The Fusion of Clinical Guidelines with Technology: Trends & Challenges

Candice MacDougall[1], Carolyn McGregor[1,2], Jennifer Percival[2]

[1]University of Ontario Institute of Technology, Faculty of HealthScience, Oshawa, Ontario, Canada

[2]University of Ontario Institute of Technology, Faculty of Business and Information Technology, Oshawa, Ontario, Canada

Abstract

The use of Health Information Technology (HIT) within the healthcare setting can be a great resource to contribute to improved patient care. Clinical guidelines are developed to aid in the decision making process of healthcare professionals and contain the leading edge of best patient practice. There is an abundance of evidence presenting the benefits that HIT contain; however, its use is rarely incorporated in today's clinical guidelines. Although, research suggests that the benefits of HIT are enough to integrate their use in clinical guidelines, there are a number of challenges that interfere with its implementation, such as, cultural diversity, interdisciplinary nature, lack of HIT knowledge for workers, evolution of technology, heavy clinical workload and lack of medical background in developers of HIT. The purpose of this research project is to present a literature review to further understand the trends and challenges of implementing HIT use within clinical guidelines. A modelling system, PaJMa is also introduced to visually depict a patient's journey and the methods of documentation. PaJMa can aid in discovering gaps in healthcare documentation and closing those gaps through HIT use within clinical guidelines. Further research revealed that there are models and approaches supporting the process and creation of clinical guidelines but none of these enable the inclusion of what technology will be used to support the implementation of these procedures. The research project concludes with ideas for future research in the area of clinical guideline development and HIT implementation.

Keywords: Clinical Guidelines, Clinical Pathways, Information Technology, Patient Journey Modeling.

1. Introduction

As time progresses, technology continues to advance and become more useful for everyday activities. One of the great benefits of technology is the impact it could have in the healthcare field. There are many devices that not only contribute to the care of patient's health problems but assist with information processing, storage, safety, and documentation. In 1989 the authors of *Opening The Black Box: Measuring Hospital Information Technology Capability* [1], discussed the need for better health information technology (HIT) use. Examples of HIT include electronic health records (EHR), diagnostic imaging, decision support tools etc. They found that in order to continue to provide a diverse and complete range of patient care, they are in need of HIT to be in place and

fully exercised [1]. After reviewing other recent studies [2, 3, 4, 5, 6], there is still a lot of discussion and review on the need for more technologically based hospital units, yet there is nothing being implemented uniformly across facilities. The most effective method to integrate a change in practice is through clinical guideline development. The purpose of clinical guidelines is to bring forth technology that can advance medical practices and incorporate their use as a part of patient care. This research paper studies the use of HIT systems within the healthcare system and the lack of explicit HIT integration within the development of clinical guidelines. It also presents the idea that many resources exist to allow collaboration of HIT and patient care, yet there is very little implementation occurring within hospital units. A key contribution of this research is that many studies have been completed to prove that there is a demand for HIT advancement within the healthcare

field, but unfortunately the technology advancement and the demand are running parallel to each other and do not seem to be converging. Research, discussion and development on the topic of HIT has been an ongoing process within the medical field [4]. With all the resources available, it is time that clinical guidelines begin to execute the use of HIT and develop standardized policies to ensure their usage. The paper is structured as follows: trends, challenges, a clinical guideline modeled an admissions case study of a Neonatal Intensive Care Unit (NICU) and future directions and conclusions.

2. Trends

2.1. Impact of Technology on Patient Care

There are various aspects of HIT that will impact patient care in a positive way, such as decrease in medication error, increased quality of care and assistance with best practice procedures. In a study completed by Menachemi et al. (2008) [6] they found that proper adoption of technology such as HIT, bar coding, dispensing systems, clinical decision support systems, etc. within a healthcare setting can improve the delivery of care process to patients [6]. They also discovered that HIT "could decrease the time spent on administrative duties and increase time spent on direct patient care" [6]. Another study completed in 2000 entitled *Using Information Technology to Reduce Rates of Medication Errors in Hospitals* [7] researched the use of robots, bar coding, automated dispensing devices and computerization of records to reduce medication administration errors. They found these various types of technology to be a useful tool and after studying their effectiveness, they concluded that technology ultimately aids in reducing medication errors [7]. The quality of care delivered and benefit it has to the patient is increased with the use of HIT [6]. These findings lead us to believe that there is a direct correlation between quality patient care administered and the use of technology. When more standardized documentation exists, diagnoses and testing will become more accurate and therefore the treatment will also be more accurate. HIT have designed reminders and various alerts that compel practitioners to follow clinical guidelines and other forms of beneficial patient care strategies [8]. This ensures that the best possible practices are being used and patient satisfaction and healing are increased. The research and findings on the impact of technology thus far have proven to directly impact patient care in a highly positive way, yet there is still hesitation in fully integrating its use within the healthcare field.

