Fall risk assessment : A prospective investigation of nurses' clinical judgement and risk assessment tools in predicting patient falls in an acute care setting

Helen Myers
Edith Cowan University

Fall Risk Assessment: A Prospective Investigation of Nurses' Clinical Judgement and Risk Assessment Tools in Predicting Patient Falls in an Acute Care Setting

A Thesis Submitted in Partial Fulfilment of the Requirements for the Award of Master of Nursing

Helen Myers (BSc)
Faculty of Communications, Health and Science

February 24, 2003

USE OF THESIS

Abstract

Falls are a significant problem in acute care hospital settings, and can have serious consequences, especially for older patients. Fall prevention has therefore been recognised as an important area for research and intervention. In order to target interventions and use resources effectively, a major strategy of many fall prevention programmes has been the development and/or use of risk assessment tools to identify patients who are at high risk of falling. Although many tools have been developed, few have been rigorously tested, and there is currently no evidence to support the clinical utility of fall risk assessment tools. There is a need to conduct further research to establish the efficacy of fall risk assessment tools for inpatient populations. Additionally, nurses' clinical judgement in assessing fall risk may aid the development of fall risk assessment protocols and further research is needed to build on limited knowledge in this area.

A prospective cohort study was used to evaluate two fall risk assessment tools and nurses' clinical judgement in predicting patient falls. Each patient was assessed for fall risk by the clinical judgement of the nurse caring for the patient and by the researcher using a data collection form containing the two fall risk assessment tools. The study wards comprised two aged care and rehabilitation wards within a 570 bed acute care tertiary teaching hospital facility in Western Australia. Test-retest reliability of the two fall risk assessment tools and nurses' clinical judgement was established over a twenty four hour period. The ability of the fall risk assessment tools, and nurses' clinical judgements to discriminate between patients with a high probability of falling and patients with a low probability of falling, was determined by calculating the sensitivity, specificity, positive predictive value and negative predictive value for each method. The reference criterion used for these calculations was whether or not the patient fell within the hospitalisation period in which they were admitted to the study. In addition, the accuracy of each method was determined by calculating the number of times the risk assessment tool or clinical judgement classified the patient into the correct fall risk category, expressed as a percentage. The same reference criterion was used for this calculation.

Both the fall risk assessment tools and nurses' clinical judgement had good test-retest reliability. When assessing validity, all three methods of determining fall risk showed

good sensitivity, ranging from 88% to 91%, but poor specificity, ranging from 25% to 26%. This meant that the risk assessment methods classified too many patients who did not fall as at high risk for falling. All methods also had limited accuracy, ranging from 35% to 36%, and overall exhibited an inability to adequately discriminate between patient populations at risk of falling and those not at risk of falling. Consequently, neither nurses' clinical judgement nor the fall risk assessment tools could be recommended for assessing fall risk in the clinical setting.

In addition, results indicated that there was a large difference between the accuracy of first year enrolled and registered nurses in assessing patient fall risk. First year enrolled nurses accurately predicted fall risk 44.4% of the time while first year registered nurses achieved an accuracy level of only 8.6%. These results are potentially biased, as measuring differences in accuracy between types of nurses was not a main focus of this study and in many cases the same nurse gave multiple judgements about patients' fall risk. The results however, provide an indication that further study is warranted using a specifically designed methodology to explore this issue.

There are a number of specific recommendations arising from the results of this study. It is recommended that further studies be undertaken to assess the reliability and validity of current fall risk assessment tools in inpatient populations. If no valid and reliable fall risk assessment tool can be identified, research should be undertaken to develop such a tool. It is also recommended that studies be conducted to assess changes in fall risk profiles over time to determine if the sensitivity and specificity of instruments changes depending on the timing of the risk assessment. Differentiating between stable and transient risk factors should be an integral component of these types of studies. Further research is also required to determine if there are differences in fall risk factors between different specialties or if a generic risk assessment tool can be used for all inpatient populations. Additionally, further investigation into the clinical judgement of registered and enrolled nurses in their first year of clinical practice should be undertaken and results reported to appropriate educational institutions. Changes in accuracy of clinical judgement in the first five years of clinical practice should also be measured.

Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

(i) incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher education;

(ii) contain any material previously published or written by another person except where due reference is made in the text; or

(iii) contain any defamatory material.

[redacted]

Helen M[redacted]

Acknowledgments

I would particularly like to thank Sue Nikoletti for her feedback and encouragement, without her this thesis would not have been possible. I would also like to thank Kate White for her input and comments. In addition I would like to thank the staff from the study wards for participating in this research project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE
INTRODUCTION

Background and Significance of the Study

Falls are a significant problem in acute care hospital settings, accounting for 38% of all patient incidents within Australian hospitals (Evans, Hodgkinson, Lambert, Wood & Kowanko, 1998). At Sir Charles Gairdner Hospital, in the 1997/1998 financial year patient falls accounted for 53% of all accident/incident reports, a total of 1189 patient falls. This is a fall rate of 7.09 falls per 1000 patient bed days (Myers, 1999).

There are numerous negative consequences for patients following a fall, ranging from psychological distress such as fear and anxiety to serious injury such as hip fracture and sometimes even death (Morse, 1997; National Health and Medical Research Council [NHMRC], 1994). Fall prevention has therefore been recognised as an important area for research and intervention. The Joanna Briggs Institute for Evidence Based Nursing and Midwifery (JBIEBNM) (1998) conducted a major review of fall prevention interventions and found that the most common approach to preventing falls was the implementation of a multifactorial programme. These programmes included risk assessment, risk diagnosis, visual identification of high-risk patients, education, promoting a safe environment, toileting and mobility interventions, medication review, and orienting confused patients. However, the level of evidence to support these interventions was minimal, with results classified as level IV (expert opinion).

A major strategy of many fall prevention programmes has been the development or use of a risk assessment tool to identify patients who are at high risk of falling. Identification of high-risk patients allows clinical staff to target fall prevention interventions, which may be costly or time consuming, at those most in need in order to use resources effectively. There is an urgent need to test existing risk assessment tools for validity as the JBIEBNM found no evidence for the efficacy of current fall risk assessment tools (Evans et al., 1998).

Nurses' clinical judgement in relation to fall risk assessment and fall prevention is an emerging area of interest in fall prevention research. Turkoski, Pierce, Schrek, Salter, Radziewicz, Gudhe and Brady (1997) suggest that nurses' clinical judgements about patients' fall risk may aid the development of fall prevention protocols and further research is warranted to build on limited knowledge in this area. Additionally, there is a need to ascertain whether nurses' clinical judgement can outperform risk assessment tools in predicting patient falls as there is little point in using a risk assessment tool that is less accurate than nurses' judgement (Dowding, 2002).

Aim of the Study

The aim of this study was to assess the reliability and validity of two fall risk assessment tools and nurses' clinical judgement in predicting patient falls in an inpatient population to determine if any of these methods of fall risk assessment would be of use in the clinical setting.

Research Objectives

1. To determine the reliability and validity (sensitivity, specificity, positive predictive value, negative predictive value and accuracy) of selected fall risk assessment tools and nurses' clinical judgement.
2. To compare the ability of selected fall risk assessment tools and nurses' clinical judgement to predict patients who fall.
3. To assess whether the combination of nurses' clinical judgement and a fall risk assessment tool is a better predictor of patient falls than either method alone.
4. To analyse the components of nurses' clinical descriptions of fall risk to identify useful constructs for risk assessment.

Operational Definitions

Fall

For the purposes of this study a fall was defined in accordance with the World Health Organisation as

> an event which results in a person coming to rest inadvertently on the ground or other lower level and other than as a consequence of the

following: sustaining a violent blow, loss of consciousness, sudden onset of paralysis, as in a stroke, [or] an epileptic seizure (Gibson, 1987).

Registered Nurse

In this study a registered nurse was defined as a professional nurse registered in division one under the Nurses Act 1992 and working as a level one under the West Australian nursing career structure.

Enrolled Nurse

An enrolled nurse was defined as a nurse registered in division two under the Nurses Act 1992 who works under the supervision and direction of a registered (or clinical) nurse.

Graduated Registered Nurse

A graduate registered nurse was defined as a registered nurse in the first year of clinical practice following graduation from an approved nursing education course.

Clinical Nurse

A clinical nurse was defined as a registered nurse employed as a level two under the West Australian nursing career structure.

CHAPTER TWO
LITERATURE REVIEW

Introduction

The literature on fall risk assessment tools and nurses' clinical judgement in relation to fall risk assessment is discussed below. A brief examination of fall risk factors is also included as many of the fall risk assessment tools are based on this body of literature.

Fall Risk Factors

There is a substantial body of knowledge on fall risk factors, however, the literature varies in quality and the findings are often contradictory. For example, although age has been identified in a number of studies as contributing to fall risk, other studies have found that age is not a risk factor (Evans et al., 1998). This makes it difficult to argue for the validity of fall risk assessment tools or fall prevention interventions based on the results of these studies. The results of two recent major reviews of fall risk factors are briefly summarised below to provide some background for the discussion of fall risk assessment tools that follows. The majority of studies on fall risk factors have examined intrinsic risk factors associated with the patient rather than extrinsic risk factors associated with the environment (Evans et al., 1998).

Evans et al. (1998) identified a number of fall risk factors for hospitalised patients classified as level III evidence (case control or cohort study designs). These risk factors included age, mental status, history of falls, medications, mobility, toileting needs, diagnosis, and type of ward. Additionally, a number of factors were identified based on level IV evidence (descriptive studies). These risk factors were mostly extrinsic and included location of falls, time of falls, activity at time of fall, length of stay and floor surface.

The National Ageing Research Institute (2000) also conducted a comprehensive review of the literature on falls in acute care settings and identified similar risk factors to those listed in the Joanna Briggs review (Evans et al., 1998). Age, diagnostic status, previous cerebrovascular accident, history of falls, depression, cognitive impairment, incontinence, mobility, sensory deficits, medications, length of stay, environmental factors and time of day were all identified as fall risk factors although the level of evidence on which these findings were based is not stated. A number of the fall risk assessment tools described below were developed from this literature and contain many similar domains.

Fall Risk Assessment Tools

A comprehensive review of the literature on fall risk assessment tools was conducted utilising electronic databases and reference list searching. The focus of the review was on fall risk assessment tools administered by nurses and developed or used for adult populations in acute care hospital settings. Fall risk assessment tools developed or used for community settings or nursing homes, or administered by physiotherapists, were not included in the review. A search of the CINAHL and MEDLINE databases was conducted using fall risk assessment as the keyword covering the years 1980 to 2001.

This search strategy revealed a total of 47 articles in which fall risk assessment tools had been developed, tested or used, either as stand-alone projects or in conjunction with fall prevention programmes. The earliest article, by Oulton, was published in June 1981 and the latest article, by O'Connell and Myers, was published in April 2001 (see Appendix 1). Of these articles, 31 described the primary development of a risk assessment tool and eight described the modification of an existing risk assessment tool. In four of these articles, secondary development occurred without any acknowledgment of the primary tool. Only nine of the primary development and two of the secondary development articles had included information about the accuracy of the tool. Of the remaining articles, six described some type of testing of an existing fall risk assessment tool while two described the use of an existing risk assessment tool without any further testing.

The following table is a summary of the fall risk assessment articles included in this literature review (see Table 1). A key to the column headings is provided below the table. Each row in the table represents a primary fall risk assessment tool. Articles listed in the same row are secondary development, testing or use of the primary fall risk assessment tool. One of the articles (Mercer, 1997) discussed the modification of an existing fall risk assessment tool, however, there were no published articles that could be located about the primary development of this tool.

Table 1
Summary of Fall Risk Assessment Tools

Key No	Author and/or name of tool	Source	Type of Develop-ment	Population Type	Health Professional Type	Sample Size	Tested	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Rater Reliab-ility	Accur-acy	Time to complete
235	Oulton (1981)	U	P	U	N QA	NS	N							NS
34	Innes & Turman (1983)	U	P	U	N QA	NS	N							NS
33	Innes (1985)	MET O	S	U	N QA	NA	N							NS
35	Widder (1985)	U	P	O GM	QA	NS	N							NS
29	Wood & Cunningham (1992) (Wood's Fall Risk Protocol)	U	P	ALL	N	NS	N							NS
5	Ruckstuhl et al. (1991)	EO U	P	ALL	N QA	NA	N							NS
4	Barbieri (1983)	IR LR EO PI FO	P	ALL	N	420 IR 25 PI	N							NS
28	Rainville (1984)	IR EO	P	MS	N	26 IR	N							NS
16	Fife, Solomon, & Stanton (1984)	LR IR EO	P	ALL	N RM	50 IR	N							NS
6	*Hill, Johnson & Garrett (1988)	MET	S	ALL	U	NA	N							NS
39	*Brians et al. (1991)	LR CC MET	S	ALL	N QA	208 CC	N							NS
36	Kostopoulos (1985)	IR	P	ALL	N QA	83 IR	N							NS
19	Hernandez & Miller (1986)	LR EO	P	PG	N	NA	N							NS
10	Morse (Morse Fall Scale) (1986)	CC	P	ALL	N	200 CC	Y	78%	83%	10.3%	99.2%	96%		NS
12	Morse et al. (1989)		T			2689	Y	70% #	76% #	11% #	98% #			3 min
15	McCollam (1995)		T			458	Y	91%	54%	10%	99%	94.5% -98%	57%	1-3 mins
22	Eagle et al. (1999)		T			98	Y	72%	51%	38%	81%		38%	NS
238	O'Connell & Myers (2001)		T			1059	Y	83%	29%	18%	90%			NS

Key No	Author and/or name of tool	Source	Type of Develop-ment	Population Type	Health Professional Type	Sample Size	Tested	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Rater Reliab -ility	Accur -acy	Time to complete
2	Tack, Ulrich, & Kerr (1987)	LR IR	P	N	M	NS	Y					82%		NS
13	Spellbring et al. (1988)	LR IR EO	P	G	N QA	NS	N							NS
14	Spellbring (1992)	MET	S	G MS	N	NA	Y					90%		10-32 min
30	Llewellyn et al. (1988)	IR FO O	P	S	N	194 IR	N							NS
24	Lund & Sheafor (1985)	CC IR MR	P	G	N	152 CC	N							NS
18	Sweeting (1994)	IR	P	G GM	N	300 IR	N							NS
11	Schmid (1990)	CC	P	ALL	N	204 CC	Y	95%	66%			88%		NS
8	Berryman et al. (1989)	IR	P	G	N	1087 IR	N							NS
3	*Kallmann, Denine-Flynn & Blackburn (1992)	LR EO MET	S	G	-	NA	N							NS
37	*MacAvoy, Skinner & Hines (1996)	LR MET	S	ALL	N QA	NA	Y	43%	70%					NS
7	Hendrich (1988)	LR MR CC	P	ALL	N QA	NS	N							NS
31	Heslin et al. (1992)	IR LR	P	ALL	U	855 IR	N							NS
247	Moore, Martin & Stonehouse (1996)		T			39	Y	60%	60%	43%	75%	76%		
32	Hollinger & Patterson (1992)	LR	P	GM	N	NA	N							NS
237	Farmer (2000)	MET U	S	G	N	NS	N							NS
27	Brady et al. (1993)	LR IR	P	G	N QA	71 IR	N							NS

Key No	Author and/or name of tool	Source	Type of Develop-ment	Population Type	Health Professional Type	Sample Size	Tested	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Rater Reliab -ility	Accur -acy	Time to complete
9	Hendrich et al. (1995) (Hendrich Fall Risk Model)	CC IR	P	ALL	N	338 CC	Y	77%	72%					1 min
47	Sullivan & Badros (1999)		U			NA	N							
46	Stetler et al. (1999)		U			NA	N							
25	Mitchell & Jones (1996)	U	P	ALL	N	NA	N							NS
277	Downton (1993)	U	P	G	MED	NA	N							
38	Nyberg & Gustafson (1996)		T	G	U	135	Y	91%	27%				52%	NS
21	Mercer (1997)	MET EO	S	GM	M	NA	N							NS
17	Bakarich McMillan & Prosser (1997)	LR EO	P	G	N	NA	Y	54% #	78% #	13% #	97% #			NS
20	Oliver et al. (1997) (STRATIFY)	CC	P	G	MED	232 CC								1 min
			T			395	Y	92%	[illegible]	[illegible]	98%			
			T			446	Y	93%	[illegible]	[illegible]	98%			
26	Price et al. (1998)	C	P	G	N MED	154 C	Y	90%	38%					NS
93	Patrick et al. (1999)	LR	P	G	M	NA	N							NS
45	Forrester, McCabe-Bender & Tiedeken (1999)	LR	P	ALL	N	NA	N							30-45 mins
	(FRCS)		T			177	Y					79%		
	(FRIS)		T			177	Y					82%		
23	Conley, Schultz & Selvin (1999) (Conley Scale)	LR U	P	ALL	N	NA								1-2 mins
			T			1168	Y	71%	59%			80%		

Key to Table 1

Key No = Endnote number: provides a connection to the references listed in Table 2

Source = Methodology used for development

LR= Literature review
EO= Expert opinion
IR= Incident review
CC= Case control study
C= Cohort study
O= Other
MET= Modified existing tool
PI= Patient interview
FO= Field observations
MR= Medical record review
U= Unknown

Type of Development

P= Primary development
S= Secondary development
T= Tested an existing tool
U= Used existing tool, no testing or development

Population Type = Type of patient population the tool was developed in/for or tested in

ALL= All
MS= Medical Surgical patients
U= Unknown
O= Orthopaedics
GM= General Medical patients
PG= Psychogeriatric patients
N= Neurological
G= Geriatric
S= Surgical patients

Health Professional Type = Type of health professional involved in the development of the tool

N= Nurse
RM= Risk management
QA= Quality assurance
M= Multidisciplinary
MED= Medical

Sample size used for development or testing
NA= Not applicable (no sample used)
NS= Not stated

Tested = Was the tool tested for accuracy

Y= Yes
N= No

Time to Complete = Time taken to complete the tool
NS= Not stated

* Next to authors name indicates no attribution given to original risk assessment tool within the article.

Shaded area indicates that the sensitivity/specificity calculations are likely to include falls rather than fallers therefore accuracy calculations may be biased (that is. they may include repeat information).

# Indicates that sensitivity/specificity calculations were not given in the article and were calculated by the researcher based on information in the article therefore they may be inaccurate.

Although numerous researchers have developed, modified or utilised fall risk assessment tools, few are based on a rigorous research design or evaluation. Many articles did not describe the method used to develop the fall risk assessment tool, for example Oulton (1981), Innes and Turman (1983) and Wood and Cunningham (1992). Some of the tools were developed based only on a literature review or expert opinion, for example Hernandez and Miller (1986), and Bakarich, McMillan and Prosser (1997). The quality of these types of tools is therefore dependent on the quality of the literature that is reviewed or the quality of the expert opinion.

The majority of tools were developed based on incident reviews, for example Fife, Solomon and Stanton (1984) and Kostopoulos (1985). Although incident reviews allow researchers to uncover common factors between patients who fall, the methodology does not allow a comparison of risk factors with a non-faller population. This may lead to biased estimates of the importance or lack of importance of risk factors. Overall, however, the major concern with studies of this nature was that most tools, once developed were not tested and had no reported sensitivity or specificity, (for example Barbieri [1983] and Rainville [1984]) making it difficult to evaluate the accuracy of such tools. Despite the limitations of fall risk assessment studies based on literature reviews, expert opinion and incident reviews, they still have the potential to offer useable fall risk assessment tools, however, further work is required to adequately assess the accuracy of these tools in clinical settings.

Only five of the fall risk assessment tools were developed using a case control (Hendrich, Nyhuis, Kippenbrock & Soja, 1995; Morse, 1986; Oliver, Britton, Seed, Martin & Hopper, 1997; Schmid, 1990) or cohort (Price, Suddes, Maguire, Harrison & O'Shea, 1998) study and included details about the accuracy of the tool. Evaluation of the validity of these tools had usually occurred in one or two settings, usually by the development authors with the same population in which the tool was developed. Only one of these tools (Morse, 1986) had been tested by other authors in different clinical settings to the development population.

The sensitivity of all five of these tools was generally strong, ranging from 70% to 95% when tested by the development authors, and appeared to remain stable, ranging from 72% to 91% for the fall risk assessment tool tested by other researchers in different settings. High sensitivity indicates that most of the people who fell were identified as high risk by the risk assessment tool.

The specificity of these tools was weaker, particularly when testing had occurred by researchers other than those who developed the risk assessment tool. Specificity ranged from 38% to 88% when measured by the primary development authors and from 29% to 54% for the fall risk assessment tool tested by other researchers. The specificity is a measure of the proportion of people who didn't fall who were identified as low risk by the risk assessment tool. The moderate specificity of these risk assessment tools is of concern when evaluating the clinical utility of such tools because too many patients who do not fall are identified as high risk. This has implications for the implementation of fall prevention interventions that are targeted at those at high risk (O'Connell & Myers, 2001).

There were strengths and weaknesses in the methodologies used in the four case control studies that impact on the validity of the results. Hendrich et al. (1995) used a retrospective chart review of all patients who fell in a one month period (n=102) and compared them with a randomly selected sample of non-fallers hospitalised in the same month (n=236). The authors collected data on 22 risk factors found to be significant in the literature or identified in the clinical setting. These risk factors were a diagnosis of cancer, orthopaedic disease, cardiovascular disease or clinical depression, being 24 hours post surgery, confusion, decreased mobility, dizziness/vertigo, presence of foley catheter, generalised weakness, history of falls within three months, intravenous line in place, impaired speech, hearing or vision, incontinence, altered level of consciousness, nocturia, sleeplessness, syncope, temperature elevation, urinary frequency/urgency and walking aids/devices.

Patient charts were reviewed for risk factors present on admission and for the cases (fallers), risk factors present in the 24 hours preceding the fall, and for controls (non fallers), risk factors present at the mid point of length of stay. Logistic regression was then used to identify significant predictors. The main strengths of this study were that the risk factors used for data collection were identified from statistically significant factors found in the literature and that the controls were selected on a random basis from the population that gave rise to the cases. The weakness of this study was that retrospective chart review was used for data collection and therefore it is difficult to ascertain if the charts contained complete and accurate information on the risk factors of interest. This has the potential to underestimate or overestimate the presence of risk factors and therefore the differences between the two groups.

Morse (1986) gives no information about how the risk factors used for data collection were identified in her study. The study used a retrospective chart review of 100 patients who fell and 100 randomly selected non-fallers to identify the presence of risk factors. No further information is given on how the non-fallers were selected. A strength of this study was that the chart audit was supplemented by patient examinations and observation of the environment to verify or add information missing from the charts. Risk factors that were compared included age, length of hospitalisation, history of falling, secondary diagnosis, mental status, skin turgor, respirator use, pulse rate, pain, nocturia with urgency, IV therapy, vision, gait, walking aids, side rails, gender, primary diagnosis, height, weight, diarrhoea, vomiting, bowel sounds, haemoglobin and orthostatic hypotension. Discriminant analysis was then used to identify statistically significant variables between the two groups, which were history of falling, secondary diagnosis, ambulatory aids, intravenous therapy, gait and mental status.

Schmid (1990) also used a case control methodology to identify significant risk factors between patients who fell (n= 102) and non-fallers (n=102) matched on age within five years and length of stay within seven days. The reason for this matching is unclear and is a major weakness of the study as both age and length of stay are included in the literature review of the study as significant risk factors for falls. Again data collection was retrospective, limiting the completeness and accuracy of the data. Risk factors that were assessed appeared to be based on a literature review although insufficient information was provided in the article. These risk factors were mobility, mental state, elimination pattern, prior fall history, current medications, depression, sleeplessness, general weakness, hearing or vision impairment, and diagnosis. Risk factors that were retained in the resultant risk assessment tool were mobility, mental state, elimination, prior fall history and medications.

The study by Oliver et al. (1997) had some major methodological problems which creates serious doubts over the validity of the findings and particularly the specificity and sensitivity calculations. The authors examined all falls that occurred over a three month period, and included repeat fallers as a new case each time they fell, thus introducing repeat measures into the fallers section of the data base. The authors then used a patient in the next bed who had not fallen as a control for the case. If this patient then went on to fall new information was collected on them and they were included in the faller database as a new case, as well as remaining in the control database as a non-faller. This introduced paired sampling into the database. Analysis for significant factors was then conducted as if the two groups were independent, and did not take into account the influence of repeated or paired measures. This bias may have led to an over or under estimation of the importance of some risk factors. The study was criticised on similar grounds by Altman (1997).

