Adverse events are a widely researched problem in health care. Three factors characterise these events. The patient suffers harm, an injury, disability or complication. The event is unintended and is associated with health care management rather than the patient's illness itself (Vincent, Neale, & Woloshynowych, 2001). Adverse events are not a new clinical phenomenon and the severity of their consequences has been recognised for some time. In North America for example, they are the fifth leading cause of death, causing more mortality than motor vehicle accidents and breast cancer (Kohn, Corrigan, & Donaldson, 2000).

Unfortunately adverse events are common in the clinical setting, affecting up to one third of hospitalised patients (Fowler et al., 2008; Griffin & Classen, 2008). Of these patients up to 20% will die as a result and 13% will suffer permanent disability (Baker et al., 2004; De Vries, Ramrattan, Smorenburg, Gouma, & Boermeester, 2008). This incidence rate is high, particularly given that up to 80% of all adverse events are considered preventable (Sharek et al., 2006; Sinopoli et al., 2007). Adverse events also carry a huge financial burden. For example a recent Australian study on patients undergoing cardiac surgery found that 36% of patients experienced at least one adverse, at a total cost of $42.5 million (Ehsani, Duckett, & Jackson, 2007).

Clinical care today is complex, team based and reliant on technology (Woloshynowych, Rogers, Taylor-Adams, & Vincent, 2005). Patients discharged from Intensive Care (ICU) for example often have unique care needs, which may be difficult to provide in a ward environment (Green & Edmonds, 2004). Various factors influence the quality of care and thus the incidence of adverse events. The analysis of these events therefore needs to move beyond simplistic conceptions of human error, fault and blame (Woloshynowych et al., 2005). This is because humans, be they novice or expert, do not deliberately try to cause harm or make a mistake. Instead their decisions or actions are based on information available at the time and the environment in which they were working. System and human factors, such as skill mix and fatigue, have been found to play a role in 70–80% of all accidents (Runciman, Webb, Lee, & Holland, 1993). This is one reason why many adverse events are deemed preventable.

Researchers and psychologists examining industrial errors have developed theoretical and conceptual models to help analyse error causation (Dean, Schachter, Vincent, & Barber, 2002). These theoretical frameworks are important as they facilitate the examination of an adverse event and enable outcomes to be linked to the existing body of knowledge (Borbasi, Jackson, & Langford, 2008). Without reference to existing knowledge, a
study and its findings exist in isolation from other similar studies, and the theoretical significance of the investigation remains unclear (Parahoo, 2006; Polgar & Thomas, 2008).

Progress in science is best advanced when the researcher identifies the theoretical notions underpinning the research and attempts to formalise the link between theory and all phases of the research (Moody, 1990). For these reasons there have been calls in recent years to strengthen the theoretical underpinnings of patient safety research (Brazil, Ozer, Cloutier, Levine, & Stryer, 2005; Mark, Hughes & Jones, 2004). One of the most popular theoretical models for adverse event analysis in health care is Reason’s accident causation model.

**AIMS**

Although a popular framework for adverse event analyses, little formal guidance exists on the use of Reason’s accident causation model and its clinical application. This paper therefore aims to discuss the theoretical underpinnings of Reason’s model and describe its application to adverse event analyses via clinical exemplars. This paper serves as a guide to researchers and clinicians considering using Reason’s model as a conceptual framework for event analysis, by demonstrating how it has been applied. The use of the model in a current programme of research on adverse events will also be described.

**ACCIDENT CAUSATION MODEL**

Reason’s (2000) model proposes that within complex systems such as hospitals, multiple barriers or layers exist to prevent accidents or errors. In health care these layers may include hospital policies, protocols or clinical guidelines. However, Reason (2000) suggests that each of these safety barriers has random holes or weaknesses and when these holes align, the patient is able to ‘pass straight through’ the barrier resulting in an adverse event. These holes are labelled latent conditions and the adverse event which occurs, an active failure (Reason, 2000).