2.2. Safety

The safety associated with patient care is of top priority to most individuals. Knowing that your personal information and health records are kept confidential is a major concern when disclosing information to healthcare profes-

sionals. With the increased use of computers, Personal Digital Assistants (PDA's) and HIT systems there is a growing concern that medical documentation can easily be exploited. In turn, studies have shown that the use of these systems is very safe and in fact can increase patient safety and privacy; [7], [4] and [5].

A study in 2008 [3] was completed to further understand the implications that HIT systems can have on patient safety. The authors found that HIT "is regarded as an essential tool to improve patient safety" [3]. Several studies have been completed by Kaushal, Barker & Bates on the impact of HIT systems and patient safety. In their paper titled *How Can Information Technology Improve Patient Safety and Reduce Medication Errors in Children's HealthCare?* [4], they found that the use of various HIT's "can reduce errors by organizing information in a timely manner, identifying links between pieces of information and doing repetitive tasks". They also concluded that the use of HIT in hospital units to be very beneficial to patient care.

There are various communication channels that can be used to exchange data and the richness of the data being exchanged determines the appropriate channel. Verbal communication or "face-to-face meetings have the highest data-carrying capacity" because sender and receiver are able to continually provide feedback through verbal and nonverbal cues [9]. However, the likelihood of misinterpretation is greatly increased. During a face-to-face discussion it is likely that the sender and receiver have different perceptions on the topic of discussion and can be in two different mental states. For example, what is an important task to the sender may be less of a priority to the receiver. Another communication barrier experienced by organizations is filtering. It is common in the workplace that messages or tasks are "filtered or stopped altogether on their way up or down the organizational hierarchy" [9]. This poses a very big risk in the healthcare industry. If information is not being processed and passed onto the right individuals there is an increased likelihood that important testing or treatments are not being completed putting the patients health and safety in jeopardy. *Oroviogoicoechea (2007)* [10] found Nurses, in particular, have a tendency to use oral communication to transmit knowledge between healthcare professionals above all other means of communication. The main concern is that the information being exchanged during a conversation is often not reported or documented resulting in verbal communication as an open source for error among healthcare professionals [11]. Kaushal, Barker & Bates (2001) [4] concluded that computerized systems can decrease the amount of error that occurs in verbal communication which allows for increased patient safety and more personalized care plans. HIT can also increase patient safety through the use of computerized order entry. This form of HIT requires practitioners to input a set of data in a method that is "complete, legible and in a standard format" [4] allowing it to be easily understood by anyone. In 2003, after reviewing various aspects of information technology and its uses, Bates

& Gawande [2] concluded that information systems can increase patient safety because specialized software will provide structure to practitioner's actions and actually detect error, send various alerts and suggest ways to fix it.

The safety of personal information documented in computer systems can be protected through the use of rigorous used authentication policies, access audits, and encryption, running the system on secure servers and periodically backing up the data. Overall, HIT can enhance the safety of patient's information and quality of care provided. If appropriate precautions are taken into consideration the information can be kept safe and confidential, while still providing the outstanding benefits to patients and their healthcare providers.

2.3. Clinical Guidelines

Clinical guidelines are developed to aid in the decision making process of healthcare professionals. Clinical guidelines are created by an ad hoc committee of specialized practitioners in specific fields and are ultimately a guide to medical treatments [12]. The development process involves a number of steps and processes that are followed closely and often repeated to ensure its reliability and effectiveness.

