Patient falls: a key issue in patient safety in hospitals

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SUMMARY

Patient safety issues in hospital settings gained worldwide attention within the adverse events discourse launched by the landmark report "to err is human" by the Institute of Medicine in 2000. In this report it was estimated that health care errors and adverse events (AE's) may account for up to 98,000 patient deaths per year in the USA. Research in AE's revealed that between 2.9% and 16.6% of hospitalized patients experience at least one AE during a hospital episode. Permanent disability or death due to AE's has been experienced by up to 15.9% of the patients. Although AE's have primarily focused on adverse events associated with surgical procedures and adverse drug reactions, in-patient falls and associated injuries deserve increasing attention as they have shown to be most frequent AE's in hospital settings.

Patient falls in the hospital care setting are recognized as a serious health problem since they are common and may result in injuries and complications which prolongs hospitalization, decreases patients' functional capacities and leads to increased health care costs. The impact a fall can have on a patient's perception of safety and well-being may inhibit the patient's ability and willingness to participate in activities of daily living and rehabilitation due to fear of falling again. Many aspects of in-patient falls in hospitals such as circumstances, patient characteristics and fall risk factors as well as interventions to prevent patient falls during hospitalization have been widely researched. Yet, there remain gaps in the evidence which guided this research program. More specifically, 1) little information was available regarding fall characteristics among clinical departments of single acute care hospitals, 2) there was a need for further validation of screening instruments to identify in-patients at risk for falling during hospitalization and 3) findings on the effectiveness of multifactorial falls prevention programs in acute care settings and their sustainability in daily clinical practice was conflicting.

This research program consisted of a series of retro- and prospective studies addressed the cited gaps. Using clinical and demographic patient data of more than 34,000 hospitalized patients from the years 1999 to 2003 of the "Stadtspital Waid", an urban public hospital in Zurich, Switzerland, and findings in relation to the following six research areas are summarized.

First, in a 5 year population-based retrospective study we examined characteristics associated with hospital in-patient falls across clinical departments using incident reporting data and administrative patient data. In a population of 34,972 hospitalized patients (mean age: 67.3 years; female 53.6%, mean length of stay: 11.9 days), 7.2% of the in-patients experienced at least one fall during their hospitalization (surgical department: 1.9%, medical department: 8.8% and geriatric

department 24.8%). Comparison of fallers and non-fallers revealed that fallers were on average 13.5 years older, consisted of 3.8% more females and stayed on average 13.1 days longer in the hospital. Two third (64.8%) of the patients who fell were not injured, 30.1% experienced minor injuries and 5.1% sustained major injuries. Three out of four patients (75.7%) fell in their bedrooms. Patients fell most often while ambulating (43%) and transferring (35%). Fall risk factors in patients who fell included: impaired mobility (83.1%), impaired cognition (55.3%), use of narcotics (38.6%), and use of psychotropics (25.4%). Half of the patients (50.1%) who fell while hospitalized had a pre-hospital history of falls. These findings are in line with international findings indicating that in-patient falls in hospitals are common especially in departments of geriatrics and internal medicine. Characteristics of falls identified in this study in relation to the time, location, and consequences are similar to findings of previous studies. It appears that in-patient falls should be regarded as an important safety issue especially since one in three falls resulted in at least a minor injury. We recommend giving attention to identifying patients at risk for falling and implementing effective interventions to prevent patient falls and to minimize fall related injuries.

Second, we investigated the association between hospital in-patient fall rates and days of the week, months and lunar cycles. Previous reports indicated that health care professionals hold perceptions that in-patient falls may increase during times of full moon. We therefore compared adjusted fall rates per 1,000 patient days with days of the week and months within 62 complete lunar cycles. The fall rates fluctuated slightly over the entire observation time, ranging from 8.4 to 9.7 falls per month (p=0.757), and from 8.3 falls on Mondays to 9.3 falls on Saturdays (p=0.587). The fall rates within the lunar days ranged from 7.2 falls on lunar day 17 to 10.6 falls on lunar day 20 (p=0.575). Our study revealed that inpatient fall rates were not associated with days of the week, months, or seasons or with lunar cycles such as a full moon or new moon. Therefore, existing perceptions that falls are associated with full moon were not confirmed. We suggest that preventive strategies focus on patients' modifiable fall risk factors (e.g. gait instability) and the provision of a safe hospital environment.

Third, we contributed to the further validation of fall risk instruments with a prospective cohort study in which we evaluated the diagnostic value of the Morse Fall Scale (MFS). The goal was to identify risk for falling in hospitalized patients analyzing different MFS cut-offs to determine which score was most useful in identifying in-hospital patients at risk for falls. A consecutive sample of 386 hospitalized patients of the department of internal medicine was studied. The primary nurses completed the MFS (fall risk items: history of falling, secondary diagnosis, ambulatory aids, intravenous therapy, type of gait, and mental status) for each newly hospitalized patient

within 24 hours of admission. ROC analysis showed that a cut off of 55 points on the MFS had the highest diagnostic value (AUC: 0.701) with a sensitivity of 74.5%, a specificity of 65.8%, and positive and negative predictive values of 23.3%, and 94.9% respectively. While the high negative predictive values (e.g. 95% of the non falling patients were identified as not at risk for falling) may give appropriate reassurance for patients with low risk for falling, the scale seems to be of limited operational value since positive predictive values were only between 12% and 24%. While screening patients for risk for falling may lead to more targeted assessment and subsequent modification of risk factors using multifactorial interventions, we recommended that the MFS undergo local validation to determine the best cut off score for a given setting before its clinical use.