Additionally, Oliver and colleagues (1997) give little information on how the risk factors used in the data collection process were identified, the only note being that the authors examined factors that could be easily identified by nurses. Factors included in the data collection process were age, Barthel index score, transfer and mobility score (from the Barthel index), mental test score, walking aid, catheter or drip, prior fall history, medications, agitation, toileting, visual, hearing or language impairment, and gait. Factors that were retained in the final risk assessment tool were prior fall history, agitation, visual impairment, toileting and Barthel's transfer and mobility score.

The most rigorous methodology was used in a cohort study conducted by Price et al. (1998). Risk factors were assessed prospectively for all patients (N=154) admitted over a three month period ensuring a higher level of completeness and accuracy of data collection. Of these admissions, 29 patients fell. Data were collected on agitation, temporal or spatial disorientation, toileting difficulties, mobility with/without supervision, medical history of hip fracture, stroke or Parkinson's disease, prior fall history, and vision. Significant variables were identified as medical history of a broken hip, stroke or Parkinson's disease, history of falling within the past month, supervision needed for mobility and poor eyesight, with the presence of at least two of these risk factors indicating a higher risk of falling. Unfortunately the study is only described in a one-page article, and is more a risk assessment method than a tool. No information is given about how to use the method in the clinical setting. There were no follow up articles that could be found in the literature.

As can be seen from this discussion, even the best of the fall risk assessment tools have shortcomings that limit the validity of the findings. The most important issue identified from the literature review was that no matter how the risk assessment tools had been developed, testing for accuracy had been limited. This makes it difficult for clinicians or researchers to know which tool may be accurate enough to use in the clinical setting as part of fall prevention programmes or research.

Another important issue identified from the literature review was the impact of confounders on accuracy calculations. There are two related but slightly different confounding variables that have the potential to impact on accuracy testing of fall risk assessment tools. These are treatment paradox and ward fall prevention measures. The potential for bias occurs because fall risk assessment tools are used to predict a later event, that is, a fall. There is therefore a period of time in which interventions may be implemented which prevent falls. This may compromise the predictive value of the fall risk assessment tools and limit their utility as screening tools. Treatment paradox occurs when ward staff are aware of the risk assessment scores and therefore implement fall prevention measures for high risk patients and not for low risk patients. To counter this it is important for ward staff to remain blind to the results of the risk assessments (NHMRC, 1999).

Even if ward staff are blind to the research risk assessments it is likely that some type of fall prevention protocol is in place in the ward environment. Falls may therefore be prevented by normal ward practices. This issue is difficult to counter as it would be unethical to ask ward staff not to implement fall prevention measures. This influence therefore needs to be accounted for within the research design.

There were 13 studies included in the literature review (see Table 1) where the accuracy of the fall risk assessment tool was tested. Issues of confounding were often not discussed and only one of the studies provided any evidence of the impact of confounding (Bakarich, MacMillan, & Prosser, 1997). However, in this study the information was not discussed within the context of confounding but was provided for a different purpose. Table 2 lists confounding identified within these 13 studies.

Table 2

Confounding Variables in Fall Risk Assessment Tool Studies that Tested for Accuracy

Article	Key No	Were ward staff blind to the research risk assessments	Treatment paradox present (Interventions implemented specifically for high risk patients identified by the study protocol)	Usual ward fall prevention measures in place	Influence of confounding variables discussed in article	Data collected to allow an assessment of confounding
Hendrich et al. (1995)	9	N/A (retrospective study)	N/A	Unknown	No	No
Morse (1986)	10	N/A (retrospective study)	N/A	Unknown	No	No
Schmid (1990)	11	No (nurse rated risk)	Unknown, but potential for	Unknown	Yes	No
Morse et al. (1989)	12	No (nurse rated risk)	Yes	Unknown	Yes	No
McCollam (1995)	15	No (nurse rated risk)	Yes	Unknown	No	No
Bakarich, McMillan & Prosser (1997)	17	No (nurse rated risk)	Yes	Unknown	No	No, but did find a significant decrease in falls between high risk group who had interventions implemented and those who didn't
Oliver et al. (1997)	20	A: Yes (researcher rated risk)	No	Unknown	Yes	No
		B: No (nurse rated risk)	Asked nurses not to intervene based on risk assessments	Yes		
Eagle et al. (1999)	22	Yes (researcher rated risk)	No	Yes	No	No

Article	Key No	Were ward staff blind to the research risk assessments	Treatment paradox present (Interventions implemented specifically for high risk patients identified by the study protocol)	Usual ward fall prevention measures in place	Influence of confounding variables discussed in article	Data collected to allow an assessment of confounding
Conley, Schultz & Selvin (1999)	23	No (nurse rated risk)	Unknown	Unknown	No	No
Price et al. (1998)	26	Unknown	Unknown	Unknown	No	No
MacAvoy, Skinner & Hines (1996)	37	No (nurse rated risk)	Yes	Yes	Yes	No
Nyberg & Gustafson (1996)	38	Unknown	Unknown	Unknown	No	No
Moore, Martin & Stonehouse (1996)	247	Yes (researcher rated risk)	No	Yes	Yes	No

Key No = Endnote reference number: provides a connection to the references listed in Table 1

The domains of the risk assessment tools included in this review are listed in Table 3. Only tools that were listed as primary development in Table 1 are included in Table 3 (apart from the one tool where a primary development article did not exist), to ensure that domains are not over represented. A total of 32 fall risk assessment tools are included in the table. The number used in the column heading relates to a specific risk assessment tool and correlates with the numbers used in Table 1. Domains are listed in frequency order with the most commonly occurring domain at the top of the table.

Table 3
Summary of Domains Included in Fall Risk Assessment Tools

Key No	235	34	4	28	16	24	35	36	19	10	2	13	7	30	8	11	5	29	31	32	27	18	9	25	277	21	17	20	26	93	45	23
Mental State	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X
Gait/ Mobility	X	X	X		X		X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Prior Fall History		X	X		X		X		X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X		X	X	X	X	X
Medications			X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X		X	X	X				X	X	
Elimination			X	X			X	X	X			X	X	X	X	X			X	X		X	X	X		X		X			X	
Vision		X	X		X						X	X			X		X	X	X		X	X		X	X	X		X	X	X		
Specific Diagnosis or Multiple Diagnoses	X	X	X						X	X			X	X				X		X		X	X						X	X		
Continence									X				X		X				X	X		X	X	X		X					X	X
Age	X			X	X		X	X				X		X	X				X	X						X						
Hearing			X		X						X	X					X	X				X		X	X	X						
Mood									X				X	X			X		X	X			X					X			X	X
Dizziness/ Blackouts			X		X				X				X					X		X			X	X							X	
Weakness					X						X	X	X					X	X				X			X					X	
Blood Pressure			X						X			X		X	X					X				X							X	
Ambulatory Devices					X	X				X	X					X								X	X	X						
Other Sensory Functions							X		X		X									X					X	X				X		
Balance	X				X						X				X		X													X		
Language/ Communication Barriers		X					X				X	X						X				X										

Key No	235	34	4	28	16	24	35	36	19	10	2	13	7	30	8	11	5	29	31	32	27	18	9	25	277	21	17	20	26	93	45	23
Personality Factors		X	X						X			X					X			X												
Post-op		X			X				X									X								X						
Seizures					X				X									X						X		X						
Physical Disabilities		X	X		X						X																					
Length of Stay				X				X						X	X																	
Unsafe Footwear		X	X									X																				
Equipment														X						X				X								
Environment Changes		X			X																											
Drugs/ Alcohol		X																X														
Sex				X																						X						
Time of Hospitalisation						X														X												
Sleeplessness													X					X														
Protective Factors						X													X													
Knowledge Level			X																													
Restraints					X																											
IV Therapy										X																						
No of Unit Transfers						X																										
Type of Admission								X																								
Temperature													X																			

x Indicates domain is included in the risk assessment tool

Key No: Endnote reference number: Provides a link to the references listed in Table 1

The tools contain many common domains with the most popular being mental state (n=29), gait/mobility (n=27), prior fall history (n=25), and medications (n=22). Moderately popular domains included elimination (n=18), vision (n=17), diagnosis (n=13), continence (n=11), age (n=11), hearing (n=10), and mood (n=10). These domains echo the fall risk factors identified in the literature.

In conclusion, the findings from this literature review show that although many fall risk assessment tools have been developed few have been tested for accuracy. In studies where the accuracy of tools had been tested this had usually been done by the developers of the tool in the same population that the tool was developed in, limiting the generalisability of the findings. The one tool that had been tested by other researchers in different clinical settings showed a decrease in specificity when tested outside the development population (Eagle, et al., 1999; McCollam, 1995; Morse, 1986; O'Connell & Myers, 2001). This indicates that current fall risk assessment tools may have limited clinical utility when used outside the original population. This is of concern to researchers and clinicians wanting to use fall risk assessment tools as part of fall prevention programmes. Of importance is the need to conduct further testing of current risk assessment tools in a variety of clinical settings to establish the accuracy of such tools for general use.

If such tools are found to be inaccurate, further development of new fall risk assessment tools is required. Researchers who wish to develop new fall risk assessment tools should learn from the methodological deficits identified in the development of current fall risk assessment tools in order to ensure increased rigour and therefore increased validity of findings. It is particularly important to ensure that ward staff are blind to the results of the researchers' risk assessments in order to prevent treatment paradox. Furthermore, data must be collected on the usual fall prevention measures in place on the ward to investigate the influence of this confounder. Newly developed fall risk assessment tools should be rigorously assessed in as many clinical settings as possible.

Nurses' Clinical Judgement

An alternative area of examination in relation to the development of fall risk assessment tools may lie in nurses' clinical judgement. This area is explored below. The following review of literature on nurses' clinical judgement is divided into two sections. The first section discusses the process of decision making focusing on theoretical frameworks that underpin studies on nurses' clinical judgement. The second section discusses studies that have examined clinical judgement and fall risk assessment.

There are many terms in the literature that are used interchangeably with clinical judgement including clinical decision making, clinical reasoning, clinical inference, diagnostic reasoning, and problem solving (Greenwood, 1998; Hamers, Abu-Saad, & Halfens, 1994; Thompson, 1999). These terms are therefore used interchangeably within this review. Due to the large amount of literature available on nurses' clinical judgement, the number of terms used to define clinical judgement, and the difficulty of narrowing the search focus within the electronic databases, literature on nurses' clinical judgement was obtained through a structured search process which covered the years 1978 to 2001. This involved identification of key articles in regard to nurses' clinical decision making, search of reference lists of key articles, and a hand search of current journals.

Just as there are many terms used to denote clinical judgement there are also many definitions used to describe these terms. A useful definition of nurses' clinical judgement provided by Greenwood (1998, p110) is "the mental activities and processes which allow nurses to collect, store, retrieve and use information in clinical practice". In simpler terms Luker and Kenrick (1992, p 458) define nurses' clinical judgement as the process by which "nursing knowledge is operationalized". Broadening the definition, both Thompson (1999) and Hamers, Abu-Saad, and Halfens (1994) view that clinical judgement is both the process of decision making and the outcome of this process. These definitions emphasise that clinical judgement occurs in the process of the nurse delivering care to the patient, thus it is goal oriented and context bound.

Theoretical Frameworks About Clinical Decision Making

Historically, literature discussing theoretical frameworks about nurses' clinical decision making has revolved around the dialectical opposition of intuition versus reason (Greenwood, 1998). Recently a new theoretical framework, which incorporates these two opposing poles, has been proposed for adoption (Thompson, 1999). This theory progression follows the typical triadic structure (adapted from Hegel) of thesis, antithesis, synthesis, in which a thesis is proposed and found to be incomplete, leading to the proposal of an antithesis, which is also found to be incomplete. The incompleteness of both the thesis and antithesis leads to a synthesis of the two into a unified whole. As is common in nursing these theoretical frameworks are drawn from a variety of disciplines emphasising the eclectic nature of nursing theory development. Whatever the time frame in which these ideas were developed outside the discipline of nursing, their adoption within the discipline appears to have proceeded in a temporal fashion.

The dominant theoretical approach for examining nursing decision making up until the 1980s was that of reason (thesis) (Greenwood, 1998; Thompson, 1999). This dominance continued until the work of Patricia Benner in the early 1980s provided the antithesis (intuition) and a new theoretical direction. Finally, recent work by Thompson (1999) and Harbison (2001) has sought to introduce the idea of the cognitive continuum (synthesis) into the theoretical debate.

Table 4 summarises the main attributes of the thesis and antithesis as they relate to theoretical frameworks about nurses' clinical judgement. Greenwood (1998) asserted that the primary difference between the two is that theories based on reason seek to explore what and how the person thinks whereas theories based on intuition seek to explore the person's experience of thinking.

Table 4

Attributes of the Thesis and Antithesis

Thesis (Reason)	Antithesis (Intuition)
Rationalist (Greenwood, 1998)	Phenomenological (Greenwood, 1998)
Privileges reason over experience (Greenwood, 1998)	Privileges subjective experience over reason (Greenwood, 1998)
Systematic positivist approach (Thompson, 1999)	Intuitive humanistic approach (Thompson, 1999)
Hypothetico-deductive process (Thompson, 1999)	
Theoretical knowledge (Benner, 1984)	Experiential (practical) knowledge (Benner, 1984)
"Know that" knowledge (Benner, 1984; Greenwood, 1998)	"Know how" knowledge (Benner, 1984; Greenwood, 1998)
Science of nursing (Carper, 1978)	Art of nursing (Carper, 1978)
Empirics (Carper, 1978)	Esthetics (Carper, 1978)
Evaluative (Carper, 1978)	Generative (Carper, 1978)
Recognition (Carper, 1978)	Empathy (Carper, 1978)

A brief word on the nursing process

Tanner (2000, p338) claimed that many nurse academics view the nursing process as "synonymous with clinical decision making and clinical judgement" and therefore use the nursing process to teach nursing students about clinical decision making. For example, Hamers, Abu-Saad and Halfens (1994) presented the nursing process as a problem-solving process. Tanner (2000, p338) also claimed that the nursing process fails to "capture the thought processes used by either beginner or experienced nurses". This view is supported by O'Connell (1998) who found that the nursing process was not applied in the clinical setting. For these reasons the nursing process will not be discussed within this literature review as a theoretical framework of nurses' clinical decision making.

Thesis (reason)

What is now known as the Age of Reason or the Enlightenment arose in the 1700s in Europe and America due to discoveries in science. Ideas of the Enlightenment challenged the established religious order in which faith and the supremacy of the Church was the prevailing worldview. According to McClure (2002, p1) people subscribing to the power of reason during this time "revered the power of the mind to reason and to determine realities. They deprecated passions and emotions. They saw reason as the ruling principle of life and the key to progress and perfection". Thus began the struggle between science and faith in which many people were censured, imprisoned or killed for their views. Theoretical frameworks about human thinking and problem solving exemplify this struggle.

Reason or analysis is described by Hamm, (1988, p81) as "slow, conscious and consistent; it is usually quite accurate (though it occasionally produces large errors); and it is quite likely to combine information using organizing principles that are more complicated than simple 'averaging'". There are two main theoretical frameworks based on 'reason' that are discussed within the nursing literature. These are decision theory and information processing theory.

Decision theory. Decision theory is a collection of prescriptive models of decision making which attempt to describe how individuals should arrive at a diagnosis or choose interventions (Taylor, 2000). There are a number of approaches to decision theory, including the Brunswik's Lens Model, Bayes' Theorem and Decision Analysis (Utility Theory) (Taylor, 2000), however, Greenwood (1998) reported that Bayes' theorem had been the most influential in nursing. The various models that make up decision theory all use probability as the basis for decision making. The way in which probability theory has been applied to decision making is unique to each model and is discussed in more detail in the following sections.

Brunswik's Lens Model examines the manner in which clinicians use information to make judgements. In particular, the model can be used to determine the consistency and accuracy of these judgements. The lens in the model is the set of cues (which can be perceived) that are used by the clinician to infer the true state of the patient (which cannot be directly perceived). The set of cues are related probabilistically to both the judgement of the clinician (the estimate) and the patient (the criterion) (Elstein & Bordage, 1988; Taylor, 2000). Because the judgement about a diagnosis or treatment plan is an inference there is a potential for error. The performance of the clinician can therefore be modelled mathematically using multiple linear regression equations. These regression equations can also be used to generate predictions about a patient's state (Elstein & Bordage, 1988). This theory was applied to nursing by Hammond (1964).

Bayes' Theorem was developed by Thomas Bayes in the eighteenth century and has been influential in both nursing and medical studies of clinical judgement. Bayes' Theorem is a statistical model for calculating how new information impacts on prior clinical judgements by considering relationships between prior, conditional and posterior probabilities (Greenwood, 1998; Taylor, 2000). The prior probability is the probability that an hypothesis is true without considering the evidence or cues (also known as the unconditional probability). The conditional probability is the probability that a cue is accurate given the hypothesis and the posterior probability is the probability that the cue is accurate without considering the hypothesis (Greenwood, 1998; Taylor, 2000).

Put simply, Bayes' theorem gives an estimation of the probability that a clinician will change their original hypothesis about a patient's problem based on new evidence that comes to the clinician's attention. The likelihood that an adjustment of the original hypothesis will occur depends on how much the clinician believes that the new evidence relates to the assumed problem. For example, if the new evidence is viewed by the clinician as unrelated to the original hypothesis the new information is more likely to be dismissed as irrelevant and the original hypothesis will not be adjusted (Greenwood, 1998; Thompson, 1999).

Decision analysis describes how decisions are made and actions are chosen under conditions of uncertainty or risk by assigning values to possible outcomes from the chosen actions (Corcoran, 1986; Taylor, 2000). These actions and outcomes can be represented using a decision tree (Corcoran, 1986; Greenwood, 1998). Corcoran (1986) describes the process of decision analysis as (1) structure a decision flow diagram (2) assign values to each set of possible outcomes (3) assign probabilities to chance events and (4) average out and fold back.

A decision flow diagram is constructed by pictorially representing the series of choices in a chronological fashion including events that are controlled by chance and the possible outcomes from each choice. Each decision or chance event is designated by a 'fork' or 'branch' in the decision tree. Assigning values to each possible outcome involves ranking the outcomes in order of preference and assigning a value between zero and one hundred according to this ranking. Assigning probabilities involves determining how likely it is that a chance event will occur and assigning probabilities from zero to one where the sum of probabilities assigned to each fork equals one. Averaging out and folding back is the process used to decide the best course of action and is a mathematical process involving manipulation of the probabilities and assigned values (Corcoran, 1986). Decision analysis is a complicated process requiring focused thinking on the part of the clinician.

Information processing theory. Information processing theory in relation to human problem solving was developed by Newell and Simon (1972), and was built on theoretical work undertaken in the fields of psychology and computer science. This descriptive theory views humans as "processors of information" and describes (and is therefore limited to) how people process "task oriented symbolic information" (Newell & Simon, 1972, p5), thus its popularity in studies of clinical judgement. The theory is limited to the study of performance, that is, someone who is performing a task as opposed to someone who is learning to perform a task, or someone who is developing with respect to a task. This implies that, in the clinical setting, the framework is applicable to studies of experts and may not be valid if extended to studies of novices or students. Additionally, sensory and motor skills or motivational and 'personality' variables are not included within the framework. Information processing theory is a mechanistic, reductionist theory that describes the process of human problem solving as a behavioural act. The model was applied to the study of individuals performing in specific task situations.

As part of information processing theory Newell and Simon (1972) outlined the Information Processing System (Figure 1). The elements within the Information Processing System are described by in a reasonably complex manner however the main elements are:

1. Receptors and effectors are the inputs and outputs of the system,
2. The memory stores symbol structures (symbols connected by a set of relationships),
3. An information process is a process that has symbol structures for some of its inputs or outputs, and
4. A processor consists of:
   a) A (fixed) set of Elementary Information Processes,
   b) A Short Term Memory that holds the symbol structures of the Elementary Information Processes, and
   c) An interpreter that determines the sequence of Elementary Information Processes to be executed by the Information Processing System.

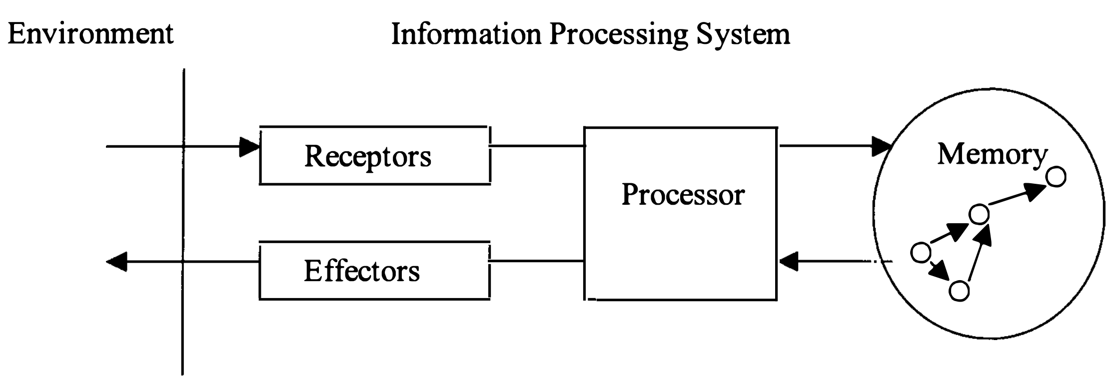

Figure 1

General structure of an information processing system (from Newell & Simon, 1972)

In this description symbols are "patterns that can be compared by the Information Processing System and judged (to be) equal or different" (Newell & Simon, 1972, p23). They are also described as instances or occurrences and are representations of objects and experiences in the environment, or ideas and processes. Elementary information processes are fundamental 'programs' used by the Information Processing System to process symbol structures. When combined together within the Information

Processing System these elementary processes constitute problem solving. Elementary Information Processes include tests and comparisons, for example, determining whether two symbols belong to the same group, symbol creation, and storing symbol structures (Newell & Simon, 1972).

Greenwood (1998) describes information processing as a series of steps involving (a) receiving data from the senses (b) interpreting the data with the aid of stored knowledge (c) integrating interpretations with a goal (d) achieving the goal through appropriate actions and (e) monitoring performance through feedback. Greenwood (1998) views information processing as anticipatory (guided by motives, plans and goals), selective (processes what is important to the individual's purposes at the time) and constructive (knowledge is constructed from the interaction between what is currently perceived and what is already known).

The task environment is another important concept discussed within the theory. Task environment is described as "a constraint on the behaviour of the problem solver" which occurs because the nature of the problem (that is, the task environment) demands that a problem be solved in a certain way (Newell & Simon, 1972, p79). In other words people exhibit "the behaviour demanded by the situation" when they are in goal oriented problem solving situations and this behaviour is usually rational and adaptive (Newell & Simon, 1972, p53). The authors maintain that the study of behaviour where the subject is motivated toward achieving a goal will either provide information about the task environment or about the psychology of the subject. For example, if the behaviour is what is expected in the situation, this provides information about the task environment whereas if the behaviour is unexpected this provides information about the psychology of the person. Therefore any analysis of human problem solving must include a discussion of the specific task environment and its influence on problem solving behaviour.

Information processing theory has been highly influential in studies of both medical and nursing clinical decision making (Hamers, Abu-Saad & Halfens, 1994). The theory has been adapted by Elstein, Shulman and Sprafka (1978) into a four stage model that includes cue acquisition, hypothesis generation, cue interpretation and hypothesis evaluation. Several authors have suggested that information processing is the model that provides the basis for many nursing studies on clinical decision making (Greenwood, 1998; Junnola, Eriksson, Salantera & Lauri, 2002; Thompson, 1999).

Applying information processing theory directly to nursing, Junnola and colleagues (2002) describe two phases. The first is the diagnostic phase, which includes data collection and processing and identification of problems. The second is the management phase in which nursing interventions are developed, implemented and evaluated (S. Salantera, personal communication, April 17, 2002,).

Although most authors describe information processing theory as belonging to the rationalist approach (for example, Thompson, 1999) Greenwood (1998) argues that information processing system models are neither rationalist nor phenomenological as they privilege reason and experience equally.

The limitations (incompleteness) of reason

A major limitation of reason as a problem solving mechanism, particularly as applied to information processing theory, is the concept of bounded rationality (Elstein & Bordage, 1988). This concept describes human information processing ability as limited, in that people can only attend to a certain amount of information at any one time. This is mainly the result of the disparity between the capacity of the working memory as opposed to the long term memory, meaning that only a small portion of what we know can be worked with at any one time. Because of bounded rationality information has to be simplified and condensed into categories, or averaged, attention to stimuli or data is selective and much of the sub processing is automatic (Elstein & Bordage, 1988; Greenwood, 1998; Hamm, 1988). As can be seen by this description the limitations of the short term memory challenge the information processing theory and begin to describe a problem solving process more akin to intuition than reason.