The process of creating a clinical guideline requires a great extent of research, teamwork and constant evaluation/revision. In the article *Clinical Guidelines: Developing Guidelines* [13] the authors present a methodology of developing a clinical guideline. In order to generate a clinical guideline, a specific topic for the guideline must initially be developed. The authors state that a guideline topic can be derived from morbidity/mortality statistics, ambiguity of various healthcare practices or from the need to preserve resources. Figure 1 outlines the steps involved in developing a clinical guideline. As previously stated the process begins at step 1 by selecting the specific guidelines topic. In step 2, a committee of healthcare professionals will gather together to verbally review and refine the guideline topic of study. Once the topic has been evaluated, one or more other committees of healthcare professionals are gathered to decide whether or not the topic is beneficial to healthcare professionals and patients. This

group considers factors such as potential cost savings, legislative requirements, patient feedback, length of training, etc. In their decision process; step 3. If the committee decides the topic is not beneficial then the process will be terminated, step 4 (a). In step 4 (b) the committee will commence "the day to day running of the work, such as the identification, synthesis and interpretation of relevant evidence" [13]. By using evidence based medicine the wide majority of patients will benefit from the guideline. The more reliable the evidence the greater the increase in value of the particular guideline therefore resulting in a more widely accepted and used guideline. According to *Evidence Based Guidelines and Critical Pathways for Quality Improvement* [14], clinical guidelines have become "the leading edge of a movement in medicine to make our practices more evidence based" [14]. Therefore, the testing of specific practices on different ailments allows guidelines to be precise, comprehensive and useful enough for clinical practice [15]. In order to find the evidence to support the treatment of different diagnoses, the committee will complete a literature review, step 5. During the review they will look for randomized controlled trials and prospective cohort studies. Randomized controlled trials will provide evidence on the effectiveness of various treatment plans whereas, the prospective cohort study will provide information on risk associated with treatments [13]. Once a variety of methods have been tested, and the best possible procedure identified based on hospital criteria (which may include cost, efficiency, risks, speed etc.), it is then incorporated into step 7, a clinical guideline. The guideline is then open for evaluation, discussion and revision and eventually for use by the healthcare industry. Overtime the guideline will need to be continually evaluated and updated to ensure the best possible practice is still included in the guideline; hence the feedback loop to step 3. The following are a few of the current tools used for clinical guideline development; HELEN, GASTON and PRODIGY. Although all of these tools are useful for the development of guidelines, majority of them are for very specific purposes. For example HELEN is used only in neonatology and the technology used in that environment [16]. These current tools are not useful in the adoption and exploration of HIT.
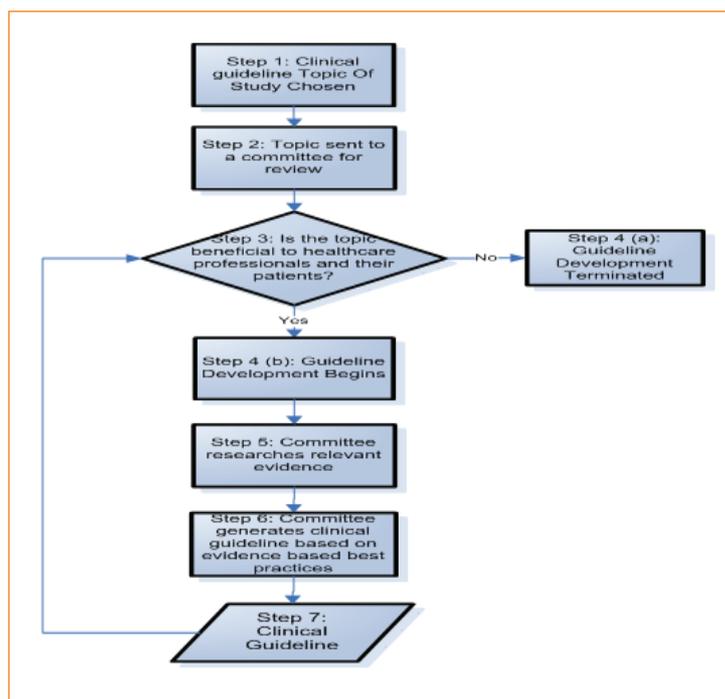
Figure 1: *Clinical Guideline Development Process*