The fourth study focused on better predicting a patient's risk of falling. We assessed the predictive value of the STRATIFY instrument, a simple fall-risk assessment tool, administered by nurses. Our prospective multi-center study was carried out in six Belgian hospitals during a 3-month period. A total of 2,568 patients expected to be hospitalized for at least 48 hours (mean age: 67.2 years; female: 55.3%) and who were admitted to four surgical (n=875; 34.1%), eight geriatric (n=687; 26.8%), and four general medical wards (n=1,006; 39.2%) were included in this study at the time of their hospital admission. Nurses completed the STRATIFY within 24 hours after admission of the patient. Subsequent falls were documented on a standardized incident report form. The number of fallers was 136 (5.3%), accounting for 190 falls. The STRATIFY showed good sensitivity (≥85%) and high negative predictive value (≥99%) for the total sample, for patients admitted to general medical and surgical wards, and for patients younger than 65 years. The STRATIFY, however, showed moderate (67%) to low (57%) sensitivity and high false negative rates (33% and 43%) for patients admitted to geriatric wards and for patients 65 years or older. Thus, although the STRATIFY satisfactorily predicted the fall risk of patients admitted to general medical and surgical wards and patients younger than 65 years, it failed to predict the fall risk of patients admitted to geriatrics wards and patients 65 years and older.

The fifth study was an intervention study, using a quasi-experimental design. More specifically, we evaluated the effectiveness of a nurse-led fall prevention program in a hospital. In a four month study period, 409 patients from an internal medicine department were included in an intervention group (n=198) or usual care group (n=211). The program consisted of training nurses in the use of the Morse Fall Scale and the implementation of 15 preventive interventions such as orienting patients to hospital environment and schedules, assisting patients with transfers and ambulation, and providing safe footwear and clothing. Patient falls were registered using the standardized falls incident report form. In the intervention group the proportion of patients at risk

for falls was higher (p=0.048), and fewer patients with multiple falls were observed (p=0.009). The intervention program was effective in preventing multiple falls but not first falls. A prolonged time to a first fall in a subgroup of fallers in the intervention group may indicate that there was increased nurse awareness of patients at risk for falling and the appropriateness of the interventions utilized. The findings indicate that the intervention program was not successful in preventing falls during the first four days of hospitalization, while some effect can be seen thereafter. Based on the experiences with this intervention protocol, an interdisciplinary hospital falls prevention program has been implemented.

In the final study, we examined in-patient fall rates and consequent injuries before and after the implementation of this interdisciplinary falls prevention program (IFP) using a serial survey design. While the fifth study tested the efficacy of the intervention program, this study assessed effectiveness in daily life. The population under study included 34,972 patients (mean age: 67.3 years; female 53.6%, mean length of stay: 11.9 days, mean nursing care time per day: 3.5 hours), hospitalized in the departments of internal medicine, geriatrics, and surgery from 1999 to 2003. Overall, a total of 3,842 falls affected 2,512 (7.2%) of the hospitalized patients. From these falls, 2,552 (66.4%) were without injuries, while 1,142 (29.7%) falls resulted in minor injuries, and 148 (3.9%) falls resulted in major injuries. The fall rates per 1,000 patient days fluctuated slightly from 9.1 falls in 1999 to 8.6 falls in 2003 (p=0.086). After the implementation of the IFP, in 2001 a slight decrease to 7.8 falls per 1,000 patient days was observed until the end of the same year. The annual proportion of minor and major injuries did not decrease after the implementation of the IFP. From 1999 to 2003, patient characteristics changed in terms of slight increases (female gender, age, nursing care time) or decreases (length of hospital stay), as did the prevalence of fall risk factors (up to 46.8%) in those patients who fell. In conclusion, following the implementation of the interdisciplinary falls prevention program, neither the frequencies of falls nor consequent injuries decreased substantially. We have hypothesized that lack of adherence to the fall prevention program lead to this ineffectiveness. Future studies need to incorporate strategies to maximize and evaluate ongoing adherence to interventions in hospital falls prevention programs.

The results of our research program contributed to the evidence based on hospital falls. First, it added detailed knowledge on characteristics of in-patient falls in departments of medicine, geriatrics and surgery within a single hospital. Second, it established for the first time evidence that in-patient falls and lunar cycles are not associated. Third, it showed that identifying in-patients at risk for falling using specific tools does at best offer an addition to clinical judgement and assessment within falls prevention programs. Fourth, it showed that a multifactorial nurse led in-

tervention program has the potential to reduce multiple falls but not first falls in hospitalized medical patients, and fifth, it revealed that the implemented interdisciplinary hospital falls prevention program was not able to substantially decrease, either the frequency of falls or consequent injuries despite the use of a state of the art intervention protocol.