A criticism levelled at decision theory is that the models are prescriptive rather than descriptive. This means that the models may describe how to improve clinical judgement but they do not describe the reality of how clinical judgements are arrived at in the clinical setting (Hamers, Abu-Saad & Halfens, 1994; Thompson, 1999). The same criticism has also been applied to information processing theory. This lack of theoretical fit with clinical realities leads to the development of the antithesis as an alternative theoretical explanation for the 'real world' process of clinical decision making (Thompson, 1999).

Antithesis (intuition)

> … the renewed and intense concentration on the rational element which started in the seventeenth century had an unexpected effect. Reason began, abruptly, to separate itself from and to outdistance the other more or less recognised human characteristics – spirit, appetite, faith and emotion, but also intuition, will and, most important, experience. This gradual encroachment on the foreground continues today. It has reached a degree of imbalance so extreme that the mythological importance of reason obscures all else and has driven the other elements into the marginal frontiers of doubtful respectability (Saul, 1993, p15).

Intuition has been described by Hamm, (1988, p81) as involving "rapid, unconscious data processing that combines the available information by 'averaging' it, has low consistency, and is moderately accurate". Benner (1984, pxviii) describes intuition in problem identification as beginning with "vague hunches and global assessments that initially bypass critical analysis" and reports that nurses describe it as "gut feeling" or a "feeling that things are not quite right". Hamm (1988) asserts that the processes underlying intuitive thinking are not based on symbols as explicated by Newell and Simon (1972) which is why information processing theory cannot be used to explain intuitive thinking. There is one major theoretical framework reported in the nursing literature that is based on intuition and this is skills acquisition theory.

Skills acquisition theory. Skills acquisition theory was originally developed by the Dreyfus brothers (one of whom was a mathematician and system analyst and one of whom was a philosopher) in the late 1970s and applied to nursing by Patricia Benner (1984). The theory views human performance as the attainment of levels of skill. Five levels of skill are described within the theory, namely, novice, advanced beginner, competent, proficient and expert. Benner's (1984) research tested the Dreyfus model in nursing practice and attempted to articulate the way in which nurses move along the continuum from beginning to advanced practice and the way in which clinical knowledge is gained and clinical judgement developed.

In this model, practical experience is the basis for expertise. Differences in the process of problem solving can be attributed to the level of experience of the nurse. Benner (1984, p36) describes experience as "the refinement of preconceived notions and theory through encounters with many actual practice situations that add nuance or shades of differences to theory" rather than as length of time in the practice setting. The expert nurse uses intuitive processes as the basis for problem solving whereas the novice nurse has to use analytical processes because lack of experience prohibits them from accessing intuitive processes (Benner, 1984). Clearly, within this model intuition is privileged, and reason is seen as a clumsy 'second cousin' used by those with few other problem solving options.

Benner (1984) identified six types of practical knowledge used by expert nurses including (1) graded qualitative distinctions, (2) common meanings, (3) assumptions, expectations, and sets, (4) paradigm cases and personal knowledge, (5) maxims, and (6) unplanned practices. Graded qualitative distinctions are subtle changes in physiological cues, linked with the patients' history and current problem, which are recognised by expert nurses before they become apparent with usual measuring devices. Common meanings include the traditions and understandings of health and illness shared among nurses. Assumptions, expectations and sets are the preconceived ideas and actions that nurses build up about clinical situations based on prior experience within a particular working environment. Paradigm cases are clinical experiences that stand out for the nurse because they change the way the nurse perceives a situation by contradicting or extending prior personal knowledge. Maxims are "cryptic instructions that make sense only if the person already has a deep understanding of the situation" (Benner, 1984, p10). Unplanned practices are new roles or tasks delegated by other members of the health care team, which change perceptions because a new skill is developed.

To become an expert who uses these types of practical knowledge nurses progress through a series of development levels each with its own performance characteristics. At stage one is the novice who has no experience of the clinical situation and relies on objective measures and rules to drive the choice of actions. The knowledge that novices apply is context-free as they have little clinical (contextual) experience on which to base their decisions and nursing actions. The second stage is that of the advanced beginner who has some clinical experience and who is starting to recognise meaningful aspects of situations (Benner, 1984).

The third stage is that of the competent practitioner. Nurses at this stage have a few years of clinical experience and base their decisions and actions on long term goals and plans rather than on being solely reactive to immediate pressures. They are efficient and organised, however, they still lack the flexibility and speed of the expert nurse. The proficient nurse is at stage four and perceives the whole situation rather than isolated aspects by using maxims. Proficient nurses can recognise when a situation does not correspond to the expected picture and this improves their decision making. Finally, stage five, that of the expert nurse is achieved. Nurses at this level do not rely on analytical principles but rather use intuition to arrive at accurate judgments of a patient's situation. They know which cues to pay attention to and which cues to ignore and only use analytical processes when presented with a new situation or with a situation that does not progress as they expect it to (Benner, 1984).

In summary, the skills acquisition model views clinical judgement as an acquired skill that reaches its full potential only when rule governed behaviour is dropped in favour of intuitive judgement based on experience.

The limitations (incompleteness) of intuition

Benner's (1984) work has been extensively criticised on a number of grounds, most notably by English (1993) and Bradshaw (1995). Bradshaw (1995, p84) finds that there is a "philosophical incoherence" between the underlying epistemology of Benner's work, based on the philosophy of Heidegger, and the methodology and focus of the study. Bradshaw (1995) believes that Benner has misinterpreted Heidegger whose philosophy is focused on care of the self (self actualisation) providing no basis for interpreting care provided to others. This means that the nurse cannot interpret the meaning of health and illness for the patient.

Additional concerns are raised by English (1993), who argued that although Benner's (1984) work contains exemplars of expert nursing it does not clarify how an expert nurse is defined and whether 'expert' is a final stage or if there are different levels of experts. He claims this lack of definition makes it difficult to understand how the nurse moves from proficiency to expertise, leaving one with the impression that this conversion occurs on an almost mystical basis.

> The expert nurse is then presented as a blessed practitioner, initiated into the protected knowledge of some secret society, and forbidden or unable to divulge the rites of passage to the acolytes. Non-expert nurses might be excused their exasperation in asking just what they have to do to be admitted into the inner sanctum (English, 1993, p389).

The model has also been criticised on the grounds that intuition is not limited to expert nurses. English (1993) claims that Benner did not attempt to disprove her own hypothesis and that no attempt was made to ascertain if non-expert nurses also used intuition, and if so, whether this intuition was shown to be correct. Paley (1996) also argues that if intuition is to be defined as a faculty only used by experts then by definition this means that other people do not use intuition. This is clearly not the case as English (1993, p392) indicates "fellow patients are often capable of pointing out that there is 'something wrong' with some patient – are they experts"? Even more sarcastically Bradshaw (1995, p83) suggested that if the "highest form of knowledge" is that arising from lived experience then perhaps the patient is the best person to care for themselves as they have an intimate and intuitive understanding of their own situation.

Paley (1996) suggested that it may be more correct to conclude that expert nurses have a different quality to their intuitive judgements than do novice nurses, however, this would need to be empirically tested. This topic has in fact been researched. For example, King and Clark (2002) studied sixty one registered nurses who worked in four speciality surgical wards and two intensive care units. The authors found that nurses used intuition across all levels of nursing and that "the difference between expert and non-expert decision making appeared to lie not in the presence or absence of intuition, but rather in the expert's ability to use intuition much more skilfully and effectively" (King & Clark, 2002, p328).

Another criticism levelled at intuitive models of clinical decision making generally, is that the basis for decision making is unable to be communicated. This makes it almost impossible for others to understand how decisions were made or for novices to determine whether their interpretations of the experienced nurse's actions are correct. This limits the ability of the novice to learn from the experienced nurse (Lamond & Thompson, 2000; Thompson, 1999). In addition, because intuitive processes cannot be communicated if the outcome of an intuitive decision is sub-optimal it is difficult to examine the decision for the source of the error (Bradshaw, 1995; Lamond & Thompson, 2000).

These criticisms describe the incompleteness of intuition as an alternative theoretical framework for explaining the process of nurses' clinical decision making. This leads to the synthesis of the two opposing theoretical viewpoints into a coherent whole as described in the cognitive continuum theory.

Synthesis (cognitive continuum)

Thompson (1999) advocated the use of the cognitive continuum theory as the 'middle ground' between theoretical frameworks emphasising reason or intuition. This view was endorsed by Harbison (2001).

Cognitive continuum theory. The cognitive continuum theory was devised by a psychologist Kenneth Hammond and applied initially to medical decision making. Although much of Hammond's work is accessible through journal publications his original work on the cognitive continuum theory was published in reports that are no longer accessible. Information provided by Hamm (1998) who later worked with Hammond on the theory is therefore used in this discussion.

The theory describes cognition (thinking) on a continuum with analytical thinking on one end and intuitive thinking on the other end. Between these two poles are a range of modes of thinking which may have features intermediate between the two poles, a mixture of features from the two poles, or involve alternation between the two poles (Hamm, 1988).

The mode of thinking that is used when clinical decisions are made is not random and is determined by a number of factors. These include the type of task the decision maker is working on, the experience and knowledge level of the decision maker and the social and institutional context in which the decision is made. The accuracy of decision making is primarily related to the decision maker using the correct mode of thinking for the task at hand and therefore understanding the type of task structure involved is of major importance in the theory. Figure 2 illustrates the six modes of enquiry described in the theory and the relationship of task features to modes of enquiry (Hamm, 1988).

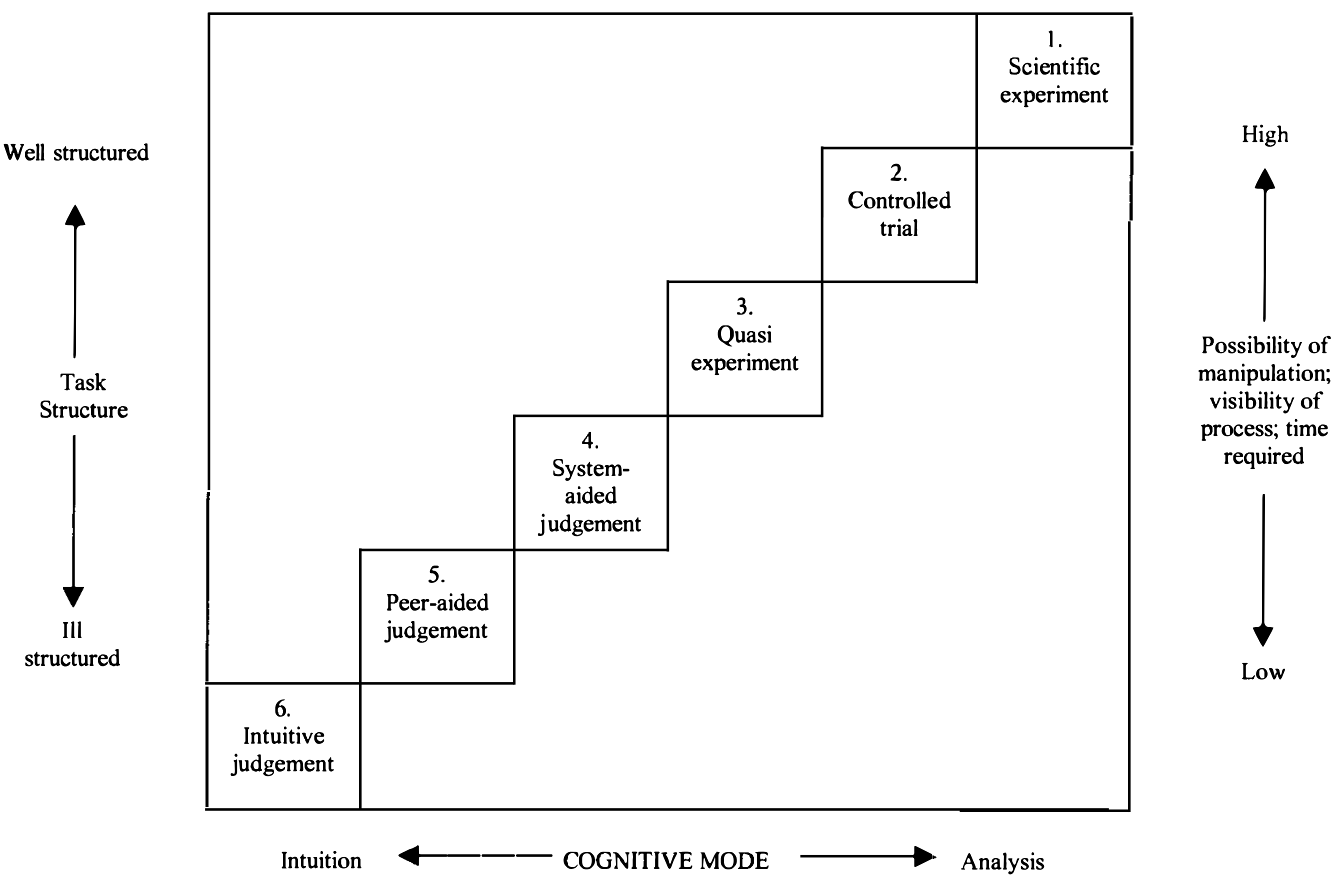

Figure 2

Cognitive continuum: the six modes of enquiry (Hamm, 1988).

Within the theory the inherent characteristics of the task induce a certain mode of cognition, either analytical or intuitive, although the decision maker may choose to use the alternative mode of cognition to solve the problem (Hamm, 1988). The features of tasks that lead to them being analysis-inducing or intuition-inducing include the complexity of the task structure, the ambiguity of the task content, and the form of the task presentation. Task features which induce certain modes of cognition are summarised in Table 5.

Table 5

Task Features and Modes of Cognition (Hamm, 1988)

Task Features	Characteristics	Type of Cognition
1. Complexity of the task structure		
a. Number of cues	Many pertinent cues	Intuition-inducing
b. Redundancy of cues	Much information	Intuition-inducing
c. Identity of the accurate organising principle	Simple linear weighted averaging organising principle is most accurate	Intuition-inducing
	Complicated procedure for combining evidence is most accurate	Analysis-inducing
2. Ambiguity of task content		
a. Availability of the organising principle	Complex organising principle readily available	Analysis-inducing
b. Familiarity of the task content	Unfamiliarity	Intuition-inducing
c. The possibility of high accuracy	Knowledge that it is possible to be highly accurate on a treatment or diagnostic selection task	Analysis-inducing
3. Form of task presentation		
a. Task decomposition	Task presented in a manner that guides the decision maker to address a series of subtasks	Analysis-inducing
b. Cue definition	Information presented pictorially	Intuition-inducing
	Cues measured objectively, presented in quantitative form	Analysis-inducing
c. Permitted or implied response time	Short time available	Intuition-inducing

The social and institutional context also influences the choice of mode of cognition that the decision maker uses. Social factors include the expectations of those around the decision maker, for example, other clinicians are less likely to accept intuitive thinking from junior staff, inducing junior staff to attempt to adopt more analytical modes of thinking. Institutional factors that can influence choice of cognition mode include type of staff education provided by the institution, kinds of information available, for example test results, and accessibility of tools, for example, computer databases and software (Hamm, 1988).

Another factor influencing mode of cognition is what the decision maker knows. If the decision maker does not know that there is an accepted procedure for dealing with a particular situation, then intuition will play a greater role in the decision making process. This aspect of the cognitive continuum theory is interesting when contrasted with the skills acquisition theory adopted by Benner (1984). In the skills acquisition theory, the more expert one is, that is, the more one knows, the more one is likely to use intuition for decision making, whereas within the cognitive continuum theory the more inexpert one is the more likely one is to use intuition. This illustrates the underlying difference between the two theories. Cognitive continuum theory attributes a change in mode of enquiry from analytical to intuitive thinking to differences in task characteristics whereas skills acquisition theory attributes these changes to the development of expertise (Hamm, 1988).

The two theories also differ in their views of the accuracy of clinical decision making. The skills acquisition theory views that better thinking is done by experts therefore intuitive thinking is more accurate. The cognitive continuum theory views that optimal accuracy can be achieved by choosing the right cognitive mode for the task at hand, therefore at times analytical thinking may be the most accurate and at other times intuitive thinking may be more accurate (Hamm, 1988). This is an area that requires further research.

In conclusion, there are a number of theoretical frameworks that have been used in the literature to inform studies of nurses' clinical judgement. These frameworks generally use either reason or intuition as the underlying model for explaining the process of nurses' decision making in the clinical setting. Examples of frameworks based on reason are decision theory and the information processing model. Skills acquisition theory is an example of a framework based on intuition. The cognitive continuum framework incorporates both reason and intuition within the model and offers an explanation for the types of circumstances in which either of these modes of thinking may be used.

Clinical Judgement and Fall Risk Assessment

Four studies were identified in the literature that examined nurses' clinical judgement and patient falls. Turkoski et al. (1997) conducted a qualitative study of clinical nursing judgement in relation to patient falls. The sample consisted of fourteen registered nurses working in rehabilitation. Data were collected using indepth semi-structured interviews. Data were analysed using content analysis and four themes were identified. These included why patients fall, identifying patients who are at risk of falling, preventing patient falls, and nurses' feelings about patient falls. Reasons why patients fall were identified by the nurses as confusion, reluctance to give up independence, trying to maintain positive relationships with nurses (not wanting to 'bother' nurses), medications, and tiredness or boredom. Although some of these factors are similar to those used in fall risk assessment tools others, such as trying to maintain positive relationships with nurses and boredom, have not been included in fall risk assessment tools and may be worthy of further exploration, using both qualitative and quantitative methodologies.

Nurses in the Turkoski et al. (1997) study discussed identifying patients at risk of falling by recognising specific clues from patients, for example, fidgeting and gaining information from patients' families and other staff. This recognition of specific clues was coupled with integrating specific knowledge about related factors, for example knowledge about the effects of ageing. Much of this clue recognition was based on intuition. Although not specifically stated in the study, processes used by nurses in identifying why patients fall illustrate two contrasting approaches. The first is an information processing approach, for example, integrating specific knowledge such as the known effects of ageing with specific patient cues. The second is an intuitive approach, for example, sensing "that a particular patient might try to do something they can't" (Turkoski et al., 1997, p128). Data from this study therefore, seem to support a cognitive continuum theoretical framework of clinical judgement in which both intuition and reason are used to reach clinical decisions, although the specific circumstances in which these two modes are used is not described.

The other three studies used quantitative methodologies to explore nurses' clinical judgement and fall risk assessment in conjunction with the testing of fall risk assessment tools. Results of testing are provided in Table 6.

Table 6

Nurses' Clinical Judgement in Predicting Fall Risk

Key No	Author	Sample Size for testing	Sensitivity	Specificity	PPV	NPV	Relia-bility	Accuracy
22	Eagle et al. (1999)	98	76%	49%	39%	83%		57%
45	Forrester, McCabe-Bender & Tiedeken (1999)	177					86%	
247	Moore, Martin & Stonehouse (1996)	39	40% 50%	60% 81%	33% 33%	67% 90%		

Key No: Endnote reference number: provides a link to studies in Table 1: PPV, Positive predictive value: NPV, Negative predictive value

Eagle et al. (1999) compared the ability of the Morse Fall Scale, the Functional Reach Test and nurses' clinical judgement to predict inpatient falls on a rehabilitation ward and a geriatric medical ward. A total of 98 patients were included in the study, 29 of whom had at least one fall during the study period. Nurses were asked to provide a clinical judgement about whether the patient was at risk of falling and to provide a rationale for this decision. Details of accuracy calculations are provided in Table 6. The authors found that the most useful rationales provided by nurses where the prediction was correct were prior fall history, walking with supervision, impulsive behaviours, aphasia, cognitive impairment, unwillingness to follow safety techniques, and poor balance. Impulsive behaviours and unwillingness to follow safety techniques are not constructs normally used in fall risk assessment tools and present new avenues for further research. The study found that nurses' clinical judgement was just as effective in predicting fall risk as either of the two tools tested in the study.

Forrester, McCabe-Bender and Tiedeken (1999) developed two risk assessment scales in addition to testing nurses' clinical judgement in predicting fall risk. Interestingly, the nurses who gave the clinical judgements were not the nurses who cared for the patients but a group of graduate nursing students enrolled in a Masters course. This group was the same group who collected the data for the fall risk assessment scales used in the study. It is not clear whether the student nurses completed the risk assessments before they gave the clinical judgement. The rationale for choosing this group to give the clinical judgements is not given in the article. The student nurses were asked to rate 177 patients' fall risk on a scale of one (low risk) to ten (high risk). Only 7 of these patients were found to have fallen. Inter-rater reliability when two student nurses assessed 42 patients was found to be .86. The clinical judgement mean score showed little variation between fallers and non-fallers and was 5.57 (SD= 2.80, N=152) for the total sample, 5.58 (SD= 2.80, n=145) for those who didn't fall and 5.43 (SD= 2.94, n=7) for those who did fall. The small sample size for fallers was a limiting factor in this study. No further calculations of the accuracy of nurses' clinical judgement were provided in the article.

A study by Moore, Martin and Stonehouse (1996) compared the accuracy of nurses' clinical judgement and a fall risk assessment tool. The researchers asked nurses for their risk assessments when the patients were admitted (N= 39) and then every week for the length of the patients' hospitalisation. Because of the repeated measures in this study the authors chose two time points for assessing the accuracy of nurses' clinical judgements, namely, the week when the most falls occurred and the admission assessments. Of concern in this study is that the authors determined the sensitivity and specificity using whether the patient fell for that week as the outcome measure, rather than whether the patient fell during hospitalisation. The risk assessment data should either have been collected at only one time point or the analysis should have used any subsequent fall during hospitalisation as the outcome measure for all the time periods.

The stability of fall risk assessments over time is an area of debate in the literature with some authors, for example Morse, Black, Oberle, and Donahue (1989) suggesting that fall risk fluctuates as the patients condition changes and therefore risk should be assessed on an ongoing basis. Other authors such as Price et al. (1998) have argued that a single admission risk assessment can be used to predict subsequent patient falls during the entire hospitalisation period and repeated assessments are not necessary. This is an area that requires further research as it may be useful to ascertain which fall risk factors are stable and which are transient and the influence that each has on the prediction of patient falls.

At present, there is limited research in the area of nurses' clinical judgement in relation to fall risk. Findings from the studies reviewed suggest that nurses' clinical judgement is at least as effective in predicting patient falls as the majority of fall risk assessment tools. Of interest is that in two of the studies nurses identified fall risk factors that were different from the factors usually identified in the fall risk literature. These included reluctance to give up independence, trying to maintain positive relationships with nurses (not wanting to 'bother' nurses), tiredness or boredom, impulsive behaviours, and unwillingness to follow safety techniques (Eagle et al., 1999; Turkoski et al., 1997). Further research into this area may prove useful in the identification of fall risk factors to improve the accuracy of risk assessment tools.

Conclusion and Justification for the Study

Falls are a major problem in acute care hospitals. There are numerous negative consequences for patients following a fall, ranging from psychological distress such as fear and anxiety to serious injury such as hip fracture and sometimes even death. There is a need to develop and implement fall prevention strategies, however, current best evidence is inconclusive on the best strategies for achieving this. A first step in implementing fall prevention programmes is to identify those patients most at risk of falling and therefore most in need of fall prevention interventions. Identification of high-risk patients allows clinical staff to target fall prevention interventions that may be costly or time consuming, at those most in need, in order to use resources effectively.

Currently fall risk assessment tools are not well validated and there is little evidence of the clinical utility of developed tools. Further research is needed to evaluate these tools in Australian acute care clinical settings. If a clinically useful risk assessment tool can be identified then this can be used as the basis for the development and evaluation of fall prevention programmes.

An emerging area of interest in fall prevention research is nurses' clinical judgement in relation to fall risk assessment and fall prevention. Nurses' clinical judgements about patients' fall risk may aid the development of fall prevention protocols and further research is warranted to build on limited knowledge in this area. Additionally, there is a need to ascertain whether nurses' clinical judgement can outperform risk assessment tools in predicting fall risk. This study will therefore focus on the testing of fall risk assessment tools and nurses' clinical judgement in predicting patient falls.

CHAPTER THREE
CONCEPTUAL FRAMEWORK

Study Variables

The variables within this study framework can be categorised into independent, dependent and confounding variables and are listed below.

Main Independent Variable

Risk assessment classification.

Other Independent Variables

Patient variables

- age,
- sex,
- length of stay (LOS) and
- FIM^{TM} Instrument Score

Nurse variables

- type/level of nurse
- years of nursing
- number of shifts caring for patient

Dependent Variables

Patient fall within admission.