Reason (2001) describes two simple ways in which failure can occur: The plan is adequate but the associated actions do not proceed as intended, or the actions go as intended but the original plan was flawed. These failures may be labelled as either an error or a violation. Errors are defined as the failure of a planned sequence of actions to achieve the desired goal (Reason, 2001). They can be further categorised as slips, lapses or mistakes. Slips are actions in which there are recognition or selection failures such as confusing the dose of two drugs. Lapses are a failure of memory or attention, such as failing to cease a drug on a medication chart. Mistakes include the incorrect choice of objective, or choice of an incorrect path to achieve it (Dean et al., 2002). Errors may therefore be a skill-based slip or memory-based lapse, or rule-based or knowledge-based mistakes. A violation is an instance in which rules of correct behaviour such as clinical guidelines are consciously ignored by the clinician (Dean et al., 2002).

**MODEL DEVELOPMENT**

Reason’s (1997) model classifies factors contributing to accidents into three domains: Organisational/systems, local workplace and unsafe acts. In doing so, the model moves the blame from human error to the environment in which humans work. In other words, the model promotes a focus on the conditions or situation in which the person is trying to perform, conditions which might be designed to create an incident or error.

Reason et al. (2001) label these conditions vulnerable system syndrome – a cluster of organisational pathologies that renders some systems more liable to adverse events. Examples of these pathologies include: Blaming front line individuals for adverse events, such as the clinicians at the bedside involved in the event; denying the existence of systemic error provoking weaknesses, such as a chronic shortage of experienced staff; and the blind pursuit of key performance indicators, such as patient throughput.

The strength of Reason’s (2000) model is its focus on the system or environment in which the event occurred, rather than the individual involved as the cause of the event, and to randomness rather than deliberate action, in medical errors (Perneger, 2005). This is because when an accident occurs it is usually due to a specific trigger...
However, it is the bedside nurse administering the medications who could easily confuse these drugs and thus be a victim of the poor design along with the patient.

**MODEL LIMITATIONS**

Reason’s model is one of the most frequently cited accident causation models. Despite this, little formal guidance exists on its use and application. Perneger (2005) therefore conducted a study to explore healthcare quality improvement professionals’ understanding of the model. A convenience sample of 85 delegates at an international conference on quality in health care completed a questionnaire on Reason’s model.

Opinion on the meaning and significance of the model was far from univocal. For example, there was varying opinion among these professionals about what the various parts of Reason’s model represent (Perneger, 2005). This finding may reflect these professionals’ misunderstanding of the model; but if experts have trouble understanding and/or applying it, then perhaps the model is too complex to be easily and usefully applied by those investigating adverse events. It was also suggested that the model places too much emphasis on systemic causes of patient harm, as opposed to an individual’s failure (Perneger, 2005). This is probably because according to Reason (1997) we cannot change the human condition, but we can change the conditions under which people work.

Reason’s (2000) model is only a framework for adverse event analysis. As with any theoretical framework it is not designed to deliver answers to those using it but rather to act as a guide to the investigation and analysis of an incident. Reason’s model is a framework not a research method and clinicians or researchers using it for incident analysis must be cognisant of this.

**MODEL IN PRACTICE**

Reason’s model can guide data collection and analysis when examining adverse events in clinical practice. Data collected on factors contributing to adverse events can be framed as organisational or systems factors, rather than mistakes made by clinicians. Examples of these factors may include staffing levels, time of patient discharge or bed
shortages. These organisational or systems factors can be included in adverse event reporting tools used by hospitals. Mark et al. (2008) for example recently established the influence of contextual factors such as hospital size, structural factors such as skill mix, and safety climate factors such as communication culture, on medication errors and patient falls. They concluded that future research may benefit from the use of theoretical models which are focussed on the explanation of particular types of adverse events (Mark et al., 2008).