Future research on in-patient falls should focus on modifying hospital falls prevention strategies. The awareness of health care professionals of the problem of falls in hospitalized patients needs to be addressed in order to support the clinicians' adherence to evidence based intervention protocols. Furthermore, commitment to changing practice must be improved and professional skills such as assessment and treatment of in-patients at risk for falling need to be further developed to strengthen interdisciplinary health care teams.

ZUSAMMENFASSUNG

Das Thema „Patientensicherheit in den Spitälern" ist in den letzten Jahren aktuell geworden. Seit dem Erscheinen des Buchs „To err is human" im Jahr 2000 beschäftigt diese Thematik die Fachwelt und breite Öffentlichkeit und hat weltweit zu kontroversen Debatten geführt. Die drängende Botschaft des Buchs bezieht sich auf Studienresultate von bis zu 98'000 Todesfällen infolge unerwünschten Ereignissen (Adverse events =AE) und Behandlungsfehlern in US-amerikanischen Spitälern pro Jahr. Inzwischen haben verschiedene internationale Studien aufgezeigt, dass zwischen 2.9% und 16% der Patienten während ihres Spitalaufenthalts mindestens von einem AE betroffen sind. Bei jedem sechsten dieser Patienten wiederum führten die AE zu dauernden schweren Gesundheitsschäden oder gar zum Tode. Obwohl sich die fachliche Diskussion um die AE mehrheitlich auf chirurgische Prozeduren und Zwischenfälle mit Medikamenten bezieht, zeigt sich zunehmend, dass Stürze und sturzbedingte Verletzungen zu den häufigen unerwünschten Zwischenfällen in den Spitälern gehören.

Patientenstürze während eines Spitalaufenthaltes stellen wegen ihrer Häufigkeit und ihren physischen, psychologischen und sozialen Konsequenzen ein bedeutendes Problem für die Gesundheit der Betroffenen sowie die Ökonomie und Reputation der Spitäler dar. Die Auswirkungen, die ein Sturz nebst Schmerzen und Verletzungen auf das Leben eines Menschen haben kann, reichen vom Verlust des Selbstvertrauens, über Angst sich wie gewohnt zu bewegen bis hin zum sozialen Rückzug. Verschiedene Aspekte des Sturzgeschehens im Spitalbereich wie beispielsweise Sturzumstände, Patientenmerkmale, Risikofaktoren und Interventionen zur Sturzprävention wurden seit den 1980 Jahren häufig untersucht. In der Literatur zeigen sich jedoch noch Forschungslücken. Dazu gehören 1) wenig detaillierte, systematisch erhobene Informationen über Sturzumstände und Patientenmerkmale innerhalb verschiedener medizinischer Disziplinen in einzelnen Spitälern, 2) wenig valide Instrumente zur Erfassung der Sturgefährdung von Patienten während der Hospitalisation und 3) teilweise widersprüchliche Resultate und fragliche Nachhaltigkeit von multifaktoriellen Programmen zur Sturzprävention im Spitalalltag.

Mit dem vorliegenden Forschungsprogramm wurde mit verschiedenen, retro- und prospektiven Untersuchungsmethoden auf die genannten Forschungslücken eingegangen. Dazu wurden demographische und klinische Daten von knapp 35'000 Patienten, die in den Jahren 1999 bis 2003 in einem städtischen Spital hospitalisiert waren analysiert. In sechs Kapiteln werden die einzelnen empirischen Forschungsarbeiten vorgestellt.

Erstens wurden in einer retrospektiven Beobachtungsstudie Sturzereignisse und Patientenmerkmale des Stadtspitals Waid aus den Jahren 1999 bis 2003 ausgewertet. In dieser Zeit waren insgesamt 34'972 Patienten länger als 24 Stunden hospitalisiert (Mittleres Alter 67.3 Jahre, Frauen 53.6% und mittlere Aufenthaltsdauer 11.9 Tage). Dabei stellten wir fest, dass 7.5% der Patienten während ihrer Hospitalisation auf einer der drei Kliniken mindestens einmal stürzten (Chirurgie 1.9%, Medizin 8.8% und Akutgeriatrie 24.8%). Der Vergleich zwischen den Patienten die stürzten und jenen die nicht stürzten zeigte, dass erstere um 13.5 Jahre älter sind, 3.8% mehr Frauen betroffen sind und im Mittel 13.1 Tage länger hospitalisiert waren. Rund zwei Drittel (64.8%) der Patienten erlitten keine sturzbedingten Verletzungen, 30.1% verletzten sich leicht und 5.1% erlitten schwerere Verletzungen. Drei von vier Stürzen (75.7%) ereigneten sich in den Patientenzimmern. Meistens kam es während des Gehens (43%) und beim Aufstehen und Absitzen (35%) zu einem Sturz. Von den gestürzten Patienten wiesen 83.1% eine eingeschränkte Mobilität (z.B. unsicherer Gang) auf, 55.3% waren kognitiv eingeschränkt (z.B. Verwirrtheit), 38.6% nahmen Schlafmittel ein und 25.4% Psychopharmaka. Zudem war die Hälfte (50.1%) von ihnen bereits mehr als einmal vor dem Spitalaufenthalt gestürzt. Die Resultate stehen mehrheitlich in Übereinstimmung mit internationalen Studienberichten insbesondere bei den Patienten der geriatrischen und medizinischen Klinik. Durch die Tatsache, dass sich einer von drei Patienten infolge eines Sturzes verletzt, sind Stürze bei hospitalisierten Patienten als ein wichtiges Merkmal der Patientensicherheit anzusehen. Systematische Massnahmen zur Erkennung sturzgefährdeter Patienten und zur Sturzprävention sind deshalb notwendig, um sturzbedingte Verletzungen nach Möglichkeit zu vermeiden.

