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Describing the Falls Prevention Program at an Acute Care Hospital in Ontario Using Leveson's Systems Model

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Graduate Program in Kinesiology
A thesis submitted in partial fulfillment of the requirements for the degree in Master of Arts
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DESCRIBING THE FALLS PREVENTION PROGRAM AT AN ACUTE CARE HOSPITAL
IN ONTARIO USING LEVESON'S SYSTEMS MODEL

(Thesis format: Monograph)

by

Mahboubeh Mehrjoo

Graduate Program in Kinesiology

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts

The School of Graduate and Postdoctoral Studies
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Abstract

Falls are the most frequent adverse event in acute care hospitals. Although a large number of studies have addressed the patients' risk factors for falls and best practices in fall prevention, patients falls still remain a major problem. This study applied a systemic methodology (Causal Analysis based on STAMP (CAST)) to depict Ontario's acute care hospital structure related to patient fall prevention. The system's component behaviours and interactions were described and deficits and inappropriate control mechanisms among the system's controllers were identified. As a result of the CAST analysis, the complexity of the health care system, lack of a consistent and clear fall prevention strategy, risk assessment tool and fall data analysis methodology, and effective communication between the controllers were identified as potentially problematic. Suggestions were offered to improve these gaps.

Keywords

Fall prevention strategy, systemic model, patients, control structure

Acknowledgments

I am glad to acknowledge all of those who played a role to complete this thesis, whether large or small.

I would like to take this time to express how truly grateful I am to my supervisor, Dr. Alan Salmoni for his continuous commitment and support he has shown me throughout my graduate degree. His attitude, patience and immense knowledge have helped me with the research and writing of this thesis. I could not imagine having a better supervisor throughout the past two years.

I would also like to thank my advisory committee, Dr. Aleksandra Zecevic and Prof. Dave Humphreys for their help and suggestions throughout my research process.

To my sister, Marzieh who supported me in Canada and played the role of my entire family, thank you. Her encouragement and emotional support was endless and made my life more beautiful. Her kindness and support meant more to me than she can imagine.

I would like to thank my parents for all the loving support from thousands of miles away. Thank you for being there exactly when I needed you. I am so blessed to have you all. I know that whatever life brings, you will be there.

Last but not the least, thanks to my fellow labmates in Ergonomics an Aging group: Cassandra Lyn Ellis and Bhupinder Kaur who have given me spirit and support in completing my thesis. I would also thank my friend Mona Madady for her help and accompany through this long way.

THANK YOU!

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List of Abbreviations

AEMS	Adverse Event Management System
CPSI	Canadian Patient Safety Institute
CAST	Causal Analysis based on STAMP
ISQua	International Society for Quality in Healthcare
LHIN	Local Health Integrated Network
MOHLTC	Ministry of Health and Long-Term Care
ROP	Required Organizational Practice
RNAO	Registered Nurses Association Organization
SFIM	Systemic Falls Investigation Methodology
STAMP	Systems-Theoretic Accident Model and Processes

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Chapter 1: Introduction and literature review

It has been well documented that older adults commonly experience the occurrence of a fall, which is a potentially devastating event that can lead to death or significant physical injuries (Peterson et al., 1999; Ward-Griffin et al., 2004). Findings show that among community-dwelling older adults over 64 years of age, 28-35% fall each year. Of those who are 80 years or older, approximately 50% experience a fall each year (Chisholm & Harruf, 2010). The frequency and severity of falls increase with age and frailty level. According to Tideiksaar (2002), a fall refers to “. . . any event in which a person inadvertently or unintentionally comes to rest on the ground or another lower level such as a chair, toilet or bed.” (p. 15). In the year 2000, the direct medical costs for fatal and non-fatal injuries related to falls among United States’ adults aged 65 years and older was \$0.2 and \$19 billion respectively (Stenens, Corso, Finkelstein & Miller, 2006). According to a SmartRisk (2010) report, in 2004, the direct health care costs from fall-related injuries was \$2 billion in Canada. The growing seniors’ population and the resulting cost burden on the health care system are important reasons for conducting studies addressing issues related to falls and the physical and emotional consequences of falling.

Not only do falls occur in the community, but falls are also frequent events in acute care hospitals (Bates, Pruess, Souney, Platt, 1995). Fall rates in hospital settings vary from 2.9-13.0 per 1000 patient days (Titler, Shever, Kanak, Picone & Qin, 2011). According to Bates et al. (1995), these falls account for a considerable proportion of injuries to patients as well as increased length and cost of hospitalization. Pain, impaired function, anxiety, fear of falling, loss of confidence and prolonged hospitalization have been reported as consequences for patients who experience a fall in a hospital (Ireland, Kirkpatrick, Boblin & Robertson, 2012). The prevention of falls among hospital patients is a priority within the Canadian patient safety

movement (CIHI, 2011), since hospital falls and injuries have been ranked as the second most common area of patient safety concern (Baker & Norton, 2002). The main focus of this research study is hospital-based falls and the administrative structure in place in Ontario to prevent such adverse events.

Most previous studies have focused on illuminating the risk factors for falls and developing fall risk assessment tools. Recognizing risk factors helps to identify patients who are likely to fall. Similar to a community setting, cognitive impairment, urinary incontinence, a high number of medications, impaired mobility and a previous history of falls are the most commonly identified risk factors for falls in a hospital setting (Oliver, Daly, Martin & McMurdo, 2004; Bates et al., 1995). A number of multifaceted fall prevention strategies and best practices have been introduced to improve the safety of patients and prevent falls among patients in hospitals (Oliver, Connelly, Victor, Shaw, Whitehead, Genc ... & Kurrle, 2007). However, falls continue to be a major issue in this setting. Although addressing the risk factors for falls helps to reduce the number of falls, information about a typical falls prevention program may help to improve our understanding of the structural deficits in a complex system such as a hospital. A view of the system-wide strategies and controls that have been put in place to minimize the occurrence of falls in (Ontario) hospitals may improve prevention efforts.

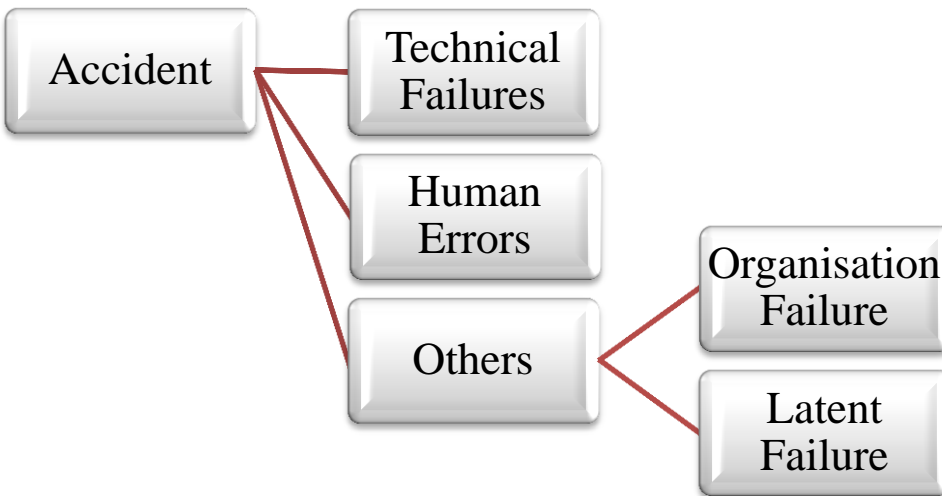
For the present study, falls are understood as accidents where an accident is defined as “an undesired or unplanned event that results in a loss, including loss of human life or human injury, property damage, environmental pollution, etc.” (Leveson, 2011). Leveson (2011) argues that until we do a better job of identifying the reasons for accidents, there will continue to be unnecessary repetition of incidents and accidents. Different accident causation models exist, however, two specific strategies for understanding the reasons for accidents/falls are relevant to

the present work. As a trained (falls) investigator, I was initially involved in studying falls in an acute care setting using the Systemic Falls Investigative Methodology (SFIM) (Zecevic, Salmoni, Lewko & Vandervoort, 2007). However, for my thesis I have taken a different perspective by making use of a model called by Leveson (2011) a Causal Analysis based on STAMP (CAST), where STAMP refers to “Systems-Theoretic Accident Model and Processes”. Whereas SFIM takes a human error focus, CAST uses an engineering strategy and focuses on system structure. Whereas the two strategies can (and will be) compared, the main focus of the thesis will be to describe the control structure in place, as it relates to falls in a single acute care hospital in Ontario. As such, a province-wide, Ministry of Health and Long-Term Care (MOHLTC) lens will be applied.

While the Leveson’s CAST model will be used, the thesis will take a slightly more generic approach. Normally Leveson and her students have used CAST to investigate single events such as major accidents or incidents like the Walkerton water contamination disaster (Leveson, Daouk, Dulac & Marais, 2003) or the friendly fire accident (Leveson, Allen & Storey, 2002). This would be the first time that this model has been used to understand the underlying systemic factors of patients’ falls. As stated above, falls in hospitals are a fairly frequent occurrence and as such the present thesis has not taken a single fall event as the starting point, but rather hospital falls in general. This is appropriate because the primary focus is the falls prevention program in place for all falls. In addition, because CAST requires an investigator to consider all levels of the (prevention) system in place, most/all of the upper levels of the prevention system are generic in nature. In Ontario, the MOHLTC dictates that all hospitals have a falls prevention program in place and the focus of the present thesis is the use of these programs in the system.

Models Designed to Understand Accidents

This section provides a brief review of accident causation models (Figure 1). The earliest accident causation models which came from industry safety (called occupational safety) placed an emphasis on the factors connected to workers protection from injury, illness, and death. The focus was on unsafe conditions and technological development in industrial accident prevention, such as open blades and unprotected belts. As a result, the most obvious workplace hazards were eliminated and the injuries started to diminish while technology became increasingly reliable. The focus then shifted from unsafe conditions to unsafe acts (human error). Accidents began to be considered as someone's mistake rather than a condition that could have been prevented by applying hazard removal in the workplace (Leveson, 2011; Hollnagel, 2004). Thus, accident records guided our attention to human error analysis. The researchers moved into studies of the management's role organizing the work place for operators. It was found that it is necessary to look at the decision errors at the management level. Figure 1 shows the development in the type of accident causes during the last century. According to this, the main models of accident causation are event-chain models and systemic models (Hollnagel, 2004). The following section contains an explanation of these two different types of models and some examples of each model to illustrate the differences as well as main areas of focus in each model.



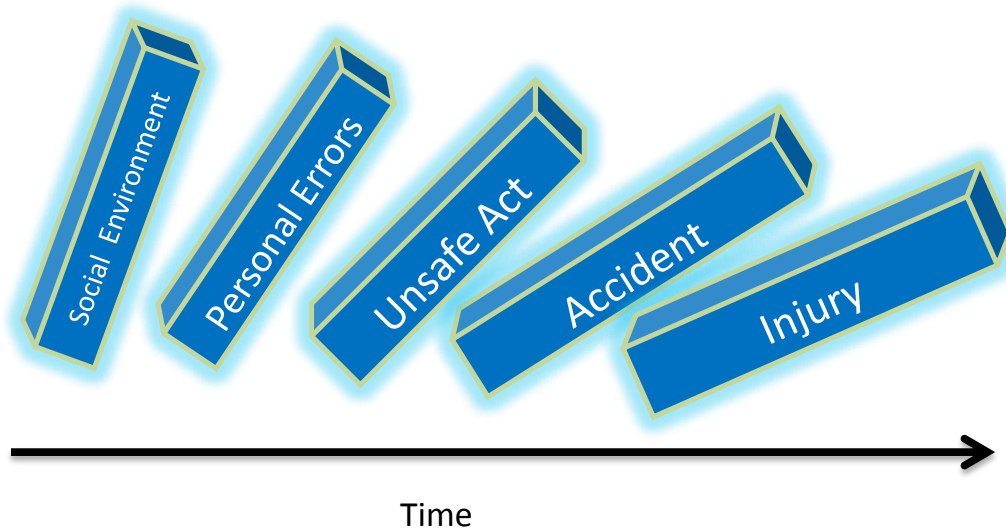
*Figure 1,
Developments in types of accident causes during the last century*

Event-chain models

The most common accident models explain accidents in terms of cause-effect (root cause) mechanisms. The occurrence process of accidents is considered as multiple sequential events in a forward chain where each single cause leads to the next failure in the chain.

The first published general accident model was Heinrich's Domino Model, published in 1931. According to Heinrich, an "accident" is one factor in a sequence that may lead to an injury (Leveson, 2011). The factors can be visualized as a series of dominoes standing on edge; when one falls, the linkage required for a chain reaction is completed (Figure 2). The model shows how these factors constitute a sequence of events where the connection between cause and effect is deterministic. Each of the factors are dependent on the preceding factor. According to Heinrich's model, a personal injury (the final domino) occurs only as a result of an accident and an accident occurs only as a result of a personal or mechanical hazard. Personal and mechanical hazards exist only through the fault of careless people or poorly designed or improperly

maintained equipment. This model has had a great influence in shifting the emphasis to human errors in safety (Hollnagel, 2004).



*Figure 2,
Heinrich's Domino Model of Accidents (Adopted from Heinrich's Domino Model, 1931)*

“Carelessness” is inherited or acquired as a result of the social environment. According to Domino theory logic, an accident can be prevented if one or more of the dominos are prevented from falling or in other ways removed. Bird and Loftus extended Heinrich’s Domino Model in 1976 (Bird & Loftus, 1976) by including management decisions to encompass the influence of management in the cause and effect of accidents. They argued that lack of management control permits the basic causes (personal and job factors) to happen. Basic causes lead to immediate causes (unsafe condition/act) which are the proximate reason of an accident; and an accident results in a loss. This modified sequence can be applied to every accident and is of basic importance to loss control management.

The Domino model was replaced by Reason 20 years later (Reason, 2000). He called it the Swiss cheese model. This model emphasizes the important role of system defences and illustrates

how defences, barriers and safeguards (represented by aligned slices of Swiss cheese) within an organization may be breached by a potential error. According to Reason, each defensive layer of the Swiss cheese model represents the safety barriers of an organization. Intact defensive layers are ideal. An accident does not happen unless the holes in all of the layers momentarily line up allowing an accident to occur (Figure 3). The Swiss cheese model focuses on human errors in order to learn how to redesign the system to reduce losses.

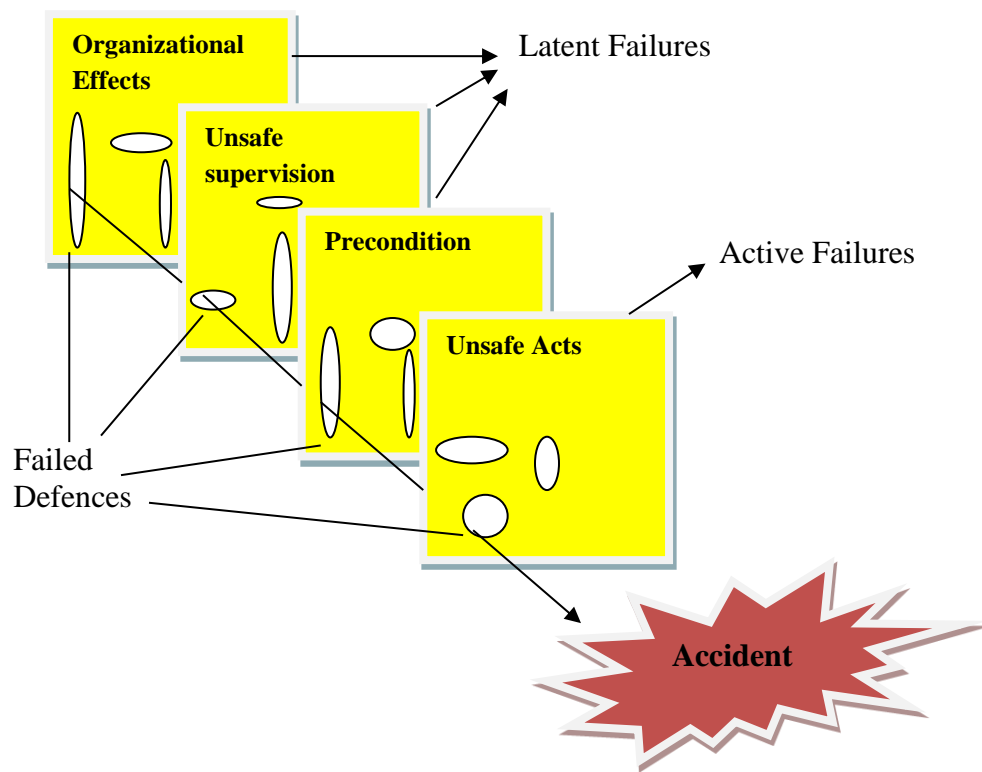


Figure 3,
Reason's Swiss cheese model of accident causal chain (Adopted from Reason, 1990)

Systemic models

The systemic accident causation models stem from control theory (Sheridan, 1992); chaos theory and stochastic resonance systemic models (Hollnagel, 2004). These theories explain accidents on the level of the system as a whole rather than on the level of specific cause-effect mechanisms in event-chain models. In this model, accidents are emergent phenomena which are “normal” in the sense of being something that derived from typical work practice. Although there obviously still must be a temporal flow of events showing the beginning of an accident’s progression and the end of its development, each event may proceed or be followed by several events. In other words, the causal relationship between the events is not required to be direct and linear (Hollnagel, 2004). There are a number of systemic accident causation models in different areas such as aviation, transportation and patient safety.

Systemic Falls Investigative Methodology (SFIM) is one example of a systemic method limited to fall investigation. Based on Reason’s Swiss cheese model (explained above) and work by the Transportation Safety Board of Canada, the SFIM was developed by Zecevic et al., (2007) to provide an in-depth understanding of seniors’ falls. SFIM is a systemic methodology of accident investigation and causation with seniors’ falls as the main focus. The SFIM model adopted the Integrated Safety Investigation Methodology (ISIM) which was developed by the Transportation Safety Board of Canada in 1998.

Another example of a systemic model of accident causation is the System-Theoretic Accident Model and Processes (STAMP) model developed in 2004 by Nancy Leveson at the Massachusetts Institute of Technology as part of system safety engineering. In STAMP, dysfunctional component interactions and external disturbances are the sources of accidents as well as component failure. Therefore, accidents occur when there is “inadequate control or

enforcement of safety-related constraints on the development, design, and operation of the system” (Leveson, 2011; p. 75). In other words, inadequate control can lead to an accident. Causal Analysis based on STAMP (CAST) is an approach to accident analysis which was introduced by Leveson.

The detailed explanation of SFIM and CAST is provided in the next section to fully understand the steps of accident analysis in each methodology.

SFIM

To provide an in-depth understanding of seniors’ falls as accidents, Zecevic et al., (2007) adopted the Integrated Safety Investigation Methodology (ISIM) which was developed by the Transportation Safety Board of Canada in 1998. The ISIM is used to provide in-depth information about transportation occurrences by investigating them. The adaptation of ISIM named the Systemic Falls Investigation Methodology (SFIM) offers a protocol for the investigation of seniors’ falls by applying the following six steps:

- 1- Planning and collecting data about the occurrence of falls by using F-SHEL (Faller, Software, Hardware, Environment and Liveware).
- 2- Creating a sequences of events and identifying safety- significant events.
- 3- Evaluating the types of errors and failures by using Generic Error Modeling System (GEMS).
- 4- Applying the unsafe acts and unsafe conditions in context by using the Swiss Cheese Model.
- 5- Identifying safety deficiencies and assessing the risk.

6- Providing safety action suggestions.

In the first step, the planning of data collection starts by investigators as soon as possible after the occurrence of a fall. The investigators apply SHEL tool to collect the needed data. The original data collection tool, SHEL, was developed by Edwards (1972). SHEL was modified by Hawkins (1993) to help investigators in gathering appropriate information and facts regarding an accident. According to the F-SHEL data collection tool, planning is directed by focusing on five components: the faller, records and documents (software), equipment (hardware), environmental conditions (environmental), and people who were directly or indirectly involved in or contributing to the incidence of the fall (liveware). In-depth interviews are used to collect data from the people who were directly or indirectly involved in the fall, especially the faller, to provide relevant information. Also, observation and examination of hardware and environmental factors, review of written material, and event reconstruction provide information regarding the fall. Accident data collection is out of the scope of this research study since the main focus is the analysis of existing information rather than investigating a particular event.