Using Reason’s model, researchers can classify data into latent conditions or as acute work conditions, such as local workplace conditions occurring only at the time of the event. The acute conditions for example could include nurse: patient ratios or staff skill mix. Other conditions could be the premature discharge of a patient from ICU to a hospital ward because of a system factor such as bed shortages. Prompting clinicians to isolate organisational factors which contribute to adverse events will highlight system changes needed to reduce the incidence of adverse events in the future, as classifying errors is pivotal to any process of change (Johnson & Young, 2011). To highlight the application of Reason’s model, examples of adverse event analysis will now be described.

Medication errors
Medication errors are one of the most common types of adverse events. The landmark report, *To Err is Human* revealed that more than one million medical mishaps occur in North America each year, resulting in 100,000 deaths, of which 75% are adverse drug events (Kohn et al., 2000). Bates and Schiller (2007) therefore applied Reason’s model to the case of a 15 year old boy who presented to an Emergency Department with slurred speech, pallor, unsteady gate, confusion and headache. On questioning the patient’s mother, it was found that she had refilled his medication prescription 2 days prior and that the patient’s physician had changed the Clonidine prescription from three times daily to once nightly. The patient had been receiving one 75 mcg tablet three times a day but to simplify the medication regime, the physician changed the order to one nightly extended-release tablet.

This within itself was not an unreasonable change to make and may have improved compliance with the medication by reducing the number of tablets the patient needed to swallow. The pharmacist however, noticed that the dose had been written incorrectly: 2.25 mg/night instead of 225 mcg/night. Despite this the pharmacist supplied the drug as prescribed, and the patient received a daily dose that was ten times greater than was intended. Using Reason’s framework, this would be labelled an active failure.

When investigating this case a number of errors or holes were identified: An incorrect dose was prescribed; it was detected but not queried by the pharmacist; the boy’s parents did not understand the change on the drug label (it was not clear if they had been informed); and two doctors in the Emergency Department and the admitting medical team failed to check the correct paediatric dose of Clonidine or the common signs of overdose of this drug (Bates & Schiller, 2007). Reason’s framework would label all these issues as latent failures. The pharmacist and medical staff involved could be considered ‘safety barriers’ in Reason’s model because these clinicians are educated, skilled health professionals. However, for whatever reason, perhaps because they are human, they all made mistakes or judgement errors.

The prescribing physician could easily have been reprimanded for making an error but such action would not guarantee that a similar error would not occur again. The pharmacist could also be asked why he/she detected a dose error but still dispensed the incorrect dose. The factors contributing to the prescription error were not reported but using Reason’s model promoted the recognition of how the error occurred and focus on how it could be prevented in the future such as by educating parents.

Right drug, wrong route
Another example of adverse event analysis using Reason’s model is an incident involving a drug administered via the incorrect route (Cohen, 2006). An oral cough medication was ordered for a patient but the route was not specified on the
medication chart, a human error. The drug was dispensed in a syringe for oral administration, but the nurse was not familiar with ‘oral syringes’. This lack of familiarity is not strictly a human error but could be considered a system error due to lack of staff education.

As the drug was dispensed in a syringe and the patient had an intravenous cannula in situ, the nurse assumed the drug was to be administered intravenously, another human error. The pharmacy label on the syringe covered the manufacturer’s instructions, ‘for oral route only’, another human error. Fortunately the patient was not harmed when the drug was administered via the incorrect route.

The nurse involved in this incident could have been disciplined for placing the patient at risk. Using Reason’s model though, it can be seen that human error was a factor – the errors of the nurse and the person who covered the manufacturer’s instructions. The nurse’s assumption to administer the drug intravenously is though understandable. However, as it is uncommon for liquids intended for oral administration to be contained in a syringe, the lack of clear guidance on the administration route is a system error. If the nurse administering the medication had been disciplined and no further action taken, then the specific factors which contributed to the error would remain, potentially causing the error to recur.