Zweitens untersuchten wir, ob Stürze an bestimmten Tagen, Monaten oder bei Vollmond gehäuft auftraten. Letzteres, nachdem von Pflegenden und anderen Fachleuten wiederholt beobachtet wurde, dass Patienten in Vollmondnächten unruhiger sind und häufiger stürzten als sonst. Dazu verglichen wir retrospektiv über einen Zeitraum von fünf Jahren die Sturzraten pro 1000 Pflegetage mit den Wochentagen, Monaten und 62 komplettem Mondphasen von je 29.5 Tagen. Die Sturzraten schwankten leicht über den gesamten Beobachtungszeitraum von 8.3 bis 9.3 Stürzen an Wochentagen (p=0.587) und von 8.4 bis 9.7 Stürzen pro Monat (p=0.757). Die Sturzraten während den Mondphasen schwankten zwischen 7.2 und 10.6 Stürzen (p=0.575). Es zeigten sich keine Häufungen von Sturzereignissen weder an bestimmten Tagen, Monaten noch zu Zeiten des Vollmonds. Somit liessen sich die eingangs geäusserten Beobachtungen nicht bestätigen. Wir empfehlen deshalb bei Präventionsstrategien die modifizierbaren Risikofaktoren bei den Patienten zu berücksichtigen und für eine sichere Spitalumgebung zu sorgen.

Drittens führten wir eine prospektive Kohortenstudie zur Validitätsprüfung der Morse Sturz Skala (MSS) welche zur Bestimmung des Sturzrisikos von Spitalpatienten verwendet wird durch. Ziel war es, die diagnostische Qualität der MSS zur Erfassung sturzgefährdeter Patienten zu überprüfen. In einer Gelegenheitsstichprobe von 386 hospitalisierten Patienten der medizinischen Klinik wurde die MSS anhand ihrer verschiedenen Skalenwerte untersucht. Die MSS enthält sechs Kriterien, die auf ein Sturzrisiko hinweisen: Früherer Sturz, mehrere medizinische Diagnosen, Hilfsmittel zum Gehen, venöser Zugang, Gangart und mentaler Zustand. Die MSS wurde von den diplomierten Pflegefachleuten innerhalb 24 Stunden nach Spitaleintritt eines Patienten ausgefüllt, dazu wurden während der Hospitalisation auftretende Stürze systematisch dokumentiert. Die ROC-Analyse zeigte bei einem Skalenwert von 55 Punkten bei einer Sensitivität von 74.5%, einer Spezifizität von 65.8%, sowie positiven und negativen prädiktiven Werten von 23.3% respektive 94.9% die beste diagnostische Qualität. Weil hohe negative prädiktive Wert zu verzeichnen waren (z.B. 95% der Patienten die nicht stürzten, wurden bei Spitaleintritt auch nicht als gefährdet eingestuft) kann man sich mit der MSS bei jenen Patienten absichern, die ein geringes Sturzrisiko aufweisen. Ihre Brauchbarkeit scheint im Hinblick auf die positiv prädiktiven Werte von nur 12% bis 24% jedoch beschränkt zu sein. Da es in der Fachliteratur trotzdem als nötig erachtet wird, frühzeitig Spitalpatienten mit einem erhöhten Sturzrisiko zu erkennen, um Abklärungen und gegebenenfalls weiterführende Interventionen einzuleiten, empfehlen wir die MSS vor Gebrauch auf anderen Spitalabteilungen zu validieren.

