access. Similarly, the researcher will not discuss who has participated or share any other identifying information with her supervisor or anybody else.

Dissemination of Results

It is anticipated that the results of this study will be shared with others in the following ways. The results of this study will be shared as part of the researcher's thesis work. Additionally, the researcher may share this research for conferences, or journal publications. You may request to receive the research findings upon completion.

Disposal of Data

Data from this study will be disposed of in January of 2016. Specifically, the audio-recordings will be erased, and the electronic documents will be deleted.

Contacts

Individuals that may be contacted regarding this study include the researcher, Janessa Griffith (telephone: x or email: x) and the researcher's supervisor, Elizabeth Borycki (telephone: x or email: x).

In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria.

If you would like to receive a copy of the verbal consent form, I can send you a copy of the form by email or by mail. Would you like a copy of the verbal consent form? ____No____Yes

Your verbal agreement indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researcher.

_____	_____	_____
Name of Participant	*Signature that the Researcher Obtained Verbal Consent*	*Date*

A copy of this consent will be sent to you, and a copy will be taken by the researcher.

Appendix D
General Letter of Invitation to Participate

Research project:

Diagnostic Imaging Ordering Practices by Referring Physicians: A Qualitative Approach

Dear Mademoiselle, Madame, or Sir,

As a graduate student, I am conducting research as part of the requirements for a Masters of Science degree in Health Information Science at the University of Victoria. It is being conducted under the supervision of Elizabeth Borycki.

I discovered your email address on [*insert name of website*], which is publicly available. As you are a medical doctor, I would like to invite you to participate in a study exploring the diagnostic imaging ordering practices of physicians. Furthermore, this study employs the snowball sampling method of recruitment. If you know of a physician who might be interested in participating in this study, forwarding this invitation would be greatly appreciated.

Purpose of the Study:

The purpose of this research project is to explore the decision making activities of referring physicians when ordering diagnostic imaging services. Specifically, this research is interested in what methods of information support a physician will seek when presented with a challenging clinical scenario as well as how a physician reaches a decision.

Setting of the Study:

The study will be conducted by telephone at a time that is convenient for you.

Participants:

Physicians who meet the following criteria are being asked to participate:

(a) Are currently practicing
(b) Are permitted to order diagnostic imaging services in his/her jurisdiction
(c) Are not a radiologist
(d) Can speak English

Participation:

If you agree to voluntarily participate in this research, your participation will include a demographic questionnaire as well as nine interview questions. The interview should take approximately 30 minutes of your time. The interviews will be audio-recorded, with your consent.

Your participation in this research must be completely voluntary. If you decide to participate, you may withdraw at any time without any consequences or any explanation. If you do withdraw from the study, your data will not be used and will be destroyed.

Risks and Benefits:

No known risks are anticipated to occur during this research; however, you may withdraw at any point. Similarly, you may answer all, some, or none of the demographic and interview questions. Participation in this study may help researchers better understand the decision making processes involved in ordering diagnostic imaging services and inform ways to promote appropriate ordering.

Confidentiality:

All information collected will be kept strictly confidential. Thus, participant names, organizational affiliations, and any other identifying information will not be used in the research or study findings. Interview audio recordings (if you consent to recording the interview) will be stored in a secure, locked cabinet. Separate from this cabinet, the demographic information and interview notes will be securely stored on a password protected computer that only the researcher can access. If you are interested in this research, a copy of the findings can be sent to you upon completion of the study. Any published documents will not include any identifying information.

Your participation will help researchers better understand the ordering practices of diagnostic imaging services and inform ways to promote appropriate ordering. If you have any questions, or are interested in participating in this study, I can be contacted at x, or x.

Thank you for your consideration.

Sincerely,

Janessa Griffith

Appendix E
General Verbal Consent Form for Participants

School of Health Information Science
University of Victoria, British Columbia

Verbal Consent Form for Participants

Telephone Script

Diagnostic Imaging Ordering Practices by Referring Physicians: A Qualitative Approach

You are invited to participate in a study, entitled **"Diagnostic Imaging Ordering Practices by Referring Physicians: A Qualitative Approach,**" that is being conducted by Janessa Griffith.

Janessa Griffith is a graduate student in the department of Department of Health Information Science at the University of Victoria and you may contact her if you have further questions by telephone (x) or email (x).