Clinical guidelines are a great resource for incorporating and disseminating innovations in the healthcare field [14]. If developers of clinical guidelines begin to integrate the use of HIT it is more likely that the process and use will be followed when a practitioner consults that specific guideline. Clercq, et al. [17], found that the clinical guidelines that incorporate decision support systems "offer promising possibilities for guideline implementation" [17], ultimately allowing guidelines and support systems to complement one another and improve how both are used. When developing the guidelines it is the committee's opportunity to research various uses of technology and integrate its use for various treatments. By involving both clinical and HIT experts in the evaluation and design process an appropriate blend of HIT can be identified to support clinical practice. The integration considerations for HIT are not necessarily restricted to large-scale information management systems such as electronic medical records and scheduling systems. The objective is to consider HIT that can enhance patient care such as personal data assistants for mobile access to current guidelines, procedures, and best practices. Where it is feasible, HIT that can automate some portions of the guidelines can also be identified. For example, while researching the effects of clinical guidelines *Cheah* (1998) [12] stated that software should be developed to aid in information storage and when connected with patient information systems it will diminish the amount of repetition in data entry. Including this process into clinical guidelines will ensure healthcare professionals adherence to the use of an HIT and therefore, reduce the time spent asking the same questions or going over the same procedures.

3. Challenges

Although it appears that the benefits of HIT are enough to integrate their use in clinical guidelines, there are a number of challenges that interfere with clinical guideline implementation. The following areas have delayed the adoption of HIT to date; number of culturally diverse roles within the healthcare field, interdisciplinary nature, lack of HIT knowledge for workers, constant evolution of technology, heavy clinical workload and lack of medical background in developers of HIT. Each of these areas are discussed further. Through the understanding of the various challenges of HIT, they can then be overcome and we can work towards a harmonious environment in which clinical guidelines and HIT work together.

Cultural diversity among the healthcare field is a top priority of most facilities. By forming a team with great cultural diversity it ensures that the best care is being delivered to all patients of any background [18]. However, the number of culturally diverse roles can result in a number of different learning strategies. Different religions and cultures have different beliefs on how to carry out certain actions and how beneficial it is to the patient. Cultural diversity is also valued by patients and their families, and there may be times where the family does not believe in the use or consent to the use of technology to aid in the care of their loved one. It is also possible in some situations that a parent or guardian may be making a decision for their loved one's care and in some cultures an entire family opposed to one individual need to consult and approve of a decision. Therefore, an obstacle to HIT use within hospitals is to ensure that it will not interfere with any belief systems of both staff and patients, and to dis-

cover a way to present the idea of HIT use that is appealing to all.

In a hospital, there are a variety of different disciplines that merge together to provide the best practice to the patient. On many hospital units, various patients may be seen by Cardiologists, Oncologists, Nurses, Anaesthetists, Physiotherapists, Neurologists, Respiratory Therapists, Spiritual Advisors, and Community Living Partners etc. This interdisciplinary nature makes it difficult to find HIT that will work with each discipline exclusively as well as maintaining uniformity to allow information to flow to and from each healthcare professional and their patient.

As a society we are currently in an era called the information age or digital age meaning we manipulate information through the use of computers and computer systems. Technology in today's world, especially in healthcare, can be very beneficial for daily practices. However, technology is evolving at a constant rate which poses a problem when trying to use HIT in the healthcare setting. The high pace of change makes many healthcare professionals unable to adapt at the same pace, as it takes significant time and consideration when integrating new technologies into patient care due to safety, regulatory, and patient concerns. In addition, as individuals begin training on the use of a system and begin to get comfortable incorporating it into their daily routine, within the next few years it will need to be updated or it will have changed completely and training may need to take place all over again. When attempting to execute the use of HIT the staff needs to fully comprehend why the change is being made, that extensive training will be involved and how it will benefit the work that they do or the patients they care for [11]. Without fully educating the staff, it is likely that there will be resistance to break their habits and the new change may not be adopted.

Chan completed the study *From Perceived Surplus to Perceived Shortage: What Happened to Canada's Physician Workforce in the 1990's?* [19] that discovered that over the past 20 years the Canadian population has increased "by 24%, from 24.8 to 30.8 million" [19] and from 1993 to 2000 there was a 5.1% drop in the physician-population ratio. Therefore, the clinical workload taken on by today's physicians is much more labour intensive than in the 1980's. With an increased patient workload, it also becomes difficult for the physicians to continually be knowledgeable on varying HIT. Although the physicians have assistance from nurses and other healthcare providers the balance is changing and physicians are experiencing more stress with incorporation of HIT. This change in severity of patients has increased the stress and workload on physicians over and above the increases in patient loads.