Accuracy/ validity of risk assessment classifications

Confounding Variables

Ward fall prevention measures

Treatment paradox

Conceptual Model

The primary aim of this study was to assess the accuracy of two fall risk assessment tools and nurses' clinical judgement in predicting patient falls. Accuracy was determined by the extent to which the risk assessment methods correctly classified patients into the appropriate risk category. The relationships between the variables used to make this determination are illustrated diagrammatically in Figure 3. Patient characteristics are filtered by the fall risk assessment tools and nurses' clinical judgement into a risk classification of low or high risk for each patient. The risk classification given by nurses is also influenced by the characteristics of the nurse. These independent variables are related to the dependent variable of whether or not the patient fell, and ultimately to the accuracy of the fall risk assessment method. The shading indicates the expected association between the risk classification and whether the patient fell. The greater this association the more accurate the risk assessment method. Determinations of the accuracy of the fall risk assessment methods may be confounded by the fall prevention measures in place in the ward area. Data collection on this variable therefore also needs to be included in the research design.

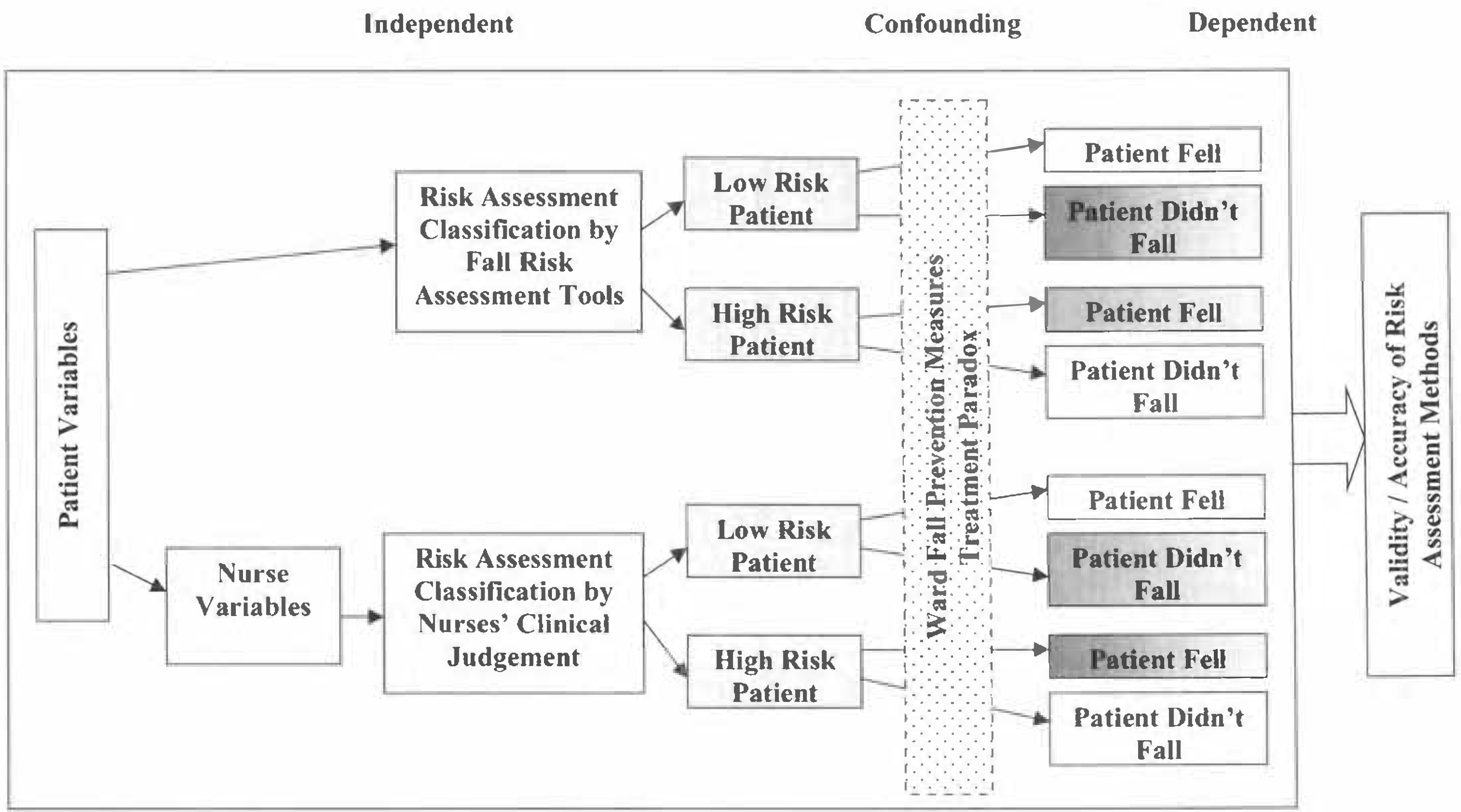

Figure 3

Relationship among the independent, dependent and confounding variables

CHAPTER FOUR

METHODS

Design, Sample and Setting

A prospective cohort study was used to evaluate the validity and reliability of selected fall risk assessment tools and nurses' clinical judgement in predicting patient falls. A descriptive qualitative study was undertaken concurrently, to collect information on the components of nurses' clinical judgements in relation to a patient's fall risk. The study wards comprised two aged care and rehabilitation wards within a 570 bed acute care tertiary teaching hospital facility in Western Australia. Fall risk data collection was completed on all consecutive admissions to the study wards over a fourteen week period. New admissions were excluded from the study if they had already been included in the study in a previous admission, therefore each patient only appeared once in the database. Data were collected at least one day after admission to allow time for clinical assessment data to be collected and entered in the notes and for nurses to become familiar with the patients.

Sample Size Calculations

Quantitative: To be clinically useful the risk assessment tool or clinical judgement needs to be capable of detecting a large (at least 50%) difference between those who are at risk of falling and those who are not at risk of falling. Therefore, to achieve 95% power at the 0.05 significance level, the sample size needs to be 41 in each group (that is, 41 fallers and 41 non-fallers). Based on previous research (O'Connell & Myers, (2001) on patient falls within the hospital, it was predicted that there would be 3-4 fallers per week on the study wards and the ratio of non-fallers to fallers would be 4:1. Therefore, if there were 41 fallers in the sample this would project to a sample size of 164 non-fallers or 205 in the total sample.

Qualitative: The sample size for this part of the study could not be predetermined as data collection would need to continue until saturation was reached.

Instruments

Fall Risk Assessment Tools

Two instruments were chosen for this study based on a literature review of fall risk assessment tools. These instruments were chosen for further testing because the domains assessed in the tool were consistent with the literature, the categories were formulated in a reasonably clear and measurable way, and the tool had a scoring system that could be used to determine whether the patient was at high risk for falls. Many tools could not be considered for testing purposes as the categories contained within the tools would have been difficult to operationalise due to their ambiguity. For example, one of the domains in the tool developed by Barbieri (1983) is patient's knowledge level, while a domain in the tool developed by Spellbring et al. (1988) is emotional upsets. Another reason that some of the tools were not chosen for testing purposes was that no scoring system was included with the tool, for example Fife, Solomon and Stanton (1984) and Hernandez and Miller (1986). This would have made it difficult to determine whether a patient was at high risk for falls.

The Morse Fall Scale developed by Janice Morse, is one of the more rigorously designed fall risk assessment tools, however, it was not chosen for this study as the researcher had already tested this tool in the same setting in a previous study. The Morse Fall Scale was found to have a sensitivity of 83%, a specificity of 29% and a positive predictive value of 18%, indicating that the scale was unable to discriminate between fallers and non-fallers in this setting (O'Connell & Myers, 2002).

Fall risk assessment tool 1 (Berryman, Gaskin, Jones, Tolley and MacMullen [1989] with revisions by MacAvoy, Skinner and Hines [1996])

This instrument was originally developed by Berrryman, Gaskin, Jones, Tolley and MacMullen (1989) through a retrospective audit of patient falls (N=1087) over an 18 month period in a 480 bed acute care hospital in America, in a geriatric patient population. The tool was then altered for use by MacAvoy, Skinner and Hines (1996) (without attribution) based on a literature review and intended for use with all patient types. The instrument was tested in an acute care hospital (N=44 falls) and found to have a sensitivity of 43% and a specificity of 70%. Positive and negative predictive values were not reported. The instrument contains nine items. The lowest possible score is zero and the highest possible score is twenty six. A score of ten or more identifies the patient as high risk for falls. The domains that are included in this tool are age, mental status (orientation), mental status (agitation, cooperation, anxiety), elimination, history of falling, sensory impairment, ambulation, types of medications and change in medications or dosages in the last five days. (see Appendix 2)

Fall risk assessment tool 2 (Schmid, 1990)

This instrument was developed through the use of a case control study comparing fallers (n=102) to non-fallers (n=102) in a 700 bed acute care hospital in America and designed for use with all patient population types. The instrument was then tested in the same setting with reported sensitivity of 95% and specificity of 66%, however, positive and negative predictive values were not given. The instrument contains five items. The lowest possible score is zero and the highest possible score is six. A score of three or more identifies the patient as high risk for falls. The domains included in the tool are ambulation, orientation, elimination, prior fall history and medications. (see Appendix 3)

Fall Risk Data Collection Form

The categories contained in the risk assessment tools were combined into a data collection form. Information on the patients' fall risk was entered on the data collection form. The information was then recoded back into the domains of each fall risk assessment tool for analysis (see Appendix 4). When developing the fall risk data collection form it was important to identify operational definitions for the components of the two fall risk assessment tools. Although the categories contained within the tools were reasonably clear and appeared to be measurable they still required some further definition to ensure that the data collected were consistent for all patients. Items were operationalised as follows.

Age: The patient identification sticker containing the date of birth was collected for each patient. The date of birth was then used to calculate the age of each patient at the time of admission to the ward.

Medications: The medications listed on the fall risk assessment tools were diuretics, 'sleepers', tranquilisers, antiseizure/ antiepileptics/ anticonvulsants, narcotics, chemotherapy, hypnotics, and psychotropics. In order to ensure consistency and completeness of data collection these medications were matched to the therapeutic classes listed in the E-MIMS^{R} version 4.00.0602 (MediMedia Australia Pty. Ltd., St Leonards, NSW, Australia) and the E-MIMS^{R} classes were then listed on the data collection form. Data were collected from the medication charts for each patient and names of prescribed medications were copied onto the data collection form. The researcher then used the E-MIMS^{R} to check if the prescribed medications were in the relevant therapeutic classes. The relationship between the medication types listed on the risk assessment tools and the E-MIMS^{R} are outlined in Table 7.

Table 7

Relationship of Medication Categories on the Fall Risk Assessment Tools and the E-MIMS^R

E-MIMS^R	FRAT1	FRAT2
2C: Diuretics (Cardiovascular System)	Diuretics	
3A: Sedatives/ Hypnotics (Central Nervous System)	Sleepers	Hypnotics/ Psychotropics
3B: Anti-anxiety Agents (Central Nervous System)	Tranquilisers	Tranquilisers/ Psychotropics
3C: Anti-psychotic Agents (Central Nervous System)	Tranquilisers	Tranquilisers/ Psychotropics
3D: Antidepressants (Central Nervous System)		Psychotropics
3G: Anticonvulsants (Central Nervous System)	Antiseizure/ Antiepileptics	Anticonvulsants
4A: Narcotic Analgesics	Narcotics	
9A-9F: Cytotoxic Agents (Neoplastic Disorders)	Chemotherapy	

FRAT1, Fall risk assessment tool 1: FRAT2, Fall risk assessment tool 2

A change in medications was recorded if a patient had any changes to their medication chart in the last five days. The medication that had been changed was noted. If there were no changes since admission even if this was less than five days ago this was recorded as no changes.

Prior Fall History: Two recording sections were included on the data collection form for prior fall history as the categories for each of the fall risk assessment tools were slightly different. There were several sources of data that needed to be checked for this category as this information was not recorded in a systematic way in the patient notes. Sources included the medical assessment on admission, the nursing assessment on admission, the ward fall risk assessment and falls care plan, the daily nursing care plan, and the daily patient notes. There was a potential for missed data with this category due to the lack of systematic recording of this information.

Sensory impairment: Visual impairment was defined as any visual problems such as blindness, glaucoma, or cataract or the need for visual aids such as glasses, or contact lenses. Hearing impairment was defined as any mention of the patient being deaf, partially deaf or the need for hearing aids. This information was not recorded in a systematic way and several sources of data needed to be checked. These sources included the medical and nursing admission assessments, and a visual check of the patient and their bedside area while retrieving patient notes. There was a potential for missing data with this category due to the lack of systematic recording of this information.

Mobility: Information on mobility was divided into two sections, the first was ambulation/gait and the second was assistance with ambulation/transfers. The information on ambulation/transfers was relatively easy to obtain from the patients' notes and was documented as ambulates/transfers without assistance, ambulates/transfers with the assistance of one person or an assistive device, and ambulates/transfers with the assistance of two people. Information on ambulation/gait was divided into three categories, patients who ambulated with no gait disturbance, patients who ambulated with an unsteady gait and patients who were unable to ambulate. Often this information was more difficult to obtain and assessment of gait was not always detailed in the patients' notes. In some cases it was difficult to ascertain from the notes whether a patient ambulated with no gait disturbance or with an unsteady gait. If this information was not explicitly stated in the notes a patient was assumed to have a gait disturbance if they ambulated/transferred with the assistance of one person or an assistive device and were assumed to have no gait disturbance if they ambulated/transferred without assistance.

Mental State: Information on a patient's mental state was divided into two sections. The first contained information on whether a patient was oriented, while the second section contained information on whether a patient was agitated, uncooperative or anxious. The first section was easy to complete as the patients' orientation was generally assessed and recorded in the patient notes on an ongoing basis. The second section was difficult to complete, as this information was not systematically recorded. It was assumed that if these three domains were not mentioned in the patient notes then these were not an issue for the patient as it is likely that problems such as these will be recorded if they are present and not documented if they are not present.

The other problem with operationalising this concept (agitated, uncooperative, anxious) was in deciding whether any of these problems if present were at a moderate or a severe level. This became a judgement call on the part of the researcher. If the issue was mentioned at least twice in the notes it was judged to be severe and if mentioned less than twice it was judged to be a moderate problem. This lack of systematic recording introduced the potential for missed information for this fall risk domain.

Elimination: The concept of elimination was operationalised in three sections on the data collection form. The first section was continence and patients were categorised as continent at all times, incontinent at all times or periodically incontinent. This information was often difficult to collect. Although a continence assessment was included in the nursing admission assessment and the nursing care plan the information was often not recorded. If this information was not included in the nursing documentation the multidisciplinary notes were searched for reference to continence. If no reference was made the patient was assumed to be continent.

The second section related to the need of the patient for assistance with elimination. This information was also difficult to collect, however, if a patient needed assistance with ambulation they were assumed to need assistance with elimination, for example to get to a toilet. The third section consisted of information about whether the patient had frequency, urgency, or diarrhoea, or had a catheter or ostomy. This information also was not recorded in a systematic way in the patient documentation. The patient was assumed not to have these problems if they were not mentioned in any documentation.

Fall Prevention Intervention Checklist

This checklist was developed by the researcher based on current fall prevention practice in the clinical area. Data were collected on whether the patient was on a fall risk care plan, whether a risk assessment was completed, the interventions identified on the care plan and if the patient had a fall risk sticker on their nursing notes. (see Appendix 5)

FIM™ Instrument

The FIM™ instrument is an 18-item instrument that assesses the severity of disability on a 7-point scale. The FIM™ instrument provides a uniform measure of disability and the outcomes of rehabilitation. The FIM™ instrument is administered by nurses on the ward and is initially done within 72 hours of the patients' admission to the wards and thereafter on a weekly basis. All ward staff receive training on using the FIM™ instrument. The FIM™ instrument has been extensively tested and has been found to be reliable (inter-rater, inter-modal, internal consistency) and to have face, construct and predictive validity (see Deutsch, Braun & Granger, 1996 for a full discussion).

The FIM™ instrument has two sub scales, motor and cognitive. The lowest possible score on the motor sub scale is 13 and the highest possible score is 91 with the midpoint at 52. The lowest possible score on the cognitive sub scale is 5 and the highest possible score is 35 with the midpoint at 20. For the entire scale the lowest possible score is 18 and the highest possible score is 126 with the midpoint at 72. The lower the score on any sub scale or on the FIM™ instrument as a whole, the greater the level of disability. (Copyright 1997 Uniform Data System for Medical Rehabilitation, a division of UB Foundation Activities, Inc. All rights reserved. Used with permission of UDS_{MR}, 232 Parker Hall, 3435 Main Street, Buffalo, NY 14214).

Procedure

Each new patient was assessed for fall risk by the clinical judgement of the nurse caring for the patient and by the researcher using the data collection form containing the two fall risk assessment tools. The data collection form allowed the researcher to collect data for both risk assessment tools simultaneously and ensured the same information was used for each assessment tool. The information used to complete the risk assessment tools was gained from a variety of sources depending on which source was the most appropriate for the data being collected. A full discussion of the data sources used to complete the risk assessment is contained in the description of the fall risk data collection form in the instruments section. The primary data sources were the patients' nursing and medical/multidisciplinary notes, using the most up to date entries. If a specific piece of information was not contained in the notes, or if contradictory information was present in the notes, the researcher asked the nurse who was caring for the patient to provide this information. For this reason there was no missing information in the database. Following data collection the information on the data collection form was recoded back into the domains of each of the risk assessment tools.

Patients were assessed one to seven days (mean 1.94 days) after admission to the study wards, depending on the availability of patient notes and the nurse caring for that patient. Nurses were not informed of the information on the data collection form prior to making a clinical judgement about the fall risk of patients. Nurses were asked to state whether the patient was a fall risk and also to rate the patients' fall risk on a scale of zero to ten, with zero being no risk and ten being the highest risk. Additional data collected from the nurse included how many times the nurse had cared for the patient and whether the nurse had previously completed a formalised fall risk assessment (as per ward care plan) on the patient.

All study patients were followed until the time of the first fall, discharge or death. Patient fall data were collected via the hospital accident/incident forms. Data were also collected on patient demographics and FIM™ instrument scores. The FIM™ instrument scores are routinely collected on the ward and each patient is assessed within 72 hours of admission and reassessed on a weekly basis. The admission scores were collected for this study.

Additionally a separate sample of twenty patients was utilised to conduct test retest reliability on the fall risk assessment tools and nurses' clinical judgement. The fall risk assessment data collection form was used to assess patients fall risk twice on two consecutive days (a time period of twenty four hours). Nurses caring for these patients were asked to provide a risk assessment and risk rating at the beginning and the end of a shift (a time period of five to six hours). It was impracticable to conduct the nurse test retest over a longer period due to shift changes and variations in patient allocation.

As the risk assessment tools are used to predict a later event (fall) there is the potential for confounding due to 'treatment paradox' (NHMRC, 1999). In other words, a fall may be prevented due to the fall prevention measures in place on the ward. If fall prevention measures are implemented for high risk patients and not for low risk patients and the measures are effective, this has the potential to affect the predictive value of the risk assessment. For this reason, ward staff remained blind to the risk assessment scores collected by the researcher. However, because fall prevention measures, including fall risk assessments, are routinely implemented in the ward environment where this study took place data on fall prevention strategies implemented for patients in the study were collected from a review of the patient's medical and nursing notes. A checklist was compiled for this purpose (see Appendix 5). This information was reviewed to ascertain if there were any systematic differences in the way in which high and low risk patients (according to the study risk assessments), or fallers and non fallers were treated in the ward environment.

Concurrently with the quantitative data collection, the nurse was asked to describe why the patient was/was not at risk of falling. This description was recorded on audiotape and transcribed for analysis. A total of 28 descriptions were collected. It was not possible to continue this aspect of the data collection due to limited resources and the amount of time it took to collect this information.

Data Analysis

Prior to data analysis the database was screened to ensure that all data were entered accurately. Data were analysed with SPSS^R for Windows version 10.1 (SPSS Inc., Chicago, IL, USA) using t-tests, chi square tests and descriptive statistics. All tests were two-tailed and the significance level was set at $p=.05$. A description of the specific data analysis methods used in this research is contained within the appropriate results sections.

Ethical Issues

Ethical approval to conduct this project was granted by the Sir Charles Gairdner Hospital Nursing Research Scientific Sub-Committee and the Sir Charles Gairdner Hospital Human Research Ethics Committee Trial number 2000-086 (see Appendix 6 and Appendix 7). Consent was not specifically sought from patients, as there were no invasive procedures used in the research process. The risk assessment tools were completed without contact with the patient. As the ward area already implements fall prevention measures the patient was not at greater risk of falling due to the conduct of this study. The main reason for not seeking consent from patients was that it was important that all patients be included in this study including confused patients who may be unable to give informed consent. Based on previous research conducted by the researcher in the same setting (O'Connell & Myers, 2001) it was likely that confused patients would be a high proportion of the fallers and it was important that they be included in the final sample to minimise bias.

Every effort was made to protect the identity of patients. The patient's UMRN and ID number were known only to the researcher and were stored separately in a locked area in the Centre for Nursing Research at Sir Charles Gairdner Hospital. The UMRN records were not entered into the computer database and were destroyed as soon as the data collection period had finished and all data linkage requirements had been fulfilled. This ensured that patient information stored in the computer database was de-identified.

Verbal consent was sought from nurses for the quantitative stage of the data collection process (that is, when they were asked to rate the fall risk of a patient). Nurses were asked for written consent for the qualitative data collection stage of this project (that is, when they were asked to describe why they thought a patient was/ was not at risk of falling) (see Appendix 8). Nurses were not identified by name in the conduct of this study.

All data were coded to ensure patient and nurse confidentiality. Paper records have been placed in locked storage in the Centre for Nursing Research at Sir Charles Gairdner Hospital and will be stored for a period of five years. Normal procedures for the storage of accident/incident report forms were followed. Access to electronic data is protected by a password known only to the researcher.

CHAPTER FIVE
RESULTS

Demographics

During the study period, 226 patients were assessed for fall risk. Of these, 34 patients fell, giving a period prevalence of fallers of 15%. Data were collected on number of patients who fell rather than on number of falls, so although some patients fell more than once only the first fall for each patient was included in the data collection and analysis. The mean age of patients was 84.91 (SD=8.53) with a minimum of 41 years and a maximum of 98 years. The majority of the sample were female (71.7%, n=162), with most of the sample either widowed (57.5%, n=130) or married (31.0%, n=70). The mean length of stay of patients was 29.13 days (SD=31.12) with a minimum length of stay of 1 day and a maximum length of stay of 218 days.

There were no significant differences between the mean age of patients who fell (85.50 years, SD=7.836) and patients who did not fall (84.80 years, SD=8.664) (t=-0.439, df=224, p=.661), or in the gender distribution of patients who fell and patients who did not fall (χ^2=0.321, df=1, p=.571). However, there was a significant difference in the mean length of stay between patients who fell (56.03 days, SD=34.192) and patients who did not fall (24.37 days, SD=28.058) (t= -5.859, df=224, p=.000).

FIM™ Instrument Data

Of the patients who were admitted to the study, 108 (47.8%) had a completed FIM™ instrument assessment. The reason for this low percentage is that the FIM™ instrument is administered by nurses on the ward and was often not completed as per the ward protocol, that is, within 72 hours of the patient's admission to the ward. The mean FIM™ instrument score for these patients was 82.39 points (SD=24.20) with a minimum of 18 points and a maximum of 120 points. The mean score on the motor sub scale was 56.25 points (SD=18.23) with a minimum of 13 points and a maximum of 85 points. On the cognitive sub scale the mean score was 26.14 points (SD=7.71) with a minimum of 5 points and a maximum of 35 points. In the sample who had a FIM™ instrument assessment completed there were 95 (88%) patients who did not fall and thirteen (12%) patients who fell. These results indicate that patients in the sample covered the full range of possible FIM™ instrument scores with the mean score slightly skewed toward higher functioning (on the entire scale and the two subscales).

The mean FIM™ instrument score of patients who fell (65.62, SD=26.33) was significantly lower than that of patients who did not fall (84.68, SD=23.11) (t=2.744, df=106, p= 007). The mean FIM™ instrument scores on the two sub scales were also significantly lower among patients who fell (motor sub scale 44.31, SD=18.48; cognitive sub scale 21.31, SD=9.01) compared with patients who did not fall (motor sub scale 57.88, SD=17.67; cognitive sub scale 26.80, SD=7.32) (motor sub scale t=2.585, df=106, p=.011; cognitive sub scale t=2.465, df=106, p=.015), indicating a higher level of disability on admission.

Fall Prevention Interventions

Standard procedure on the study wards was that all patients were assessed for fall risk using a tool derived from unknown origins and incorporated into a care plan. This risk assessment tool included the domains of mobility, assistance with activities of daily living, gait, continence, mental state, medications, previous falls, and other risk factors. The tool does not contain a scoring mechanism. If a patient was deemed to be at risk for falls (by having at least one risk factor) they were placed on a fall risk care plan by ward staff. The care plan contained a list of six core standards and sixteen additional standards that could be chosen and implemented by nursing staff as fall prevention strategies for that patient.