As a graduate student, I am required to conduct research as part of the requirements for a Masters of Science degree in Health Information Science. It is being conducted under the supervision of Elizabeth Borycki. You may contact my supervisor at x.

Purpose and Objectives
The purpose of this research project is to explore the decision making activities of referring physicians when ordering diagnostic imaging services. Specifically, this research will examine what methods of information support a physician will seek when presented with a challenging clinical scenario as well as how a physician reaches a decision.

Importance of this Research
Research in diagnostic imaging ordering practices is important for eliminating inappropriate ordering and therefore promoting patient safety and using limited resources responsibly. Although research relating to why physicians inappropriately order is present in the literature, how physicians order diagnostic imaging services remains unclear. This study will aim to fill this knowledge gap using a qualitative approach. Particularly, grounded theory will be applied to discover theory in the data. Contributing to the field of health informatics, this research will help to inform how information technology can be developed to best support physician needs and ordering practices.

Participants Selection
You are being asked to participate in this study because you:

(a) Are a practicing physician
(b) Are permitted to order diagnostic imaging services in your jurisdiction
(c) Are not a radiologist
(d) Speak English

What is Involved
If you agree to voluntarily participate in this research, your participation will include:

1. Completing a short demographic questionnaire.

As part of the interview, the researcher will ask you some basic demographic information. You may answer all, some, or none of these demographic questions. This demographic questionnaire component should take approximately five minutes.

2. Interview questions.

The second component of this research involves a semi-structured interview. During the interview, a set of nine questions will be asked. Again, you may choose to answer some of the questions, all of the questions, or none of the questions. With your consent, the interview will be audio-recorded. This part of the interview should take approximately 25 minutes.

Inconvenience
Participation in this study may cause some inconvenience to you, including requiring approximately 30 minutes of your time. However, telephone interviews are intended to be scheduled at a time that is convenient for you.

Risks
There are no known or anticipated risks to you by participating in this research.

Benefits
The potential benefits of your participation in this research include contributing to the state of knowledge with respect to understanding how physicians order diagnostic imaging examinations. As well, informing ways to develop information technology to suit user needs in an effort to reduce inappropriate ordering may be beneficial to society.

Voluntary Participation
Your participation in this research must be completely voluntary. If you do decide to participate, you may withdraw at any time without any consequences or any explanation. If you do withdraw from the study your data will not be used and will be safely destroyed.

On-going Consent
To make sure that you continue to consent to participate in this research, I will remind you of your right to withdraw from the study at any time without consequences or explanation.

Anonymity
In terms of protecting your anonymity, your name and any identifying information will not be used for any component of the research. The audio-recorded interview (if you give consent to be recorded) will be stored in a locked cabinet which only the researcher can access. The electronic interview note documents will have assigned numeric codes for the researcher to reference; all identifying information such as names and locations will be removed from these documents. This information will be stored in a separate electronic document from that of the participant names list. All electronic notes will be stored on a password protected computer, only accessible to the researcher.

Confidentiality
Your confidentiality and the confidentiality of the data will be protected by keeping the audio-recordings in a locked cabinet to which only the researcher can access. After written notes are

transcribed to a computer file, they will be shredded and discarded. Meanwhile, electronic notes will be stored on a password protected computer to which only the researcher can access.

Dissemination of Results

It is anticipated that the results of this study will be shared with others in the following ways. The results of this study will be shared as part of the researcher's thesis work. Additionally, the researcher may share this research for conferences, or journal publications. You may request to receive the research findings upon completion.

Disposal of Data

Data from this study will be disposed of in January of 2016. Specifically, the audio-recordings will be erased, and the electronic documents will be deleted.

Contacts

Individuals that may be contacted regarding this study include the researcher, Janessa Griffith (telephone: x or email: x) and the researcher's supervisor, Elizabeth Borycki (telephone: x or email: x).

In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria.

If you would like to receive a copy of the verbal consent form, I can send you a copy of the form by email or by mail. Would you like a copy of the verbal consent form? ____No____Yes

Your verbal agreement indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researcher.

Name of Participant	*Signature that the Researcher Obtained Verbal Consent*	*Date*

A copy of this consent will be sent to you, and a copy will be taken by the researcher.