Another challenge that HIT application faces is by its developers skill set. Most designers of HIT have little or no medical background. They are designing systems based on appearance and, in their opinion, the most simplistic method to get the job done. However, when it comes time for healthcare professionals to begin to use the system they may find it difficult to navigate or more time consuming than using a pen and paper. A large communication barrier is occurring in these situations and more consistent and concise communication needs to take place [20]. HIT specialists and various healthcare professionals need to collaborate on the development and design of HIT to make it useful for healthcare, while maintaining the simplistic nature it needs to be time and cost effective.

Even with all the challenges of cultural diversity, training and the pace of technological change, the most critical challenge is one about communication and documentation. There is currently no effective process flow or patient journey modelling method which integrates the needs of healthcare professionals in developing clinical pathways with technology requirements. When the development of technology is not integrated with the needs of healthcare professionals to support patient care, it will never be able to effectively meet all their requirements. Similarly, if technology is not integrated into the development of clinical guidelines, we cannot expect that it will be integrated into the care of patients.

4. Case Study

In 1998, a hospital completed a study that examined their current delivery of care systems. The hospital created several flow charts for current and prospective clinical guideline occurrences within different areas of a particular unit. The flows include the approved procedures for admissions, transfers, bereavement and follow-ups. These flows show a patient's journey within the unit including referrals, prevention, education programs, family and staff involvement etc. There is a lot of discussion on developing techniques to improve patient care delivery, however integrating HIT use to support the process is lacking.

Throughout the report there is little discussion about the use of technology during the patient's time within the hospital. One area of the report states that during the time of the study there was no appropriate database or maintenance of it, the systems in place were not uniformed, no documentation systems present at the bedside, lack of appropriate patient scheduling system and that there is insufficient computer access for the staff. Although, the authors of the report made note of the lack of technological use within their unit, their future development section does not address these technology related issues.

Figure 2 illustrates the hospital's flow chart method of evaluating the clinical pathway occurring during admissions. Not only does the model become difficult to follow, but it becomes apparent the original modelling method does not provide any sort of mechanism for integrating with technology. However, this visualization does assist in identifying where technology could aid/support better care practices if someone wanted to analyse this aspect as part of the evaluation process.

The Patient Journey Modelling Architecture (PaJMa) (similar to patient flow or pathways of care) has been designed specifically for healthcare and focuses on provid-

ing a visual representation of the processes involved in a patient journey [15]. This modelling technique represents the staff roles, processes, information creation/movement patient needs/practice guidelines/policies and metrics [21]. Working from the top-down, each layer provides important information related to the patient journey, specifically: 1) the top layer indicates the patient's point of entry into the journey and subsequent interactions with the roles and processes contained in the journey; 2) the second layer represents the staff roles involved; 3) the third layer includes processes and possible decisions that comprise the action items of the journey; 4) the fourth layer depicts the information required or obtained by each process; and 5) the lowest layer details the patient needs, clinical guidelines, and policies that are relevant to the various processes [22]. The PaJMa representation is a more efficient modelling technique than flow charts because it includes multiple roles, highlights discontinuities of care, demonstrates current information needs and requirements, and displays patient needs, and guidelines that are followed. Through developing the models we are engaging healthcare practitioners in the process of understanding where and when it makes sense to use information systems such as EHR. We can more easily demonstrate how the HIT can be integrated into existing clinical guidelines for the benefit of organizational efficiency as well as patient safety. The models help the healthcare practitioner understand the need for guideline modification in order to use the HIT as effectively as possible. Through the participation and use of the models, the healthcare practitioners gain valuable knowledge on not only how but when they should be using

the HIT in order to reduce their workloads while still maintaining or improving the overall care of patients. Integrating its use into a clinical guideline will bridge the current gap and inefficiencies where no technology exists. Current research is exploring how PaJMa can provide a more complete set of HIT system requirements, possible alternatives for improved patient care and information flow between caregivers, and how it can be used to increase the level of involvement and understanding of the information system selection process by the health care practitioners [21].