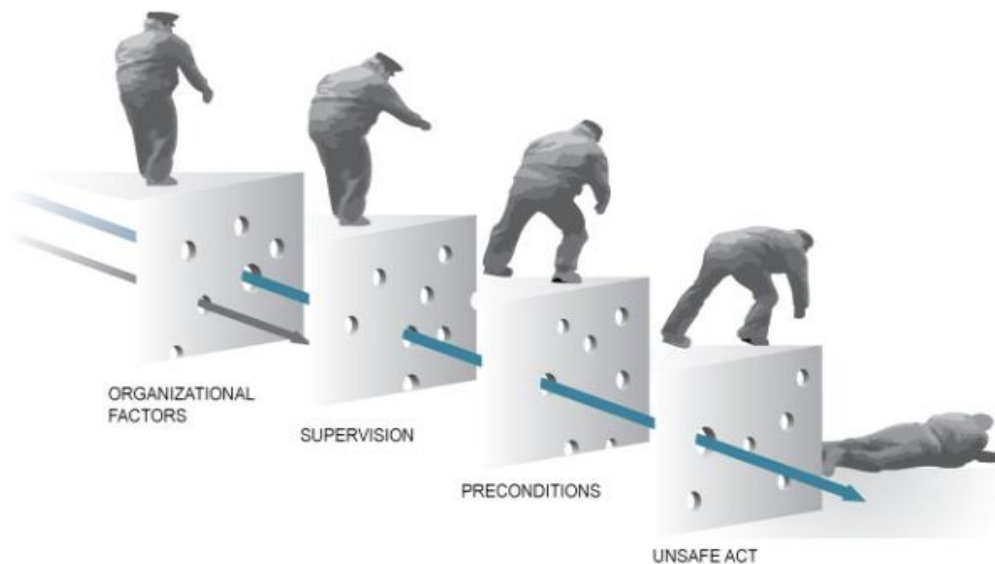
The second step in a fall investigation is to provide a logical, sequential and meaningful arrangement of information based on the material collected during the first step. The event chain is constructed using available information and has a logical flow. The sequence of events is the entry point to analyze data and identify safety significant events. Safety significant events are potential events which reveal unsafe acts/conditions. Four main questions can guide investigators to identify safety significant events: is the event undesirable? Is the event/act non-standard? Is the event/act linked or potentially linked as an antecedent to another undesirable event? And are there any other alternative actions or options available to prevent the unsafe event/act?

The third step in the SFIM protocol is analyzing the safety significant events using GEMS. GEMS was suggested by Rasmussen (1987) as a human error taxonomy framework and three years later it was revised by Reason (1987, 1990). GEMS establishes links between human error and underlying contributors by recognizing the types of error and behavioural antecedents. The outcome of the third step in SFIM facilitates identifying the types of committed errors and makes the unsafe actions clear. This analysis illuminates whether the action (unsafe act or decision) was intentional or unintentional. Errors of execution explain the unintentional actions, whereas errors of planning (action is executed well but poorly planned) are intentional action indicators. Less effective motor control and frequent memory failures are characteristics of the aging process which expose older adults to unintentional unsafe actions.

The fourth step is identifying unsafe acts, preconditions, supervision and organizational factors using the Reason's Swiss Cheese Model of accident causation (Figure 4). Unsafe acts explain characteristics of the fall such as the location of fall and the fall itself; what was the mindset of the faller and so on. Preconditions for an unsafe act include internal and external risk factors of falls in the elderly (i.e. medication, impaired mobility). Supervision consists of two components: informal supervision such as family and friends, and formal supervision such as nurses and physicians. Organizational factors relate to factors connected to service providers and policy makers such as government. Holes in the different layers of the Swiss cheese represent active failures or latent conditions that can be dynamically modified in response to local situations (Reason, 2000). When holes line up, an accident occurs. According to Reason's Swiss Cheese Model, the holes in different layers represent active failures or latent conditions. The local conditions can influence the failures' that can change over time. For instance, in the SFIM analysis, lack of formal supervision may not contribute to an oriented patient's fall. However,

lack of supervision can be identified as a contributing factor to the fall of a person who is disoriented. Thus the holes in different layers of the Swiss Cheese Model are constantly being modified in response to the situation. Accidents do not happen unless holes in different layers line up (Figure 4).

After analyzing safety significant events and unsafe conditions and identifying causal factors, the next step is determining which of these events has the potential threat for an adverse event and how properly the existing defenses are designed. The level of risk is assessed for each event during the fifth step.



*Figure 4,
Reason's Swiss Cheese Model of accident causation adopted for SFIM (Zecevic et al., 2007)*

Introducing the safety actions happens in the last step of the falls investigation since identifying safety deficiencies and suggesting the appropriate defense mechanisms is the goal of an incident investigation.

Zecevic et al. (2009) applied SFIM to identify safety deficiencies that contributed to falls in community-dwelling older adults. They investigated fifteen falls of community-dwelling seniors in London, Ontario, Canada. The findings of the study demonstrated that there is a need to study seniors' falls with a systems approach rather than focusing solely on assessing the risk factors of falling (Zecevic, Salmoni, Lewko, Vandervoort, & Speechley, 2009).

CAST

Leveson (2004) developed STAMP as an accident causation model based on basic systems theory. In systems theory, accidents are emergent from the interactions between system components rather than single causal factors. In STAMP, systems are viewed as components that are kept in a state of dynamic equilibrium by feedback loops of information and control. Control is associated with the imposition of constraints and feedback provides information about the actual state of the control process. Thus, continuous control and feedback in a complex system is vital to avoid any inconsistencies and hazards. A system is not static; it is dynamic, constantly adapting to achieve its goals and to respond to changes in the system itself and its environment. STAMP shifts the focus in system safety from preventing failures to enforcing the appropriate safety constraints or controls.

In STAMP, accidents occur when the control system fails to properly handle external disturbances, component failures, or dysfunctional interactions among system components. Safety is viewed as a control problem and safety is managed by a hierarchical control structure driven by an adaptive socio-technical system (Rasmussen, 1997). The main goal of this hierarchical control structure is to enforce constraints on system design, development and

operation. Designing a control structure that will enforce the necessary constraints helps to prevent future accidents.

The basic concepts in STAMP are: constraints, hierarchical control structures, and control loops and process models. The most basic concept in Leveson's STAMP model is constraints rather than an event. The lack of constraints imposed on the operation of the system at each level of a socio-technical system may cause an accident (or in this case a patient fall in a hospital). Systems are defined as hierarchical control structures where each level of the hierarchy enforces constraints on the activity at lower levels of the hierarchy. Safety is an emergent property which is the result of successful imposition of these constraints from one level to the next level. Based on systems theory, the interaction between system components that violates the hierarchical safety control structure is another reason for accidents.

The hierarchical control structure in Leveson's STAMP model is derived from the socio-technical model of system operation introduced by Rasmussen in 1997 (Figure 5). Rasmussen's model of system operation involves the control of safety in a dynamic society and uses a control-based model at the social and organisational levels. Rasmussen discussed that, in a very fast paced, constantly changing, technological era, complex systems and workers are forced to constantly adapt to various pressures (e.g., productivity, cost cutting measures, etc.). Hollnagel (2004) refers to these pressures as the efficiency-thoroughness trade off (ETTO). These pressures can cause the organizational behaviour to migrate towards the boundary of unsafe behaviour. Rasmussen (1997) discussed that humans in any system behave according to the system's objectives often changing their behaviour (adapting) in order to improve productivity. These adaptations and changes often remain unnoticed until an accident occurs. Rasmussen (1997) argued that the workers' performance change should be understood as adaptation to new

situations rather than workers' errors. In the Walkerton water supply disaster, many adaptations to the water testing process/system had occurred because of the pressures imposed by the severe cost cutting measures taken by the provincial government (Leveson et al., 2003). Unfortunately these adaptations were not identified until after people became ill from the contaminated water.

In the hierarchical control structure of any complex system, there are control processes between levels of the system. The control processes enforce safety constraints to control the actions at each level in the hierarchy. According to Leveson (2011), missing constraints, inadequate safety control commands, commands that were not performed correctly at a lower level, or insufficient communication or feedback about constraint enforcement are the possible reasons for inadequate control at each level of the hierarchical structure.

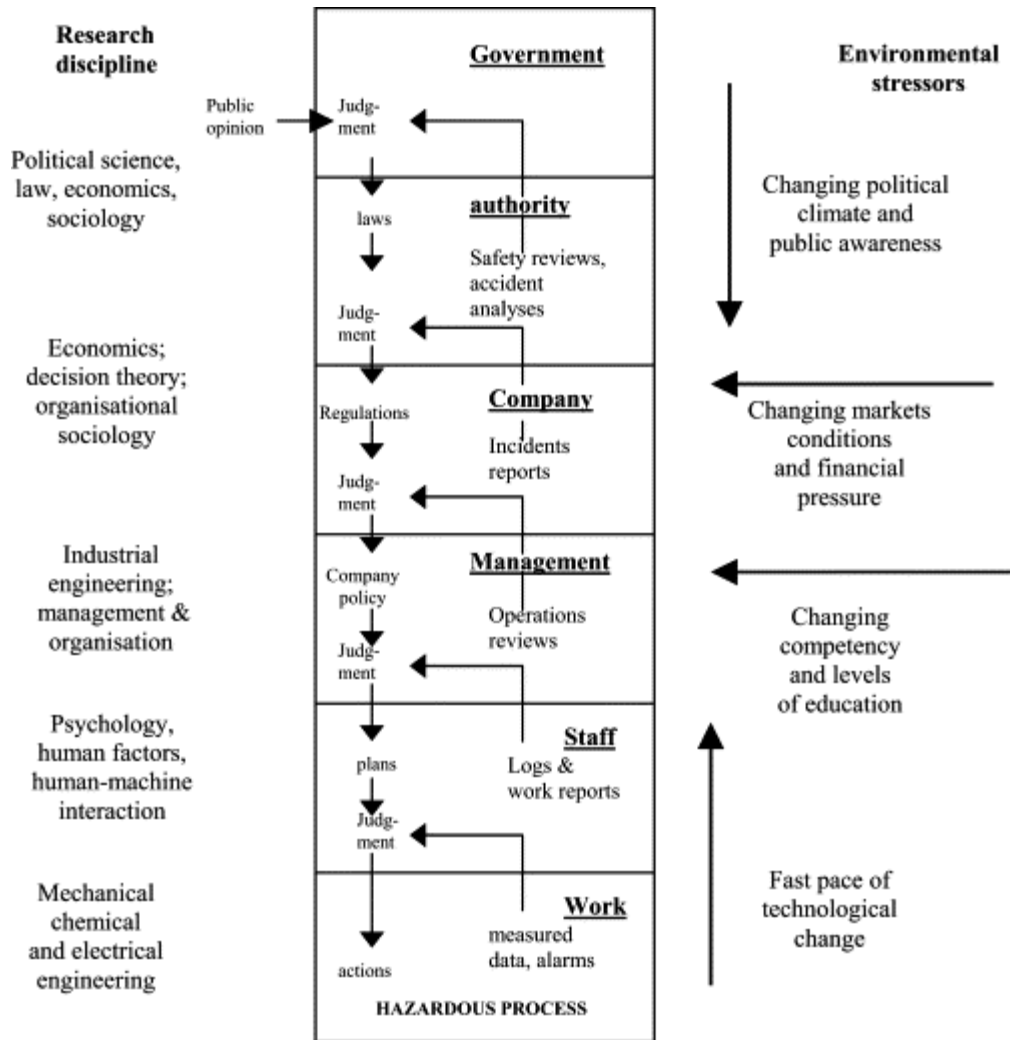
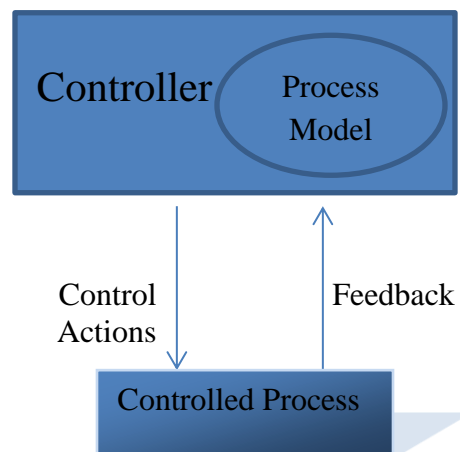


Figure 5, Rasmussen Socio-Technical model of system operation (Rasmussen, 1997)

According to Leveson (2011), every controller (automated or human) at different levels of the hierarchical structure must contain a process model to control a process in a control loop. A standard control loop is shown in Figure 6. The four important conditions to control a process are: a goal, an action condition (control channels), an observability condition (feedback), and a model condition (process model). An example in the water safety control structure at the time of the Walkerton water accident will assist to make the process clearer (Figure 6). The Walkerton Public Utilities Commission (WPUC) was responsible for operating the Walkerton water system,

acting as the controller to oversee operations to ensure that water quality was not compromised. The WPUC operations were responsible for measuring the well's chlorine residuals (measured variables or feedback) and applying adequate chlorine (controlled variable) to kill bacteria. The main goal of the control loop was to provide safe drinking water for Walkerton. Usually, accidents occur when the process model used by the controller does not match the controlled process. In the Walkerton case, there was a lack of training on drinking water safety and as a result a poor understanding of the water treatment process.



*Figure 6,
A simple control loop (Adopted from Leveson, 2011)*

Leveson (2011) introduced an accident analysis technique based on STAMP, called CAST which helps to understand why accidents occur. The entire sociotechnical system design is examined using CAST to recognize the weaknesses in the existing safety control structure. The CAST analysis normally relies on previously reported information about the occurrence (e.g., in the Walkerton case there were thousands of pages of court documents) and does not include a formal accident investigation. Indeed, information is gained through any source available,

including newspapers, government documents, etc. Analyzing an accident using STAMP is a matter of putting all three basic concepts (constraints, hierarchical control structures, and control loops) together in one diagram of the total control structure. The procedure for CAST includes the following nine steps.

- “Identify the system(s) and hazard(s) involved in the loss.
- Identify the system safety constraints and system requirements associated with the hazard.
- Document the safety control structure in place to control the hazard and enforce the safety constraints. This structure includes the roles and responsibilities of each component in the structure as well as the controls provided or created to execute their responsibilities and the relevant feedback provided to them to help them do this. This structure may be completed in parallel with the later steps.
- Determine the proximate events leading to the loss.
- Analyze the loss at the physical system level. Identifying the contribution of each of the following to the events: physical and operational controls, physical failures, dysfunctional interactions, communication and coordination flaws, and unhandled disturbances. Determine why the physical controls in place were ineffective in preventing the hazard.
- Moving up the levels of the safety control structure, determine how and *why* each successive higher level allowed or contributed to the inadequate control at the current level. For each system safety constraint, either the responsibility for enforcing it was never assigned to the component or components did not exercise adequate control to ensure their assigned responsibilities (safety constraints) were enforced in the

components below them. Any human decisions or flawed control action need to be understood in terms of (at least): the information available to the decision maker as well as any required information that was *not* available, the behaviour-shaping mechanisms (the context and influences on the decision-making process), the value structures underlying the decision, and any flaws in the process models of those making the decisions and why those flaws existed.

- Examine overall coordination and communication contributors to the loss.
- Determine the dynamics and changes in the system and the safety control structure relating to the loss and any weakening of the safety control structure over time.
- Generate recommendations.” (Leveson, 2011; p.350)

According to Leveson (2004), STAMP requires users to think based on systems theory and to consider environmental and behaviour shaping factors during an accident analysis. For example, lack of knowledge and training of the Walkerton commissioners and environmental officers were identified as contributing factors in the Walkerton water contamination accident in May 2000. They were unaware that E. coli was potentially fatal and their knowledge affected their behaviour in providing water safety. Leveson (2004) discussed that accidents are the result of a complex process which results in the system behaviour violating the safety constraints. The control loops between different levels of the hierarchical control structure enforce the safety constraints during design, development and operation. Based on the STAMP causality model, one or more of the following must have occurred if there is an accident:

- 1- The controller fails to enforce the safety constraint.
 - a. The suitable control actions necessary to apply the related safety constraint were not provided.

- b. The suitable control actions were provided but too soon or too late or stopped too soon.
 - c. Unsafe control actions were provided that caused the safety constraint violation.
- 2- Suitable control actions were provided but not followed.

The STAMP accident causation model has been used to analyze many major accidents such as public water supply contamination in the small town of Walkerton, Ontario (Leveson et al., 2003), and a friendly fire accident in Iraq (Leveson, Allen & Storey, 2002). The results of CAST analysis showed the systemic causes of accidents and the underlying accident processes as well as making recommendations that do not simply fix symptoms but eliminate the root causes.

Understanding the Reasons Behind Adverse Events

The accident causation model used to analyze an adverse event should encourage and guide a comprehensive analysis at multiple technical and social system levels (Leveson, 2011). The method used to understand or analyze events may affect the findings. There are similarities and differences between SFIM and CAST which may cause differences in the analysis of the same accident. SFIM (stemming from Reason's Swiss Cheese accident causal model) and CAST (based on Leveson's STAMP accident model) both strive to create approaches to safety based on modern system thinking and systems theory. Clarifying some of these differences may help explain the approach taken with this thesis.

SFIM is an accident causation methodology which focuses on falls as adverse events in a systemic approach. SFIM considers active failures, preconditions, supervision and organizational failures in describing the contributing factors to falls. Rather than looking for individual "holes" in system barriers, CAST forces the investigator to describe the entire system and its parts,

including a government's role. Fairly similar to SFIM, CAST considers technical (including hardware and software), human and organizational factors in complex socio-technical systems. Leveson (2011) outlines that the STAMP model of accident causation can be applied to any complex, sociotechnical system such as health care (Leveson, 2011).

Analysing error type and failure mode using GEMS is one of the steps of the SFIM accident causation methodology. The error analysis in SFIM illuminates the fact that the main focus is on human errors as potential causes. In SFIM, human errors are identified in a sequence of events as active failures which result in a person falling. Although the GEMS model was developed by Rasmussen in 1987, ten years later he argued (Rasmussen, 1997) that a shift was needed from a focus in explaining the role of human errors in accidents to one emphasizing instead the factors that shape human behaviour. He recommended focusing on the mechanisms generating human behaviour in a dynamic context rather than on human errors and violations of the rules. He argued that breaking down the behaviour into actions or events causes the isolation of the phenomenon from the context in which the behaviour happens. Such an approach suggests controlling behaviour by identifying the boundaries of safe performance. This is made possible by knowing the safe boundaries explicitly, by having the chance to develop coping skills at the boundaries, by designing the system to support safe adaptation in response to pressure, by identifying potentially dangerous outcomes of individual decisions, by planning for error tolerance, and by neutralizing the pressures that caused the safety constraint violations (Rasmussen, 1997; Leveson, 2011).

Systems are not static. The dynamic interaction of workplace circumstances makes the relationship between the systems components' behaviours and collaboration challenging. All humans involved in the system adapt to difficulties and re-shape their behaviour to meet the

demands of their job (Woods and Dekker, 2000). According to Woods and Dekker (2000), the introduction of new technology and changes causes workers to create new ways of doing things. Therefore the reality of technological change is *transformation* and *adaptation*. Adaptation is a phenomenon that happens when the work place situation, motivation and pressure changes for the workers. All the accident causation approaches that aim to enhance safety of complex and dynamic systems must account for adaptation. Rasmussen has argued that major accidents are often caused by a systemic migration of organizational behaviour to the boundaries of safe behaviour under pressure in a competitive environment. Due to work pressures and resulting adaptations, attempts to produce an effective safety culture will never end. Rasmussen argues that human adaptations are only viewed as “errors” when accidents are viewed retrospectively. A good example of this in a hospital setting is the work adaptations made by nurses on a unit that is short staffed. To maintain productivity (within an efficiency thoroughness trade-off situation) workers will adapt normal practice to deal with the high workload, often “juggling” many patients simultaneously. Indeed, under most conditions these workers will be praised for their high productivity. Only following an incident is this productivity seen as an error. This error labelling is referred to as hindsight bias (Woods & Dekker, 2000). STAMP focuses on the pressures that drive decision makers to violate safe practices instead of trying to identify human errors (Leveson, 2011), and importantly seeks to understand the control structures in place to manage safety

In each control loop at each level of the hierarchical control structure a missing or inadequate constraint on the process at a lower level or inadequate implementation of the constraint leads to violation which can cause ineffective/unsafe behaviour. Since each component of the system may involve insufficient control, analysis starts by testing each of the

general control loop components and assessing their potential involvement: (1) the controller may provide insufficient or inappropriate control actions, including insufficient supervision of failures or disturbances in the physical process; (2) control actions may be inadequately performed, or (3) there may be missing or insufficient feedback. Two American Black Hawk helicopters and all their occupants were fired on and destroyed by an American Air Force F-15 in the Iraqi no-fly zone in 1994. The Airborne Warning and Control System (AWACS) aircraft was acting as an air traffic control tower in the sky and providing surveillance and control for the aircraft in the area. Not providing the proper command to F-15 (the helicopter must not be identified as a threat) is an example of an inadequate control action by AWACS. Also, the F-15 lead pilot must not fire on the helicopters without identifying them properly. (He did not check the helicopter identification by a second pass). Inadequate feedback involved in the friendly fire accident was the limited signals from the helicopters to the AWACS due to the mountainous area and narrow line of sight.

These same general factors apply at each level of the socio-technical control structure, but the interpretations (applications) of the factors at each level may differ. The control processes may vary in different layers of the safety control structure. The higher-level control process may present only general goals and constraints while the lower level control processes may include many details to achieve the general and local goals in the immediate conditions. For instance, in the friendly fire accident (Leveson et al., 2002), the Mission Director's responsibility (as a higher level component) was having the complete awareness about the status of all aircraft in the area of the mission and commanding to stop targeting the helicopters. Lower level components such as pilots are involved in very detailed control actions close to the accident. The connection between identified contributing factors (hazards) at each safety barrier layer of the Swiss cheese model of

SFIM is not tested to identify the linking between them. For instance, lack of an informal support network and consistent medical follow up were identified as two contributing factors of a patient's fall (the fall case will be discussed below) at the supervision level of the Swiss Cheese model. The potential connection between these two contributing factors is not dealt with directly in the SFIM accident analysis. In contrast, CAST looks for effective coordination and communication channels between the hierarchical levels of the system as well as within the hierarchical levels. According to Rasmussen (1997), lack of vertical integration and communication is a major threat to an effective safety structure. Communication includes both exchange of information and feedback. The downward *reference channel* provides the necessary information to enforce constraints on lower levels and the upward *measuring channel* provides feedback in Leveson's model of accident causation. In addition to communication, feedback is necessary in providing adaptive control in any open system (Leveson, 2004).