Of the 226 patients admitted to the study, 202 (89.4%) had a risk assessment completed on admission by ward staff and 199 (98.5%) of these were placed on a fall risk care plan. For patients on a fall risk care plan only twenty seven percent (n=54) had either core or additional standards identified as interventions. The most common interventions implemented for these patients were the core standards (94.5%, n=51). The six core standards were a) educate patient and involve patient in decisions regarding safety, safety precautions and factors impacting on safety, b) orient patient to environment, c) call bell within easy reach at all times, d) ensure adequate lighting at all times, e) remove potential hazards/obstacles from the patient's room and f) have frequently used objects within easy reach.

Of the individualised standards the most common interventions implemented included bed in low position (87.0%, n=47), patient assisted in transferring at all times (81.5%, n=44), toilet patient prior to settling in bed and offer urinal/commode/toilet regularly (81.5%, n=44), patient to wear non slip shoes/slippers when ambulating (75.9%, n=41), patient assisted to ambulate at all times (72.2%, n=39), side rail(s) of bed elevated at all times (55.6%, n=30), use of appropriate signage to indicate "patient at risk of a fall" (53.7%, n=29), offer commode/toilet after meals (53.7%, n=29), and ensure walking aids used as required and patient aware of correct use of aids (50.0%, n=27).

Of the 54 patients with interventions identified, 40 (74.1%) had a high risk for falls sticker on their notes. Of the 199 patients on a fall risk care plan 117 (58.8%) had a high risk for falls sticker on their notes. Of the entire sample of 226 patients, 129 (57.1%) had a high risk for falls sticker on their notes. These results indicate that 12 patients who were not on a fall risk care plan had a high risk for falls sticker on their notes.

Although nurses were not informed of the researcher's risk assessments, it was possible that the nurses were independently assessing fall risk and implementing fall prevention interventions differentially for high and low risk patients. Therefore data were investigated to ascertain if any form of treatment paradox was operating inadvertently. Firstly, when nurses were giving a clinical judgement about the patient's fall risk nurses were asked whether they had already completed a formal risk assessment on the patient. Only 20.8% of nurses indicated that they had completed a prior risk assessment on the patient. Secondly, there were no significant differences between the number of fallers and non-fallers who had a routine risk assessment completed on admission (χ^2=0.136, df=1, p=.712) or were placed on a fall risk care plan (χ^2=0.371, df=1, p=.542). There were also no significant differences between the number of high risk and low risk patients who had a routine risk assessment completed on admission for either Fall Risk Assessment Tool 1 (χ^2=0.046, df=1, p=.830), Fall Risk Assessment

Tool 2 (χ^2=1.316, df=1, p=.251) or nurses' clinical judgement (χ^2=0.027, df=1, p=.870). Additionally there were no significant differences between the number of high risk and low risk patients who were placed on a fall risk care plan for either Fall Risk Assessment Tool 1 (χ^2=0.288, df=1, p=.592), Fall Risk Assessment Tool 2 (χ^2=1.502, df=1, p=.220) or nurses' clinical judgement (χ^2=0.606, df=1, p=.436). There was, therefore, no need to adjust for these variables in the analysis of results as it can be assumed that all groups (fallers and non fallers, high and low risk patients) were treated similarly.

Reliability Testing

The test-retest reliability of the two risk assessment tools and nurses' clinical ratings was determined by calculating the intraclass correlation coefficient (3,1) (two way mixed effect model, single measure) for each method and for each item on the two fall risk assessment scales. Additionally, the Pearson's correlation coefficient was calculated to compare the results of using these two methods of assessing test-retest reliability. As can be seen from the results there was little difference between the two measures. Both fall risk assessment tools had an ICC ≥ .80 while nurses' clinical ratings had an ICC = .90 indicating that all three methods had good test retest reliability (see Table 8) being above the minimum acceptable level of .7 (Nunnally & Bernstein, 1994).

Examination of the intraclass correlation coefficient for the items contained in each of the fall risk assessment tools (see Table 9 and Table 10) indicates that some items had only moderate test-retest reliability. These items were elimination, prior fall history, sensory impairment and change in medications for Fall Risk Assessment Tool 1 and elimination for Fall Risk Assessment Tool 2. Apart from the item related to medication change in the last five days which is likely to have changed in the twenty four hour period of data collection the moderate reliability of the other items reflects the lack of consistency with which information on these items was recorded in the patient notes.

Cronbach's alpha was used to assess the internal consistency of the two fall risk assessment tools. It was not expected that internal consistency would be very high due to the small number of items contained within each scale. In addition the items that make up the two scales do not appear to be related as they measure very different concepts, for example continence and gait. As expected the internal consistency of the two fall risk assessment tools was low, .29 and .36 for Fall Risk Assessment Tool 1 and Fall Risk Assessment Tool 2 respectively.

Table 8

Reliability of Risk Assessment Methods

Method	Mean test score (n=20)	Mean retest score (n=20)	Mean difference (n=20)	SD test (n=20)	SD retest (n=20)	Cronbach's alpha (N=226)	Pearson's r (n=20)	ICC (3,1) (n=20)
FRAT1	11.75	12.15	.40$^{\delta}$	3.68	3.60	.29	.85	.85
FRAT2	3.80	3.90	.10$^{\delta}$	1.36	1.37	.36	.89	.80
CR	6.05	5.80	.25$^{\delta}$	2.26	2.02	not computed	.90	.90

$^{\delta}$ t-test for paired comparisons not significant: ICC, Intraclass correlation coefficient: SD, Standard deviation: FRAT1, Fall risk assessment tool 1: FRAT2, Fall risk assessment tool 2: CR, Clinical rating

Table 9

Reliability of Fall Risk Assessment Tool 1

FRAT1	Mean test score (n=20)	Mean retest score (n=20)	Mean difference (n=20)	SD test (n=20)	SD retest (n=20)	Cronbach's alpha (N=226) †	Pearson's r (n=20)	ICC (3,1) (n=20)
Age	1.45	1.45	‡	.51	.51	.29	1.0	1.0
Mental status A	1.40	1.50	.10δ	1.85	1.93	.18	.74	.74
Mental status B	.50	.60	.10δ	1.28	1.31	.22	.82	.82
Elimination	2.70	2.85	.15δ	.92	.67	.24	.69	.65
Fall history	2.60	2.40	.20δ	2.16	1.93	.26	.57	.57
Sensory impairment	.25	.30	.05δ	.44	.47	.32	.63	.63
Ambulation	1.60	1.70	.10δ	.50	.47	.27	.80	.80
Medications	.95	.95	‡	.76	.76	.28	1.0	1.0
Medication change	.30	.25	.05δ	.47	.44	.32	.63	.63

δ t-test for paired comparisons not significant: ‡ t value cannot be computed because the standard error of the difference is 0: † Cronbach's alpha value given for each item represents the effect of removing that item from the scale: ICC, Intraclass correlation coefficient: SD, Standard deviation: FRAT1, Fall risk assessment tool 1

Table 10
Reliability of Fall Risk Assessment Tool 2

FRAT2	Mean initial (n=20)	Mean retest (n=20)	Mean difference (n=20)	SD initial (n=20)	SD retest (n=20)	Cronbach's alpha (N=226) †	Pearson's (n=20)	ICC (3,1) (n=20)
Ambulation	.65	.75	.10δ	.49	.44	.35	.79	.78
Mental status	.40	.40	.00δ	.50	.50	.27	.79	.79
Elimination	.90	.95	.05δ	.31	.22	.33	.69	.65
Fall history	1.25	1.15	.10δ	.79	.74	.26	.83	.83
Medications	.60	.60	‡	.50	.50	.32	1.0	1.0

δ t-test for paired comparisons not significant: ‡ t value cannot be computed because the standard error of the difference is 0: † Cronbach's alpha value given for each item represents the effect of removing that item from the scale: ICC, Intraclass correlation coefficient: SD, Standard deviation: FRAT2, Fall risk assessment tool 2

Validity of the Risk Assessment Tools

The ability of the fall risk assessment tools (and nurses' clinical judgements) to discriminate between patients with a high probability of falling and patients with a low probability of falling, was determined by calculating the sensitivity, specificity, positive predictive value and negative predictive value of each method. The reference criterion used for these calculations was whether or not the patient fell within the hospitalisation period in which they were admitted to the study.

The sensitivity is the proportion of patients who fell who were correctly identified as high risk by the risk assessment method. The specificity is the proportion of patients who didn't fall who were correctly identified as low risk by the risk assessment method. The positive predictive value is the proportion of patients identified as high risk by the risk assessment method who did fall and the negative predictive value is the proportion of patients identified as low risk by the risk assessment method who did not fall (Gordis, 2000) (see Appendix 9). In an ideal test the proportion for each of the measures of sensitivity, specificity, and the positive and negative predictive values would be one (or 100%). An accurate risk assessment method would therefore approach 100% on all four measures.

In addition to the measures described above, the accuracy of each method was determined by calculating the number of times the risk assessment tool (or nurses' clinical judgement) classified the patient into the correct fall risk category, expressed as a percentage. The same reference criterion was used for this calculation.

The risk assessment tools showed good sensitivity, however, both tools had poor specificity and positive predictive value (see Table 11). This meant that both risk assessment tools classified too many patients who did not fall as at high risk for falls. Only thirty five percent (n=79) of patients were classified into the correct fall risk category by Fall Risk Assessment Tool 1 and only thirty six percent (n=82) of patients were classified into the correct risk category by Fall Risk Assessment Tool 2. Although both risk assessment tools were not useful as clinical diagnostic tools there was a statistically significant association between risk category and patient fall status for both Fall Risk Assessment Tool 1 (χ^2=4.326, df=1, p=. 038) and Fall Risk Assessment Tool 2 (χ^2=4.998, df=1, p=. 025).

Table 11

Validity of the Fall Risk Assessment Tools

Instrument	Sensitivity %	Specificity %	PPV %	NPV %
FRAT1	91	25	18	94
FRAT2	91	27	18	94

FRAT1, Fall risk assessment tool 1: FRAT2, Fall risk assessment tool 2: PPV, Positive predictive value: NPV, Negative predictive value

Receiver operating characteristic (ROC) curves were constructed for each of the fall risk assessment tools (see Figure 4 and Figure 5). ROC curves are designed to illustrate the relationship between the sensitivity and specificity of a test, in this case, the fall risk assessment tools. The ROC curve is obtained by calculating the sensitivity and specificity of every observed data value and then plotting 1-specificity (x axis) against sensitivity (y axis) (Altman & Bland, 1994, Crichton, 2002). If the risk assessment tool discriminated perfectly between fallers and non fallers the curve would be close to the upper left hand corner. If the fall risk assessment tool did not discriminate at all between fallers and non fallers the curve would be a straight line running from the bottom left hand corner to the top right hand corner (Altman & Bland, 1994, Crichton, 2002).

The other indicator of the validity of the test method is the area under the curve. A perfect test would have an area under the curve of 1 while a non-discriminating test would have an area under the curve of 0.5 (Crichton, 2002). In the ROC curves for the two fall risk assessment tools, the curve lies close to the diagonal and the area under the curve is .646 (Fall Risk Assessment Tool 1) and .622 (Fall Risk Assessment Tool 2). This illustrates the lack of accuracy of both fall risk assessment tools.

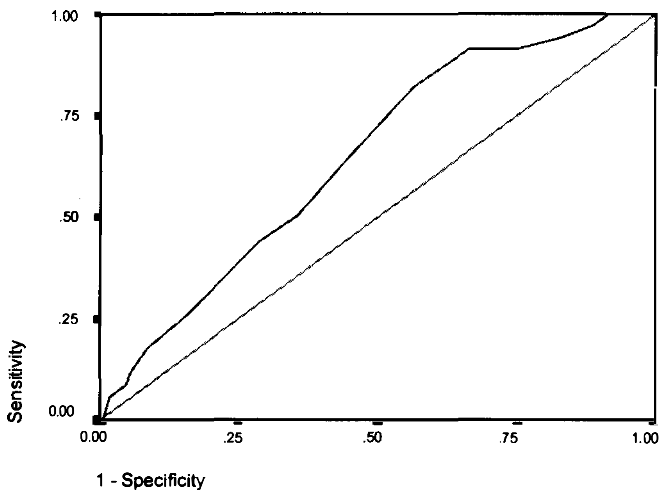

Figure 4

ROC curve for fall risk assessment tool 1

Area under the ROC Curve = .646

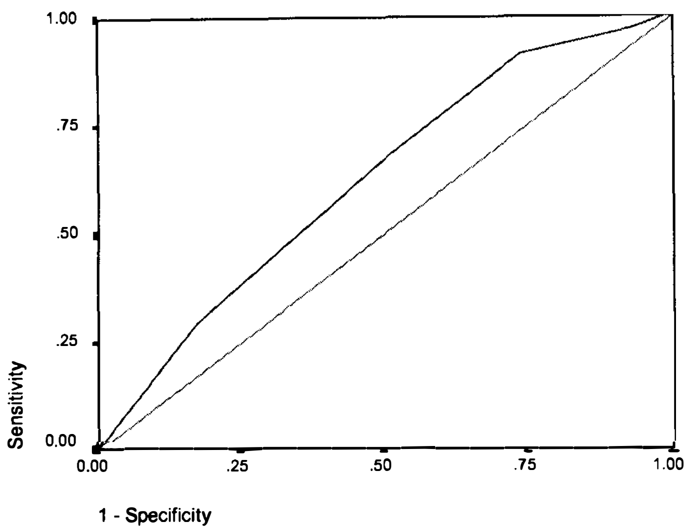

Figure 5

ROC curve for fall risk assessment tool 2

Area under the ROC Curve = .622

An examination of the distribution of scores obtained from both Fall Risk Assessment Tool 1 and Fall Risk Assessment Tool 2 shows that the distribution of scores for both fallers and non-fallers are very similar (see Figure 6 and Figure 7). The fallers' risk scores tend to start at a slightly higher level than the non fallers' scores, however, the extent of overlap between the two distributions would make it difficult to choose a cut off score for differentiating between fallers and non fallers. The potential for misclassification is high no matter what score is chosen.

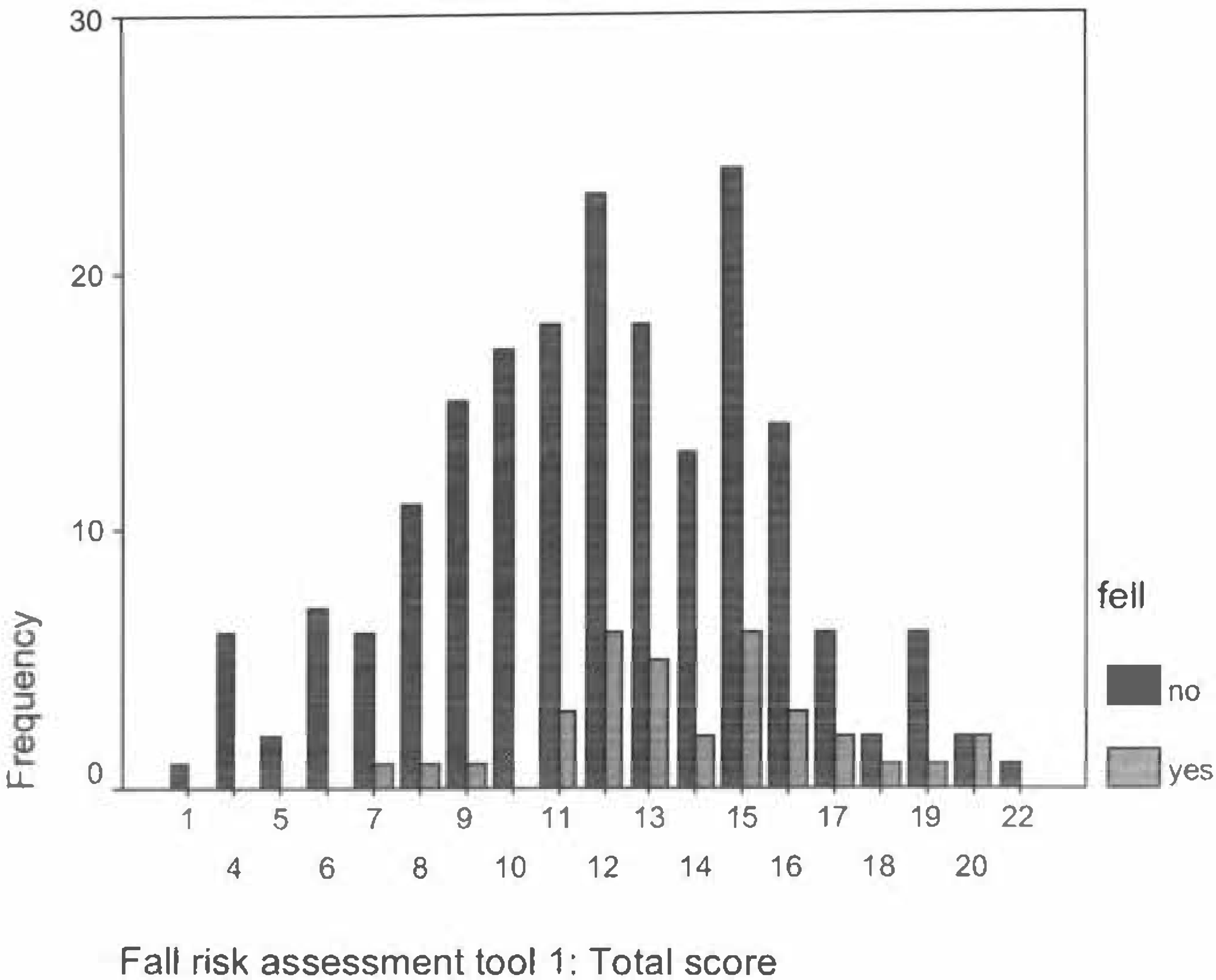

Figure 6

Distribution of fall risk assessment scores for fallers and non fallers from fall risk assessment tool 1

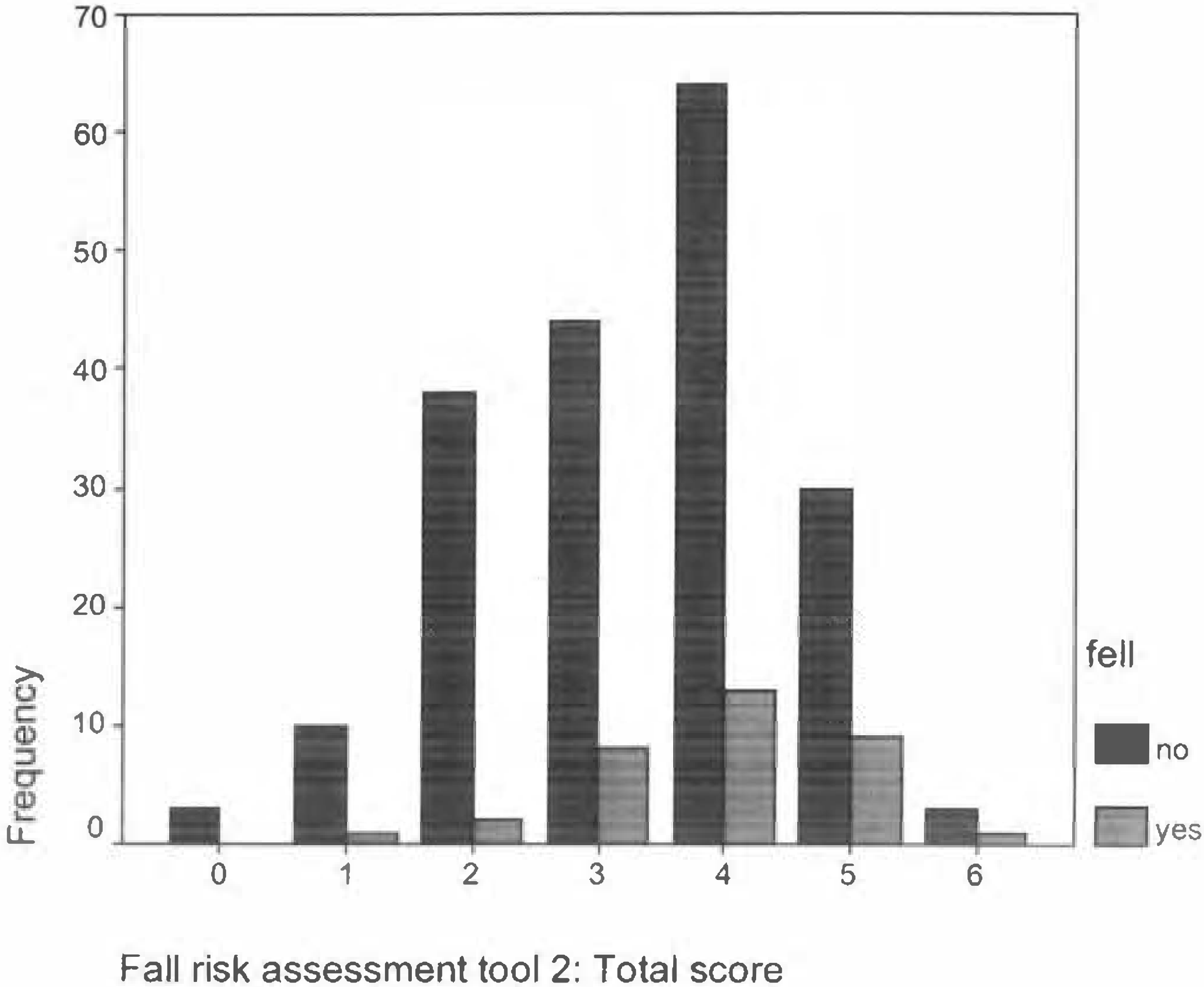

Figure 7

Distribution of fall risk assessment scores for fallers and non fallers from fall risk assessment tool 2

Validity of Nurses' Clinical Judgements

Nurses were asked to state whether they considered the patient was a fall risk. Clinical judgements about patients' fall risk were given 101 times by registered nurses (RN) (44.7%), 69 times by enrolled nurses (EN) (30.5%), 36 times by graduate nurses (Grad) (15.9%) and 20 times by clinical nurses (CN) (8.8%). In two cases nurses were unsure about the fall risk status of a patient, and therefore these cases were excluded from the analysis (giving a sample size of 224 patients). The mean number of years that participants had been nursing was 12.08 years (SD= 10.80) with a range of 39.92 years from a minimum of 1 month to a maximum of 40 years. It should be noted that in many cases nurses gave a clinical judgement about more than one patient, therefore the above figures contain multiple cases and do not refer to one clinical judgement per nurse.

As with the fall risk assessment tools, nurses' clinical judgements also exhibited good sensitivity but poor specificity and positive predictive value (see Table 12). In contrast to the fall risk assessment tools there was no significant association between nurses' clinical judgement and patient fall status (χ^2=3.141, df=1, p=. 076).

Table 12

Validity of Nurses' Clinical Judgement in Assessing Fall Risk

Instrument	Sensitivity %	Specificity %	PPV %	NPV %
CJ	88	26	18	92

CJ, Clinical judgement: PPV, Positive predictive value: NPV, Negative predictive value

Nurses were also asked to rate the patients' fall risk on a scale of zero to ten. The ROC Curve for these ratings is illustrated in Figure 8 and consistent with the fall risk assessment tools, shows a curve close to the diagonal and an area under the curve of .646 indicating poor discriminating ability. This means that no matter where the cut off score is set for determining those at high risk for falls the accuracy would still be poor. This is confirmed by an examination of the distribution of scores for fallers and non fallers according to nurses' clinical ratings of fall risk (see Figure 9 below).