Time was spent converting the flow charts from the hospital study into PaJMa models in order to enhance the visual representation of clinical guidelines followed within the unit. The dashed line within Figure 2 illustrates the area of the flow chart that was converted into a PaJMa model as shown in Figure 3. Within the flow diagram from Figure 2, it is difficult to determine where the patient is directly involved and what staff roles are outlined. When reviewing the PaJMa model, Figure 3, patient involvement and staff roles are explicit. In addition, it becomes evident that the ratio of processes to documentation is very uneven. There are an abundant amount of processes occurring both simultaneously and consecutively and the main source of documentation occurring during these processes is through a verbal report. Although verbal communication has proven to be the richest form of exchanging data, when it comes to administering tests and treatments a more solid documentation method must take place in order to ensure that the job is remembered and completed.
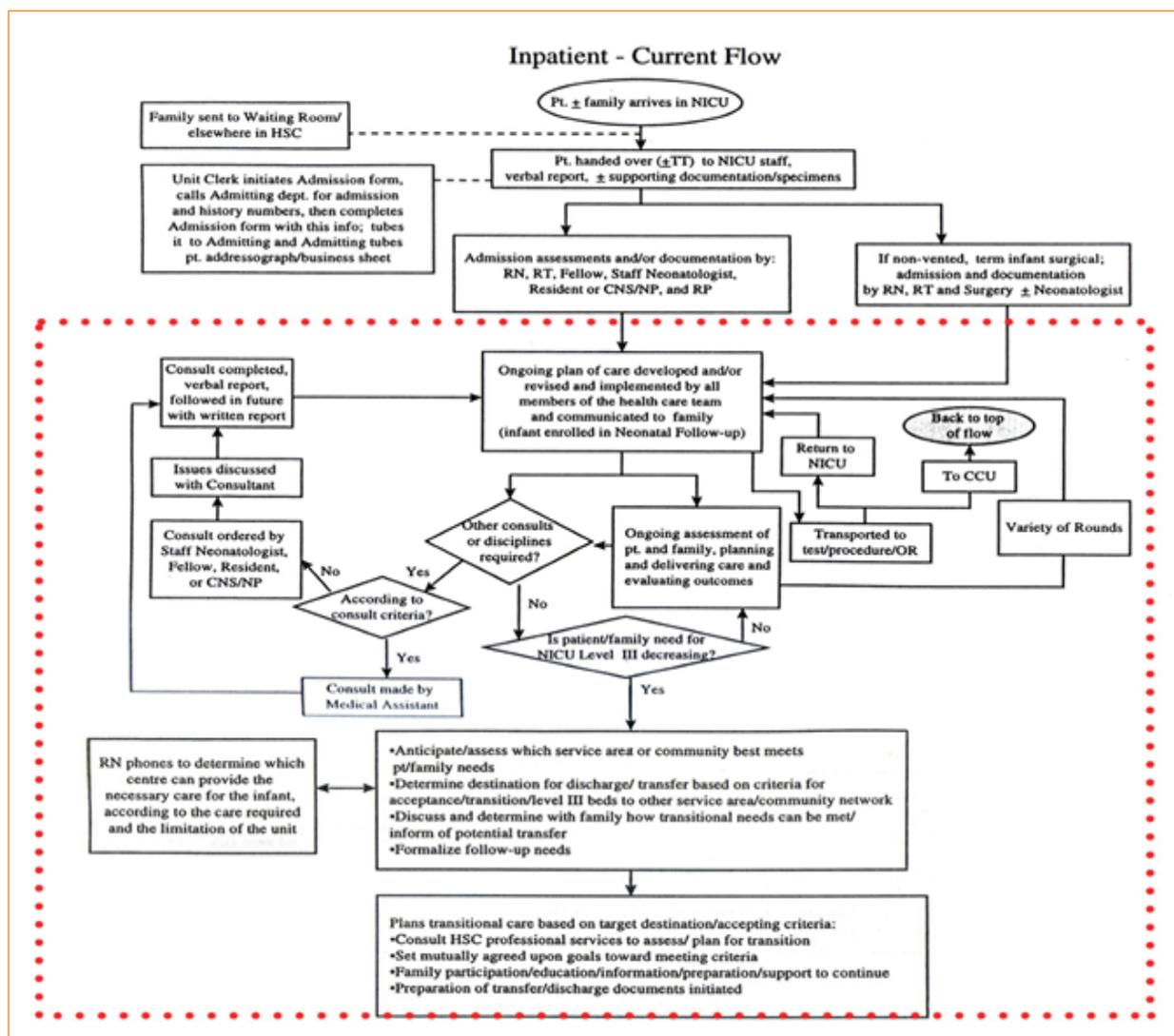
Figure 2: *The Hospital Inpatient Current Flow [23]*

Also, documentation is needed for data mining and auditing of procedures and practices in future. Healthcare professionals have a lot of tasks to complete during their shift and, although it may not be intentional, it is very easy to forget things if it is not reordered appropriately. Also, when tasks aren't reordered it is hard to track if it's been done resulting in repetition of tasks which can lead to increased costs, possibility of overdosing drugs or dismissal of tasks completely leaving tests uncompleted, poor quality of care delivered and longer weight times for diagnosis/treatment.