Mit der vierten Untersuchung überprüften wir wie gut sturzgefährdete Spitalpatienten erkannt werden können. Dazu wurde das STRATIFY ein einfaches Sturzrisiko-Instrument in einer prospektiven Multi-center Studie in sechs belgischen Spitälern eingesetzt. In die Studie konnten 2'568 Patienten (Mittleres Alter 67.2 Jahre, Frauen 55%) mit einer Hospitalisationsdauer von mindestens 48 Stunden eingeschlossen werden. Chirurgie (n=875, 34.1%), Geriatrie (n=687, 26.8%) und Medizin (n=1'006, 39.2%). Die Pflegefachleute füllten das STRATIFY bei den Patienten innerhalb von 24 Stunden nach Spitaleintritt aus und dokumentierten die während der Hospitalisation auftretenden Stürze. Bei 136 (5.3%) Patienten waren insgesamt 190 Stürze zu verzeichnen. Das STRATIFY wies bei den medizinischen und chirurgischen Patienten sowie den jünger als 65 Jährigen eine gute Sensitivität ($\geq$ 85%) und hohe negative prädiktive Werte von $\geq$ 99% auf. Tiefere Werte bei der Sensitivität (67% und 57%) sowie hohe falsch negativen Werte von 33% und 43% wurden bei den geriatrischen Patienten respektive den älter als 65 Jährigen beobachtet. Obwohl das STRATIFY das Sturzrisiko bei den Patienten prospektiv insgesamt gut erfasste, ist es für Patienten in der Geriatrie und Patienten älter als 65 Jahre ungeeignet.

Mit der fünften Untersuchung, einer Interventionsstudie (Quasi-experiment) evaluierten wir die Wirksamkeit eines pflegerischen Sturzpräventionsprogramms im Spital. Dazu wurden 409 Patienten aus zwei vergleichbaren Stationen der Medizinischen Klinik während vier Monaten aufgeteilt in eine Interventionsgruppe (n=198) und eine Vergleichsgruppe (n=211) beobachtet. In der Interventionsgruppe benützen die entsprechend geschulten Pflegefachleute die MSS und setzten bei den sturzgefährdeten Patienten (MSS Cut-off Wert 55 Pkt.) ein Interventionsprotokoll mit 15 definierten Pflegemassnahmen um. In der Vergleichsgruppe wurde die MSS (ohne Skalenwerte) ausgefüllt und die übliche Pflege durchgeführt. Patientenstürze wurden in beiden Gruppen mit einem standardisierten Sturzprotokoll erfasst. In der Folge zeigte sich, dass in der Interventionsgruppe der Anteil der sturzgefährdeter Patienten höher war (p=0.048) und dass deutlich weniger Patienten mehrmals stürzten (p=0.009) als in der Vergleichsgruppe. Beim ersten Sturz zeigte sich kein Unterschied. Im Weiteren dauerte es in der Interventionsgruppe im Mittel bis zu fünf Tage länger als in der Vergleichsgruppe bis ein Patient erstmals stürzte. Dies weist darauf hin, dass die Pflegefachleute das Sturzrisiko dieser Patienten mit der MSS erkannten und sich die präventiven Massnahmen insgesamt positiv auswirkten. Infolge dieser Studie wurde beschlossen im ganzen Spital ein interdisziplinäres Sturzpräventionsprogramm einzuführen.

Mit der sechsten und letzten Studie beobachteten wir, ob sich die Einführung des interdisziplinären Sturzpräventionsprogramms (ISSP) auf Sturzraten und sturzbedingte Verletzungen auswirken würde. Im Beobachtungszeitraum von 1999 bis 2003 waren knapp 35'000 Patienten hospitalisiert (Mittleres Alter 67.3 Jahre, Frauen 53.6%, mittlere Aufenthaltsdauer 11.9 Tage, mittlere Pflegezeit pro Patient und Tag 3.5 Stunden). Insgesamt wurden in dieser Zeit 3'842 Stürze bei 2'512 hospitalisierten Patienten registriert. Von diesen Stürzen blieben 2'552 (66.4%) ohne Folgen, 1'142 (29.7%) führten zu leichten und 148 (3.9%) zu schwereren Verletzungen. Die Sturzraten pro 1'000 Pflegetage schwankten leicht von 9.1 Stürzen in 1999 und 8.6 Stürzen in 2003 (p=0.086). Nach der Einführung des ISPP in 2001 war bis Jahresende ein leichter, nicht signifikanter Rückgang auf 7.8 Stürze pro 1'000 Pflegetage zu beobachten. Die jährliche Anzahl an leichten und schwereren Verletzungen ging nach der Einführung des ISPP nicht wesentlich zurück. Die Patientenmerkmale veränderten sich von 1999 bis 2003 mit einer leichten Zunahmen beim Anteil Frauen (um 1.5%), beim mittlerem Alter (um 1.6 Jahre) und bei der benötigten mittleren Pflegezeit pro Tag und Patient (um 18 Minuten) sowie einem Rückgang bei der mittleren Aufenthaltsdauer (um 0.8 Tage). Bei den Patienten die stürzten nahmen die Risikofaktoren bis zu 46.8% zu. Zusammenfassend ist festzustellen, dass infolge der Einführung des ISPP weder die Sturzraten noch die sturzbedingten Verletzungen

wesentlich zurückgingen. Auf Grund der Rückmeldungen aus den Audits mit den Pflegefachleuten, Ärzten und Physiotherapeuten sowie den Veränderungen bei den Patienten-merkmalen nehmen wir an, dass das ISPP von Pflegenden und Ärzten im klinischen Alltag unterschiedlich konsequent umgesetzt wurde. Deshalb müssen die Fachleute in Zukunft mit besseren Umsetzungsstrategien gefördert und mit geeigneten Mitteln zur Sturzprävention unterstützt werden um ihre Fachkompetenzen in einem sich verändernden klinischen Umfeld bestmöglich einzusetzen.