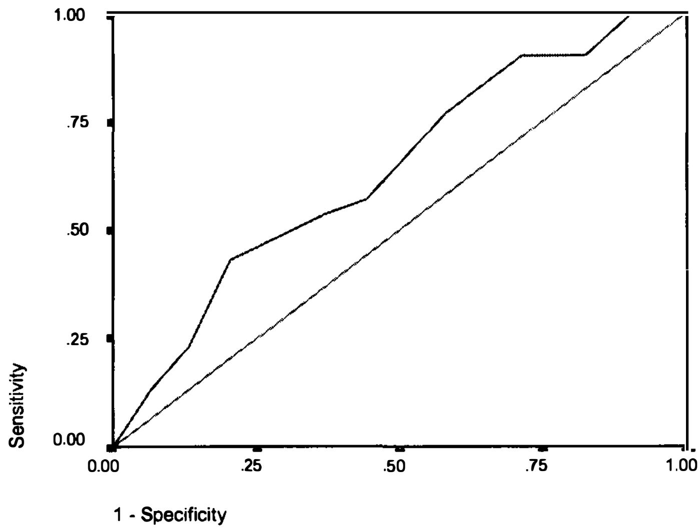

Figure 8

ROC curve for nurses' clinical ratings

Area under the ROC Curve = .646

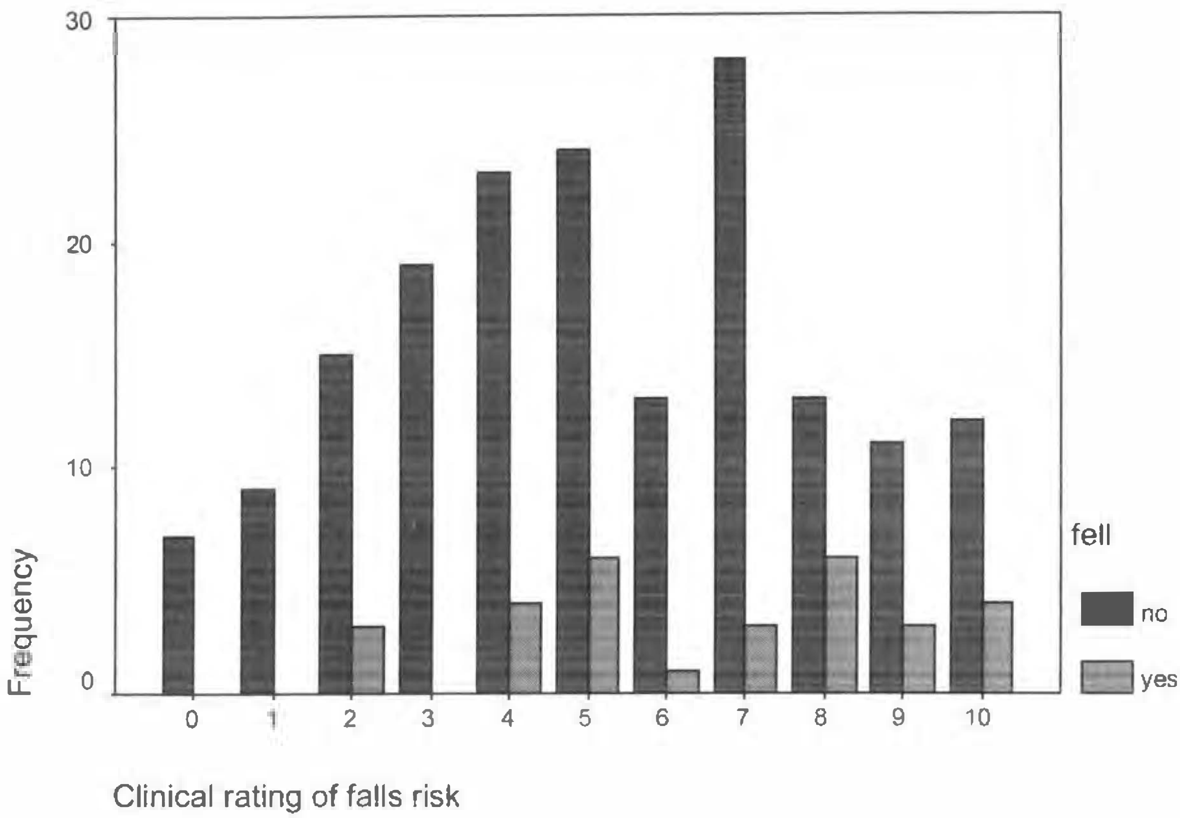

Figure 9

Distribution of fall risk assessment scores for fallers and non fallers from nurses' clinical ratings

Data indicated that nurses gave a correct clinical judgement in 35.3% of cases (n=79). The accuracy of the clinical judgements varied across levels of nurses, with enrolled nurses having the highest level of accuracy and graduate registered nurses having the lowest level of accuracy (see Figure 10).

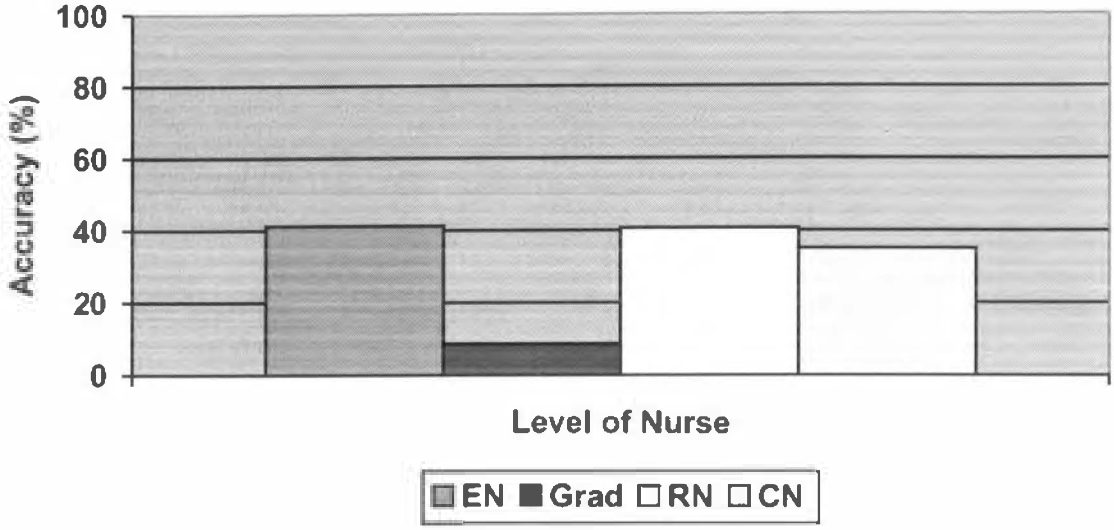

Figure 10

Accuracy of clinical judgement based on level of nurse

The accuracy of nurses' clinical judgement was also influenced by the number of years they had been nursing (see Figure 11). Accuracy improved as the number of years of nursing increased.

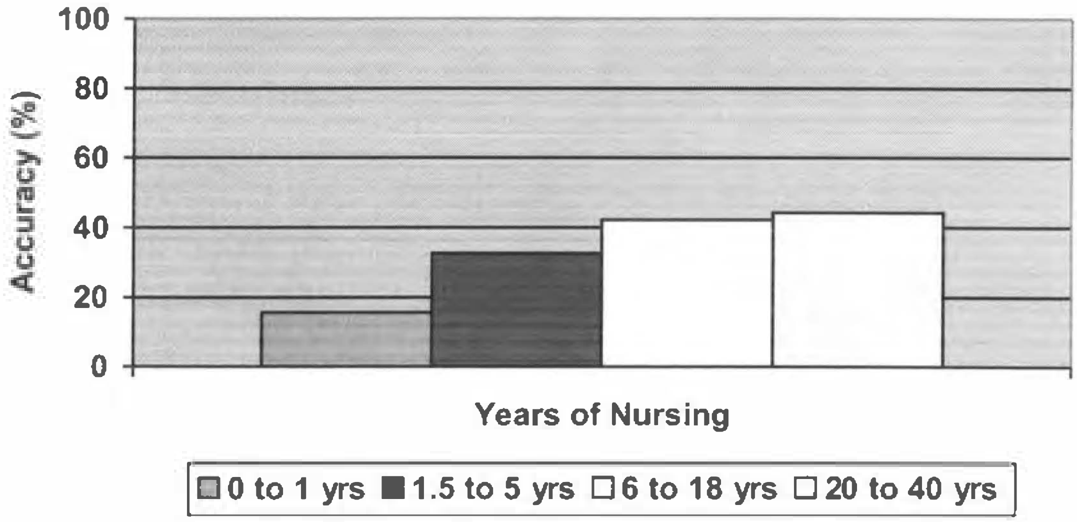

Figure 11

Accuracy of clinical judgement based on years of nursing

Table 13 shows the number and level of nurse in each years of nursing category. There was a large variation in sample size between each of the groups and therefore results should be interpreted with caution.

Table 13

Number of Clinical Judgements by Level of Nurse and Years of Nursing

Years of Nursing	Enrolled Nurses	Graduate Registered Nurses	Registered Nurses	Clinical Nurses	Total
0-1 years	9	35†	1	0	45
1.5-5 years	32	0	22	1	55
6-18 years	14†	0	25	6	45
20-40 years	13	0	53	13	79
Total	68	35	101	20	224

† 1 nurse in each of these categories was unsure of the fall risk of a patient and was excluded from the analysis

Figure 12 shows the accuracy of nurses' clinical judgements by level of nurse and years of nursing. Of note, is the large difference in accuracy between enrolled nurses in their first year of clinical practice (44.4%) and graduate registered nurses in their first year of clinical practice (8.6%).

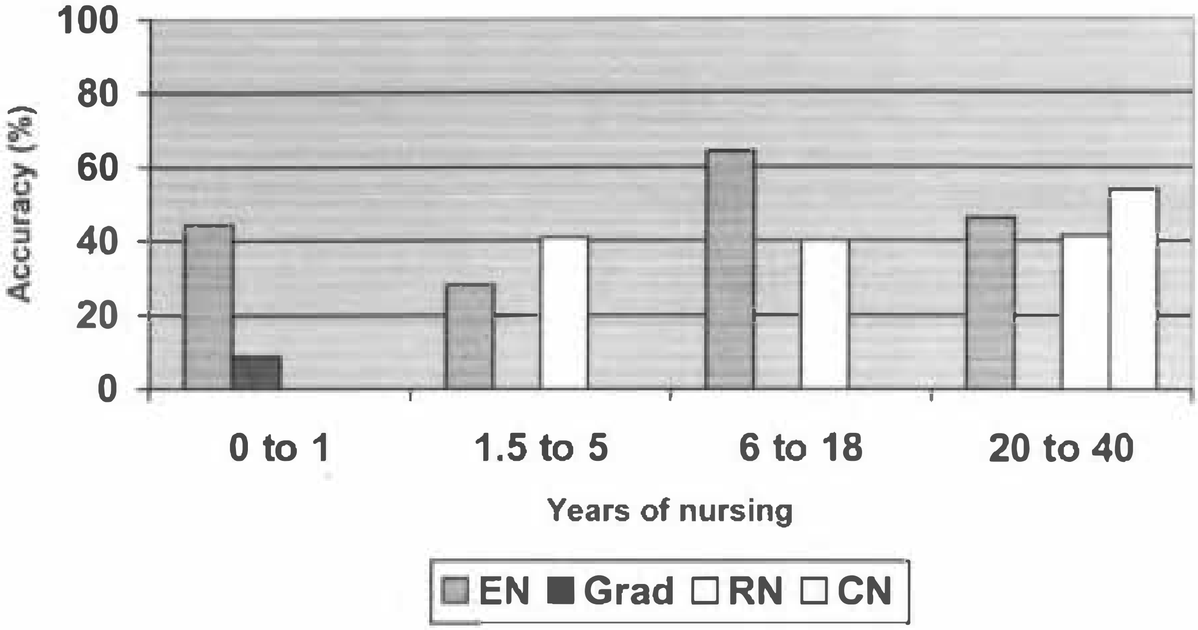

Figure 12

Accuracy based on years of nursing and level of nurse

Comparison of Risk Assessment Methods

Across all three risk assessment methods the number of patients classified as high risk or low risk for falls was similar for both patients who fell and patients who did not fall (see Table 14).

Table 14

Frequency of Risk Assessment Classifications for each Assessment Method

	Fall	No Fall	Total
High risk			
FRAT1	31	144	175
FRAT2	31	141	172
CJ	30	141	171
Low risk			
FRAT1	3	48	51
FRAT2	3	51	54
CJ	4	49	53
Total			
FRAT1	34	192	226
FRAT2	34	192	226
CJ	34	190	224

FRAT1, Fall Risk Assessment Tool 1: FRAT2, Fall Risk Assessment Tool 2: CJ, Nurses' Clinical Judgement

Agreement between the three methods in the classification of patients as high or low risk for falls is outlined in Table 15 using the kappa statistic. The kappa statistic is a measure of the consistency or reliability between methods and adjusts for the amount of agreement that would occur between methods purely by chance. Maximum reliability would be indicated by a kappa statistic of 1, while minimum reliability would be indicated by a kappa statistic of 0 or less (Dawson-Saunders & Trapp, 1994). Landis and Koch (1977) outlined criteria for interpreting the strength of agreement between methods. In this study, the highest level of agreement was between the two fall risk assessment tools with the kappa statistic indicating a substantial level of agreement between the two methods according to the criteria set by Landis and Koch (1977). Agreement between Fall Risk Assessment Tool 1 and clinical judgement was interpreted as slight while agreement between Fall Risk Assessment Tool 2 and clinical judgement was interpreted as fair using the same criteria.

Table 15

Agreement Between Risk Assessment Methods

	Agreement		Disagreement		Kappa
	n	%	n	%	
FRAT1/ CJ	161	71.9	63	28.1	0.20
FRAT2/ CJ	163	72.8	61	27.2	0.25
FRAT1/ FRAT2	201	88.9	25	11.1	0.69
All Methods	150	66.9	74	33.1	0.39

FRAT1, Fall Risk Assessment Tool 1: FRAT2, Fall Risk Assessment Tool 2: CJ, Nurses' Clinical Judgement

Sequential Testing of Risk Assessment Methods

Sequential testing of the risk assessment methods was undertaken to assess whether or not the combination of nurses' clinical judgement and a fall risk assessment tool was a better predictor of patient falls than either method alone. Sequential testing is a two stage screening process in which those who test positive on the first test are then tested on a second test. Sequential testing usually results in a gain in net specificity and a loss in net sensitivity. In other words this type of testing usually reduces the number of false positives (patients who are at high risk but don't fall) (Gordis, 2000). However, in this study sequential testing of the risk assessment methods was of no benefit and resulted in a loss of net specificity (see Table 16). This result is probably due to the inaccuracies inherent in all three risk assessment methods.

Table 16

Validity of Sequential Testing of Risk Assessment Methods

Instruments	Sensitivity %	Specificity %	PPV %	NPV %
FRAT1/ CJ	94	22	20	94
FRAT2/ CJ	90	19	20	90
CJ/ FRAT1	97	21	21	97
CJ/ FRAT2	93	21	20	94

FRAT1, Fall Risk Assessment Tool 1: FRAT2, Fall Risk Assessment Tool 2: CJ, Nurses' Clinical Judgement: PPV, Positive predictive value: NPV, Negative predictive value

Components of Nurses' Clinical Judgements

Nurses' clinical judgements about patients' fall risk were divided into two main categories, contributive and protective factors using an open coding technique. The most frequently mentioned contributive factors included age, altered ambulation/gait, poor use of ambulation aids, disease processes, lack of insight often accompanied by a desire to maintain independence, altered mental state including confusion and memory loss, need for assistance, poor physical state, prior fall history, problems with transferring, and problems with weight bearing. Less frequently mentioned contributive factors included poor balance, not doing up clothing adequately, lack of confidence, lack of energy, medications, poor nutritional state, altered sensory state, and wandering.

Protective factors that were mentioned frequently included good ambulation/gait, proper use of ambulation aids, and no problems with weight bearing. Less frequently mentioned protective factors included lack of related disease processes, good health, insight, no language barriers, no contributing medications, good mental state, and no problems with transferring.

The domains mentioned by the nurses in this study as contributing to patients' fall risk were similar to those identified in the fall risk assessment literature (Morse, 1997; Whedon & Shedd, 1989). Continence, a frequently used construct in fall risk assessment tools in the literature, was not mentioned by any of the nurses in this study.

Nurses in this study appeared to use both intuition and reason when describing why a patient may be at risk for falling, lending support to the cognitive continuum theory of clinical judgement. For example, one nurse described a patient judged to be not at risk of falling as:

> She's oriented to time and place. She walks with a zimmer frame and I've observed her walking with a zimmer frame and she is steady on her feet and she walks quite well. She's able to say if she needs any assistance (Interview 4).

This description appeared to be underpinned by a reasoning process. Another nurse described a patient judged to be at risk of falling in the following way.

> He's on supine and erect blood pressures, well there's no difference in either of those, so there's no postural drop or anything like that. Just a general feeling that he could sort of have a problem. He's been on the supine erects for about four days now and they haven't changed much either. I can't give you any sort of concrete evidence to say why I feel that he's a falls risk (Interview 5).

This nurse appeared to use both intuition and reason when deciding whether a patient was a falls risk.

CHAPTER SIX
DISCUSSION AND CONCLUSION

Accuracy of Risk Assessment Methods

In this setting, the methods of assessing fall risk that were tested, did not appear to be accurate. All three methods were unable to adequately discriminate between patient populations at risk of falling and those not at risk of falling. Of particular concern was that all of the methods had low specificity, that is, they overestimated the population at risk. Consequently, neither nurses' clinical judgement nor the two fall risk assessment tools tested in this study could be recommended for assessing fall risk in the clinical setting. This study adds to the literature on the accuracy of fall risk assessment tools and confirms the findings of the JBIEBNM that fall risk assessment tools had low specificity and were therefore of limited use for clinical practice (Evans et al., 1998).

The fall risk assessment tool developed by Berryman et al. (1989) and modified by MacAvoy, Skinner and Hines (1996) that was tested in this study (Fall Risk Assessment Tool 1) showed an increase in sensitivity from 43% in the original study to 91% in this current study. The tool showed a decrease in specificity from 70% in the original study to 25% in the current study. This variation may be because of the definition of sensitivity and specificity used by MacAvoy, Skinner and Hines (1996, p216) to determine the accuracy of the fall risk assessment tool. These authors describe sensitivity as "the degree to which those identified as high risk actually fell". This is actually the positive predictive value rather than the sensitivity. Similarly, specificity is described by the authors as "the degree to which those identified not at high risk did not fall". This is actually the definition of negative predictive value rather than specificity.

Fall Risk Assessment Tool 2 (Schmid, 1990) showed a slight decrease in sensitivity from 95% in the original study to 91% in the current study. The specificity of the risk assessment tool decreased from 66% in the original study to 27% in the current study. This difference may be due to difference in study design, for example in Schmid's (1990) study the risk assessments were completed by ward nurses whereas in the current study the risk assessments were completed by the researcher. This change in specificity may also be due to differences between the patient populations being studied.

Schmid (1990) developed her risk assessment tool with a sample of all hospitalised patients whereas the current study tested the tool in an aged care population.

In terms of nurses' clinical judgement, when compared to the Eagle et al. (1999) study, the sensitivity of nurses' clinical judgement increased from 76% in the original study to 86% in the current study while the specificity decreased from 49% in the original study to 26% in the current study. This change in sensitivity and specificity may reflect differences in the nurse populations who generated these clinical judgements. For example there may have been differences in the level of experience of the nurses in the two samples, however, Eagle et al. (1999) did not provide any information about the demographics of the nurses in their study.

There are a number of possible explanations for the low specificity of the risk assessment methods tested in this study. The most likely explanation for the lack of accuracy of the fall risk assessment methods is that the domains of the fall risk assessment tools and the constructs in nurses' clinical judgements did not adequately capture the factors that place an inpatient at increased risk for falls. The fall risk assessment methods tested in this study may only contain domains or constructs that are indicative of an overall increased risk for falls for all hospitalised patients when compared to a healthy population. In other words, the risk assessment methods are not able to capture specific fall risk factors beyond the almost universal risk factors that many hospitalised patients with a compromised health status share.

If the domains or constructs of the risk assessment methods are based on risk factors common to many hospitalised patients this would explain the tendency of the methods to overestimate the population at risk. This explanation implies that researchers need to look beyond the obvious factors that indicate an increased fall risk and focus on the more subtle indicators of risk or combinations of risk factors in order to increase the specificity of fall risk assessment tools. The work of Stephen Lord and colleagues (2001) in investigating fall risk factors in community dwellers using a comprehensive set of objective measures provides a good starting point for researchers working in acute care settings who wish to investigate this issue.

As outlined in the literature review and the conceptual framework for this study a problem for researchers when testing the accuracy of fall risk assessment methods in the clinical setting is the presence of confounding variables. These confounding variables may affect the specificity of the risk assessment methods. The main confounding variable is the influence of usual ward fall prevention practices on the accuracy of the risk assessment methods. Patients who were assessed as at high risk for falls may have been at high risk, but because of the usual fall prevention interventions in place on the study wards these 'potential' falls were prevented, leading to a loss of specificity. It is difficult to overcome this limitation, as it would be unethical to discourage fall prevention interventions in the clinical setting in order to test risk assessment tools. At this stage there is no other measure to use as the gold standard for determining the validity of fall risk assessment methods besides an actual patient fall as there are no current reliable and valid tests of fall risk.

In order to assess the influence of this confounder, data were collected on fall prevention measures that were documented for the patients in this study. Of the 226 patients admitted to the study, 202 (89.4%) had a risk assessment completed on admission by ward staff and 199 (98.5%) of these had a fall risk care plan in their notes. There is some evidence that appropriate interventions were not always identified or applied consistently. For example, of the 199 patients who had a fall risk care plan in their file only twenty seven percent (n=54) had specific fall prevention interventions identified on the care plan and only 117 patients (58.8%) had a high risk for falls sticker on their file. Moreover, twelve patients who were not on a fall risk care plan had a high risk for falls sticker on their nursing notes. There were no significant differences between the number of fallers and non-fallers who had a risk assessment completed on admission or who had a fall risk care plan in their notes indicating that both fallers and non fallers were treated similarly.

It is difficult to determine the extent to which fall prevention interventions were actually applied on the study wards. Although the documentation collected for this study provides an indication of the intentions of nurses in relation to fall prevention it is not known how these intentions translated into practice.

Another point to consider when assessing the influence of ward fall prevention measures on the accuracy of fall risk assessment methods is that to date, fall prevention interventions have not been scientifically validated in the literature and it is impossible to confirm whether fall prevention interventions are effective in preventing patient falls. Current best evidence in fall prevention promotes the use of multiple strategies to prevent inpatient falls based on level IV evidence, which is expert opinion (Evans, Hodgkinson, Lambert, Wood & Kowanko, 1998: JBIEBNM, 1998). So even if fall prevention interventions were implemented for patients in this study it is not possible to comment on whether these interventions were likely to have been effective due to the lack of scientific evidence about fall prevention interventions.

In summary, the argument for the confounding effect of fall prevention measures as a likely explanation for the lack of specificity of the fall risk assessment methods is lessened by the following three factors. Firstly, current fall prevention strategies have not been scientifically validated and may therefore be wholly or partially ineffective. Secondly, there is evidence that fall prevention measures may be inconsistently implemented in the ward setting. Thirdly, there is evidence that fallers and non fallers were treated similarly in the ward setting. Despite the evidence against the influence of ward fall prevention measures as a confounding variable in this study it remains likely that this confounder was responsible for some of the lack of specificity of the fall risk assessment methods tested in this study. This is a limitation of this study and similar studies of this nature and is difficult to overcome due to the ethical implications previously mentioned.

Another related confounding variable is treatment paradox. This describes a situation in which the ward staff implement fall prevention measures only for patients identified as high risk by the risk assessment method. Treatment paradox was not operating in this study as the ward nurses were blind to the results of the researchers risk assessments. Additionally, there did not appear to be any indirect treatment paradox operating as there were no significant differences between the number of high and low risk patients who had a routine risk assessment completed on admission or who were on a fall risk care plan for either of the risk assessment tools or nurses' clinical judgement.

A further influence on the study findings relates to the timing of the risk assessments. In this study all risk assessments were completed close to the admission of the patient to the ward and no data were collected on changes in these risk profiles over time as it was beyond the resources of this project. It may be that a patient's risk profile changes substantially during an admission and that a one-off admission assessment cannot capture these changes. The accuracy of fall risk assessment methods may therefore increase or decrease according to the timepoint at which a patient's fall risk is assessed. There is some disagreement about this issue in the literature. For example, Morse and colleagues (1989) conducted daily fall risk assessments on 2689 patients and found that 50.4% of the patients' risk scores varied (either increased or decreased) during the study period. The majority of changes related to ambulatory aids, gait, removal of an IV and mental state.

In contrast, Price et al. (1998) studied risk factors that were present on admission that could be used to indicate risk for the entire hospitalisation period. These authors concluded that a single assessment of risk was sufficient. The authors discussed the need to differentiate between stable risk factors that were present on admission and did not change and transient risk factors that may change during the hospitalisation period. No details were given about which types of risk factors were stable and which were transient. This issue is worthy of further study as the ability to differentiate between stable and transient fall risk factors may aid researchers to develop risk assessment tools that have a higher specificity. In particular, studies which assess risk profiles on a daily basis and then assess changes in sensitivity and specificity according to time of risk profile collection would be useful.

A final factor that may have impacted on the accuracy of the fall risk assessments is the limitations of the data collection methods used for this study. These limitations were firstly that the researcher was not caring for the patient population in the study and had to rely on completing the risk assessment from the data in the patient's notes. Some of the required data was not recorded in a systematic manner in the notes and it is therefore possible that information needed for the risk assessments was not adequately captured. This means that at times the risk assessments could have been inaccurate. For example, although the overall test retest reliability was satisfactory there were individual items in each of the two fall risk assessment tools that exhibited only moderate reliability being below the minimum acceptable level of .7 described by Nunnally and Bernstein (1994). These items were elimination, prior fall history, sensory impairment and changes in medications for Fall Risk Assessment Tool 1 and elimination for Fall Risk Assessment Tool 2.