Throughout the patient journey in Figure 3, ongoing assessments and consults are made and no use of HIT or documentation of any kind takes place. If the patient is to remain in this particular hospital's care with the same healthcare providers, this may not pose a problem as that particular healthcare professional is familiar with the patient and what treatment they are receiving and what testing has already been completed. However, the PaJMa

model clearly outlines there is the potential for the patient to be transferred to another unit. If the patient does have to be transferred to another unit or facility without the use of HIT there will be a great deal of time spent duplicating data collection that occurred while in the care in the previous unit. A future flow PaJMa model could be created for this particular incidence to demonstrate how the integration of HIT, more specifically EHR, into this patient journey could help reduce the duplication of data, improve patient records and increase the time spent treating the patient rather than re-assessing them and repeating procedures that have already been completed. The model is also an important tool to support the development of improved clinical guidelines. If the clinical guideline currently does not state any incorporation of HIT during ongoing assessments and discussions then the visualization provided in this model can help determine and organize a more structured protocol to enforce HIT when it is most beneficial to incorporate its use.

After reviewing the report it becomes apparent that the benefits of HIT were not reviewed and incorporated into the hospital's plans for the future. Even though the report states that the current technology was not benefitting their current care practices their future flow charts did not address this issue. Through the use of more structured clinical guidelines that incorporate HIT use, overlooking problems related to HIT, can be avoided in future. Overall, the use of HIT in clinical guidelines can increase patient safety, increase staff communication and reduce medical errors.

5. Future Directions & Conclusion

This paper presents the trends and challenges faced by the fusion of clinical guidelines with HIT system adoption in hospitals. It also presents a case study where HIT system adoption is in great need and the future directions of clinical guidelines and technology fusion. Throughout the paper various findings have made it obvious that the use of HIT systems within the healthcare field will be very beneficial to both the patient and staff. The use of HIT systems will increase patient safety, uniform data collection, increase accessibility to patient information and increase functionality within the unit. Unfortunately, there is no accepted methodology for the integration of HIT systems into the clinical guideline development and implementation process.

This research further supports our current research directions for using PaJMa to support clinical guideline documentation, development and reengineering. PaJMa models will allow healthcare professionals to discover where they require improved guidelines to assist in improving documentation and adherence to the clinical guideline. Developers of clinical guidelines will also benefit from the use of PaJMa modelling technique. During step 5, table 1, the committee can alter the PaJMa models to visually display how different aspects of the guideline can simplify and increase the use of IT systems. Also, it will allow designers of HIT systems to visually understand where the unit needs help the most and how they can create a system to support their needs.