Purpose of the Present Study

Patients' falls are among the most common reported adverse events in clinical settings (Hill, Hoffman, Hill, Oliver, Beer, McPhail ... & P.Haines, 2010; Shorr, Mion, Chandler, Rosenblatt, Lynch & Kessler, 2008). For example, 2.9-13.0 per 1000 patient days is the reported rate of falls in hospitals (Titler et al., 2011). The importance of patient fall prevention for every caregiver in clinical settings has led to many research studies in this area. Although a large number of studies have addressed patients' risk factors for falls and best practices in fall prevention, patients falls still remain a major problem in the acute care hospital setting.

It would be advantageous to identify the systemic risk factors for falls by looking at system-wide fall prevention strategies and controls. The main purpose of this thesis is to depict Ontario's health care and an acute care hospital's structure (in Ontario) related to patients fall prevention strategies, to examine the system's components behaviours and interactions, and to identify deficits and inappropriate control mechanisms among the system's controllers. This holistic approach to review the health care system's dynamics and connections to reduce patient falls will assist in addressing the system's deficits and optimizing patients' safety in the future.

Chapter 2: Methodology

A single fall at an acute care hospital, investigated using the SFIM methodology, was used as a starting point for this study. Whereas the SFIM methodology allows for the study of “organizational” factors (in the Swiss Cheese model) there is no prescription requiring the investigator to explore and describe the entire socio-technical system in question. In contrast, the CAST methodology dictates that the entire socio-technical system surrounding an accident be mapped out, so that the control structures can be described and understood. Using CAST, data is gathered by various techniques to map out the system in place to control adverse events (in this case falls in a hospital). All the existing cases in a web-based SFIM database related to hospitals’ falls were reviewed (it is important to note that the present author helped with the investigation of some of these falls). Each occurrence report in the SFIM data base includes information about demographics of falls and fallers, a summary of the fall event, a sequence of events, unsafe events, human errors, contributing factors and conclusions. Since each case has a different amount of information available due to the nature of the falls investigations, the case judged to have the most complete data in the database was selected for this research study. The inclusion criterion was a fall that happened in the hospital setting and had the richest information available. The information about the faller, contributing factors of the fall related to the faller and his environment were obtained by reviewing the SFIM database.

In line with the main goal of the present research study, Ontario’s health care safety control structure relevant to the prevention of patient falls was studied. Roughly, the control structure begins with the Ministry of Health and Long-Term Care, running down through the Local Health Integration Networks to an individual hospital. Since the whole control structure in place was examined, the CAST-driven analysis used here did not illuminate the reasons for a particular

patient fall in an acute care hospital, but rather, attempted to explain the deficits in the system relevant to the patient fall prevention strategies used by the hospital in question.

This research study received ethics approval from the Research Ethics Board at the University of Western Ontario in order to review and use the existing data in the SFIM data base.

All steps applied to fully understand how falls prevention strategies are prescribed in an acute care hospital are described below. Since many of the prevention strategies used are responses to government policy and best practices, there will be some commonality from hospital to hospital in Ontario. In this thesis, the approach to the analysis of the health care system was adopted from a research study by Leveson, Couturier, Thomas, Dierks, Wierz, Psaty, and Finkelstein (2012). Leveson et al., (2012) used the CAST accident analysis to understand deficits in the health care system related to drug safety in United States. They examined the overall pharmaceutical safety control structure to determine the main components of the system and their behaviour and interactions. A complete analysis of an adverse event in accordance with the CAST process described above, adapted for the present study (Leveson et al., 2012), and contained the following steps:

1. An explanation of Ontario's health care system's goals regarding patient fall prevention strategies.
2. An explanation of the system and potential hazard(s) involved in a fall.
3. A description of the system safety constraints and system requirements related to falls.
4. A description of the health care hierarchical safety control structure that attempts to prevent patients' falls. To map out what exists presently, a static model of the system control structure is required. This static model of health care safety control structure

related to fall prevention shows the entire system in the form of a hierarchy in which each higher level imposes constraints on the action(s) of the lower level beneath it.

5. A gap analysis to provide information about the state of different components of the control structure. In a gap analysis the controllers and their control actions which were explained in the static model (a step before the gap analysis) will be examined to identify potentially problematic areas. The controlled processes will be tested to recognize whether the controllers are able to perform effectively under the specific work conditions. The detailed information is provided in the gap analysis step.
6. Finally, recommendations to improve falls prevention in an acute care hospital will be made.

This research study looked at the health care hierarchical control structure in Ontario relevant to the fall prevention strategies at the time of a patient's fall in an acute care hospital. An investigated and analyzed fall (using SFIM) in an acute care hospital was used to start the CAST analysis (A copy of the SFIM accident causation analysis is included in Appendix A). Information about the higher levels of the health care control structure related to fall prevention was required to conduct the CAST analysis. Therefore, the principal investigator gathered information about the system itself, identified the different system controllers that have relevance to patient fall prevention, and specified how the controllers interact with each other. A primary source of information was the public information provided in official organizational websites. The policies and standards were identified through the information on the websites (see Appendix B). The accountability agreement between the Ministry of Health and Long-Term Care (MOHLTC) and Local Health Integrated Network (LHIN) was reviewed, as well as their performance agreement in order to fully comprehend the collaboration relationship between the

two organizations. Also, the LHIN- Hospital services accountability agreement (which was available on-line) was read to learn about the hospital's funding allocations and accountability indicators.

Additional fact finding was performed by the principal investigator through phone calls and emails to health care staff within the hierarchy. Staff members in different organizations who agreed to participate were asked questions about their role and responsibilities in patient fall prevention. Unlike the SFIM methodology where a template on how to collect information is provided, there is no designated procedure for doing this within the CAST methodology. Perhaps the best way to describe the investigation is that of an investigative reporter. When questions about the control structure arose attempts to contact relevant staff were made. As suggested in the Leveson et al. (2012) study, for various reasons it was not always possible to collect complete information. An accepted limitation of the present investigation, as well as the SFIM methodology is the fact that people often refuse to answer questions or simply do not reply to email requests. Despite the principal investigator's efforts to contact all individuals within various organizations who likely possessed the most relevant information about the fall prevention strategies in the health care system, she was not able to make contact with all the desired contacts. The following positions and departments were contacted:

- Health System Accountability and Performance division at the MOHLTC,
- Best Practice Guideline Manager at the Registered Nurses Association of Ontario (RNAO),
- Policy Analyst at RNAO,
- Health Services Research Specialist at Accreditation Canada,
- Program Development department at Accreditation Canada,

- Financial Reporting and Funding department at the LHIN,
- Falls Program Lead at the LHIN.

Following a lengthy data gathering period (6-8 months), the hierarchical control structure was depicted using the information obtained from various staff members, as well as from organizational charts from the hospital and the MOHLTC.

Chapter 3: Case Study Accident Description

The fall chosen took place in an acute care hospital and caused some minor injuries to a stroke survivor. The patient, an older adult fell to the ground on May 17, 2012 at 15:55. The stroke unit's physiotherapist assisted the patient to the washroom in his room after an afternoon physiotherapy session. The patient was able to walk with his walker but required assistance and supervision by at least one other person. The patient left his walker just outside the washroom door and before leaving him the physiotherapist reminded the patient to call his nurse using the call bell in the washroom when he wanted to return to his bed. The faller used the call bell to call for help but after five minutes of waiting became impatient and decided to transfer to his bed independently. He stepped out of the washroom and grabbed onto his walker. As he started walking his foot hit the walker and he tripped over the walker. He lost his balance and fell forward onto the ground. His nurse came into his room and noticed the faller on the floor. She rushed to the room's doorway and called for assistance from other nurses nearby. Two other nurses arrived and helped the patient into his bed. The patient was assessed for injuries and some bruises were found.



*Figure 7,
Left: the washroom in patient's bedroom. Right: The patient's walker*

Chapter 4: Using CAST

This chapter presents the CAST analysis of the Ontario-based system designed to prevent patient falls, like the one described above, in an acute care hospital.

Step 1: System Definition and its Goals

Understanding the goals of any studied system is essential to realize its purpose and to evaluate how well it meets its objectives. The federal government, the ten provinces, and the three territories create Canada's health care system. The provinces and territories administer a collection of plans under the "Canada Health Act", each differing from the other in some sense but similarly designed to meet national principles. The main objective of the health care system is "to ensure that all residents have reasonable access to medically necessary hospital and physician services, on a rapid basis" (Health Canada, 2010).

It is acknowledged that the focus of this thesis is fall prevention strategies in Canada's health care system, specially an acute care hospital in Ontario. Thus, the system goals regarding patient fall prevention can be defined as:

1. Identifying hospital patients at risk of falling.
2. Developing and implementing effective fall prevention strategies.
 - a. The appropriate organizations are assigned to develop and implement the strategies.
 - b. Updated scientific knowledge is provided.
3. Ensuring the fall prevention strategies are appropriate to address a patient's safety needs and to prevent falls (Canadian Institute for Health Information, 2011).

There are many different types of hospitals such as acute, community and rehabilitation hospitals. However, for the present research study the acute-care-hospital setting (where the

reported fall occurred) was studied. Acute care hospitals provide complex care for patients (Hospital Report, 2007). In the acute care hospital's goal map, it was found that the final goal as a part of the health care system is: "To achieve excellence in patient care and safety, to provide the best patient and family experience, to transform by new discoveries and innovations, and to collaborate with partners to provide an integrated system of patient care." According to the goals of the hospital, patient safety is central to high quality care. Employing best practices that align with the quality and patient safety framework is essential to attaining the highest quality of care. Best practices for health care professionals refer to the best evidence-based interventions available from the research (Hartford Center of Geriatric Nursing Excellence, 2012). The fact that an acute care hospital consists of many different units (e.g., pediatrics, stroke, and neurology) and different patients with various conditions poses several challenges for falls prevention. For example, patients presenting with dementia are more prone to fall than non-demented patients (Shaw, 2002). The present reality for Ontario hospitals is the goal of attempting to minimize the number of falls that occur.

Step 2: System Hazard Identification

In some socio-technical systems like aviation and transportation systems, a hazard is perceived as something in the environment. For example, a mountain in the path of the aircraft is a hazard. Leveson (2011) argued that in System Safety, a hazard is defined as both environmental and within the designed system and not just in its environment. For instance, flying too close to a mountain would be a hazard also. According to Leveson (2011, p.184), a hazard is defined as "A system state or set of conditions that, together with a particular set of worst-case environmental conditions, will lead to an accident (loss)."

The system level hazards associated with patient falls are:

H1. Patient supervision is not continuous.

1. Nurses provide care for multiple patients often necessitating multi-tasking often under “ETTO” conditions (Kalisch & Aebersold, 2010). According to Hollnagel (2004), human error is not a useful theory to explain accidents. He argued that normal work performance often consists of a number of trade-offs between efficiency and thoroughness (ETTO principle). Hollnagel believes that these trade-offs are learned and effective. Accidents can be preventable if the normal human performances and the conditions in which the trade-offs occur are investigated (Hollnagel, 2004). Given that health care expenditures in Ontario are considered to be very high and hospitals in Ontario currently operate under very strict budgetary conditions, this practice is likely to continue (Drummond & Burleton, 2010).
2. Patients span 24 hours in a patient day, nurses work in shifts of less than 24 hours.
3. Patient needs are variable across patients and across time.
4. Monitoring of patient needs (e.g., a call bell system) is not always reliable.

H2. Best practices for and implementation of falls prevention is not perfect.

1. The specifics of falls prevention protocols are not dictated for hospitals.
2. Best practices do not always exist (lack of research clarity).
3. Adverse event reporting and analysis of fall events is not perfect.
4. Not all risk assessment tools are valid and reliable (Scott, Votova, Scanlan & Close, 2007).

H3. Patients have many conditions that affect balance and their risk of falls (Bates et al., 1995).

1. Some patients arrive being fall prone as a secondary condition to the primary reason for hospital admission.
2. Surgery/treatment often has after effects.
3. Many admission conditions directly and severely impact balance and strength (e.g., strokes).
4. Patients' conditions are not constant.

H4. Patients do not always follow care instructions.

1. A patient's bodily needs (urination) often pre-empt safety concerns (Maslow, 1954).
2. Patients often have cognitive/mental conditions that interfere with logical thinking/problem solving (e.g., older patients often have dementia).

Falls are a very common accident in hospitals (Hill et al., 2010; Shorr et al., 2008). A patient's fall can be identified as a hazard itself and system design should not let the hazard exist. However, it is likely not possible to control all falls considering the variety of patients' and environmental conditions. The patient related factors such as dementia are out of the control of the health care system. According to Leveson et al, (2012) "There is nothing in the world that is totally safe under all conditions" (p. 395). Therefore, it is important to create a safe health care system which attempts to control the possible hazards and decreases the probability of fall related hazards as much as is possible.

Step 3: System Safety Constraints and Requirements

The system level constraints required to address (i.e., prevent) the aforementioned hazards are:

- 1- The work place circumstances such as nurses multi-tasking need to be considered to provide the most efficient care/supervision for the patients. The fall prevention strategies and best practices need to reflect the ETTO condition.
- 2- Health care policies for falls prevention need to be developed including responsibilities for all health care providers.
- 3- There should be a national evidence-based fall prevention protocol to dictate to hospitals what to perform as an effective fall risk assessment, fall prevention strategies, and fall related data analysis.
- 4- There should be effective communication between health care providers to increase patient safety.
- 5- The fall risk factors of patients need to be identified during admission, the treatment process, and after a fall. Moreover, the patient's care plan should address their risk factors while they are staying in the hospital.
- 6- The health care system should provide oversight to ensure that patient safety policies and activities are being carried out successfully.

The system requirements necessary to prevent the aforementioned hazards and enable safe execution of roles and responsibilities are:

- 1- There should be fall prevention/management strategies reflecting the ETTO condition for the acute care hospital nursing staff who is working under specific work place circumstances.
- 2- The responsibilities of all health care providers related to the fall policies should be outlined clearly.

- 3- There should be an explicit fall risk assessment tool introduced to acute care hospitals as well as a fall prevention strategy to identify the patients at risk of fall and to prevent falls. Moreover, a fall related data analysis methodology is required to effectively identify the contributing factors to patients' falls.
- 4- Health care providers should be in contact with each other effectively to optimise the care and safety for the patients.
- 5- There should be approaches for regular patient safety checks.

The main goal of identifying the system level hazards and constraints is to design effective controls to enforce them, and to observe and improve an existing system that needs to satisfy the requirements as much as possible. The directors of the hospital require knowledge about the safety state of the whole system in order to improve the services over time for the future. A summary of steps 2 and 3 are shown in Table 1.

Hazards	Safety Constraints
<p>Patient supervision is not continuous.</p> <ol style="list-style-type: none"> 1. Nurses are multitasking and adopting with the work condition circumstances. 2. Patients span 24 hours in a patient day, nurses work in shifts of less than 24 hours. 3. Patient needs are variable across patients and across time 4. Monitoring of patient needs (e.g., call bell system) is not always reliable. 	<p>The work place circumstances such as nurses multi-tasking need to be considered to provide the most efficient care/supervision for the patients. The fall prevention strategies and best practices must reflect the ETTO condition.</p> <p>Policies for falls need to be developed including responsibilities for all health care providers.</p>
<p>Implementation of falls prevention is not perfect.</p> <ol style="list-style-type: none"> 1. A specific falls prevention protocol is not dictated for hospitals. 2. Best practices do not always exist (lack of research clarity). 3. Adverse event reporting and 	<p>There should be a national evidence-based fall prevention protocol to dictate to hospitals what to perform as an effective fall risk assessment, fall prevention protocol, and fall related data analysis.</p>

<p>analysis of fall events not perfect.</p> <p>4. Risk assessment tools are not perfect.</p>	
<p>Patients have many conditions that affect balance and their risk of falls.</p> <ol style="list-style-type: none"> 1. Some patients arrive being fall prone as a secondary condition to the primary reason for hospital admission. 2. Surgery/treatment has after effects. 3. Many admission conditions directly and severely impact balance and strength (e.g., strokes). 4. Patients' conditions are not constant. 	<p>The fall risk factors of patients need to be identified during admission, the treatment process, and after a fall.</p>
<p>Patients do not always follow care instructions.</p> <ol style="list-style-type: none"> 1. Bodily needs (urination) often preempt safety needs (Maslow's hierarch of needs) 2. Patients often have cognitive/mental conditions that interfere with logical thinking/problem solving (e.g., ALCs often have dementia) 	<p>It is important to remember the fact that a certain number of falls are inevitable in acute care hospitals. The health care team need to provide safety of patients in addition to prepare them for a routine life.</p> <p>The fall prevention strategy promotion has to address the needs for the patients with various health issues.</p>

*Table 1,
System Hazards and Safety Constraints*

The next section describes the static model of what exists in place today as the health care control structure in Ontario for patients' fall prevention. The next step after describing the static model is to conduct a gap analysis to identify what needs to be changed to assist in preventing future patients' falls in acute care hospitals.

Step 4: Static Model of the Hierarchical Fall Prevention Control Structure

In this step, a static model of the fall prevention control structure is provided. Leveson et al. (2012) distinguish between a static model and a dynamic model. “Static” simply refers to the fact that the model is representative of the present structure of the system, whereas “dynamic” refers to a computer representation that allows the effects of changes to the system to be tested. Only the static version of this process is used here in this thesis. The health care safety control structure related to fall prevention models the entire system in the form of a hierarchy in which each higher level imposes constraints on the action(s) of the lower level beneath it. The hierarchical system safety control structure for Ontario acute care hospital falls prevention is provided in Figure 8. The objective of the control structure is to ensure that the health care system’s goals are achieved. This control structure illuminates that patient fall prevention strategies and constraints are enforced by a complex system. A focus on some parts of the hospital hierarchical control structure was needed since the safety control structure was very complex. In Figure 8, the black arrows show the imposed constraints to the lower level of the control structure by the higher level component. The dotted black arrows and the returning arrows to the upper level components represent feedback between the components of the health care system (as understood from the information gathering process). An overview of the system’s controllers’ roles, responsibilities, and interfaces related to patient falls prevention is explained.

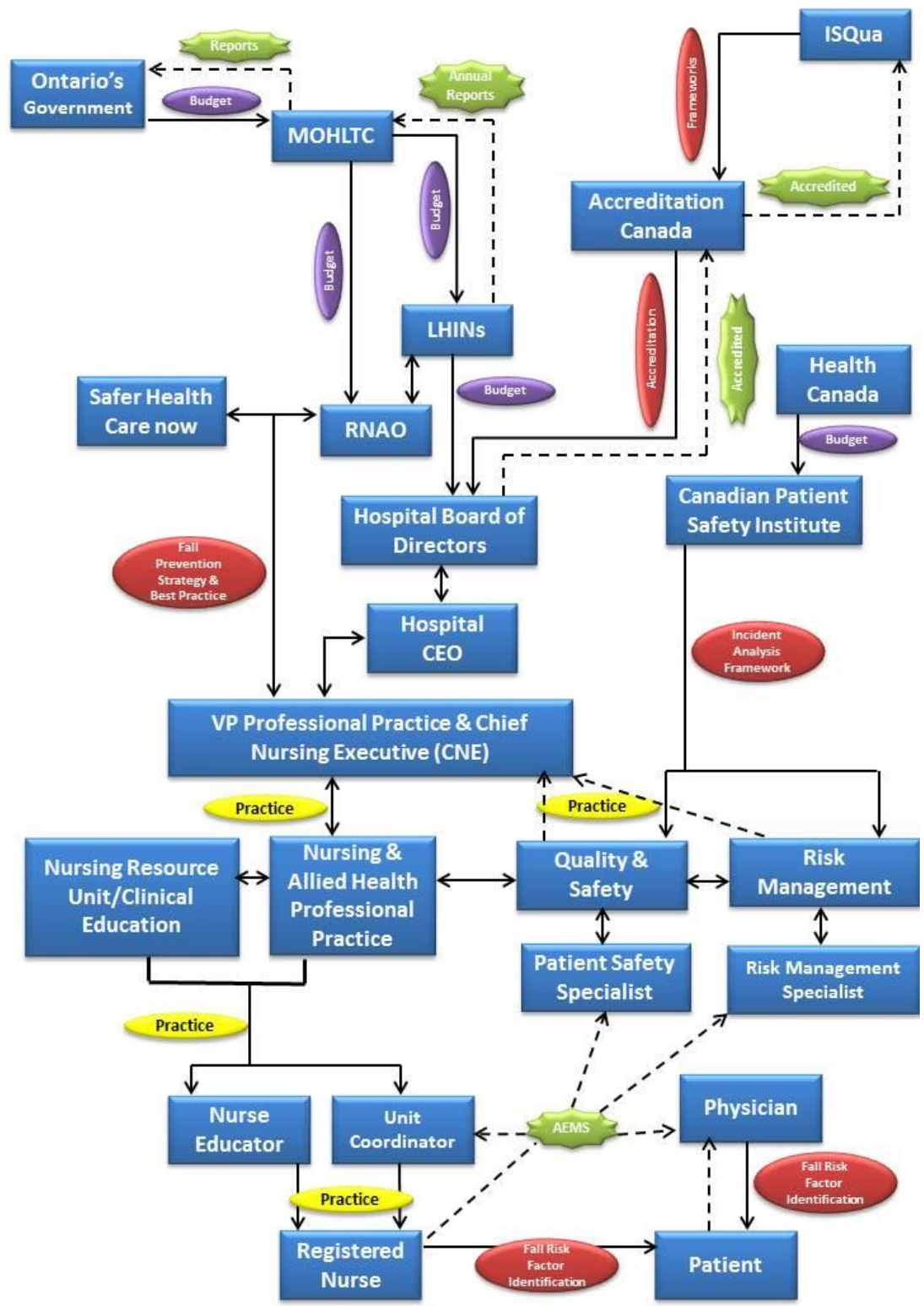


Figure 8:
The hierarchical control structure for the Ontario health care system regarding fall prevention strategies.