Die Resultate unserer Studien haben zum Verständnis des Sturzgeschehens im Spitalbereich beigetragen. Erstens konnten aufgrund systematischer Beobachtungen Sturzumstände und Sturzmerkmale bei Patienten aus je einer medizinischen, chirurgischen und geriatrischen Kliniken in einem Spital detailliert beschrieben werden. Zweitens konnte erstmals überhaupt nachgewiesen werden, dass die Sturzhäufigkeit im Spital *nicht* mit den Mondphasen im Zusammenhang steht. Drittens konnte aufgezeigt werden, dass Instrumente zur Erfassung des Sturzrisikos bei Spitalpatienten im besten Fall in Ergänzung zur klinischen Einschätzung und zum detaillierten Assessment im Rahmen eines Präventionsprogramms nützlich sind. Viertens, die beste Sturzprävention bietet ein multifaktorielles pflegegestütztes Interventionsprogramm, dadurch, das deutlich weniger Patienten wiederholt stürzten. Fünftens wurde ersichtlich, dass ein spitalweit eingeführtes interdisziplinäres Sturzpräventionsprogramm trotz verfügbarer „State of the art" Interventionen" zu keiner wesentlichen Reduktion der Sturz- und Verletzungshäufigkeit bei hospitalisierten Patienten führte.

Weitere Untersuchungen zum Sturzgeschehen im Spitalbereich, insbesondere zur nachhaltigen Effektivität von multifaktoriellen Präventionsprogrammen sind nötig. Dabei spielt das Problembewusstsein der Fachleute der Sturzproblematik gegenüber und ihr professionelles Verhalten im klinischen Alltag eine Rolle. Dazu muss ihre Fachkompetenz hinsichtlich wirksamer und zweckmässiger Abklärung, Therapie und pflegerischen Betreuung der sturzgefährdeten Patienten verbessert werden. Zur nachhaltigen Umsetzung multifaktorieller Präventionsstrategien sind geeignete Förderungsstrategien und eine aktive Zusammenarbeit mit den Fachleuten zur Stärkung der interdisziplinären Teams nötig.

1   INTRODUCTION

1.1   Patient safety

The report "To err is human" of the Institute of Medicine (IOM) published in 2000 estimated that health care errors and adverse events may account for up to 98,000 patient deaths per year in the USA. This report brought the topic of health care errors and adverse events in clinical settings to the health policy agenda and the forefront of a public debate worldwide [1]. Large studies in the USA, Australia and other countries [2-6] have increased clinician, patient and policy maker awareness of the relevance of adverse events as a threat to the safety of patients [7]. Patient safety represents a fundamental principle of health care. Patient safety is simply defined as "the prevention of harm to patients" [8]. Although simple in definition, the road to ensuring patient safety presents considerable challenges for researchers, managers and clinicians seeking to accurately develop safe health services in today's highly complex health care systems. Ensuring patient safety includes operational systems and processes that minimize the likelihood of errors and maximize the likelihood of intercepting them when they occur [1]. Improving safety demands a complex system-wide multilevel effort, involving a broad range of actions in performance improvement, environmental safety and risk management, including infection control, safe use of medicines, equipment safety, safe clinical practice and safe environments of care. It embraces nearly all health-care disciplines and actors, and thus requires a comprehensive, multifaceted approach in identifying and managing actual and potential risks to patient safety in individual services [9]. Improvement of healthcare quality and patient safety are of paramount importance to nurses since they have the most consistent presence at the patient's bedside and, thus, guarantee a surveillance system [10]. The IOM emphasizes the urgent need to invest in patient safety to improve health care quality. Several studies have shown that adverse events such as medication errors, nosocomial infections, and injuries including patient falls affect thousands of persons in hospitals per year [8]. In addition, the International Council of Nurses (ICN) recognized with its international campaign "Safe staffing saves lives" the importance of the patient safety movement, focusing on a variety of care indicators such as falls, drug errors and inappropriate surgeries, factors that increase the morbidity and mortality of patients [11].

1.2 Adverse events

An *adverse event* is defined as an injury caused by medical management rather than underlying disease that prolongs hospitalization, produces a disability at the time of discharge, or both [3]. Adverse events (AE's) are also referred to as untoward incidents, therapeutic misadventures, iatrogenic injuries, or other adverse occurrences directly associated with care or services provided within the jurisdiction of a medical center, outpatient clinic, or other facility [8]. Apart from direct medical and legal costs, there are many other costs for patients that arise from AE's, such as increased pain, disability, and psychological trauma, erosion of trust in the health care system, loss of independence, impaired functionality and loss of productivity. Human costs to health care professionals include a loss of confidence and satisfaction; depression; stress; and feelings of frustration, shame, guilt and inadequacy [8].