Standardizing clinical guideline development is a necessary future direction. The use of technology by healthcare professionals needs to be enforced through policy and guidelines alike. Clinical guideline development needs to involve another step that strictly focuses on integrating an HIT system strategy component in order to find appropriate technology to assist in patient care. We are exploring new research directions to enrich clinical guidelines and adding a technology layer to the PaJMa model. Also, hospital administration needs to ensure that the committee developing the guideline adheres to the strict and specific policy change. For example they could provide the committee with Figure 1 and request documentation of step by step activities that they have carried out in order to come to a specific conclusion. Another section of Figure 1 that needs to be altered is step 6. In the future, step 6 should be expanded to include who exactly the committee is, what technology is going to be incorporated, why that technology was chosen, and what the benefit is.
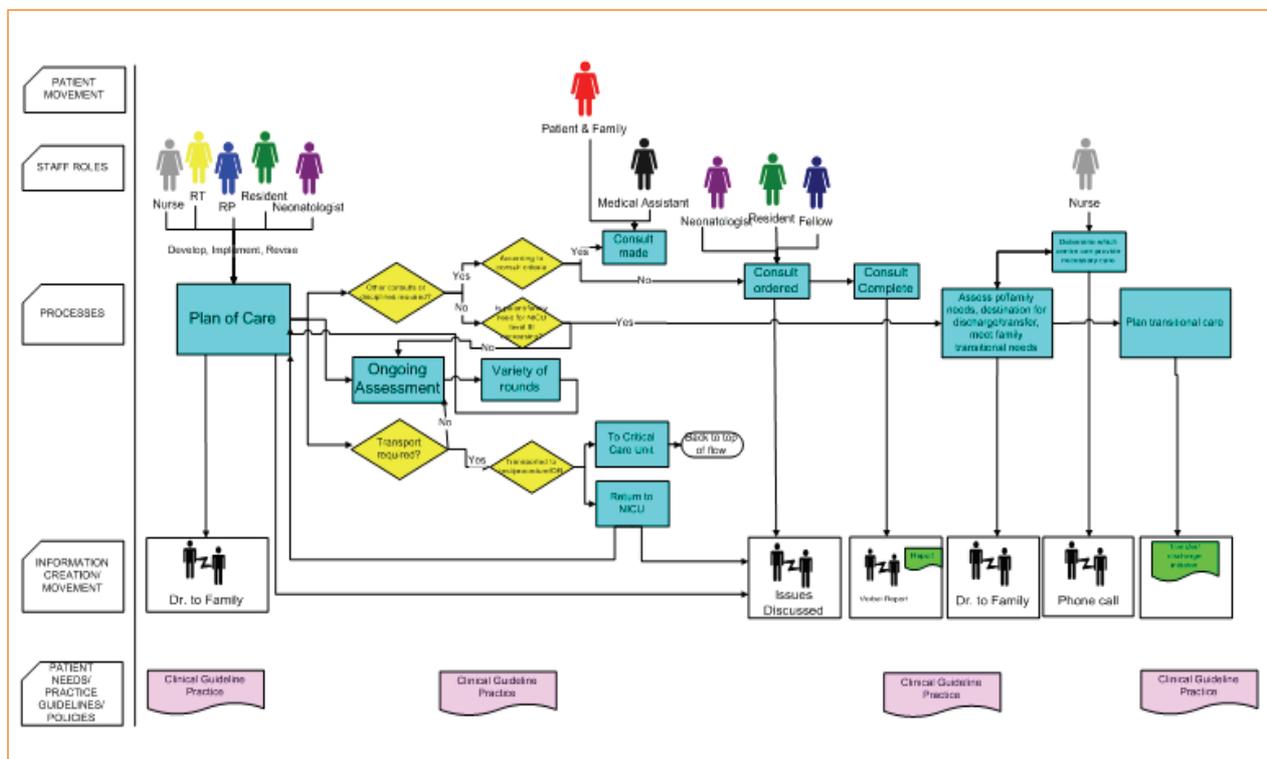

Figure 3: *PaJMa Model of Inpatient Current Flow*

Furthermore, we are currently conducting a health informatics capacity audit at The Hospital for Sick Children, to analyse the impact of technology in the patient journey from a variety of healthcare professionals' perspectives. The survey will also explore HIT-specific details for both the hospital and NICU, providing a sense of the importance placed to date on integrating technology into the organization and the success of its strategic HIT objectives to analysing. The goal is to understand how information flows are managed throughout the patient journey from the perspective of different members of the NICU team; this includes how information is generated, used, stored, and shared within the NICU and hospital information system. Through the completion of the capacity audit, the NICU team describes their view of information flow during the patient journey, specifying which processes they interact with and what information they access. With the results of the capacity audit, we have transferred the data collected into the PaJMa data model. From there it is our goal to develop and design an HIT system that will aid in a continuum of care that is accepted by the staff and patients.

Hesitation in incorporating technology of any kind into clinical guidelines needs to be avoided. There is an abundance of evidence showing the large amount of potential benefits that HIT systems alone can bring into the healthcare field. Even though research and discussion of technology will continue, it is time that great focus is now placed on testing and implementation into the field. The most effective way of jump starting this change is within clinical guidelines, given that clinical guidelines are the leading edge in incorporating new innovations into the healthcare field.

Implementing HIT systems isn't as easy as it seems. Healthcare professionals along with HIT system designers and developers need to collaborate in order to make the change successful. A better understanding of one's needs and wants is the key to push starting HIT system use within the healthcare setting.

Enhanced understanding of the trends and challenges of HIT systems is the first step in executing a change within clinical guidelines.

Acknowledgement

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Correspondence

Author Correspondence Details:
Candice MacDougall
Bachelor of Health Science Graduate
University of Ontario Institute of Technology
2000 Simcoe St. North
Oshawa, On
L1H 7K4
Phone: 647-351-3044
candice.macdougall@gmail.com