Hierarchical Control Structure Roles and Responsibilities:

In this section, different control loops and their connections are introduced to understand the nature of the system. In addition, the upper level and lower level components and controllers' responsibilities and their connections are presented to clarify their roles and controlled processes in the hospital.

Control Loops and Interfaces:

It is important to distinguish the different control loops and their function in the hierarchical control structure. Also, different control loops have specific control actions and process models to control a process. The type of control action in a control loop is specified in this research study and the control loop mechanisms are shown in ovals. As shown by different colours of ovals in Figure 8, there are four major control loops across the system's hierarchical control structure called budgetary, educational, practice, and policy control loops.

Budgetary control loops: in this control loop, the upper level organization provides the budget for the lower level organization's actions. The budgetary control loops have a strong influence on the whole system due to the financial support of the upper level's organization. The lower level organization is dependent on the budget provided by the higher level for its operation. Budget is the main output of the upper level organization. This constraint makes the lower level's behaviour dependent on the upper level's output. For example, each LHIN is dependent on the budget provided by the MOHLTC to plan, integrate and fund health care services to meet the local health needs and priorities. The purple ovals represent the budget control loops.

Educational control loops: in the educational control loops, the upper level controller imposes the appropriate constraint to the lower level by providing them with educational information. For example, fall prevention strategies and best practices are educational constraints which are

provided by the collaboration of three different organizations (Safer Healthcare Now, RNAO, and the LHIN). The fall prevention strategy is an educational evidence-based best practice introduced to the acute care hospital. The fall prevention strategies and best practices increase the awareness of the health care team, patients and families about falls. The red ovals show the educational control loops.

Practice control loops: in the practice control loops, the upper level controller introduces the proper practice as a constraint to the lower level's behaviour. Usually, the practice control loop is the result of an existing educational control loop. The fall prevention strategies and best practices provided to the hospital's vice president of professional practice and chief nursing executive officer results in imposing the designated practices to the lower level controllers such as the nurse educators and unit coordinators. This flow of information continues to other lower levels within this hierarchy down to the registered nurse level where this information gets put into practice. For instance, the registered nurses will be notified to apply a specific fall risk assessment tool (for the present hospital it was the Morse Fall Scale) on every admission. For the present hospital patients identified at risk of falling wear a wrist-band which indicates that the patient is at risk of falling. In turn, this information assists the nurses with identifying the patients at risk of falling and helping to prevent falls from occurring. The yellow ovals show the practice control loops.

Policy control loops: in the policy control loops, the upper level organization imposes a constraint on the behaviour of the lower level organization by introducing new policies and standards. Thus, the main output of the upper level organization or function is policy. For instance, in the present hospital there is a policy control loop between the risk management department and each unit to report the adverse events by using the AEMS reporting system. The

registered nurses are responsible to report patient falls with different levels of injury. The orange oval between the risk management department and all hospital units in the static model represents a policy control loop.

The Upper Level Controllers:

The Ontario government provides the budgetary source for the health care system. MOHLTC receives its budget from the Ontario government. Ontario's Local Health Integration Networks (LHINs) were created by the MOHLTC in March 2006. The province of Ontario was divided into 14 regions or LHINs (LHIN, 2013). The MOHLTC provides funding for the LHINs and the Local Health System Integration Act, 2006 authorizes the LHINs to manage their local health care system (MOHLTC, 2012). The purpose of the act is: "to provide for an integrated health system to improve the health of Ontarians through better access to high quality health services, co-ordinated health care in local health systems and across the province and effective and efficient management of the health system at the local level by local health integration networks" (Local Health System Integration Act, 2006). In Ontario, each LHIN must develop an integrated health service plan for the local health system. The LHINs plan, integrate and fund health care services enabling each service to meet their local community's health needs and priorities. Hospitals are one of the health care services funded by LHINs (LHIN, 2013). According to the Local Health System Integration Act (2006), each LHIN must submit to the Minister an annual report on its affairs and operations during its immediately preceding fiscal year (Local Health System Integration Act, 2006). The LHINs are accountable to the Ministry through the Ministry-LHIN Accountability Agreements (LHIN, 2011). Related to parts of the Local Health System Integration Act (2006) these agreements lay out the funding and performance obligations of both parties. The MOHLTC often funds provincial programs relevant

to falls by the LHINs and or Health Service Providers. The budgetary control loops between MOHLTC and LHIN; LHIN and the acute care hospital; and MOHLTC and organizations that provide provincial programs relevant to falls are illustrated in Figure 9.

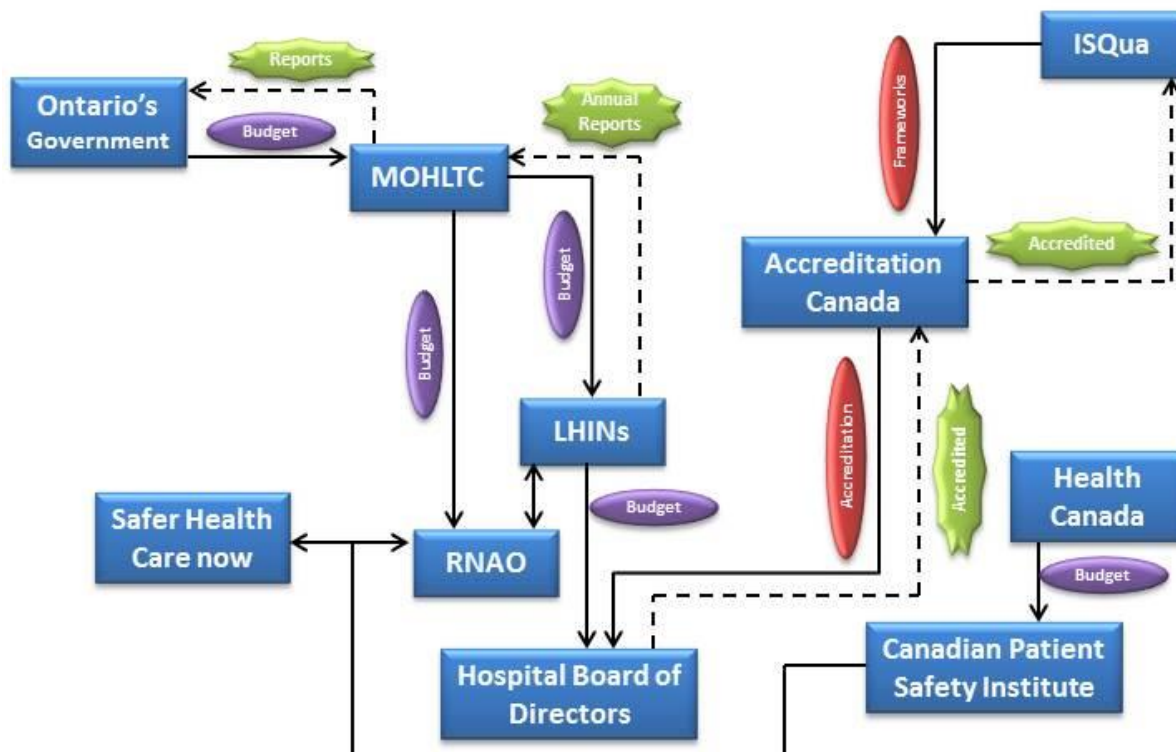


Figure 9,
The hierarchical control structure for the health care system regarding fall prevention strategies. (Higher level components)

LHINs are aligned with some other provincial and national organizations and initiatives in order to reduce falls and decrease the health care system burden resulting from falls.

Accreditation Canada and RAO are two organizations that collaborate with LHINs.

In September 2010, fall prevention was identified as a top priority by the MOHLTC (LHIN, 2011). As a result, the Integrated Provincial Falls Prevention Project was started by LHINs in October 2010. This project included a framework for fall prevention at the local and provincial level to guarantee a consistent approach to prevent falls across the province. The project

consisted of two phases. The existing successful fall prevention programs, fall assessment tools and resources were identified during the first phase of the Integrated Provincial Falls Prevention project. The main focus of the project's second phase was on releasing this framework and toolkit to health care services across the province as well as implementing some of the key actions in the framework. As a result of this project, an evidence-based best practice guideline introduced by RNAO and Safer Healthcare Now was introduced to the acute care hospital as a fall prevention strategy (LHIN, 2011). The project was funded by the MOHLTC. The funding process of the LHIN and health care providers, such as hospitals accountability indicators, is as follows: MOHLTC and LHINs set a target for each health care accountability indicator such as emergency room length of stay and wait time for cancer surgery. The funding process is based on an achieved target. In order to receive the allocated fund for a health care accountability indicator, a health care provider is required to perform at the LHIN's accountability agreement target or better. Presently falls are not part of the accountability indicator in the agreements between the LHIN and the acute care hospital being studied. However, the benchmarking process could exist in the future to allocate budget for fall prevention in acute care hospitals within the present LHIN. In other words, the LHIN could add another accountability indicator and define the hospital's fall rate as an accountability indicator and set a target based on the adverse event reporting systems' data from different hospitals. Therefore, some part of the budget transfer could be dependent upon whether the hospital is within the acceptable range of fall rate (the target) as provided in annual hospital reports (feedback) to the LHIN. Obviously a hospital budget is very complicated and the benchmarking process is only one small portion of this. However, because accountability is an important aspect of the current health care system, benchmarking and other budgetary controls are very common.

The International Society for Quality in Healthcare (ISQua) is an independent organization with 70 members from across the world (ISQua, 2012). ISQua evaluates and accredits health care accreditors in different countries such as Accreditation Canada. “Accreditation Canada is a not-for-profit, independent organization accredited by the ISQua. We provide national and international health care organizations with an external peer review process to assess and improve the services they provide to their patients and clients based on standards of excellence” (Accreditation Canada, 2013). In Ontario, more than 400 organizations are accredited through Accreditation Canada. Accreditation is a voluntary process for organizations to regularly and consistently examine and improve the quality of their services. The accreditation program is free, national, bilingual, and not-for-profit. Accreditation Canada staff assess health care organizations every four years to determine whether health care organizations meet the Required Organizational Practices (ROPs) identified in various patient safety areas such as falls prevention (Accreditation Canada, 2012). Within the program of Accreditation Canada, an ROP is defined as: “an essential practice that organizations must have in place to enhance patient/client safety and minimize risk” (ROPs, 2012, p. 1). Accreditation Canada has identified having a falls prevention strategy in place (specific details of the strategy are not identified explicitly) as an ROP (see Appendix B for fall prevention strategy as a ROP). The goal of this ROP is to reduce the risk of injuries resulting from falls. There are a number of compliance measures used, which include:

- The health care team (hospital) has implemented a fall prevention strategy.
- The strategy identifies the population(s) at risk for falls.
- The strategy addresses the specific needs of the population at risk for falls.

- The team evaluates the fall prevention strategy on an on-going basis to identify trends, causes and degree of injury.
- The team uses the evaluation information to make improvements to its fall prevention strategy (ROPs, 2012, p. 54).

A number of surveyors from Accreditation Canada conduct on-site surveys in hospitals to study if the ROPs are meeting the standards. They study patient-related documents, interview different program staff, leaders, educators and patients to identify areas for improvement and a measure of an organization's services compared against standards of excellence. Accreditation is a proactive process which aims to improve the services provided to the patients.

The LHIN would work with Accreditation Canada to identify the accredited organizations and determine how they are meeting the ROPs. At the time of this study the acute care hospital where the patient fell was accredited by Accreditation Canada (including its falls prevention strategy) and is preparing for its next accreditation process.

The RNAO is a professional association representing Registered Nurses in Ontario. In collaboration with Safer Healthcare Now, an evidence-based best practice guideline, "Prevention of Falls and Injuries in the Older Adult" was developed through funding from the MOHLTC (RNAO, 2005). The guideline's main objectives were increasing all nurses' confidence, knowledge, skills and abilities in the identification of adults within health care settings at risk of falling and to define interventions for the prevention of falling and reduction of injury. This guideline, updated in 2012, is at the centre of many of the falls prevention strategies seen in health care settings across the province such as the hospital where the patient discussed in this thesis experienced his fall. The nursing and allied health professional practice department receives the best practice guidelines under the supervision of the vice president of professional

practice and the chief nursing executive officer in the hospital. The fall prevention best practices are presented to all nurse educators as a designated practice to educate nursing staff about falls, fall risks, and fall prevention strategies. The following strategies were implemented in the present hospital as fall prevention interventions:

- Fall risk assessment – utilizing the Morse Fall Scale completed on every admission, transfer, weekly, after a fall or change in patient status or medications.
- Communication of the risk – using yellow arm bands, falls risk signs at head of beds, and provision of non-slip socks for the patients at risk of falling.
- Patient/family education about the risk of falling.
- Implementation of interventions suggested by higher level controllers (i.e. RNAO and Safer Healthcare Now) for those at risk of falling. The following checklist is the standard intervention implemented in the acute care hospital to reduce fall rates for the patients at high risk of falling:

- Providing a call bell within the patient's reach.
- Adjusting the patient's bed to the appropriate height.
- Providing non-slip and secure footwear.
- Supplying mobility aids such as canes and walkers and putting them within a patient's reach.
- Assessing the patient's need for toileting.
- Providing family and patient education about falls.

As discussed above, the patient safety specialists and risk management specialists receive the Adverse Event Management System (AEMS) report when a fall happens in the hospital (A detailed explanation about AEMS is provided in the following section). They analyze fall data

based on the “Canadian Incident Analysis Framework” introduced by the Canadian Patient Safety Institute (CPSI). The CPSI received funding support from Health Canada in order to establish this framework (Incident Analysis Collaborating Parties, 2012). This analysis method is a holistic structured process used to analyze different types of patient safety incidents (with harm/no harm included) and near misses. The incident analysis framework assists the specialists to determine what happened, why that happened, what actions can be taken in reducing the risk of the accident, what can be learned, and how the learning can be shared (Canadian Incident Analysis Framework, 2012). The incident analysis is a part of the incident management continuum (see appendix D for the incident management continuum). Three timelines are discussed in the continuum including before the incident, immediate, and after the incident. Before the incident, there is a need for a safety culture with leadership support at all levels of the organization to ensure the safety of patients. Also, the learning generated from the previous events promotes building of an improved safety culture within the organization. Support and care for the patient/family members and providing the incident report to the risk management department is required immediately after the incident. The incident analysis is the responsibility of specialists after the accident which assists to better understand what happened and why. Two methods introduced to analyze individual accidents in this framework are: comprehensive and concise. The “*comprehensive*” analysis method is usually used for complicated and complex incidents that resulted in catastrophic/major harm, or the significant risk thereof. Multiple sources of information are consulted, including interviews with those directly or indirectly involved in the incident as well as experts, supplemented by a literature review...., The final report produced includes a detailed chronology of the facts, contributing factors and their influences, findings from the literature search/environmental scan, context analysis,

recommended actions, and where applicable, implementation, evaluation and dissemination plans. *Concise* analysis is a succinct, yet systematic way to analyze incidents with no, low or moderate severity of harm. Generally the incident and analysis process is localized to the unit/program where care was delivered. The sources of information consulted are the available reports, supplemented with a small number of select interviews and a targeted review of other sources of information. The analysis is completed in a short interval of time by one or two individuals. At the end of the analysis, a report is produced that contains the facts (including a brief timeline), contributing factors, a brief context analysis, and where applicable, recommended actions and a plan for evaluation and dissemination.” (Canadian Incident Analysis Framework, 2012; p. 36).

MOHLTC, LHINs, Accreditation Canada, RNAO, Safer Healthcare Now, and Canadian Patient Safety Institute are the main upper level controllers in Ontario’s health care system to control fall prevention strategies above the hospital settings. LHINs provide the budget for health care providers and collaborative organizations through MOHLTC and Ontario’s government. Accreditation Canada is an organization to accredit the health care providers that meet the standards of excellence and ROP requirements. Every hospital is required to implement a fall prevention strategy to satisfy the accreditation process by Accreditation Canada. The specifics of these strategies are not dictated by a higher level organization to the hospitals. Thus, each hospital meets its accreditation needs in unique ways (the fall prevention strategy implemented in this acute care hospital was explained above). The hospital’s fall prevention strategy was derived from an evidence-based best practice guideline, “Prevention of Falls and Injuries in the Older Adult” which was developed in collaboration with the RNAO and Safer Healthcare Now. In addition to the upper level controllers, the lower level controllers play an important role in

patients' fall prevention in an acute hospital. The roles and connections between the lower level controllers will be described in the following section.

The Lower Level Controllers:

The risk management specialist designs and maintains the Adverse Event Management System (AEMS) which is a web-based adverse-event reporting system. The fall related data captured is analyzed and reported to a patient safety specialist. Also, the risk management specialist has the responsibility to identify the possible risk factors of falls by analyzing the adverse event reports and suggesting strategies to minimize falls in collaboration with other departments.

The patient safety specialist has the responsibility of monitoring the fall data through AEMS and utilizing the data to educate and improve patient safety, ensuring that the implementation of the fall prevention strategies in all units of the hospital are effective, evaluating fall risk assessment tools to see if the tool is valid and reliable, and analyzing falls in collaboration with the risk management department.

Nurse educators have a pivotal role in teaching staff about falls, falls' risk to patients, fall prevention strategies and interventions, and process/actions to be taken if someone falls. In addition, nurse educators have the responsibility to audit staff compliance of education related to assessing risks related to falls and implementing appropriate strategies to reduce falls.

Every acute care hospital consists of different units and there are health care team members assigned for different responsibilities in different units. Therefore, each unit has its own director, manager and coordinator. The unit coordinator is in direct contact with patients, registered nurses, allied health care providers and physicians to discuss the best possible arrangement of

care for the patients in a specific unit. The unit coordinator enables the nursing staff to focus more on the medical needs of the patient, which in turn results in a higher quality of care and better safety. The unit coordinator is in contact with the patient safety specialist and nurse educator and together, they discuss the best practices for fall prevention in the unit.

Physicians are one of the primary health care individuals responsible for the care of patients including identifying any risk factors for falls after a fall and adhering to a care plan which reduces the risks. Examples include: reviewing the patient's medications and adjusting them, eliminating the need for intravenous medications if possible, and consulting with a physiotherapist, occupational therapist and/or dietician as necessary, etc.

Registered Nurses are responsible for the care of patients, including assessing for falls risk and follow up with interventions, communication to the health care team about patient risks, and managing the care of the patient after a fall. The specific care after a fall includes: assessment, documentation, and follow up with appropriate care depending on the seriousness of the fall as well as maintaining and/or increasing relevant interventions for fall risk such as a closer eye on the patient, use bed alarms, etc.

Figure 10 presents the picture for the lower levels of the health care hierarchical control structure (the acute care hospital). Different control loops in the lower levels of the hierarchy will be explained in detail along with a separate picture in order to optimize clarification.

If and when a patient falls the nurse, who is assigned to the patient, completes the AEMS report after the patient's fall. The AEMS is a web-based tool to assist the organization to identify, document and investigate any unexpected and undesirable events or near misses related to patients, the hospital, and patient property. It was implemented in the present hospital in January 2009 for the first time and there were 494 events logged into the system a month later,

365 of which were actual events and 129 that were near misses. The top three event-types during a month in the hospital were: 1) medication related, 2) falls, and 3) laboratory test related (The AEMS report, 2009). The AEMS report includes the details about the event and identifies contributing factors to the event. The following information is provided in an AEMS report related to any type of adverse event.

- The date and time of the adverse event.
- The unit/department in which the event occurred.
- The event type. There are different types of adverse events which may occur in acute care hospitals such as food/nutrition, fall, and infection related adverse events. In addition, the type of fall is specified in the AEMS report. A fall from bed, chair, toilet, wheelchair, in tub/shower, and while walking/standing are different types of falls defined in the AEMS reporting system in the acute care hospital.
- The event severity (see below).
- The people involved in the event. In fall related events, it is required to clarify if the event was witnessed or not. According to the information from the literature, most in-patient falls are un-witnessed by staff members (Healey, Scobie, Glampson, Pryce, Joule & Willmott, 2007).
- The details related to the adverse event. A narrative description of the event which briefly states the facts describing what happened, and potential contributing factors, is provided in the AEMS report.
- The immediate actions taken after the event.