Additionally, the information contained in the patient notes could have been inaccurate or out of date. At times there were discrepancies in the data recorded in the patients' notes, however, this information was always checked with the nurse looking after the patient to ensure accuracy, and the most up to date entries were used for information. Despite these limitations, the risk assessments completed by the researcher were at least as accurate as the clinical judgements given by the nurses caring for the patients.

Another possible limitation of this study was that the outcome variable of whether a patient fell was derived from the completed accident/incident forms. It is possible that not all falls were recorded on these forms. Information from the ward Clinical Nurse Specialists and hospital Quality Improvement Coordinator suggested that accident/incident forms were the most reliable method of collecting data on patient falls available in the hospital, although the possibility of falls being under-reported could not be excluded.

Nurses' Clinical Judgements

In this study enrolled nurses had the highest level of accuracy in determining a patient's fall risk. Of note, was the large difference between the accuracy of first year enrolled and registered nurses in assessing patient fall risk. First year enrolled nurses achieved an accuracy level of 44.4% (n=9) while graduate registered nurses achieved an accuracy level of only 8.6% (n=35). This finding is of concern as enrolled nurses undertake an eighteen month education course at a Technical and Further Education (TAFE) college and are required to work under the supervision of a registered nurse, while registered nurses undertake a minimum three year degree course at University level and work independently. These results should be interpreted with caution, as measuring differences in accuracy between types of nurses was not a main focus of this study and consequently the study design could have introduced bias.

Of particular concern is that in many cases the same nurse gave multiple judgements about patients' fall risk. The results are therefore potentially biased, for example, if the sample included a particularly accurate first year enrolled nurse and a particularly inaccurate graduate registered nurse, and these two nurses gave the majority of judgements for the subgroup. No data were collected on the number of nurses providing clinical judgements or the number of times each nurse provided a clinical judgement.

The results provide an indication that further study is warranted using a specifically designed methodology to explore this issue. Additionally, it is not clear from the present study whether the disparity in the accuracy of clinical judgement between first year enrolled and registered nurses is evident only in the assessment of fall risk or whether other areas of clinical judgement would exhibit the same pattern. This aspect also requires further study. Factors that should be studied include the duration and type of clinical practice during the nursing education programme, and any changes in accuracy of clinical judgement during the first five years of clinical practice after graduation.

In the qualitative component of the study nurses discussed some of the factors that may impact on a patient's risk of falling. The majority of these factors, for example age, altered ambulation/gait, disease processes and altered mental state are all domains that are frequently discussed in the fall risk literature. A number of domains were identified by nurses in this study that are infrequently or never discussed in the literature and these may be worthy of further investigation as potential fall risk factors. These include a lack of insight accompanied by a desire to maintain independence, not doing up clothing properly, lack of confidence, poor nutritional state and wandering.

Although some nurses used both intuition and reason when describing a patient's fall risk the predominant method used was that of reason. This may have been due to the nature of the task with which nurses were presented, which was to describe the reason for their judgement about a patients' fall risk. This is congruent with the cognitive continuum theory of clinical judgement where features of the task may induce the clinician to use a certain mode of thinking. This finding may therefore be more indicative of the type of task involved rather than of the actual nature of nurses' cognitive processes in relation to fall risk assessment.

Conclusion

The results indicate that the methods of assessing fall risk tested in this study were not accurate and were unable to adequately discriminate between patient populations at risk of falling and those not at risk of falling. All three methods had low specificity and identified too many patients as at high risk for falls who did not then go on to fall during their hospital admission. None of the methods tested in this study can be recommended for assessing fall risk in the clinical setting. Based on the results there is no benefit in using either of the fall risk assessment tools in preference to nurses' clinical judgements about a patient's fall risk.

The most likely explanation for this finding is that the domains included in the fall risk assessment tools, and the components of nurses' clinical judgements, are indicative of a general increased fall risk in hospitalised patients when compared to the general non-hospitalised population. Further research is required to identify specific patient factors that differentiate between fallers and non fallers in acute care settings. These findings could then be used to develop a valid and reliable fall risk assessment tool for use with inpatient populations. Another explanation that cannot be excluded is that fall prevention measures implemented on the study wards may have prevented some patient falls and therefore impacted on the accuracy, particularly the specificity, of the fall risk assessment methods.

An additional finding in this study was that there was a large difference between the accuracy of first year enrolled and registered nurses in assessing patient fall risk. These results should be viewed with caution as measuring differences in accuracy between types of nurses was not a main focus of this study and consequently the study design could have introduced bias. Further research is warranted to explore this issue.

Recommendations for Future Research

There are a number of specific recommendations arising from the results of this study in regard to future research in the area of fall risk assessment. It is recommended that further studies be undertaken to assess the reliability and validity of current fall risk assessment tools in inpatient populations. If no valid and reliable fall risk assessment tool can be identified, research should be undertaken to develop a valid and reliable fall risk assessment tool for inpatient populations.

It is also recommended that studies be conducted to assess changes in fall risk profiles over time to determine if the sensitivity and specificity of instruments changes depending on the timing of the risk assessment. Differentiating between stable and transient risk factors should be an integral component of these types of studies. Further research is also required to determine if there are differences in fall risk factors between different specialties or if a generic risk assessment tool can be used for all inpatient populations. Additionally, further investigation into the clinical judgement of registered and enrolled nurses in their first year of clinical practice should be undertaken and results reported to appropriate educational institutions. Changes in accuracy of clinical judgement in the first five years of clinical practice should also be measured.

Implications for Practice

In addition to the recommendations for further research described above there are a number of implications for practice arising from the results of this study. Firstly, the study findings indicate that neither of the fall risk assessment tools tested in this study are useful for the clinical practice setting. Additionally, none of the fall risk assessment tools currently found in the literature can be recommended for clinical practice. Although nurses' clinical judgement was not particularly accurate when predicting fall risk, it was no less accurate than either of the fall risk assessment tools tested in this study. Currently there is no advantage in using a risk assessment tool instead of nurses' clinical judgement to predict patient falls.

This may create difficulties for nurses who are required by managers to document a patient's fall risk using a risk assessment tool, to comply with quality improvement and risk management strategies. If nurses are using a risk assessment tool that has no established reliability and validity this may create cognitive dissonance for nurses who are increasingly being encouraged to base practice on best evidence. Additionally, if the risk assessment tools that are used in the clinical setting identify too many patients as high risk for falls who do not subsequently fall, nurses will be implementing fall prevention interventions inappropriately which is wasteful of time and resources. This may lead nurses to become desensitised to the value of fall prevention programmes. Therefore, the need to develop a valid and reliable fall risk assessment tool for use in acute care settings is imperative.

Secondly, the low reliability of some of the domains included in the fall risk assessment tools needs to be addressed. In particular the difficulty in finding consistent references to a patient's prior fall history in medical and nursing notes is of concern. Prior fall history has been shown to be significantly associated with the risk of falling in at least four independent studies (Evans, Hodgkinson, Lambert & Wood, 2001). It is recommended that a type of systematic fall flagging system that would alert nurses to a patient's fall history be implemented in the hospital environment. This may best be achieved through some type of computer system.

Finally, it may be beneficial to conduct further education on fall risk factors and fall risk assessment for nurses, especially for graduate registered nurses in an effort to improve the accuracy of nurses' clinical judgement.

REFERENCES

Altman, D.G. & Bland, J.M. (1994). Statistics notes: Diagnostic tests 3: Receiver operating characteristic plots. *British Medical Journal, 309*, 188.

Altman, D.G. (1997). Study to predict which elderly patients will fall shows difficulties in deriving and validating a model. *British Medical Journal, 315*(7118), 1309.

Bakarich, A., McMillan, V., & Prosser, R. (1997). The effect of a nursing intervention on the incidence of older patient falls. *Australian Journal of Advanced Nursing, 15*(1), 26-31.

Barbieri, E.B. (1983). Patient falls are not patient accidents. *Journal of Gerontological Nursing, 9*(3), 165-173.

Benner, P. (1984). *From novice to expert: Excellence and power in clinical nursing practice.* Menlo Park, CA: Addison-Wesley.

Berryman, E., Gaskin, D., Jones, A., Tolley, F., & MacMullen, J. (1989). Point by point: Predicting elders falls. *Geriatric Nursing, 10*(4), 199-201.

Bradshaw, A. (1995). What are nurses doing to patients? A review of theories of nursing past and present. *Journal of Clinical Nursing, 4*(2), 81-92.

Brady, R., Chester, F.R., Pierce, L.L., Salter, J.P., Schreck, S., & Radziewicz, R. (1993). Geriatric falls: Prevention strategies for the staff. *Journal of Gerontological Nursing, 19*(9), 26-32.

Brians, L.K., Alexander, K., Grota, P., Chen, R.W.H., & Dumas, V. (1991). The development of the RISK tool for fall prevention. *Rehabilitation Nursing, 16*(2), 67-69.

Carper, B.A. (1978). Fundamental patterns of knowing in nursing. *Advances in Nursing Science, 1*(1), 13-23.

Conley, D., Schultz, A.A., & Selvin, R. (1999). The challenge of predicting patients at risk for falling: Development of the Conley Scale. *MEDSURG Nursing, 8*(6), 348-354.

Corcoran, S. (1986). Decision analysis: A step-by-step guide for making clinical decisions. *Nursing and Health Care, 7*, 149-154.

Crichton, N. (2002). Information point: Receiver operating characteristic (ROC) curves. *Journal of Clinical Nursing, 11*, 136.

Dowding, D. (2002). Interpretation of risk and social judgement theory. In C. Thompson & D. Dowding (Eds.), *Clinical decision making and judgement in nursing* (pp 81-93). London: Churchill Livingstone.

Downton, J.H. (1993). *Falls in the elderly*. London: Edward Arnold.

Eagle, D.J., Salama, S., Whitman, D., Evans, L.A., Ho, E., & Olde, J. (1999). Comparison of three instruments in predicting accidental falls in selected inpatients in a general teaching hospital. *Journal of Gerontological Nursing, 25*(7), 40-45.

Elstein, A.S., Shulman, L.S. & Sprafka, S.A. (1978). *Medical problem solving: An analysis of clinical reasoning*. Cambridge, Mass: Harvard University Press.

Elstein, A.S., & Bordage, G. (1988). Psychology of clinical reasoning. In J. Dowie & A. Elstein (Eds.), *Professional judgment: A reader in clinical decision making* (pp. 109-129). Cambridge: Cambridge University Press.

English, I. (1993). Intuition as a function of the expert nurse: A critique of Benner's novice to expert model. *Journal of Advanced Nursing, 18*, 387-393.

Evans, D., Hodgkinson, B., Lambert, L., Wood, J. & Kowanko, I. (1998). *Falls in acute hospitals: A systematic review.* Adelaide: The Joanna Briggs Institute for Evidence Based Nursing and Midwifery.

Evans, D., Hodgkinson, B., Lambert, L. & Wood, J. (2001). Fall risk factors in the hospital setting: A systematic review. *International Journal of Nursing Practice, 7*, 38-45.

Farmer, B.C. (2000). Fall Risk Assessment. *Journal of Gerontological Nursing, 26*(7), 6-7.

Fife, D.D., Solomon, P., & Stanton, M. (1984). A risk/falls program: Code orange for success. *Nursing Management, 15*(11), 50-53.

Forrester, D.A., McCabe-Bender, J., & Tiedeken, K. (1999). Fall risk assessment of hospitalized adults and follow-up study. *Journal for Nurses in Staff Development, 15*(6), 251-259.

Gibson, M.J. (1987). The prevention of falls in later life. *Danish Medical Bulletin: Gerontology Special Supplement Series Number Four, 34*(4).

Gordis, L. (2000). *Epidemiology* (2nd ed). Philadelphia: WB Saunders.

Greenwood, J. (1998). Theoretical approaches to the study of nurses' clinical reasoning: Getting things clear. *Contemporary Nurse, 7*(3), 110-116.

Hamers, J.P.H, Abu-Saad, H.H., & Halfens, R.J.G. (1994). Diagnostic process and decision making in nursing: A literature review. *Journal of Professional Nursing, 10*(3), 154-163.

Hamm, R.M. (1988). Clinical intuition and clinical analysis: Expertise and the cognitive continuum. In J. Dowie & A. Elstein (Eds.), *Professional judgment: A reader in clinical decision making* (pp. 78-105). Cambridge: Cambridge University Press.

Hammond, K.R. (1964). Clinical inference in nursing: A methodological approach. *Nursing Research, 13*(4), 315-319.

Harbison, J. (2001). Clinical decision making in nursing: Theoretical perspectives and their relevance to practice. *Journal of Advanced Nursing, 35*(1), 126-133.

Hendrich, A.L. (1988). An effective unit-based fall prevention plan. *Journal of Nursing Quality Assurance, 3*(1), 28-36.

Hendrich, A., Nyhuis, A., Kippenbrock, T., & Soja, M.E. (1995). Hospital falls: Development of a predictive model for clinical practice. *Applied Nursing Research, 8*(3), 129-139.

Hernandez, M., & Miller, J. (1986). How to reduce falls. *Geriatric Nursing, 7*(2), 97-102.

Heslin, K., Towers, J., Leckie, C., Thornton-Lawrence, H., Perkin, K., Jacques, M., Mullin, J., & Wick, L. (1992). Managing falls: Identifying population-specific risk factors and prevention strategies. In S.G. Funk, E.M. Tornquist, M.T. Champagne & R.A. Wiese (Eds.), *Key aspects of elder care: Managing falls, incontinence, and cognitive impairment* (pp70-80). New York: Springer.

Hill, B.A., Johnson, R., & Garrett, B.J. (1988). Reducing the incidence of falls in high risk patients. *Journal of Nursing Administration, 18*(7,8), 24-28.

Hollinger, L.M. & Patterson, P.A. (1992). A falls prevention program for the acute care setting. In S.G. Funk, E.M. Tornquist, M.T. Champagne & R.A. Wiese (Eds.), *Key aspects of elder care: Managing falls, incontinence, and cognitive impairment* (pp 110-117). New York: Springer.

Innes, E.M. (1985). Maintaining fall prevention. *Quality Review Bulletin, 11*(7), 217-221.

Innes, E.M., & Turman, W.G. (1983). Evaluation of patient falls. *Quality Review Bulletin, 9*(2), 30-35.

Joanna Briggs Institute for Evidence Based Nursing. (1998). Falls in Hospital. *Best practice: Evidence based practice information sheets for health professionals, 2*(2), 1- 6.

Junnola, T., Eriksson, E., Salantera, S., & Lauri, S. (2002). Nurses' decision-making in collecting information for the assessment of patients' nursing problems. *Journal of Clinical Nursing, 11*, 186-196.

Kallmann, S.L., Denine-Flynn, M., & Blackburn, D.M. (1992). Comfort, safety, and independence: Restraint release and its challenges. *Geriatric Nursing, 13*, 143-148.

King, L., & Clark, J.M. (2002). Intuition and the development of expertise in surgical ward and intensive care nurses. *Journal of Advanced Nursing, 37*(4), 322-329.

Kostopoulos, M.R. (1985). Reducing patient falls. *Orthopaedic Nursing, 4*(6), 14-15.

Lamond, D., & Thompson, C. (2000). Intuition and analysis in decision making and choice. *Journal of Nursing Scholarship, 32*(4), 411-414.

Landis, J.R., & Koch, G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*(1), 159-174.

Llewellyn, J., Martin, B., Shekleton, M., & Firlit, S. (1988). Analysis of falls in the acute surgical and cardiovascular surgical patient. *Applied Nursing Research, 1*(3), 116-121.

Lord, S.R., Sherrington, C., & Menz, H.B. (2001). Falls in older people: Risk factors and strategies for prevention. Cambridge: Cambridge University Press.

Luker, K.A., & Kenrick, M. (1992). An exploratory study of the sources of influence on the clinical decisions of community nurses. *Journal of Advanced Nursing, 17*, 457-466.

Lund, C., & Sheafor, M.L. (1985). Is your patient about to fall? *Journal of Gerontological Nursing, 11*(4), 37-41.

MacAvoy, S., Skinner, T., & Hines, M. (1996). Fall risk assessment tool. *Applied Nursing Research, 9*(4), 213-218.

McClure, B. (2002). The enlightenment or age of reason [on-line]. Available: http://faculty.stcc.cc.tn.us/lessons2/enlightenment.htm. Accessed 02/05/2002.

McCollam, M.E. (1995). Evaluation and implementation of a research-based falls assessment innovation. *Nursing Clinics of North America, 30*(3), 507-514.

Mercer, L. (1997). Falling out of favour. *Australian Nursing Journal, 4*(7), 27-29.

Mitchell, A., & Jones, N. (1996). Striving to prevent falls in an acute care setting – action to enhance quality. *Journal of Clinical Nursing, 5*, 213-220.

Moore, T., Martin, J., & Stonehouse, J. (1996). Predicting falls: Risk assessment tool versus clinical judgement. *Perspectives, 20*(1), 8-11.

Morse, J.M. (1986). Computerized evaluation of a scale to identify the fall-prone patient. *Canadian Journal of Public Health, 77*, 21-25.

Morse, J.M., Black, C., Oberle, K., & Donahue, P. (1989). A prospective study to identify the fall-prone patient. *Social Science and Medicine, 28*(1), 81-86.

Morse, J.M. (1997). *Preventing patient falls*. Thousand Oaks, CA: SAGE.

Myers, H. (1999). [Yearly fall rates]. Unpublished raw data.

National Ageing Research Institute. (2000). *An analysis of research on preventing falls and falls injury in older people: Community, residential aged care and acute care settings*. Canberra: AusInfo.

National Health and Medical Research Council. (1994). *Falls and the older person* (Series on clinical management problems in the elderly no 6). Canberra: National Health and Medical Research Council.

National Health and Medical Research Council. (1999). *How to review the evidence: Systematic identification and review of the scientific literature.* Canberra: Australian Government Publishing Service.

Newell, A., & Simon, H.A. (1972). *Human problem solving.* Englewood Cliffs, NJ: Prentice-Hall.

Nunnally, J.C., & Bernstein, I.H. (1994). *Psychometric theory* (3rd ed). New York: McGraw Hill.

Nyberg, L., & Gustafson, Y. (1996). Using the Downton Index to predict those prone to falls in stroke rehabilitation. *Stroke, 27*(10), 1821-1824.

O' Connell B. (1998). The clinical application of the nursing process in selected acute care settings: A professional mirage. *Australian Journal of Advanced Nursing, 15*(4), 22-32.

O'Connell, B., & Myers, H. (2001). A failed fall prevention study in an acute care setting: Lessons from the swamp. *International Journal of Nursing Practice, 7*(2), 126-130.

Oliver, D., Britton, M., Seed, P., Martin, F.C., & Hopper, A.H. (1997). Development and evaluation of an evidence based risk assessment tool (STRATIFY) to predict which elderly inpatients will fall: Case-control and cohort studies. *British Medical Journal, 315*(7115), 1049-1053.

Oulton, R. (1981). Use of incident report data in a system-wide quality assurance/ risk management program. *Quality Review Bulletin, 7*, 2-7.

Patrick, L., Leber, M., Scrim, C., Gendron, I., & Eisner-Parsche, P. (1999). A standardized assessment and intervention protocol for managing risk for falls on a geriatric rehabilitation unit. *Journal of Gerontological Nursing, 25*(4), 40-47.

Paley, J. (1996). Intuition and expertise: Comments on the Benner debate. *Journal of Advanced Nursing, 23*(4), 665-671.

Price, C., Suddes, M., Maguire, L., Harrison, S., & O'Shea, D. (1998). Single assessment of risk predicted which elderly patients would fall. *British Medical Journal, 316*(7146), 1750.

Rainville, N.G. (1984). Effect of an implemented fall prevention program on the frequency of patient falls. *Quality Review Bulletin, 9*, 287-291.

Ruckstuhl, M.C., Marchionda, E.E., Salmons, J., & Larrabee, J.H. (1991). Patient falls: An outcome indicator. *Journal of Nursing Care Quality, 6*(1), 25-29.

Saul, J.R. (1993). *Voltaire's bastards: The dictatorship of reason in the West*. London: Penguin.

Schmid, N.A. (1990). Reducing patient falls: A research-based comprehensive fall prevention program. *Military Medicine, 155*(5), 202-207.

Spellbring, A.M. (1992). Assessing elderly patients at high risk for falls: A reliability study. *Journal of Nursing Care Quality, 6*(3), 30-35.

Spellbring, A.M., Gannon, M.E., Kleckner, T., & Conway, K. (1988). Improving safety for hospitalized elderly. *Journal of Gerontological Nursing, 14*(2), 31-37, 46-47.

Stetler, C.B., Corrigan, B., Sander-Buscemi, K., & Burns, M. (1999). Integration of evidence into practice and the change process: Fall prevention program as a model. *Outcomes Management for Nursing Practice, 3*(3), 102-111.

Sullivan, R.P., & Badros, K.K. (1999). Recognize risk factors to prevent patient falls. *Nursing Management, 30*(5), 37-40.

Sweeting, H.L. (1994). Patient fall prevention – a structured approach. *Journal of Nursing Management, 2*, 187-192.

Tack, K.A., Ulrich, B., & Kehr, C. (1987). Patient falls: Profile for prevention. *Journal of Neuroscience Nursing, 19*(2), 83-89.

Tanner, C.A. (2000). Critical thinking: Beyond nursing process. *Journal of Nursing Education, 39*(8), 338.

Taylor, C. (2000). Clinical problem-solving in nursing: Insights from the literature. *Journal of Advanced Nursing, 31*(4), 842-849.

Thompson, C. (1999). A conceptual treadmill: The need for 'middle ground' in clinical decision making theory in nursing. *Journal of Advanced Nursing, 30*(5), 1222-1229.

Turkoski, B., Pierce, L.L., Schreck, S., Salter, J., Radziewicz, R., Gudhe, J. & Brady, R. (1997). Clinical nursing judgement related to reducing the incidence of falls by elderly patients. *Rehabilitation Nursing, 22*(3), 124-130.

Widder, B. (1985). A new device to decrease falls. *Geriatric Nursing, 6*(5), 287-288.

Wood, L., & Cunningham, G. (1992). Fall risk protocol and nursing care plan. *Geriatric Nursing, 7/8*, 205-206.

APPENDIX 1: LIST OF FALL RISK ASSESSMENT STUDIES IN PUBLICATION DATE ORDER

Date	Endnote Number	Reference
June 1981	235	Oulton, R. (1981). Use of incident report data in a system-wide quality assurance/ risk management program. *Quality Review Bulletin, 7*, 2-7.
Feb 1983	34	Innes, E.M. & Turman, W.G. (1983). Evaluation of patient falls. *Quality Review Bulletin, 9*(2), 30-35.
March 1983	4	Barbieri, E.B. (1983). Patient falls are not patient accidents. *Journal of Gerontological Nursing, 9*(3), 165-173.
Sept 1984	28	Rainville, N.G. (1984). Effect of an implemented fall prevention program on the frequency of patient falls. *Quality Review Bulletin, 9*, 287-291.
Nov 1984	16	Fife, D.D., Solomon, P. & Stanton, M. (1984). A risk/falls program: Code orange for success. *Nursing Management, 15*(11), 50-53.
April 1985	24	Lund, C. & Sheafor, M.L. (1985). Is your patient about to fall? *Journal of Gerontological Nursing, 11*(4), 37-41.
July 1985	33	Innes, E.M. (1985). Maintaining fall prevention. *Quality Review Bulletin, 11*(7), 217-221.
Sept 1985	35	Widder, B. (1985). A new device to decrease falls. *Geriatric Nursing, 6*(5), 287-288.
Nov 1985	36	Kostopoulos, M.R. (1985). Reducing patient falls. *Orthopaedic Nursing, 4*(6), 14-15.
March 1986	19	Hernandez, M. & Miller, J. (1986). How to reduce falls. *Geriatric Nursing, 7*(2), 97-102.
May 1986	10	Morse, J.M. (1986). Computerized evaluation of a scale to identify the fall-prone patient. *Canadian Journal of Public Health, 77*, 21-25.
April 1987	2	Tack, K.A., Ulrich, B. & Kehr, C. (1987). Patient falls: Profile for prevention. *Journal of Neuroscience Nursing, 19*(2), 83-89.
Feb 1988	13	Spellbring, A.M., Gannon, M.E., Kleckner, T. & Conway, K. (1988). Improving safety for hospitalized elderly. *Journal of Gerontological Nursing, 14*(2), 31-37, 46-7..
July 1988	6	Hill, B.A., Johnson, R. & Garrett, B.J. (1988). Reducing the incidence of falls in high risk patients. *Journal of Nursing Administration, 18*(7,8), 24-28.
Nov 1988	7	Hendrich, A.L. (1988). An effective unit-based fall prevention plan. *Journal of Nursing Quality Assurance, 3*(1), 28-36.
Nov 1988	30	Llewellyn, J., Martin, B., Shekleton, M. & Firlit, S. (1988). Analysis of falls in the acute surgical and cardiovascular surgical patient. *Applied Nursing Research, 1*(3), 116-121.
July 1989	8	Berryman, E., Gaskin, D., Jones, A., Tolley, F. & MacMullen, J. (1989). Point by point: Predicting elders falls. *Geriatric Nursing, 10*(4), 199-201.