The patient safety problem reveals that between 2.9% and 16.6% of hospitalized patients experience at least one AE during a hospital episode (Table 1). AE's are a threat to patients' health. Their impact on the health care systems is also reflected by the clinical consequences that AE's can have. Permanent disability due to AE's has been experienced by 2.6% to 13.7% of hospitalized patients, and death due to AE's by 4.9% to 15.9% of patients [2, 3, 5, 6, 12]. The types of procedure or events to which AE's have been related include surgical (e.g., wound infections, technical complications) and non-surgical categories (e.g., drug complications, diagnostic and therapeutic mishaps) (Table 1). As table 1 demonstrates, AE studies have primarily focused on adverse events associated with surgical procedures and adverse drug reactions. Overall, in-patient falls accounted only for a little fraction of events (1.3% - 5%) in most of the AE studies [2, 4, 12]. These findings may reflect the fact that in-patient falls are not classified as an AE due to its definition as "an injury caused by medical management rather than underlying disease" [3, 13]. In the hospital setting, three types of falls have been identified: 1) 14% of all falls are considered as "accidental falls" caused by the patient slipping, tripping, or having some other mishap; 2) "anticipated physiological falls" occurring in 78% of patients who are prone to falls based on certain risk factors; and 3) "unanticipated physiological falls" occurring in 8% of patients and are attributable of physiological causes that can not be predicted before the first fall [14]. In addition, non-injurious falls may not have been reported since AE definitions use disability and injury as prerequisites. Therefore, the occurrence of falls may be underestimated since errors in healthcare do not lead necessary to injury because the patient is resilient, or because of good luck [15].

AE studies have not always focused on what has been shown to be an important AE in hospitals, i.e. falls. Indeed, slips, trips and falls (41%) were the most common type of incidents found in the UK's National Patient Safety Agency multi-center study in 2005 based on a total of 28,998 voluntarily reported incidents from 18 NHS trusts [16]. These findings emphasize that the focus of AE studies should be expanded beyond AE's primarily associated with surgical procedures and adverse drug events [3, 4, 12]. Given their suggested high incidence and established negative consequences in hospital settings, patient falls should also be explicitly addressed in AE studies.

Table 1: Studies of AE's in hospital patients

Study (year)	Setting (sample)	Patients with AE	Types of AE's*	Consequences of AE's	Preventable AE's
Brennan et al (1991), Leape et al (1991) "The Harvard Medical Practice Study"	51 hospitals in New York, USA (n=30,195)	3.7%	Operative (47.7%) such as wound infection, technical, late and other complication, and surgical failure. Non-operative (52.3%) such as drugs (19.4%), diagnostic† (8.1%), therapy‡ (7.5%), medical procedures (7%), falls (2.7%), fractures (1.2%), and others (6.4%)	2.6% disability§ 13.6% mortality	Not stated
Thomas et al (1992) "The Utah and Colorado Medical Study"	28 hospitals in Utah and Colorado, USA (n=14.700)	2.9%	Surgery (44.9%), drugs (19.3%), medical procedures (13.5%), diagnosis† (6.9%), therapy‡ (4.3%), obstetric (3.6%), falls (1.3%), fractures (0.4%), and others (5.9%)	Disability not stated 8.8% mortality	53%
Wilson et al (1995) "The Quality in Australian Health Care Study"	28 hospitals in Australia (n=14,179)	16.6%	Operative (50.3%), diagnosis† (13.6%), therapy‡ (12%), drug (10.8%), medical procedures (8.6%), fracture (5.5%), obstetric (5.5%), falls (2.9%), and others (19.1%)	13.7% disability§ 4.9% mortality	51%
Vincent et al (2001)	2 hospitals in London (n=1,014)	10.8%	Two examples of AE's were described: wound infections due to treatment failures and incorrect management.	6% disability§ 8% mortality	48%
Baker et al (2004) "The Canadian Adverse Events Study"	20 hospitals in Canada (n=3,745)	7.5%	Procedures or events to which AE's were related: surgical (34%), drugs (24%), clinical management (12%), diagnostic (11%), medical (7%), and others (e.g., burns, falls) 5%.	5.2% disability§ 15.9% mortality	36.9%

*Type of procedure or event to which AE's were related,

†An AE arising from a delayed or wrong diagnosis,

‡An AE arising when a correct diagnosis was made but there was incorrect therapy or a delay in treatment,

§Permanent disability

1.3 The problem of hospital in-patient falls

In-patient falls, admittedly an important AE in hospital settings, have not received as much attention as other AE's despite their high incidence and associated negative clinical consequences. The following sections outline the scope of the problem of hospital in-patient falls in more detail.

In-patient falls - incidences and consequences in hospital settings

Depending on hospital type, operational definitions, case finding and reporting methods, between 15% and 80% of the incident reports and reported accidents in hospitalized patients are falls [17-25]. Approximately 2% to 17% of patients experience a fall during their hospital stays [26-30]. Fall rates vary across different hospital settings from 2.2 falls per 1000 patient days in large tertiary university hospitals up to 17.9 falls per 1000 patient days in rehabilitation settings [19, 23, 25, 30-39]. Fall related injuries occur in 15% to 50% of hospital falls, and serious injuries including fractures, sprains, lacerations, or contusions are seen in 1% to 10% of hospitalized patient who fall [19, 26, 31, 33, 35-38, 40].