The nurse in charge of the patient is responsible to complete the adverse event report, provide the information related to the patient's fall, and submit the AEMS report online when a fall happens. The submitted events create notifications based on the severity of harm to the most responsible leader for review. Different levels of harm introduced in the AEMS web-based tool are as follows:

Level 1: No harm/ injury, no assessment required

Level 2: No harm/injury, assessment/monitoring required

Level 3: Temporary harm

Level 4: Permanent harm

Level 5: Death

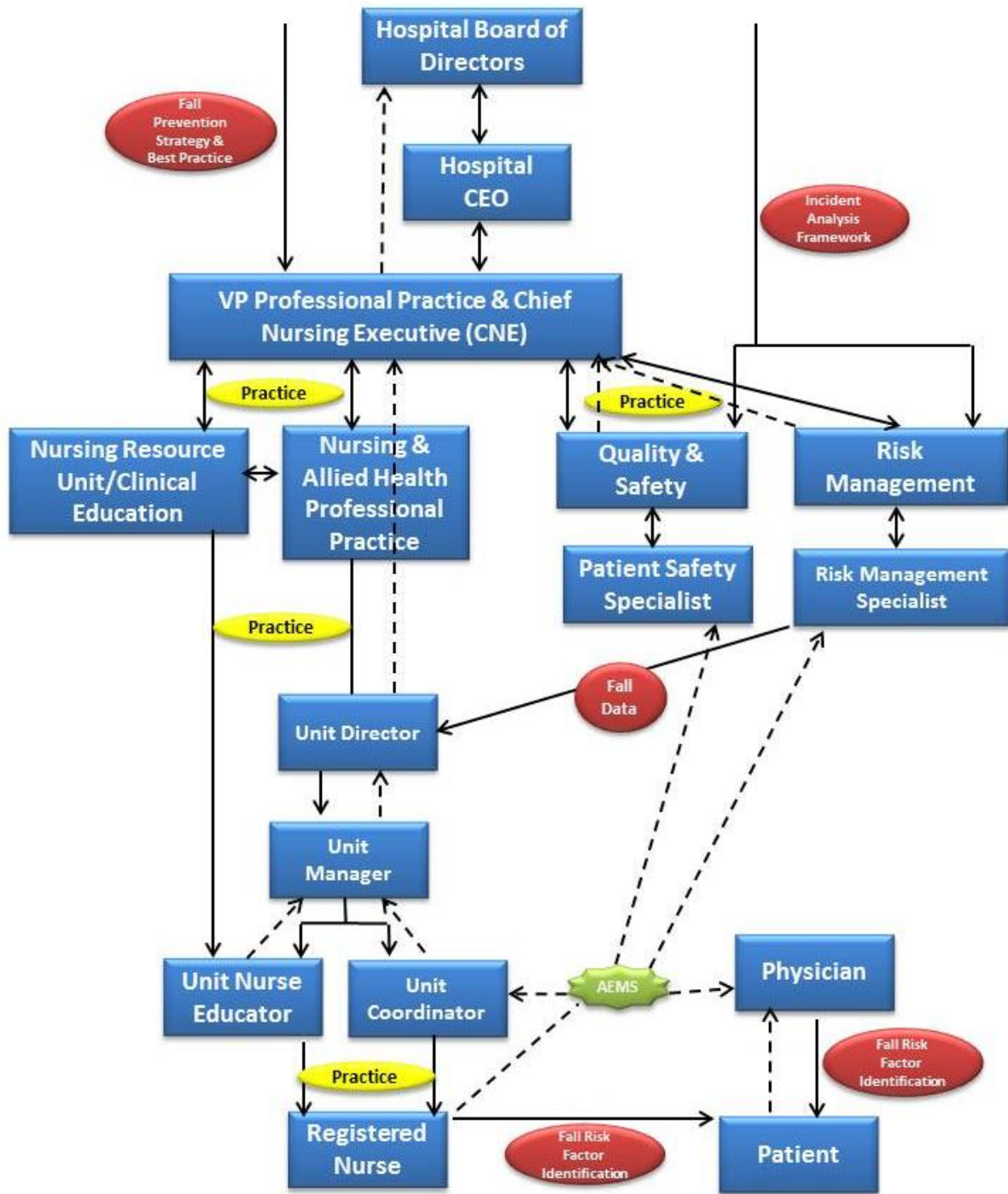


Figure 10,
The hierarchical control structure for health care system regarding fall prevention strategies.
(Lower level components)

For example, in the present study the patient’s fall injury level was identified as a three since some bruises were found on his body. For level three of harm, the unit coordinator and physician are the most responsible caregivers who receive the notification. In any event that involves higher levels of harm (higher than three), the unit coordinator, physician, chief resident, medical chief, risk management department, quality and safety department, and Chief Executive Officer (CEO) receive notification of the AEMS report. Also, the Ministry of Labour receives notification about a fall labelled as a level five (falls resulting in death). Thus, depending on the severity of the fall, notifications go to different levels of the hierarchical control structure. The more severe fall notifications go to higher levels. This is considered as feedback to the health care team about the fall occurrence. Figure 11 illustrates the AEMS reports notifications related to patients’ falls to different levels of the acute care hospital.

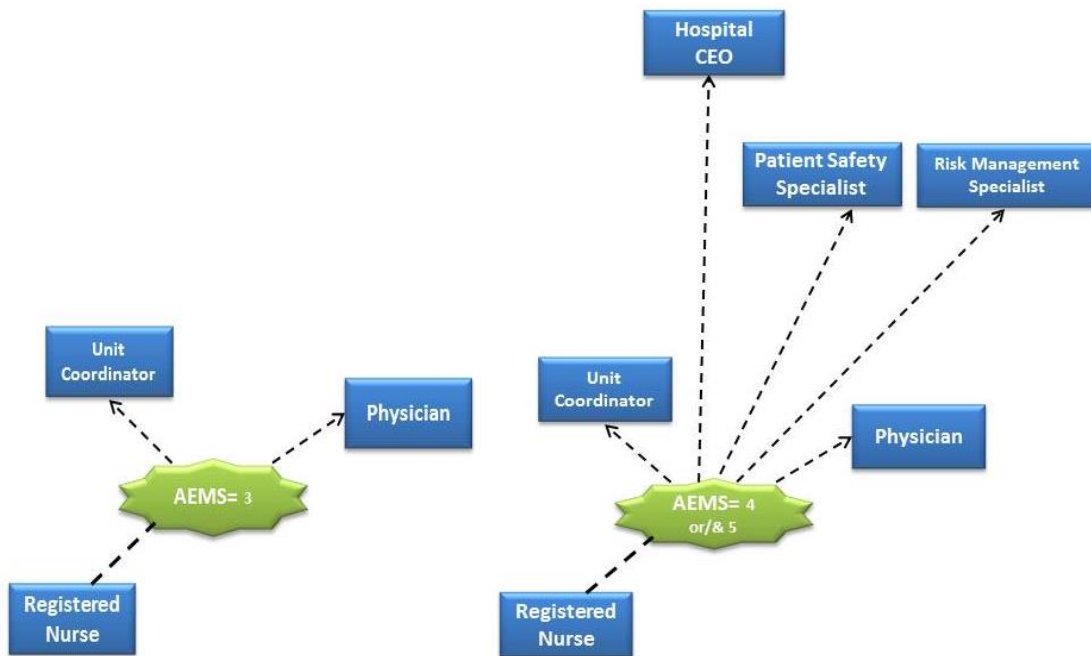


Figure 11, AEMS report notifications related to falls (feedback). LEFT: notifications for the fall injury level of three. RIGHT: notifications for the fall injury level of four or/and five.

The patient safety specialist in the Quality and Safety department and risk management specialist in the Risk Management department receive the AEMS reports for falls resulting in level four or five/death. These departments do not receive the AEMS reports for the lower levels of falls unless they request them (which they do for annual reports – see below). Patient safety and risk management specialists analyze the data separately (AEMS reports) based on the “Incident Analysis Framework” introduced by Canadian Patient Safety Institute (CPSI). The Incident Analysis Framework is a qualitative analysis method to analyze the incidents that cause harm to patients. However, this framework is not specifically designed to analyze falls or near falls. After analysing the data, patient safety and risk management specialists provide some input and feedback into the system as a result of incident analysis. The inputs are considered as constraints to lower level behaviour. For example, patient safety and risk management specialists could consider the lack of supervision as a patient’s fall risk factor. Then, they might make the suggestion to assign more nurses for the patients having the same condition. The patient safety and risk management specialists will pass their suggestions to their director. The next level for the suggestions is the vice president of professional practice and chief nursing executive officer. The change will be introduced as a practice if the suggestions are accepted. This is a practice control loop. Unit coordinators and nurse educators obtain the designated practice information and inform the registered nurses. Figure 12 represents this practice control loop in the hospital.

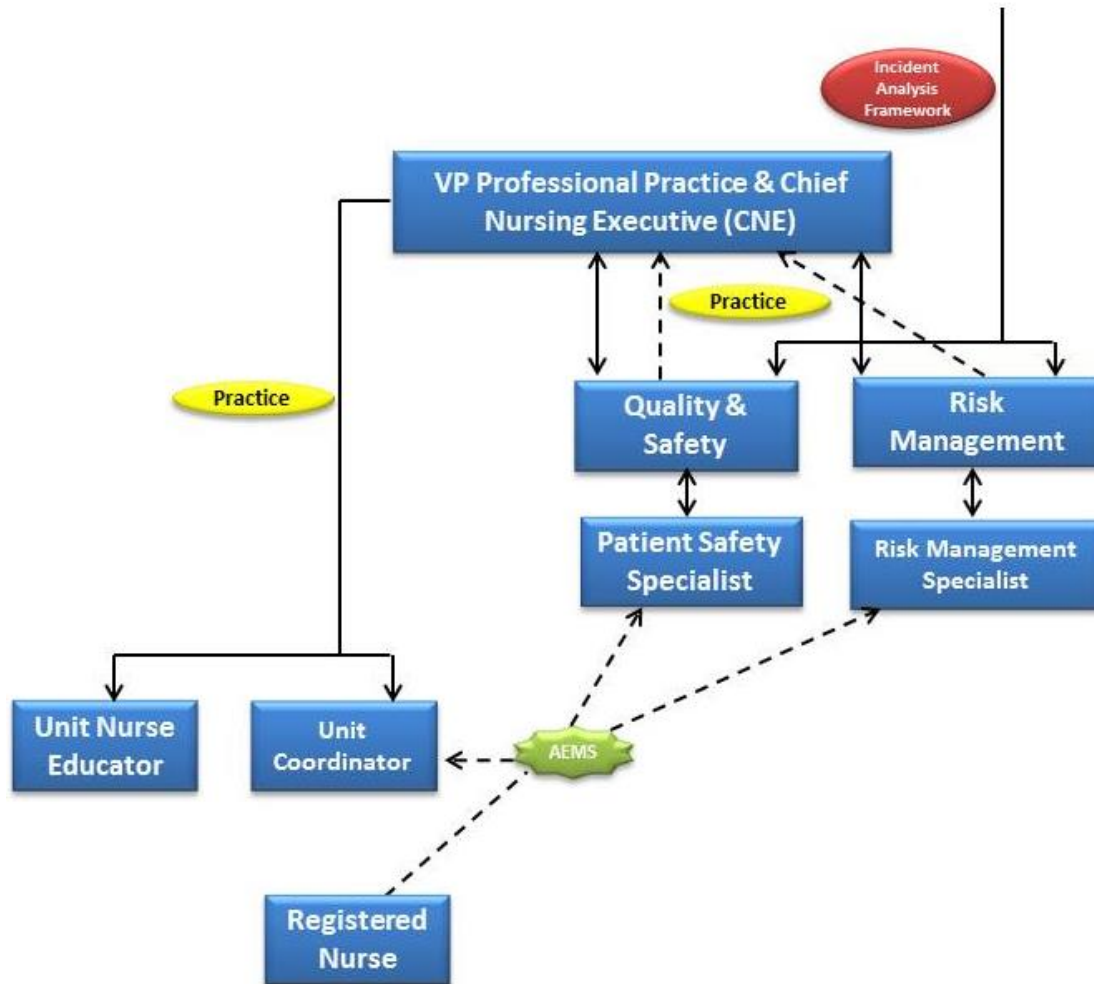
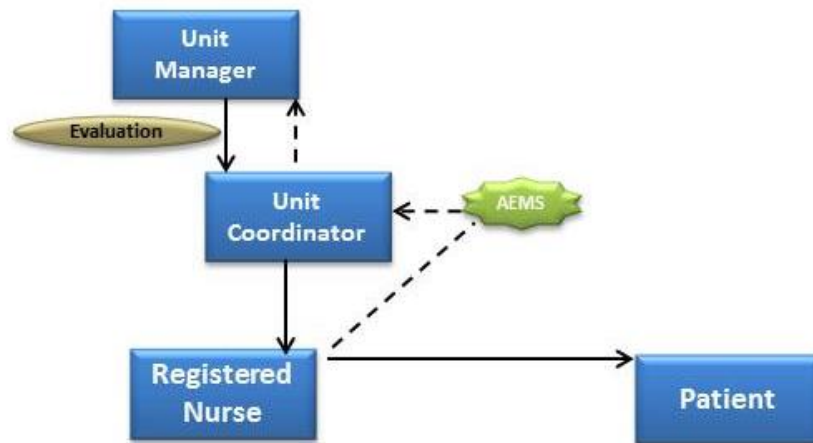


Figure 12,
The practice control loop related to AEMS analysis in the hospital.

As part of their annual evaluation process, the unit coordinators may have the number of falls in their unit as a performance indicator. These performance indicators may also have implications for annual salary increments. The unit manager and unit coordinator meet to evaluate the coordinator's performance. The performance evaluation process is assumed to have an influence on the entire unit's (including the nurses and PSWs) behaviour to reduce adverse events in the unit (Figure 13). Obviously annual evaluations for any employee may involve information about falls, however, falls are not tagged as a formalized part of the review process.

For example, a nurse educator could be evaluated for his/her performance regarding fall prevention strategy delivery to the registered nurses. If the LHIN was to identify falls as part of the benchmarking process, it would be more likely that falls would appear in annual evaluations of particular hospital employees, like unit coordinators.



*Figure 13,
The evaluation process in the hospital.*

The unit director (who reports to the vice president of professional practice and chief nursing executive officer directly) receives the analyzed adverse events' data/information from the risk management specialist every year in order to identify the most common adverse events and their characteristics in the unit. The unit director will ask the unit manager to investigate the problem areas and provide a written plan/report to reduce such occurrences. The unit manager will request the unit coordinator and nurse educator to deliver a solution as a plan/report as soon as possible. The unit coordinator and nurse educator investigate the problem in their unit and provide the report/plan based on the practice and educational constraint received from upper level components (clinical education, and nursing and allied health professional practice

department). The unit director will report (feedback) the result of a unit's achievements regarding adverse event prevention strategies to the Vice President, Professional Practice and Chief Nursing Executive officer. Ultimately the hospital Board of Directors will receive the feedback from the Vice President (Figure 14).

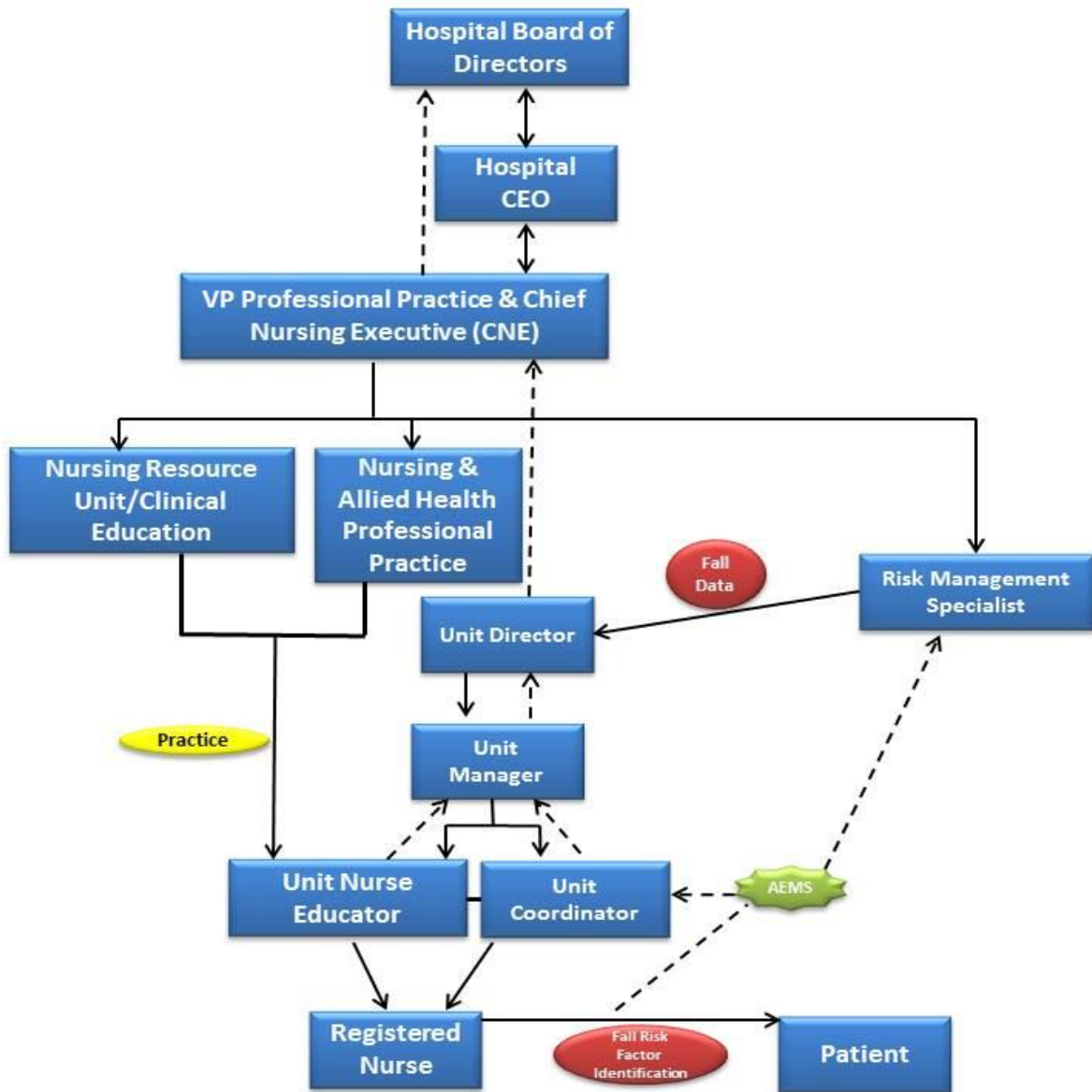


Figure 14, The practice control loop in identification of the most common adverse event in a unit and its preventive strategies.

Understanding the process of identifying patients at risk of falling before a fall happens in the hospital will help to clarify the hospital's fall prevention program. The registered nurse and physician are two members of the health care team who assess the patient's fall risk factors. At this hospital the Morse Fall Scale is applied during the admission process to evaluate a patient's risk of falling. Wearing a yellow arm bracelet and having a "fall" sign beside the patient's bed are strategies used to identify patients at risk. Patients with a high risk of falling and their families receive a pamphlet as well as verbal instructions and education about falls and risk factors for falls in a hospital setting.

The fall risk identification process, communication of the risk, and prevention strategies stem from the educational control loop provided by higher levels of the hierarchy such as RNAO and Safer Healthcare Now. This educational information functions as a constraint on lower level components assisting nurses and patients to behave safely. The information flows downward to the vice president of professional practice, nursing resource unit/clinical education department, nursing and allied health professional practice department, Quality and Safety department, and Risk Management department in the hospital. Every nurse educator in a specific hospital unit receives the fall prevention strategies and best practices through his/her clinical education update in the hospital. The registered nurses obtain the designated practices for patients' fall prevention through the nurse educator. Figure 15 represents the connection between both the educational and practice control loops regarding patient's fall risk assessments in the hospital.

Many personnel play a role in the fall prevention efforts of a hospital (lower level of the system). Different control loops between these components (personnel) show the interaction and feedback between them. The registered nurses have the responsibility of filling out the AEMS reports when a fall occurs. The patient safety and risk management specialists analyze the

reported falls based on the incident analysis framework and introduce the required changes as a practice. The unit coordinator and nurse educator receive the designated practices and introduce them to the registered nurse in order to prevent falls and reduce the failures.