1989	12	Morse, J.M., Black, C., Oberle, K. & Donahue, P. (1989). A prospective study to identify the fall-prone patient. *Social Science and Medicine, 28*(1), 81-86.
May 1990	11	Schmid, N.A. (1990). Reducing patient falls: A research-based comprehensive fall prevention program. *Military Medicine, 155*(5), 202-207.
March 1991	39	Brians, L.K., Alexander, K., Grota, P., Chen, R.W.H. & Dumas, V. (1991). The development of the RISK tool for fall prevention. *Rehabilitation Nursing, 16*(2), 67-69.
Oct 1991	5	Ruckstuhl, M.C., Marchionda, E.E., Salmons, J. & Larrabee, J.H. (1991). Patient falls: An outcome indicator. *Journal of Nursing Care Quality, 6*(1), 25-29.
April 1992	14	Spellbring, A.M. (1992). Assessing elderly patients at high risk for falls: A reliability study. *Journal of Nursing Care Quality, 6*(3), 30-35.
May 1992	3	Kallmann, S.L., Denine-Flynn, M. & Blackburn, D.M. (1992). Comfort, safety, and independence: Restraint release and its challenges. *Geriatric Nursing, 13*, 143-148.
July 1992	29	Wood, L. & Cunningham, G. (1992). Fall risk protocol and nursing care plan. *Geriatric Nursing, 7/8*, 205-206.
1992	31	Heslin, K., Towers, J., Leckie, C., Thornton-Lawrence, H., Perkin, K., Jacques, M., Mullin, J. & Wick, L. (1992). Managing falls: identifying population-specific risk factors and prevention strategies. In S.G. Funk, E.M. Tornquist, M.T. Champagne & R.A. Wiese (Eds.), *Key aspects of elder care: Managing falls, incontinence, and cognitive impairment* (pp70-80). New York: Springer.
1992	32	Hollinger, L.M. & Patterson, P.A. (1992). A falls prevention program for the acute care setting. In S.G. Funk, E.M. Tornquist, M.T. Champagne & R.A. Wiese (Eds.), *Key aspects of elder care: Managing falls, incontinence, and cognitive impairment* (pp 110-117). New York: Springer.
1993	277	Downton, J.H. (1993). *Falls in the elderly*. London: Edward Arnold.
Sept 1993	27	Brady, R., Chester, F.R., Pierce, L.L., Salter, J.P., Schreck, S. & Radziewicz, R. (1993). Geriatric falls: Prevention strategies for the staff. *Journal of Gerontological Nursing, 19*(9), 26-32.
July 1994	18	Sweeting, H.L. (1994). Patient fall prevention – a structured approach. *Journal of Nursing Management, 2*, 187-192.
Aug 1995	9	Hendrich, A., Nyhuis, A., Kippenbrock, T. & Soja, M.E. (1995). Hospital falls: Development of a predictive model for clinical practice. *Applied Nursing Research, 8*(3), 129-139.
Sept 1995	15	McCollam, M.E. (1995). Evaluation and implementation of a research-based falls assessment innovation. *Nursing Clinics of North America, 30*(3), 507-514.
1996	247	Moore, T., Martin, J., & Stonehouse, J. (1996). Predicting falls: Risk assessment tool versus clinical judgement. *Perspectives, 20*(1), 8-11.

July 1996	25	Mitchell, A. & Jones, N. (1996). Striving to prevent falls in an acute care setting – action to enhance quality. *Journal of Clinical Nursing, 5*, 213-220.
Oct 1996	38	Nyberg, L. & Gustafson, Y. (1996). Using the Downton Index to predict those prone to falls in stroke rehabilitation. *Stroke, 27*(10), 1821-1824.
Nov 1996	37	MacAvoy, S., Skinner, T. & Hines, M. (1996). Fall risk assessment tool. *Applied Nursing Research, 9*(4), 213-218.
Feb 1997	21	Mercer, L. (1997). Falling out of favour. *Australian Nursing Journal, 4*(7), 27-29.
Sept 1997	17	Bakarich, A., McMillan, V. & Prosser, R. (1997). The effect of a nursing intervention on the incidence of older patient falls. *Australian Journal of Advanced Nursing, 15*(1), 26-31.
Oct 1997	20	Oliver, D., Britton, M., Seed, P., Martin, F.C. & Hopper, A.H. (1997). Development and evaluation of an evidence based risk assessment tool (STRATIFY) to predict which elderly inpatients will fall: Case-control and cohort studies. *British Medical Journal, 315*(7115), 1049-1053.
June 1998	26	Price, C., Suddes, M., Maguire, L., Harrison, S. & O'Shea, D. (1998). Single assessment of risk predicted which elderly patients would fall. *British Medical Journal, 316*(7146), 1750.
April 1999	93	Patrick, L., Leber, M., Scrim, C., Gendron, I. & Eisner-Parsche, P. (1999). A standardized assessment and intervention protocol for managing risk for falls on a geriatric rehabilitation unit. *Journal of Gerontological Nursing, 25*(4), 40-47.
May 1999	47	Sullivan, R.P. & Badros, K.K. (1999). Recognize risk factors to prevent patient falls. *Nursing Management, 30*(5), 37-40.
July 1999	22	Eagle, D.J., Salama, S., Whitman, D., Evans, L.A., Ho, E. & Olde, J. (1999). Comparison of three instruments in predicting accidental falls in selected inpatients in a general teaching hospital. *Journal of Gerontological Nursing, 25*(7), 40-45.
July 1999	46	Stetler, C.B., Corrigan, B., Sander-Buscemi, K. & Burns, M. (1999). Integration of evidence into practice and the change process: Fall prevention program as a model. *Outcomes Management for Nursing Practice, 3*(3), 102-111.
Nov 1999	45	Forrester, D.A., McCabe-Bender, J. & Tiedeken, K. (1999). Fall risk assessment of hospitalized adults and follow-up study. *Journal for Nurses in Staff Development, 15*(6), 251-259.
Dec 1999	23	Conley, D., Schultz, A.A. & Selvin, R. (1999). The challenge of predicting patients at risk for falling: Development of the Conley Scale. *MEDSURG Nursing, 8*(6), 348-354.
July 2000	237	Farmer, B.C. (2000). Fall Risk Assessment. *Journal of Gerontological Nursing, 26*(7), 6-7.
April 2001	238	O'Connell, B. & Myers, H. (2001). A failed fall prevention study in an acute care setting: Lessons from the swamp. *International Journal of Nursing Practice, 7*(2), 126-130.

APPENDIX 2: FALL RISK ASSESSMENT TOOL 1

(Berryman, Gaskin, Jones, Tolley and MacMullen [1989] with revisions by MacAvoy, Skinner and Hines [1996])

I.	AGE			
	65-79 years		1	O
	80 and above		2	O
II.	MENTAL STATUS			
	A.	Oriented at all times or comatose	0	O
		Confusion at all times	2	O
		Intermittent confusion	4	O
	B.	Agitated / uncooperative / anxious – moderate	2	O
		Agitated / uncooperative / anxious – severe	4	O
III.	ELIMINATION			
	Independent and continent		0	O
	Catheter and / or ostomy		1	O
	Elimination with assistance		3	O
	Independent and incontinent		5	O
IV.	HISTORY OF FALLING WITHIN SIX MONTHS			
	No history		0	O
	Has fallen one or two times		2	O
	Multiple history of falling		5	O
V.	SENSORY IMPAIRMENT			
	Sensory impairment		1	O
VI.	ACTIVITY			
	Ambulation / transfer without assistance		0	O
	Ambulation / transfer with assist of one or assistive device		2	O
	Ambulation / transfer with assist of two		1	O

VII.	MEDICATIONS	Yes		No
	Narcotics	O		O
	Tranquilisers	O		O
	Sleepers	O		O
	Diuretics	O		O
	Chemotherapy	O		O
	Antiseizure / antiepileptic	O		O

For the above medications, check how many the patient is taking.

No medications	0	O
1 medication	1	O
2 or more medications	2	O

Add one point if	Yes	1	No
Change in these medications or dosages in the past five days	O		O

A score of 10 or more indicates a high risk for falling.

APPENDIX 3: FALL RISK ASSESSMENT TOOL 2

[Schmid (1990)]

MOBILITY		
Ambulates with no gait disturbance	0	O
Ambulates or transfers with assistive devices or assist	1	O
Ambulates with unsteady gait and no assistance	1	O
Unable to ambulate or transfer	0	O
MENTATION		
Alert, oriented to time, place and person	0	O
Periodic confusion	1	O
Confusion at all times	1	O
Comatose/unresponsive	0	O
ELIMINATION		
Independent in elimination	0	O
Independent with frequency or diarrhoea	1	O
Needs assistance with toileting	1	O
Incontinence	1	O
PRIOR FALL HISTORY		
Yes – before admission (home or previous inpatient episode)	1	O
Yes – during this admission	2	O
No	0	O
Unknown	1	O
CURRENT MEDICATIONS		
Anti convulsants/ tranquilisers or psychotropic/hypnotics	1	O
None of the above medications	0	O

A score of 3 or above indicates patient is at potential risk for falls.

APPENDIX 4: FALL RISK DATA COLLECTION FORM

MOBILITY				
Ambulates with no gait disturbance				O
Ambulates with unsteady gait				O
Unable to ambulate				O
Ambulation / transfer without assistance (person or device)				O
Ambulation / transfer with assistance of one person or assistive device				O
Ambulation / transfer with assistance of two persons				O
MENTAL STATE				
Alert, oriented to time, place and person				O
Periodic confusion				O
Confusion at all times				O
Comatose/unresponsive				O
Agitated	Moderate	O	Severe	O
Uncooperative	Moderate	O	Severe	O
Anxious	Moderate	O	Severe	O
Unknown				O
PRIOR FALL HISTORY				
Yes – before admission (home or previous inpatient episode)				O
Yes – during this admission				O
No				O
Unknown				O
No history within last six months				O
Has fallen one or two times in last six months				O
Multiple history of falling in last six months				O
SENSORY IMPAIRMENT			Yes	No
Visual impairment			O	O
Hearing impairment			O	O

ELIMINATION

Continent at all times							O
Periodic incontinence							O
Urinary	O	Faecal	O	Both	O	N/A	O
Incontinent at all times							O
Urinary	O	Faecal	O	Both	O	N/A	O
Independent with elimination							O
Needs assistance with elimination							O

	Yes	No
Frequency / Urgency	O	O
Diarrhoea	O	O
Catheter	O	O
Ostomy	O	O

MEDICATIONS	Yes	No
2C: Diuretics (CVS)	O	O
3A: Sedatives / Hypnotics (CNS)	O	O
3B: Antianxiety Agents (CNS)	O	O
3C: Antipsychotic Agents (CNS)	O	O
3D: Antidepressants (CNS)	O	O
3G: Anticonvulsants (CNS)	O	O
4A: Narcotic Analgesics	O	O
9A-9F: Cytotoxic Agents (Neoplastic disorders)	O	O
Change in medications or dosages in the past five days	O	O

APPENDIX 5: FALL PREVENTION INTERVENTION CHECKLIST

	Yes	No
Fall risk assessment completed on admission	O	O
On fall risk care plan	O	O
Standards implemented		
1: Educate patient and involve patient in safety precautions	O	O
2: Orientate patient to environment	O	O
3: Call bell within easy reach at all times	O	O
4: Ensure adequate lighting at all times e.g. use of night light	O	O
5: Remove potential hazards/obstacles from the patient's room	O	O
6: Have frequently used objects within easy reach	O	O
a: Bed in low position	O	O
b: Use low height bed	O	O
c: Side rail(s) of bed elevated at all times	O	O
d: Patient assisted in transferring (bed/chair) at all times	O	O
e: Patient assisted to ambulate at all times	O	O
f: Patient to wear non slip shoes/slippers when ambulating	O	O
g: Ensure walking aids used as required and pt aware of correct use	O	O
h: Ensure walking aids within easy reach of patient	O	O
i: Toilet patient prior to settling in bed and offer toilet regularly	O	O
j: Medical staff and CNS review of patient re risk management	O	O
k: Assess/review medication that may increase pts risk of falling	O	O
l: Use restraining devices	O	O
m: Encourage supervision of pt by family if appropriate	O	O
n: After consultation with CNS, nurse patient on floor	O	O
o: Use appropriate signage to indicate "patient at risk of falls"	O	O
p: Offer commode/toilet after meals	O	O
Fall risk sticker on nursing notes	O	O

APPENDIX 6: COPY OF NURSING RESEARCH SCIENTIFIC SUB-COMMITTEE APPROVAL LETTER

Metropolitan Health Service

SIR CHARLES GAIRDNER HOSPITAL

21st July 2000

Helen Myers
Clinical Nurse Research
Nursing Practice Research Network
Q Block
Sir Charles Gairdner Hospital
Nedlands. WA 6009

Dear Helen

" Fall Risk Assessment: A prospective investigation of nurses' clinical judgement and risk assessment tools in predicting patient falls in an acute care setting".

The Nursing Research Scientific Sub-Committee (NRSS) met on the 18th July 2000 to review your proposal. The committee commented on the high calibre of your proposal. I have great pleasure in advising you that the committee approved your proposal.

You may commence your study once approval documentation from Human Research Ethics Committee have been received by the SCGH University Department of Nursing Research and Development in Q Block.

Yours sincerely

[redacted]

EXECUTIVE DIRECTOR OF NURSING SERVICES

Hospital Avenue, Nedlands, Western Australia 6009
Telephone + 618 9346 3333 Facsimile + 618 9346 3759 T.T.Y Line + 618 9346 3900
Website:http://www.scgh.health.wa.gov.au

APPENDIX 7: COPY OF SIR CHARLES GAIRDNER HOSPITAL HUMAN RESEARCH ETHICS COMMITTEE APPROVAL LETTER

Metropolitan Health Service

SIR CHARLES GAIRDNER HOSPITAL

NJD/mmg/Ethics 2000-086
Ext 2999
2 August 2000

Ms H Myers
Nursing Practice Research Network
Q Block
THE QUEEN ELIZABETH II MEDICAL CENTRE

Dear Ms Myers

HUMAN RESEARCH ETHICS COMMITTEE – Trial No. 2000-086
Fall Risk Assessment: A prospective investigation of nurses' clinical judgement and risk assessment tools in predicting patient falls in an acute care setting

The Human Research Ethics Committee has reviewed your application for the above project. Although the following matters require attention it was agreed that the Deputy Chair be empowered to approve the project as soon as a satisfactory reply to these matters has been received.

It was noted in the Nurse Information Sheet that the interview 'will take no longer than five minutes'. This was considered to be an unrealistic period of time and you are requested to amend the sentence to read 'approximately five minutes'. It is further requested that a statement to the effect that the interview will be conducted in a quiet area be inserted in the Information Sheet.

Would you please send your reply to me at your earliest convenience in order to ensure prompt approval of your project. Please quote Ethics 2000-086 as our reference number.

Yours sincerely,

[redacted]

DEPUTY CHAIR
HUMAN RESEARCH ETHICS COMMITTEE

Hospital Avenue, Nedlands, Western Australia 6009

Telephone + 618 9346 3333 Facsimile + 618 9346 3759 T.T.Y Line + 618 9346 3900

Website:http://www.scgh.health.wa.gov.au

SIR CHARLES GAIRDNER HOSPITAL

Metropolitan Health Service

LAS/mmg/Ethics 2000-086a
Ext 2999
4 August 2000

Ms H Myers
Nursing Practice Research Network
Q Block
THE QUEEN ELIZABETH II MEDICAL CENTRE

Dear Ms Myers

HUMAN RESEARCH ETHICS COMMITTEE – Trial No. 2000-086
Fall Risk Assessment: A prospective investigation of nurses' clinical judgement and risk assessment tools in predicting patient falls in an acute care setting

Thank you for the amended copy of the Information Sheet received in response to the Committee's request. Please be advised that ethical approval of the project has been granted by the Human Research Ethics Committee. This approval is for the submitted protocol and the Information Sheet and Consent Form dated 3 August 2000. It is granted on the understanding that the project will commence within twelve months of the date of this letter or a new application may have to be submitted. Equally if the project is discontinued before the expected date of completion the Committee must be informed and the reasons provided for the cessation.

Whilst the Committee is satisfied that the protocol as submitted has adequate safeguards to protect the rights of individual participants it is the responsibility of the researcher to advise the Committee of any departure from the original protocol which could impact on this ethical approval.

The Committee is bound by National Health and Medical Research Council guidelines to monitor the progress of all approved projects until completion to ensure that they continue to conform to approved ethical standards. Therefore you are required to submit annual reports on the human rights aspects of your study and immediate reports of any adverse events. You are also requested to submit for approval copies of advertisements to be used to recruit subjects (if applicable). An annual report is due in August 2001.

As the responsibility for the conduct of the trial lies with you as the investigator, all communication to the committee should be signed by you.

Please quote Ethics 2000-86 on all correspondence associated with this study.

Yours sincerely,

[redacted]

DEPUTY CHAIR
HUMAN RESEARCH ETHICS COMMITTEE

cc Nursing Research Scientific Committee

Hospital Avenue, Nedlands, Western Australia 6009
Telephone + 618 9346 3333 Facsimile + 618 9346 3759 T.T.Y Line + 618 9346 3900
Website:http://www.scgh.health.wa.gov.au

APPENDIX 8: PARTICIPANT INFORMATION SHEET AND CONSENT FORM

Sir Charles Gairdner Hospital

Hospital Ave, Nedlands Western Australia, 6009

Fall Risk Assessment: A prospective investigation of nurses' clinical judgement and risk assessment tools in predicting patient falls in an acute care setting

Investigators: Helen Myers, Dr Sue Nikoletti

Participant Information Sheet

The prevention of patient falls in acute care hospital settings has been identified as a major priority for intervention and research. There is an urgent need to develop and implement fall prevention strategies that have been tested in clinical settings. Often, a first step in implementing fall prevention programs is to identify those patients most at risk of falling and therefore most in need of fall prevention interventions. Identification of high-risk patients allows clinical staff to target interventions in order to use resources effectively. In conjunction with testing the validity of some fall risk assessments tools identified from a literature review we would like to gain further information about how nurses make decisions about which patients are at risk of falling. This information can be used to either improve existing risk assessment tools or design new fall risk assessment tools that are useful for nurses in the clinical setting.

We would like to interview you about your views on why a particular patient is or isn't at risk of falling. This would involve;

- asking you to make a decision about whether a particular patient is at risk of falling, and
- asking you to describe what factors you considered when you made this decision.

The interview will be taperecorded and will take approximately five minutes. The interview will be conducted in the patient interview room or the handover room to ensure privacy and quietness. At any time during this interview you may ask for the tape to be switched off.

Confidentiality

All information that you give during the interview will remain confidential. The interview transcripts are coded with an identification number and your name will not be attached to the identification number. The interviews tapes will be transcribed and the tapes erased. The interviews will be conducted by Helen Myers and the names of nurses who were interviewed will not be disclosed to other ward staff.

Information from your interview may be used in the research report, but you will not be identified in any way. The transcripts of the interviews will be stored in a locked cabinet for a period of 5 years.

It is important for you to know that you do not have to participate and that your decision to participate or not will be respected. Taking part is voluntary and you can withdraw at any time.

For any further information please phone Helen Myers on [redacted] at the Nursing Practice Research Network.

3/8/2000

Sir Charles Gairdner Hospital

Hospital Ave, Nedlands Western Australia, 6009

Fall Risk Assessment: A prospective investigation of nurses' clinical judgement and risk assessment tools in predicting patient falls in an acute care setting

Investigators: Helen Myers, Dr Sue Nikoletti

Consent Form

THIS IS TO CERTIFY THAT I,

____, have been given clear information (verbal and written) about this interview and have been given time to consider whether I want to take part. All related questions have been answered to my satisfaction by the researcher, and I understand that I am able to ask any further questions in this regard. I understand that I am free to withdraw from this interview at any time. I have volunteered to assist the researchers and participate in this interview and give permission for the data to be published as long as I am not identified.

....

Name of Nurse Signature of Nurse
Date

....

Name of Witness to Nurse's Signature Witness to Signature
Date

....

Name of Investigator Signature of Investigator
Date

The Sir Charles Gairdner Hospital Human Research Ethics Committee has given ethics approval for the conduct of this project. If you have any ethical concerns regarding the study you can contact the secretary of the Sir Charles Gairdner Hospital Human Research Ethics Committee on telephone No. (08) 9346.2999.

All study participants will be provided with a copy of the Information Sheet and Consent Form for their personal records.

3/8/2000

APPENDIX 9: VALIDITY CALCULATIONS FOR RISK ASSESSMENT METHODS

Fall Risk Assessment Tool 1

	Fell (Dx+)	Didn't fall (Dx-)	Total
High risk score (Positive) (10 or more)	n=31 (a) (True positive)	n=144 (b) (False positive)	n=175 (a+b)
Low risk score (Negative) (less than 10)	n=3 (c) (False negative)	n=48 (d) (True negative)	n=51 (c+d)
Total	n=34 (a+c)	n=192 (b+d)	N=226

Sensitivity
(Proportion of patients who fell who were correctly identified as high risk by the risk assessment method)

$$= \frac{a}{a+c} = \frac{31}{34} = 91\%$$

Specificity
(Proportion of patients who didn't fall who were correctly identified as low risk by the risk assessment method)

$$= \frac{d}{b+d} = \frac{48}{192} = 25\%$$

Positive predictive value (PV+)
(Proportion of patients identified as high risk by the risk assessment method who did fall)

$$= \frac{a}{a+b} = \frac{31}{175} = 18\%$$

Negative predictive value (PV-)
(Proportion of patients identified as low risk by the risk assessment method who did not fall)

$$= \frac{d}{c+d} = \frac{48}{51} = 94\%$$

Fall Risk Assessment Tool 2

	Fell (Dx+)	Didn't fall (Dx-)	Total
High risk score (Positive) (3 or more)	n=31 (a) (True positive)	n=141 (b) (False positive)	n=172 (a+b)
Low risk score (Negative) (Less than 3)	n=3 (c) (False negative)	n=51 (d) (True negative)	n=54 (c+d)
Total	n=34 (a+c)	n=192 (b+d)	N=226

Sensitivity
(Proportion of patients who fell who were correctly identified as high risk by the risk assessment method)

$$= \frac{a}{a+c} = \frac{31}{34} = 91\%$$

Specificity
(Proportion of patients who didn't fall who were correctly identified as low risk by the risk assessment method)

$$= \frac{d}{b+d} = \frac{51}{192} = 27\%$$

Positive predictive value (PV+)
(Proportion of patients identified as high risk by the risk assessment method who did fall)

$$= \frac{a}{a+b} = \frac{31}{172} = 18\%$$

Negative predictive value (PV-)
(Proportion of patients identified as low risk by the risk assessment method who did not fall)

$$= \frac{d}{c+d} = \frac{51}{54} = 94\%$$

Clinical Judgement

	Fell (Dx+)	Didn't fall (Dx-)	Total
High risk score (Positive) (Yes)	n=30 (a) (True positive)	n=141 (b) (False positive)	n=171 (a+b)
Low risk score (Negative) (No)	n=4 (c) (False negative)	n=49 (d) (True negative)	n=53 (c+d)
Total	n=34 (a+c)	n=190 (b+d)	N=224

Sensitivity
(Proportion of patients who fell who were correctly identified as high risk by the risk assessment method)

$$= \frac{a}{a+c} = \frac{30}{34} = 88\%$$

Specificity
(Proportion of patients who didn't fall who were correctly identified as low risk by the risk assessment method)

$$= \frac{d}{b+d} = \frac{49}{190} = 26\%$$

Positive predictive value (PV+)
(Proportion of patients identified as high risk by the risk assessment method who did fall)

$$= \frac{a}{a+b} = \frac{30}{171} = 18\%$$

Negative predictive value (PV-)
(Proportion of patients identified as low risk by the risk assessment method who did not fall)

$$= \frac{d}{c+d} = \frac{49}{53} = 92\%$$