Applying Reason’s model to this event encourages the analysis of underlying factors, rather than simply blaming the clinician involved.

**Adverse Events**

Reason’s model is currently being used by the authors in a large programme of research examining adverse events following discharge from ICU. The aim of the research programme is to improve post-ICU patient outcomes through the examination of key factors contributing to adverse events in this unique population. The research programme also aims to promote the development of corrective action to reduce the risk and severity of future adverse events in this patient cohort.

The first phase of the programme was a qualitative analysis of ICU readmission (Elliott, Crookes, Worrall-Carter, & Page, 2011). This clinical adverse event was examined as previous research on the topic has not isolated contributing factors, only the associated disease processes (Elliott, 2006). The first phase identified five key factors believed by respondents to contribute to ICU readmission. A literature review was also conducted to identify factors which contribute to adverse events in all acute settings. It was hypothesised that the findings of the first phase and those in the literature would contribute to most adverse events following ICU discharge.

Using Reason’s model, these factors were categorised into three domains: Those relating to the system or environment in which care is delivered; those relating to clinicians; and those relating to patients. These were formatted into a questionnaire which was used to explore nurses’ opinions of factors contributing to adverse events following ICU discharge (Elliott et al., in press). Categorising factors contributing to adverse events using Reason’s model encouraged nurses completing the questionnaire to think beyond superficial causes such as ‘nurses don’t know how to care for these patients’. Instead it prompted them to view an adverse event as an outcome or result of flaws or limitations within clinical care. Conceptualising adverse events this way allows processes of care to be modified thus reducing the risk of future adverse events.

**SUMMARY**

Adverse events are a common problem in health care and represent a breach in care quality and patient safety. These events carry a high cost for the patient, staff and organisation involved. Adverse events are generally not caused by a single mistake or error and although preventive barriers or safety mechanisms exist in health care organisations, patients are still harmed. These barriers are not perfect and contain weaknesses that may be bypassed if the right conditions exist. The investigation and analysis of adverse events must focus on identifying these conditions and the weaknesses in safety barriers.

There is always the likelihood of errors occurring in health care due to the human factor. However, often it is factors external to clinicians, such as the environment in which they work, which lead to errors. Unfortunately the historical
approach to error investigation has focused solely on the clinicians involved and this fails to correct the weaknesses within the system which allow errors to occur (Kohn et al., 2000).

Bedside clinicians respond to the environment they are working in at the time, but do not ‘create’ the environment. For example, they have little control over staff; patient ratios or equipment availability. This is why it is so important to examine the conditions or environment the clinician was working in at the time to identify causative factors, rather than the easier option of apportioning blame (Reason, 1990).

Using an accident causation model is a constructive way of identifying the underlying causes of adverse events and to strengthen a study’s theoretical underpinnings. Reason’s model is recommended as a useful framework for adverse event analysis. It prompts the researcher to identify specific causes of an adverse event rather than blaming the clinician involved. It promotes an examination of the organisational or system factors which contributed to the event including failure of safety barriers.

By using an accident causation framework such as Reason’s model, adverse events may be analysed in a way that allows for the underlying causes to be isolated thus helping to improve care quality and patient safety, and prevent future adverse events. Despite having had a major impact on the way accidents are conceptualised, there is little published guidance on the practical application of Reason’s model (O’Hare, 2000). There is also disagreement among safety experts about how the model should be applied to medical adverse events (Perneger, 2005). The incidence and nature of in-hospital adverse events: A systematic review.

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**Supporting a Strong and Resilient Contemporary Nursing Workforce**

A special issue of *Contemporary Nurse* – Volume 44 Issue 2 – June 2013
Editors: Debra Jackson (University of Technology, Sydney, NSW, Australia), Michelle Cleary (National University of Singapore, Singapore) and Sharon Andrew (Anglia Ruskin University, Chelmsford and Cambridge, United Kingdom)

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