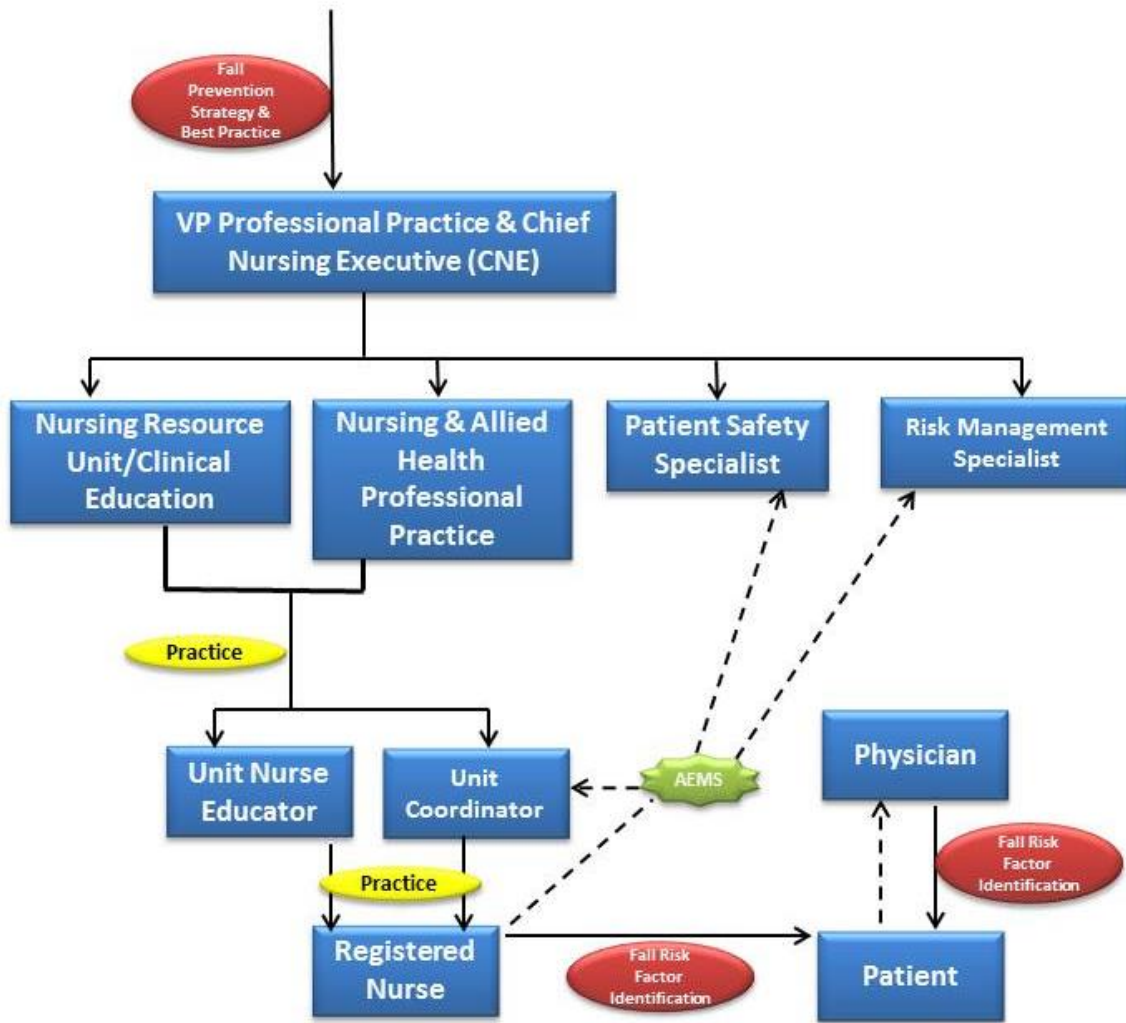
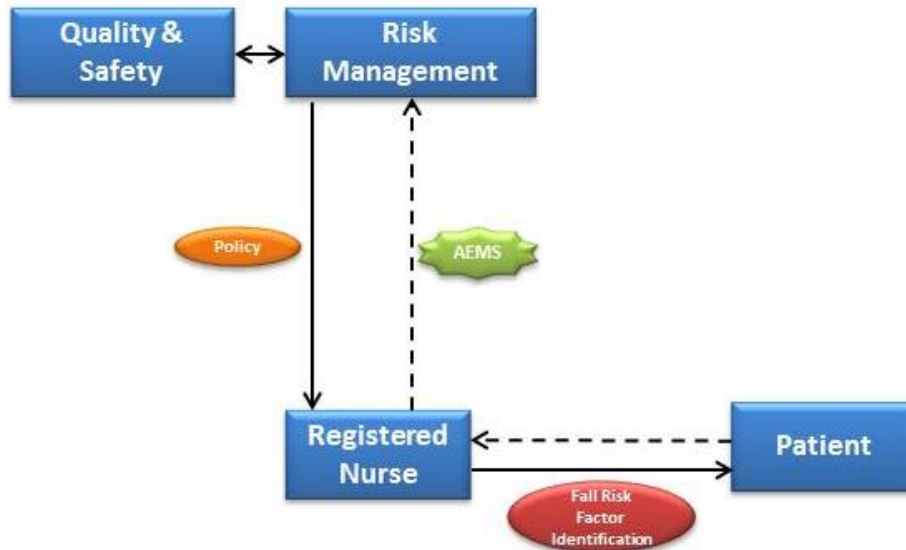


Figure 15, The educational and practice control loops regarding patient's fall risk assessment in the hospital.

Step 5: Gap Analysis

In the gap analysis, the controllers and their control actions which were explained in the static model above will be examined to identify potentially problematic areas. The controllers were analyzed to determine whether the context they work in allows them to properly satisfy their safety responsibilities and whether they have the resources and information they need to enforce the safety constraints they have been assigned. Furthermore, the overall communication and coordination between system controllers was studied as well as the general system safety culture related to patient fall prevention.

According to the aforementioned information, the fall related AEMS reports are under the jurisdiction of the nurse in charge of the patient's care in the acute care hospital. Figure 16 represents the policy control loop related to the AEMS report. The upper level's (risk management department) constraint on nurses' behaviour is the policy of filling out the AEMS reports in case of a patient fall. The Risk Management and Quality and Safety department requires understanding the environment and context in which the nurses play their role in patient care. Therefore, both departments need to ensure that the context the nurses' work in allows them to properly satisfy their safety responsibilities. The fall related AEMS reports in the hospital contain limited information about the fall and the contributing factors of falls because they are filled out by the nurses who have to multi-task during their shift. The context in which the nurses play their role requires them to multi-task in a challenging environment. The nurses often do not have enough time to report a fall during their shift. It was learned that many AEMS reports are completed after a nurse finishes her shift. Memory for details may be poor and the nurses may be motivated to keep the reports brief if they are doing this work on their own time. In addition to filling out the AEMS reports, there are other issues as well.



*Figure 16,
The policy control loop related to AEMS reports by the nurses.*

Using the AEMS data the patient safety specialist in the acute care hospital (where the fall occurred) found it difficult to introduce productive/functional policy changes or instructions to reduce fall rates in the stroke unit. In addition to the fact that the reports lack detail, as mentioned above, there are other problems with adverse event reporting as highlighted by the specialist as well as in the research literature. Firstly, the information in the AEMS report is not sufficient to fully understand the contributing factors to falls. To understand the contributing factors of falls requires sufficient information. The data from an acute care hospital will not be enough data/information to provide the statistical power to look for contributing factors. The National Patient Safety Agency (NPSA) was created to address this problem in Britain (Shaw et al., 2005). They have produced an IT-based system to which many hospitals contribute their adverse event data. Different hospitals submitted their adverse event reports into the central registry system to collect higher powered data in order to improve safety within Britain's health care

system. According to the results of a study by Shaw et al. (2005) this national IT-based reporting system enables the health care system to collect more powerful data (30,000 incidents from 18 health care delivery organizations in Britain within a 10 month period) on incidents. This centralizing strategy does not exist in Ontario meaning that each hospital will have only a limited data source with which to work. In Ontario, a provincial/central adverse event reporting system could improve this analysis process. Obviously the MOHLTC could be the organization to provide the budget and resources for this process.

Communication and Coordination:

Communication and coordination between the system's controllers play an important role to identify sources of unsafe behaviour (Leveson, 2011). In this step of the CAST analysis, overall communications and coordination (specifically in the higher levels of the health care system) are examined to identify instances where coordination and communication between controllers may have contributed to patient falls.

The complexity of Ontario's health care system regarding fall prevention strategies and policies may be problematic. There are many controllers affecting fall prevention strategies in Ontario's health care system. This, potentially, needless complexity and redundancy increases the interaction and dependency between different controllers in the hierarchical control structure. For example, the hospital receives information about fall prevention best practices from RNAO, Safer Healthcare Now and the LHIN. According to Leveson (2011), when multiple organizations/controllers control the same process, coordination risks arise. As a result, two unsafe interactions may occur due to coordination risks:

- 1- Both controllers assume that the appropriate control actions are being performed by the other controller, and as a result, neither controller takes action. Or,
- 2- Conflicting control actions are provided that have unintended consequences.

The coordination risks cause the migration towards unsafe zones in the long-term. To avoid the coordination risk there should be a consistent supervision and flow of feedback between the controllers about the controlled process.

According to the information received from the acute care hospital, the patient safety specialists analyze the AEMS reports data independently from the risk management specialists. There is a lack of communication between the patient safety and risk management specialists even though they are in the same overall department. This lack of communication can cause either duplication of work or absence of the proper action. Moreover, it was learned that the patient safety specialists utilize sources of information about falls other than the AEMS reports (such as call-bell reports in a specific unit that a fall happened, and staffing records) because they believe that the AEMS report is not sufficient to uncover reasons for falls. The patient safety specialist interviewed believed that the AEMS reports are not always completed precisely. The patient safety specialist also believed that there should be educational sessions for the nurses in order to know about specific fall cases in a unit. Although the patient safety specialist shares her findings with the unit coordinator and upper level controllers (in the case of suggesting a new practice), she thought it would be more helpful for the nurses to know about each fall case and the specialists' idea/ analysis about the contributing factors to falls in their unit.

The other communication problem identified in the control structure is related to the risk assessment process. Different health care provider organizations (i.e. hospital, long-term care etc.) use different fall risk assessment tools to identify patients at risk of falling. The Morse fall

scale is used in this particular acute care hospital. The Morse fall scale is a valid and reliable tool in acute care setting (Morse, Morse, & Tylko, 1989; Scott et al., 2007), but not all risk assessment tools are valid and reliable. Although this hospital applies the Morse risk assessment tool, health care settings have the freedom to choose a fall risk assessment tool and apply it in their setting. There is a need for vertical communication between the upper level controllers to provide directions about a suitable fall risk assessment tool to the health care organizations. Scott et al. (2007) found that many institutions in Ontario were using non validated tools.

Dynamics and Feedback:

According to Leveson (2011), most major accidents occur due to the migration of the system towards reduced safety margins over time. In this particular patient's fall case, Ontario's health care control structure related to patient falls prevention showed some weaknesses by the presence of multiple controllers and a lack of feedback. In some cases, the control over the fall prevention strategy's introduction was handled by three different organizations. At the same time, the lack of inspections and surveillance programs performed by the organizations reduced the feedback to the upper levels of the control structure regarding the state of the system. The lack of feedback combined with the process being used by different controllers over time can cause the migration of a system towards an unsafe condition. Feedback is required for any complex system because there is a lack of direct information for the controllers about the process (Leveson, 2011; Hollnagel, 2004). Incorrect and/or no feedback can lead to accidents. According to Leveson (2011), two basic types of feedback are needed to keep a complex system with human controllers in a safe state. First, there must be feedback about the state of the controlled process. This will help to understand the controllers' process models and identify failures in

other parts of the control loop. Second, there must be feedback about the result of controllers' actions. This feedback makes the human errors observable and therefore preventable. In addition, according to a research study conducted by Fixsen, Scott, Blase, Naoom and Wagar (2011), introducing an evidence-based fall prevention program to an organization without evidence-based implementation methods is problematic. In other words, the upper level controllers are unable to realize whether the fall prevention strategies are implemented accurately in the acute care hospital, unless there is effective implementation. The authors argue that in addition to understanding of WHAT (prevention strategies) needs to be done in order to reduce patients' falls, there is a need for recognising HOW (implementation strategies) to ensure the effective use of the fall preventions in practice. Fixsen et al. (2011) concluded that: "Implementation, organization change, and system change methods produce the conditions that allow and support the full and effective use of evidence-based intervention."(p.419). Although fall prevention strategies and best practices are provided to the hospital by RNAO, LHIN and Safer Healthcare Now, there is a lack of feedback channels from the hospital itself to the responsible organizations. At the same time, the lack of oversight and inspection to monitor the performance of the hospital and its controllers at different levels by three different organizations exists. A more effective strategy would be to require hospitals to provide feedback about the fall prevention strategies and best practices implementation process in the hospital to the RNAO, LHIN and Safer Healthcare Now organizations. Also, these organizations need to know if the strategies are appropriate in terms of reducing fall occurrences. Reporting the number of falls and the contributing factors of falls (provided in AEMS reports) will increase the awareness of the three organizations about the need of patients and the gaps in the hospital's health care team. Also, providing implementation methods for the introduced fall prevention strategies and best

practices will assist the upper level organizations to assure the effective uses of the strategies in practice.

This lack of feedback and supervision exists between the Canadian Patient Safety Institute and the hospital. CPSI has no plan in place to monitor the performance of the hospital's patient safety specialists and risk management specialists. CPSI provides the educational information regarding accident analysis techniques and does not evaluate how the technique is performing within the hospital. The appropriate feedback in regards to the application of the incident analysis framework in fall-related incidents by the hospital will also assist with better comprehension of the patients' demands because the Incident Analysis Framework is used to analyze all adverse events in the hospital such as medication related incidents. Figure 17 illustrates the missing feedback loops in the health care hierarchical control structure. The red dotted arrows display the missing feedback in the system.

As indicated above, the lack of functional policy constraint from the patient safety and risk management department to the stroke unit's health care team can be related to the lack of feedback to RNAO, Safer Healthcare Now and CPSI about the fall prevention strategies and Incident Analysis Framework. The feedback from the acute care hospital's responsible departments will help to fill in the gaps in this framework and to develop strategies to decrease the fall rates in the hospital.

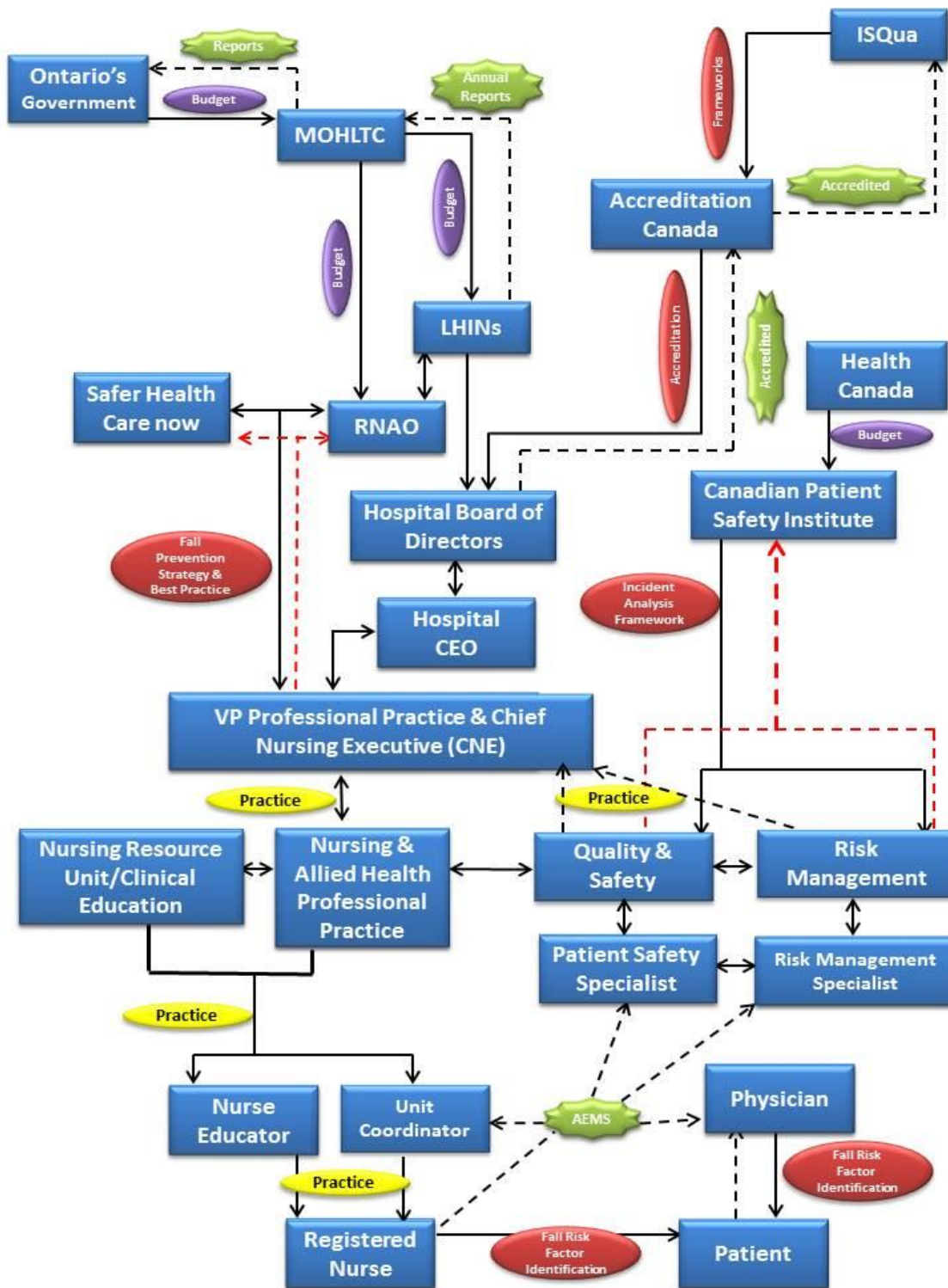


Figure 17,
The missing feedbacks in health care control structure in patients' fall prevention.

Chapter 6: Discussion

The primary reason for injury admissions to Canada's acute care hospitals is falls, accounting for 54.4% of all injury hospitalizations in acute care hospitals (CIHI, 2000). In 2012, Montreal hospitals publicly reported medical accidents which "contributed to or resulted in" the deaths of at least 10 patients over the previous year and caused permanent disabilities in 16 patients (Derfel, 2012). These medical accidents included: a medication overdose, a patient fall in the hospital, and an undetected malfunction of critical equipment among the causes of deaths. According to the National Patient Safety Agency (2007), accidental falls have been identified as the most commonly reported patient safety incident in hospitals. Identifying the systemic contributing factors of falling and implementing fall prevention programs in hospitals can prevent falls in the hospital setting, shorten the length of time patients spend in the hospital, and improve the hospital mortality rate due to falls.

The complexity of the health care system that provided fall prevention strategies for the acute care hospital was identified as a likely systemic problem. Complexity is difficult to handle. The increasing complexity has unavoidable consequences, i.e., that the interaction and dependency between different controllers increases (Holnagel, 2004). The complexity of the system may prevent the flow of information from properly getting to the next level on-time. According to Leveson (2011), a complex system causes some difficulty for the controllers to operate safely. Therefore, increasing complexity of the system is one cause of degradation in safety over time. Assigning fewer controllers/organizations to ensure fall prevention is suggested to address the complexity of the system.

The upper level components in the health care system do not provide consistent and explicit instructions about the most appropriate fall risk assessment tool, fall prevention

strategy, and fall data analysis technique to the lower level components. There appears to be too much freedom for health care providers to decide on how to prevent falls in their organizations, which will cause inconsistency and subjectivity to be factors affecting care in hospitals. For instance, only two valid and reliable fall risk assessment tools have been identified in the acute care setting, yet different hospitals use markedly different fall risk assessment tools to identify patients at risk of falling (Hempel, Newberry, Wang, Booth, Shanman, Johnsen ... & Ganz, 2013). Furthermore, this freedom can cause confusion and lack of evidence-based knowledge in taking the appropriate action in patient fall prevention. Upper level components of the health care system need to impose appropriate and clear constraints on each lower level components' behaviour by providing them the information about the most appropriate/evidence-based fall risk assessment tool, fall prevention strategy, and fall data analysis technique. One of the requirements to introduce valid and reliable techniques to reduce falls in hospitals is to understand falls in hospitals. This requires capturing rich and accurate data about patients' falls in acute care hospitals. Promoting a provincial adverse event reporting system and data registry for acute care hospitals is suggested as a result of this thesis. A provincial adverse event reporting system will help to capture reliable data due to the greater number of reported events in one data-base, analyze the data accurately, and having the power to identify contributing factors for falls and trends across acute care hospitals. According to the result of a study performed in the National Health Service (NHS) in England and Wales, creating a national incident reporting system to collect data on adverse events supplied data on patient safety and health care delivery issues. The study collected data on various adverse events in different health care settings (95% of the data was from acute care settings) which helped to better understand problems in health care organizations (Shaw, Dever, Hughes, Osborn & Williams,

2005). It has been proven that data obtained solely through adverse event reporting systems are not sufficient to initiate quality improvements in patient care due to underestimation/underreporting of the falls (Hill et al., 2010; Shorr et al., 2008). In addition to the national adverse event reporting system, each hospital can still perform its own local accident investigation and provide feedback to the upper level components to better target their fall prevention interventions (Oliver, 2007). If an adverse event reporting system is to be used in hospitals it is necessary for staff to receive proper training and adequate time to complete such work. Congregating inaccurate or imprecise data is not helpful.

Fall risk assessment may not be the best strategy to start fall prevention in acute care hospitals. Although it helps to realize whether the patient is at high or low risk of falling (then apply a yellow arm band on their wrist for communication of the risk), fall risk assessment tools do not always categorize people correctly as high or low risk. Oliver (2006) argued that a risk assessment tool is different from a risk factor checklist which encourages health care team members (e.g. nurses) to assess the patients' fall risk factors and then try to address them. He claimed that: "the risk factors that *cause* falls are not necessarily synonymous with those that *predict* them – nor with those that can be reversed or modified to prevent them" (Oliver, 2006, p.91). It has been suggested that paying attention to the reversible risk factors (confusion, mobility and/or visual impairment, medication, and urinary incontinence) is a better prevention strategy. Thus, it is better to identify all patients' risk factors and then address the risk factors by using a patient-centered intervention. According to the result of a study by Healy, Monro, Cockram, Adams and Heseltine (2004), there was an association between a targeted risk factor intervention plan and relative risk of falls reduction in a hospital. Eight units of a hospital were allocated in the study. Pairs of these units were randomly assigned to control or intervention

groups. Nursing staff on intervention units were asked to screen the fall risk factors (medical, environmental, and physical) for the patients admitted with a history of falls. The health care team was asked to address patients' fall risk factors with the targeted intervention plan. Healy et al. (2004) focused on targeted risk factor reduction instead of categorizing patients into risk categories and found a positive association between the intervention plan and the relative risk of recorded falls. Therefore it was suggested to identify a patient's fall risk factors on their admission and design a targeted intervention plan to reduce these risks.

The ineffectiveness of the AEMS reporting system is problematic. The observational data achieved from the AEMS reporting system in the acute care hospital as well as the patient safety specialist's comments highlighted some important points. The AEMS reports related to patient falls lack necessary details and filling out the reports is voluntary. This finding is in line with other studies which claim clinical staff under-report the adverse events due to time constraints, lack of focus on events, and fear of censure (Shaw et al., 2005; Hill et al., 2010). Shojania (2008) argued that to promote a well-designed incident reporting system, the system needs to be easy to use. He suggested that the incident reporting system should only capture the type and severity of the incidents which lies in triaging for further investigation. This strategy would make the incident reporting system easy to use since these systems are often perceived as a source of frustration for the clinical staff (Shojania, 2008). The trained personnel in risk management and accident investigation should take the responsibility to further investigate adverse events of interest, not the nurses reporting the incidents (Shojania, 2008; Thomas & Peterson, 2003). The patient safety and risk management specialists are not able to effectively analyze the data from the adverse event reporting system in the hospital. They receive the reports but they are unable to benefit from this information because either the data provided is not appropriate and/or sufficient

or the analysis tool is not designed to analyze such data. As suggested above, a provincial adverse event reporting system will help to capture different types of adverse events in health care provider organizations and collect sufficient data for further incident analysis. In addition, a dictated fall incidents analysis methodology/tool by the higher levels of the control structure would assist the specialists to analyze the data more accurately.

It is important to learn from errors. Adverse event reporting and analysis systems were devised as an essential component to improve safety by learning from errors (Wu, Pronovost & Morlock, 2002). The AEMS system being used at the present hospital does not seem to provide information useful to a learning process. Reason (1997) introduced four components of a safety culture within an organization: *reporting culture, just culture, flexible culture, and learning culture* to limit the organizational accidents. Each of these components' existence makes the organization a safer place with fewer accidents. He suggested that a good safety culture must be based on learning. He stated that: "..., an organization must possess a learning culture – the willingness and competence to draw the right conclusions from its safety information system, and the will to implement major reforms when their need is indicated." (Reason, 1997; p. 196). In addition, according to the technology acceptance model, a person starts using a technology when the introduced technology is perceived useful and easy to use (Venkatesh & Davis, 2000). The clinical staff reporting patient falls need to understand the usefulness of reporting the falls by using the AEMS in the hospital. In this way, they can realize how their report can transform to information which assists them to reduce falls. Therefore, there is a need to learn from the data reported so that staff will continue this voluntary task. The patient safety specialist's shares the findings (from analyzing the AEMS reports information) with the unit coordinator. The patient safety and risk management specialists would also share their findings with the nursing

professional practice department, if they are making suggestions for changes in practice.

According to the patient safety specialist, it would help to prevent more falls if the cases and the lessons learned can be shared with all of the units. The lack of opportunity to share this information diminishes the awareness and knowledge translation about falls in the hospital.

Another reason that affected safety in this system is lack of supervision and feedback between some controllers in the system. The educational information provided by the system's controllers (CPSI, LHIN, RNAO, and Safer Healthcare Now) is not sufficient to keep the system in a safe state when planning for the long-term. This leaves the control loops incomplete. There should be sufficient and appropriate feedback from the hospital to the upper level organizations to complete the control loops.

Using CAST to identify the control structures for patients' falls prevention in an acute care hospital presented several challenges. Since CAST is derived from systems engineering, the language and terminology can pose difficulties for a practitioner with limited background in engineering. This language set is designed for engineers and it requires mastery of the language as a first step (which is a time consuming process) before CAST can be applied effectively. Another challenge when applying the CAST analysis is the data collection process. At times, communicating to the upper level controllers and obtaining the needed information is not possible since the responsible people are not either willing to respond to the questions or do not have time to do so. Moreover, in contrast to the extensive information available to the public for a disaster such as the Walkerton Water incident, there is very limited public information available about non major accidents such as falls in hospitals. Having connections to insiders at various levels of the system would be very advantageous, however they are very difficult, if not impossible to make. A limitation of this thesis is the fact that the amount of information obtained

was not optimal and there is almost certainly gaps between the control structures as described and the structure that exists. Another challenge when using CAST is deciding how to represent the control system in diagram form. A complex system such as the health care system means that diagrams used to describe it are also very difficult to create and often difficult to understand. Notwithstanding these challenges however, a CAST analysis provides an effective way to understand system safety and potentially make recommendations for its improvement.

Conclusion

The purpose of this research study was to conduct a qualitative accident analysis technique (CAST) to better understand the health care system's deficits in providing fall prevention strategies in acute care hospitals. This thesis examined the entire health care system to understand different organizations' responsibilities and roles.

As the result of CAST analysis, the complexity of the health care system, lack of a consistent and clear fall prevention strategy, risk assessment tool and fall data analysis methodology, and effective communication between the controllers were identified as potentially problematic. In addition, lack of feedback and supervision was found as another systemic area of concern.

The results of this thesis lead to the following recommendations for both upper level controllers and the hospital: the needless complexity in the system should be removed to ensure effective communication (including supervision and feedback) between the controllers. A provincial adverse event reporting system would improve the health care system's ability to capture more comprehensive data related to patient falls. Analyzing more robust data should promote the identification of deficits in health care organization and the development of

operational fall prevention strategies which addresses those deficits. The upper level controllers are responsible for introduction of fall prevention and implementation strategies, fall risk assessment tools, and fall analysis methods to the health care providers. An explicit, evidence-based, and unambiguous provision of these strategies would decrease the seemingly unnecessary freedom and confusion by health care providers to select and implement appropriate strategies.

In the acute care hospital setting, it is recommended to identify patients' fall risk factors instead of categorizing them in groups of high and low risk of falling. A targeted fall prevention plan should be performed to address the risk factors for patients who have these fall risk factors. A learning culture enhances using lessons from previous adverse events. Providing the opportunity for the sharing of fall data and analysis results with hospital nurses in regular meetings is a recommended strategy to improve learning from previous falls. The regular learning meetings in the hospital will also deliver feedback to the nurses about their contribution to the adverse events reporting process.

It is hoped that the findings of this thesis will help to improve the patient safety and quality of care in acute care hospitals in Ontario.

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Appendix A: SFIM Accident Causation Analysis

Following the patient's fall, on May 15, 2012 the SFIM team investigated the accident and completed the causal analysis of the fall in accordance with the stroke unit's staff in an acute care hospital. This section of this thesis summarizes the findings of the SFIM accident analysis report.

SFIM findings

The SFIM requires the investigative team to analyze the accident in accordance with the four main layers of failures/conditions. The accident report found seven main "causal factors/action/events" that led to the patient's fall. Each event/unsafe act had related "pre-conditions" and "supervisory/organizational issues" that contributed to the fall. Based on Reason's Swiss Cheese model of accident (Reason, 2000), the following are the causal and contributing factors of the patient's fall in an acute care hospital. The causal factors are categorized as unsafe acts (the first layer of the Swiss Cheese Model closest to the fall). The related contributing factors in other layers of the Swiss Cheese Model are introduced as follows:

Causal and Contributing Factors:

- Causal Factor #1: After his stroke, the patient experienced falls 2-3 times a week during 2008 to 2010 (He self-diagnosed his first stroke and ignored any medical treatment in 2008).

Related Contributing Factors:

- The patient's isolation- the patient was living alone without any friend or family members other than his landlord. (Precondition)
- Not having a family doctor (Organization)

- Lack of consistent medical follow up (Supervision)
- Causal Factor #2: The patient started to use a walker inconsistently in 2010 as he was becoming increasingly weak due to significant muscle wasting.

Related Contributing Factors:

- Significant muscle wasting (Precondition)
 - General weakness (Precondition)
 - Malnourishment- The patient had an unhealthy diet. His poor diet consisted mainly of chocolate bars and cigarettes. (Precondition)
 - Lack of assistance in grocery purchase and meal preparation (Supervision)
- Causal Factor #3: The patient experienced three falls in one day, the day before his admission to the acute care hospital (13 May, 2012). He was unable to pick himself up after his third fall.

Related Contributing Factor:

- Patient's frailty (Precondition)
- Causal Factor #4: The patient laid on the floor for seven hours after his fall (13 May, 2012).

Related Contributing Factors:

- Lack of formal support network (Organization)
- Lack of informal support network (Supervision)

- Causal Factor #5: The patient's recovery process was slow (14-17 May, 2012).

Related Contributing Factors:

- Lack of patient's motivation to participate in activities of daily living (Precondition)
- Patient's depression (Precondition)

- Causal Factor #6: The patient decided to leave washroom without assistance (17 May, the day of the fall).

Related Contributing Factors:

- Patient's confusion (Precondition)
- Patient's impulsiveness (Precondition)
- Patient's lack of motor skills due to stroke (Precondition)
- Patient's need of one assistance for all his transfers (Supervision)
- Inappropriate use of words by the patient which makes him difficult to deal with. (Precondition)

- Causal Factor #7: The patient's right foot hit the walker (17 May, 2012).

Related Contributing Factor:

- The patient's unfamiliarity with the walker which was given to him in the hospital (Precondition)

- Causal Factor #8: The patient tripped over his walker (17 May, 2012).

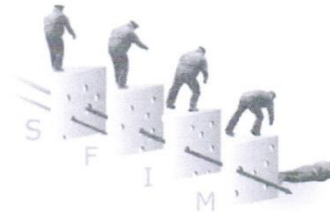
Related Contributing Factor:

- Patient's lack of limb movement control (Precondition)

- Causal Factor #9: The patient lost his balance (17 May, 2012).

Related Contributing Factors:

- The patient's general muscle weakness (Precondition)
- The patient's lack of coordination (Precondition)
- The patient's legs often gave out (Precondition)



SFIM

Case ID: 1200412

Date: 2013-01-03

Subject #: 16774

Fall Information

2.1 Date of the fall: 2012-05-17

2.2 Day: Thursday

2.3 Time of fall: 24-hour clock
15:55

2.4 Witnesses: Un-witnessed

- 2.5 Location of the fall:
- Indoors
 - Public building (includes hospitals or long term care homes)
 - Hospital or LTC bathroom

2.6 Activity at the time of the fall:

- Toileting

2.6a Was this person multi-tasking? Yes

2.7 Action by the faller prior to loss of balance:

- Rising out of bed, chair, toilet, bath

2.8 Type of fall:

- Loss of support

2.9 Direction of the fall:

- Forward

2.10 Environment at the fall location:

- Transition between surfaces

2.11 Mobility aid used at the time of the fall:

- Walker without wheels

2.12 Footwear worn by the faller at the time of the fall:

- Shoes

2.13 How did faller get up after the fall?

- Assisted by another person

- Nurse/Other staff

Please specify how the faller was assisted:

- Manual Aide (e.g. cane/walker/wheelchair)

2.14 Injury? Yes

2.15 Injury severity:

- Minor - did not require medical attention (e.g. bruise, abrasion, contusion)

2.16 Injury type:

- Bruise

2.17 Injury location:

2.18 Type of medical attention received:

Already in hospital (attended by hospital staff)

2.19 Was something new or unusual related to this situation? (e.g. new environment, doing something for the first time, new medication, new timing, etc.)

No

SFIM

Case ID: 1200412

Date: 2013-01-03

Subject #: 16774

Information About the Faller

3.1. Demographics:

Year of birth: 1946 _____ Age Calculated: 66

Gender: Male

Population: Acquired brain injury
 Cognitive impairment
 Stroke survivor

3.2 Falls history:

Multiple faller (falls regularly)

3.3 To get an idea of the frequency with which this person falls, please answer the following questions:

a) Falls frequency

Number of falls in the last week: 1

Number of falls in the last month: 3

Number of falls in the last year: 3

b) Loss of balance frequency - Number of near falls (sudden or uncontrollable losses of balance without landing):

Unknown

3.4 Marital status:

Divorced

3.5 Mental status:

Agitated/aggressive/combative

Isolated

Confused or disoriented

Depressed

3.6 MMSE score:

Not available

3.7 Education:

Unknown

3.8 Mobility aids:

Assistance by another person All of the time

Walker without wheels All of the time

Wheelchair Occasionally

3.9 Other aids used by the faller:

Bath bench/shower seat

Bathroom grab bar

Bed rails

Glasses for distance

3.10 Medical problem at the time of the fall:

Blood pressure (high or low)

Deconditioning

Depression

High Cholesterol

Muscle weakness

Pulmonary Disease

Stroke Functional Independence Measure Score (Maximum score 126):
 Not available

Montreal Cognitive Assessment Score (Maximum score 30):
0

Montreal Cognitive Impairment Score (MoCA < 26):
 Not available

Other, please specify:

Confusion, swallowing, balance loss, coordination,

3.11 Medications:

7 Number of prescription medications used by the faller on the day of the fall

Medication Name: Acetylsalicylic acid EC 81 mg

Medication Name: Lodipine 5 mg PO daily

Medication Name: Atorvastatin 20 mg daily

SFIM

Case ID: 1200412

Date: 2013-01-03

Subject #: 16774

Investigative Report Summary

The faller, a 66 year old stroke survivor fell to the ground on Thursday, May 17, 2012 at 15:55. After an afternoon physiotherapy session, the faller was assisted to the washroom in his hospital room by the physiotherapist (PT). The faller was able to walk with his walker but required assistance and supervision by at least one other person. The faller left his walker just outside the washroom door and before leaving him the PT reminded the faller to call his RN using the call bell in the washroom when he wanted to leave. The faller used the call bell to call for help but after 5 minutes of waiting became impatient and decided to go to his bed independently. He stepped out of the washroom and grabbed onto his walker. As he started walking his foot hit the walker and he tripped over the walker. He lost balance and fell forward to the ground. The RN walked into his room and noticed the faller on the floor. She rushed to the room doorway and called for assistance from other nurses nearby. Two other RNs arrived and helped the faller into his bed. Faller was assessed for injuries but only minor bruises were found.

The faller

This 66 year old gentleman previously experienced a stroke in 2008. At the time he lived alone and had not seen a doctor in many years. He did not seek medical treatment for his stroke and self-diagnosed himself. After this event, the faller's health started to decline. He was experiencing 2-3 falls per week and in 2010 he noticed the onset of slurring of words. He began to use a walker inconsistently as he was becoming increasingly weak due to significant muscle wasting. His diet at this time consisted mainly of chocolate bars. The faller was a chain smoker and heavy drinker. His mobility around the apartment began to decline to the point of spending the majority of his days sitting in an armchair watching television. Due to his decreased mobility the faller used empty jars to urinate in and these jars rested around his armchair within arm's reach. On May 13, 2012, the faller felt very weak and uncoordinated in his movements, he fell three times. The first fall occurred when he lost his balance and landed on the armchair. He was unable to pick himself up and his landlord had to help him back up. The second time he missed his chair and landed in a seated position on the floor. He sat there for several hours before his landlord saw him and helped him back up. During the third fall the faller fell to the ground while trying to reach the telephone, he was unable to pick himself up and lay there for seven hours before his landlord came by to check up on him again. His landlord called an ambulance and the faller was taken to the emergency room. The faller was diagnosed with right caudate putamen stroke. On May 14, 2012, the faller was transferred to the neurology unit where he stayed until May 30, 2012 at which time he was discharged to a stroke rehabilitation hospital. During his stay at the acute care hospital the faller's recovery progressed slowly due to his lack of motivation to participate in therapies. The faller had pronounced speech impairments and communicated with great difficulty. His speech was slurred and very difficult to understand. The faller was also very inappropriate in speech, often times cursing and using vulgar language that easily offended others. Although he did not physically harass members of the health care team, his inappropriate language made him an unpleasant patient. The faller had been suffering from depression for many years and it was believed that his depression was linked to personal and family issues.

Family

The faller was divorced and estranged from his children. He did not have any friends or family other than his landlord who periodically checked up on him and assisted with groceries. The apartment that he lived in was owned by the landlord who lived upstairs while the faller lived in the basement apartment. After his second stroke the faller's daughter started to visit her father and became more involved with his care. After his discharge from the rehabilitation hospital the faller's daughter visited faller once or twice a week to assist with groceries.

Environment

At the time of the fall the faller was walking from the washroom of his hospital room to his bed. The room was occupied by the faller and one other patient. The curtains around the faller's bed were drawn to separate the faller's space from his roommate's. The washroom was shared by the faller and his roommate. His roommate did not witness the fall as he was not in the room at the time of the fall. The faller's bed was closest to the washroom, approximately 6 meters away. The room was lit by overhead lighting and a large window closest to the faller's

roommate's bed.

CCAC

The Community Care Access Centre (CCAC) was not involved with the faller's care before his second stroke. Because he never visited a hospital or doctor no one was made aware of the faller's declining living conditions. His landlord acted as his only informal support and was only able to provide the faller with minimal assistance. After his discharge from the rehabilitation hospital on July 5, 2012 the faller was referred to CCAC but refused assistance. Faller's daughter was later able to convince faller to accept assistance from the CCAC and faller agreed. Faller's daughter also arranged for daily meal delivery with Meals on Wheels and purchased and installed equipment, such as bathroom grab bars.

Right caudate putamen stroke

It is believed that a stroke in the right caudate putamen can affect many types of motor skills including, controlling motor learning, motor performance and tasks, motor preparation, specifying amplitudes of movement and movement sequences. This form of stroke is also thought to affect reinforcement and implicit learning. Reinforcement learning is interacting with the environment and catering actions to maximize the outcome. Implicit learning is a passive process where people are exposed to information and acquire knowledge through exposure. Stroke affecting the putamen has also been shown to impair performance of rule-based tasks.

SFIM
Case ID: 1200412

Date: 2013-01-03

Subject #: 16774

Swiss Cheese Report

Organizational Factors:

- Faller does not have a family doctor.
- Faller does not have a formal support network.

Supervision:

- Faller does not have consistent medical follow up.
- Faller has no assistance with grocery purchase or meal preparations.
- Faller does not have an informal support network.
- Faller requires one person assistance for all transfers.

Preconditions:

- Faller is isolated.
- Faller has significant muscle wasting.
- Faller is malnourished.
- Faller has general weakness.
- Faller has poor muscle coordination.
- Faller has poor diet, which consists mainly of chocolate bars and cigarettes.
- Faller is frail.
- Faller lacks motivation to participate in activities of daily living.
- Faller is depressed.
- Faller is confused.
- Faller is impulsive.
- Faller has impaired motor skills and learning due to stroke.
- Faller speaks inappropriately and often swears at staff.
- Faller's behavior makes him very difficult to deal with as a patient.
- Faller was unfamiliar with the walker given to him in the hospital.
- Faller is unstable and has difficulty controlling limb movements.
- Faller has general muscle weakness.
- Faller has poor coordination.
- Faller's legs often give out.

Unsafe Acts:

- Faller experiences a fall 2-3 times/week after initial stroke. 2008 - 2010
- Faller starts using a walker inconsistently. 2010
- Faller is unable to pick himself up after the third fall. May 13, 2012
- Faller lies on floor for seven hours. May 13, 2012
- Faller's recovery is slow. May 14, 2012 - May 17, 2012
- Faller decides to leave washroom without help. 15:54
- Faller's right foot hits walker. 15:55
- Faller trips over the walker. 15:55
- Faller loses balance. 15:55

SFIM

Case ID: 1200412

Date: 2013-01-03

Subject #: 16774

Conclusions

The faller, a 66 year old stroke survivor fell to the ground on Thursday, May 17, 2012 at 15:55. After an afternoon physiotherapy session, the faller was assisted to the washroom in his hospital room by the physiotherapist (PT). The faller was able to walk with his walker but required assistance and supervision by at least one other person. The faller left his walker just outside the washroom door and before leaving him the PT reminded the faller to call his RN using the call bell in the washroom when he wanted to leave. The faller used the call bell to call for help but after 5 minutes of waiting became impatient and decided to go to his bed independently. He stepped out of the washroom and grabbed onto his walker. As he started walking his foot hit the walker and he tripped over the walker. He lost balance and fell forward to the ground. The RN walked into his room and noticed the faller on the floor. She rushed to the room doorway and called for assistance from other nurses nearby. Two other RNs arrived and helped the faller into his bed. Faller was assessed for injuries but only minor bruises were found.

This event was investigated using the Systemic Falls Investigative Method (SFIM). Multiple contributing factors were identified for this event and included deficiencies within all four levels of the Swiss Cheese Model of Accident Causation. These are discussed below:

Due to a stroke affecting the right caudate putamen region, the faller had difficulty with limb movements and motor tasks. He was given a walker while at the acute care hospital which was not specifically made for him but was rather borrowed from the hospital. He had difficulty walking with this walker. Just before his fall, the faller hit the walker with his right foot, stumbling on the walker which caused him to fall forward onto the ground.

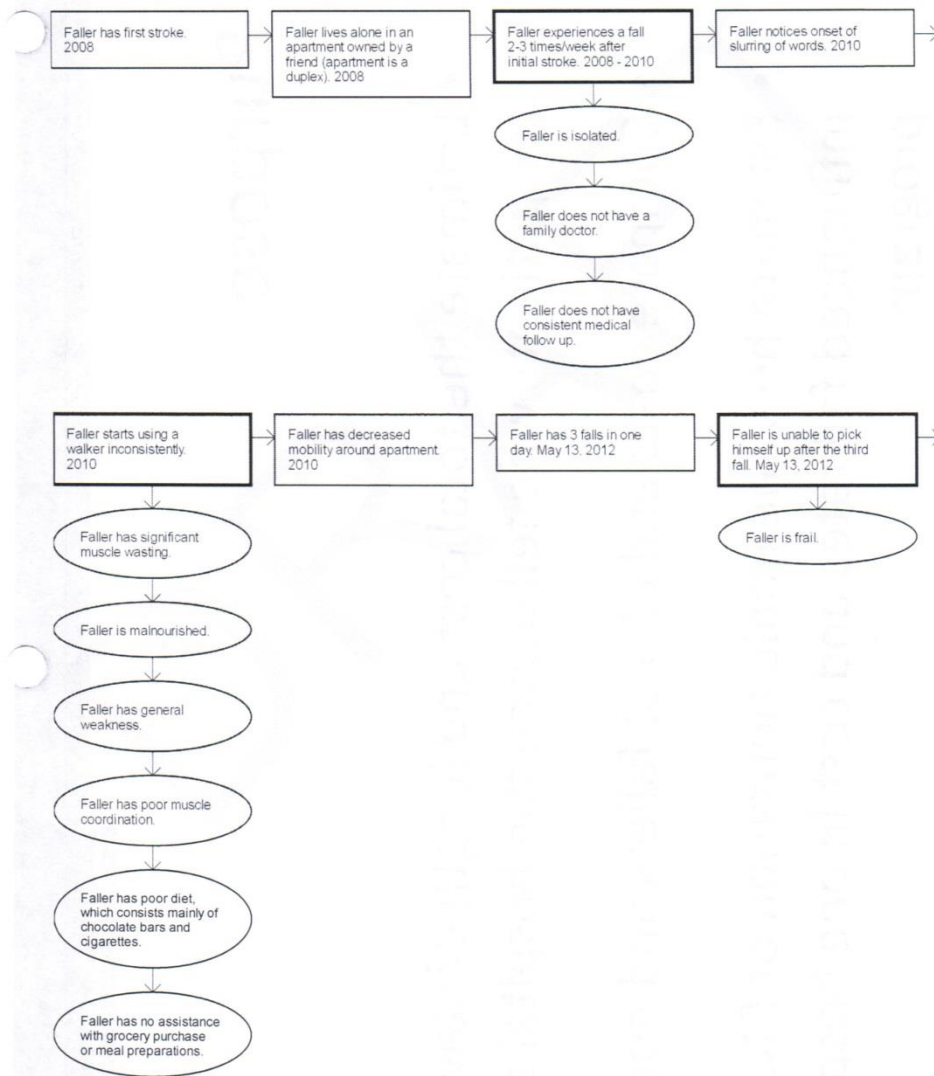
The faller needed assistance with most activities of daily living and always required assistance and supervision from at least one other person with transfers and ambulation. Because he was impulsive and impatient the faller attempted to leave the washroom to head back to his bed by himself instead of waiting for assistance from his RN.

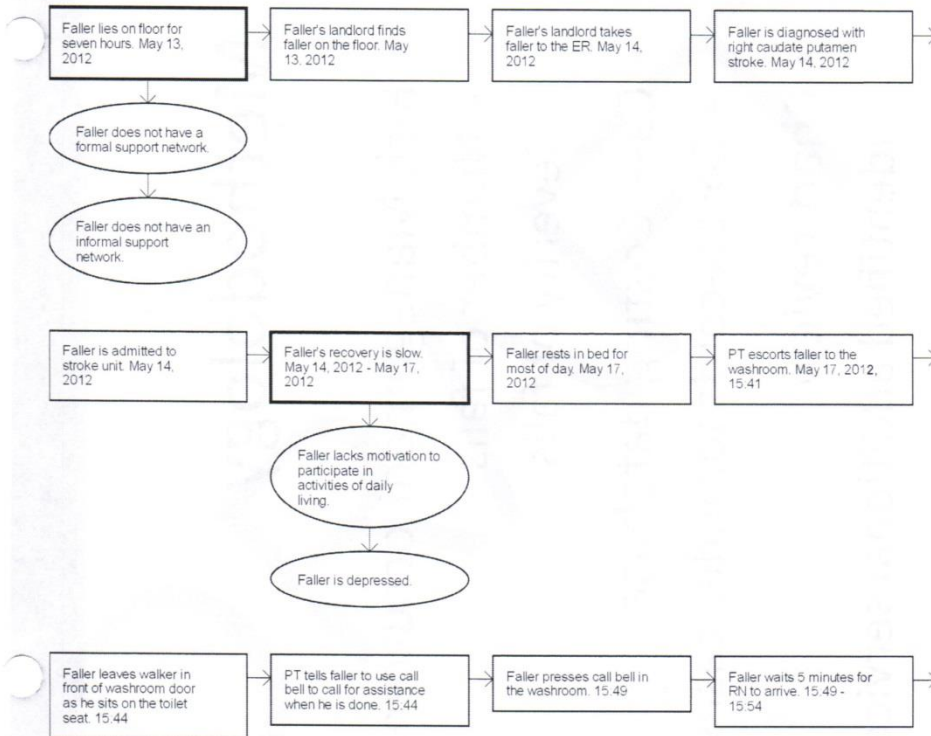
The faller had significant muscle weakness and wasting, as well as poor balance. He was unsteady on his feet, uncoordinated in walking movements and his legs often gave out. He was confused and frail and often did not follow instructions. He suffered from depression and was not at all motivated to get better or participate in therapies.

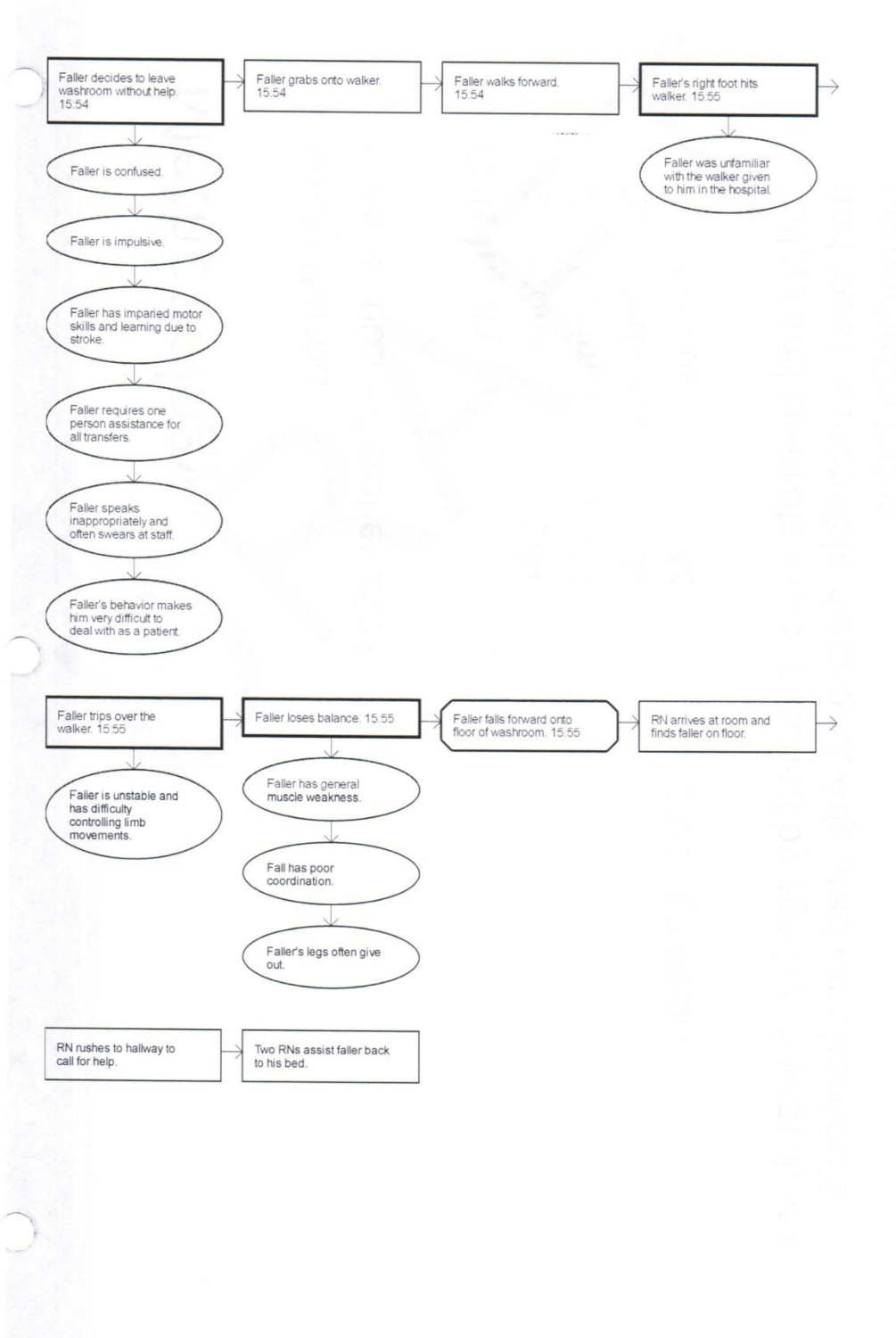
Before his second stroke which brought him to the hospital the faller lived alone in a basement apartment owned by a friend. He lacked any kind of formal support and his only source of informal caregiving was the friend or landlord who owned the apartment. The landlord lived in the apartment above the faller and periodically visited the faller to help him.

In 2008 the faller suffered what he self-diagnosed as a stroke. He never sought medical attention for this incident. He did not have a family physician and had not seen a doctor in many years. Soon after this event his health began to decline. His mobility around his apartment began to decrease to the point of spending most of his days on an armchair watching television. His general muscle weakness and wasting compounded the problem further. The faller suffered from depression and became increasingly isolated. He was malnourished as his diet consisted of chocolate bars and cigarettes. He lacked the will to live and thrive and this was evident in his living conditions. He used empty jars to urinate into and placed them around his armchair.

The faller was divorced and estranged from his children. His alcoholism had been the cause of this and it was at this time that faller became depressed. Although his only source of assistance and caregiving came from his landlord, the landlord was not knowledgeable in what resources were available to him. He was not sure what to do for the faller and therefore continued to provide him with minimal assistance when time permitted.







Appendix B: The Upper Level Organizations' Official Web-Site

Organization	Official website and/or staff consulted
Ministry of Health and Long-Term Care:	http://www.health.gov.on.ca/en/
Local Health Integration Network:	http://www.lhins.on.ca/home.aspx
South West LHIN:	http://www.southwestlhinc.on.ca/ <i>Financial Reporting and Funding team Lead.</i>
The International Society for Quality in Health Care:	http://www.isqua.org/
Accreditation Canada:	http://www.accreditation.ca/en/ <i>Health Services Research Specialist</i>
Registered Nurses' Association of Ontario:	http://rnao.ca/ <i>Senior Policy Analyst</i> <i>Program Manager (in International Affairs and Best Practice Guidelines Centre)</i>
Safer Healthcare Now:	http://www.saferhealthcarenow.ca/EN/Pages/default.aspx
Canadian Patient Safety Institute:	http://www.patientsafetyinstitute.ca/English/Pages/default.aspx
The Acute Care Hospital	<i>Patient Safety Specialist</i> <i>Clinical Educator</i>

Appendix C: Fall Prevention Strategy as a ROP in Accreditation Process

REQUIRED ORGANIZATIONAL PRACTICES

RISK ASSESSMENT

Identify safety risks inherent in the client population

FALLS PREVENTION STRATEGY

The team implements and evaluates a falls prevention strategy to minimize client injury from falls.

GUIDELINES

Falls may lead to client injury, increased health care costs, and possibly claims of clinical negligence.

Falls prevention programs may include but are not limited to staff training, risk assessments, balance and strength training, vision care, medication reviews, physical environment reviews, behavioural assessments, and bed exit alarms. Possible measures to evaluate a falls prevention strategy may include tracking the percentage of clients receiving a risk assessment, falls rates, causes of injury, and balancing measures such as restraint use. Conducting post-fall debriefings may also assist to identify safety gaps, and to prevent the recurrence of falls..

In Canada, Safer Healthcare Now! has identified falls prevention as a safety priority. Reducing falls and fall injuries can increase quality of life for clients and reduce costs associated with serious injury from falls.

TESTS FOR COMPLIANCE

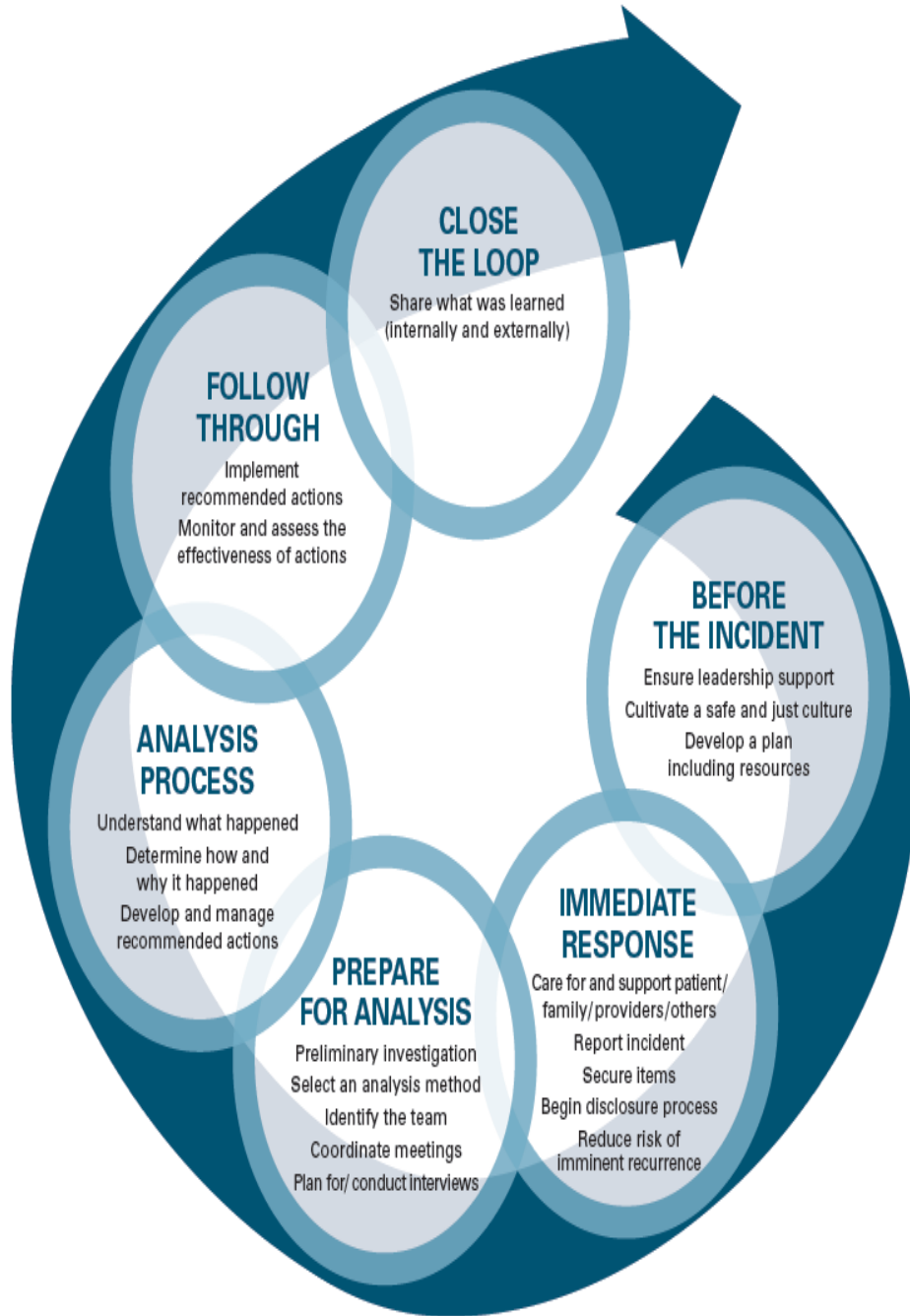
Major	• The team implements a falls prevention strategy.
Major	• The strategy identifies the populations at risk for falls.
Major	• The strategy addresses the specific needs of the populations at risk for falls.
Minor	• The team establishes measures to evaluate the falls prevention strategy on an ongoing basis.
Minor	• The team uses the evaluation information to make improvements to its falls prevention strategy.

REFERENCE MATERIAL

- BC Injury Research and Prevention Unit. (2011). Falls and Related Injuries in Residential Care: A Framework and Toolkit for Prevention. BC Injury Research and Prevention Unit [On-line]. Available: www.injuryresearch.bc.ca/admin/DocUpload/3_20110811_100931Residential%20Care%20Framework_Aug%2010_2011.pdf
- BC Injury Research and Prevention Unit. (2012). Falls Prevention. BC Injury Research and Prevention Unit [On-line]. Available: www.injuryresearch.bc.ca/categorypages.aspx?catid=1&subcatid=7
- Beard, J., Rowell, D., Scott, D., van, B. E., Barnett, L., Hughes, K. et al. (2006). Economic analysis of a community-based falls prevention program. *Public Health*, 120, 742-751.
- Cusimano, M. D., Kwok, J., & Spadafora, K. (2008). Effectiveness of multifaceted fall-prevention programs for the elderly in residential care. *Inj.Prev.*, 14, 113-122.
- Local Health Integration Network Collaborative. (2011). Integrated Provincial Falls Prevention Framework & Toolkit. Local Health Integration Network Collaborative [On-line]. Available: www.alphaweb.org/docs/lib_014321248.pdf
- Oliver, D., Killick, S., Even, T., & Willmott, M. (2008). Do falls and falls-injuries in hospital indicate negligent care -- and how big is the risk? A retrospective analysis of the NHS Litigation Authority Database of clinical negligence claims, resulting from falls in hospitals in England 1995 to 2006. *Qual.Saf Health Care*, 17, 431-436.
- Safer Healthcare Now! (2010). Reducing Falls and Injury from Falls. Safer Healthcare Now! [On-line]. Available: www.saferhealthcarenow.ca/en/interventions/falls/pages/default.aspx



Appendix D: The Incident Management Continuum in Canadian Incident Analysis Framework



Mahboubeh Mehrjoo

Education

Faculty of Health Sciences, Western University, Canada (2011)

M.A. in kinesiology

Human Movement Science faculty, Vrije University Amsterdam, Netherlands (2009-2010)

M.Sc. in Human Movement Science

School of physical education and sport science, Alzahra University, Iran (2004-2007)

B.Sc. in Physical Education and Sport Sciences

Academic and Research Experiences

- Faculty of Health Sciences, Western University (2012)

Master Thesis: The effectiveness of two accident analysis methodologies to understand systemic countermeasures of falls and safety culture of an acute care hospital to prevent fall injuries (Ergonomics).

- Reviewing different accident investigation/causation methods to promote safety.
- Understanding occupational health and safety practices and policies of the acute care hospital.
- Reviewing incident reports of the hospital.
- Analyzing accident (fall) by using accident analysis methodologies to achieve health promotion goals.
- Providing recommendations to improve environment safety of the hospital to prevent future accidents.

- Faculty of Health Sciences, Western University (2012)

Research Assistant: Systemic causes of falls in stroke survivors as they transition through the continuum of care.

- Root cause investigating the fall in stroke survivors in three different care facilities (acute care, stroke rehabilitation unit and community)
- Conducting literature review
- Recruiting stroke survivors in an acute care unit
- Obtaining consent to participate in the research project from stroke survivors
- Conducting interviews with participants as well as health care providers
- Reviewing medical charts
- Filling out questionnaires
- Entering the data in an established database and reviewing it to check the accuracy of data
- Discussing the cases during weekly meetings

- Faculty of Health Sciences, Western University (2012)

Independent study: Comparison between two accident causation models, System-Theoretic Accident Model and Processes (STAMP) vs. Swiss cheese Model of accident analysis.

- Reviewing the history of development of accident causation methods.
- Reviewing hazard analysis strategies.

- Faculty of Health Sciences, Western University (2012)

Current topics in health and aging course project: An enhanced attitude towards seniors fall prevention programs: a combination of person-centered approach and systems approach (critical literature review)

- Looking at the differences and similarities of two different approaches of fall prevention programs (person-centered and systems approach)

➤ Faculty of Health Sciences, Western University (2011)

Qualitative research methods in Health and Rehabilitation Sciences course project: How Seniors Perceive their Falls: A Methodologically-oriented review paper

- Investigating issues of aging and fall among seniors
- Identifying seniors' main concerns about their fall

➤ Faculty of Human movement Science, Vrije University Amsterdam (2010)

Master Thesis: The effectiveness of visual attention training on elite female basketball players

- Submitting research ethics
- Giving the designed visual training to elite female basketball players 3 days a week
- Looking at the effects of the visual training on accuracy of their jump shot

➤ Faculty of Human movement Science, Vrije University Amsterdam (2009)

Exercise and health group project: Physical activity and breast cancer mortality (literature review)

➤ Faculty of Human movement Science, Vrije University Amsterdam (2009)

Psychological factors in sport course project: the effect of instructional self-talk on sport performance

➤ Faculty of Human movement Science, Vrije University Amsterdam (2009)

Applied sport psychology course project: Mental training interventions effectively reduce anxiety and choking under pressure in athletes