Circumstances of in-patient falls in hospital settings have been elaborated in various studies. Up to 88% of the falls occurred in the patient's room [17, 34, 41, 42] often when patients were unattended leading to more than 80% of falls being unwitnessed [39, 42]. Times of falls shows that 48% to 58% of the falls occurred during the night [42, 43]. The type of activities that hospitalized patients were involved in when falls occurred included bed-related activities in 23% to 39% of falls [14, 19, 25, 33, 34]. Other fall related activities included: walking (e.g., going to the bathroom) in 10% to 42% [14, 19, 25, 33, 34, 39] or transferring (e.g., standing up, sitting down) in 7% to 24% of falls [14, 18, 25, 33].

The burden of patient falls

In general, falls among older community dwelling people as well as in hospitalized persons are recognized as a serious health problem. About one in three non-institutionalized older people (>65 years) fall at least once a year, and fall rates rise with increasing age by an estimated 10% per decade [44-52]. Fall rates in older people living in health care facilities, such as nursing homes are even higher, affecting up to 57% of residents per year [53, 54]. The incidence ranges from 0.2 to 3.6 falls per bed per year [55]. Often, falls result in negative clinical and economical outcomes in relation to mortality, and morbidity (e.g. injuries, fear of falling, and reduced activities of daily living), emergency department visits, hospital admissions, premature nursing home admissions and litigation [56-60]. In addition, falls are associated with increased health care costs [61-65]. Falls are rarely due to a single cause; they generally result from an interaction of

multiple and diverse personal and environmental risk factors and situations. Ageing and medical conditions of the patients often combined with medication use can lead to transient or permanent impairments and disabilities and may initiate a fall event [66-71]. The fall event may occur as a result of interactions with environmental hazards in the homes of older people, in health care facilities and in public areas. In addition, patient behaviors e.g., the use of unstable chairs as ladders or an overestimation of one's abilities while hospitalized can increase exposure to fall risk leading to minor or major injuries and additional consequences [14, 71-74].

The definition of falls

Since the "Kellogg International Workgroup on the prevention of falls in the elderly" introduced in 1987 their fall definition; "A fall is a sudden, unintentional change in position causing an individual to land at a lower level, on an object, the floor or the ground, other than a consequence of a sudden onset of paralysis, epileptic seizure, or overwhelming external force"[75], there have been many alterations in fall definitions. For falls in the hospital a simplified definition such as "an event in which a patient suddenly and involuntary comes to rest on the floor with or without physical injury," is often used in fall incident report forms [76-80]. Recently, the Prevention of Falls Network Europe recommended defining a fall as "an unexpected event in which the participant come to rest on the ground, floor or lower level" [81].

Falls in hospital settings - etiology and risk factors

The situation for a hospitalized patient has to be considered as being extraordinary since he/she is unfamiliar with the hospital environment. The health condition of older patients including alterations in the physical and cognitive status can either increase or decrease the risk of falls [82]. More specifically, bed rest due to hospitalization superimposes factors such as enforced immobilization, reduction of plasma volume, accelerated bone loss, decreased pulmonary ventilation and sensory deprivation which lead to depressed psycho-physiologic function and increase the risk of falls [27, 83, 84].

Several risk factors for falls in hospitalized patients have been identified based on cohort and case-control studies. Gait instability, agitated confusion, urinary incontinence/ frequency, a fall history, and the use of drugs such as sedative/hypnotics have been found to be consistent risk-factors associated with falls [85-87]. The risk for hip fractures due to falls increases substantially as the number of fall risk factors increase [88]. Risk factors associated with in-hospital hip fractures among older patients include: low body weight, a prior in-hospital fall, confusion, assisted ambulation, use of psychotropic drugs, and impaired vision. Although the etiology of hospital

inpatient falls is multifactorial, including both intrinsic and extrinsic factors, anecdotes from clinical practice exist in which health care professionals express the idea that in-patient falls may increases during times of full moon. Interestingly, one hospital reported that fall rates increased before and after full moon [89]. However, the majority of studies that examined associations between the lunar cycles and human health have not found evidence to support a relationship [90]. Increasing evidence from recent studies support the idea that characteristics of the nursing care organization, e.g. nurse staffing and skill mix, may be relevant factors in fall risk [91].

Conceptual model for falls in a hospital setting

A conceptual model provides as helpful summary of the multifactorial nature of in-patient falls in hospital settings. In order to conceptualize the complexity of hospital falls, risk factors at the patient and environmental level, the clinical context and the clinical and economic consequences are graphically represented in Figure 1. This model is based on an existing model [92], which was further extended based on empirical evidence from our own work [38], and that of others [93]. The model helps to explain the multidimensional nature of factors associated with falls and suggests that fall risk assessment as well as in falls prevention programs need to be taken into consideration these interrelated factors.

Figure 1: Conceptual model of hospital falls
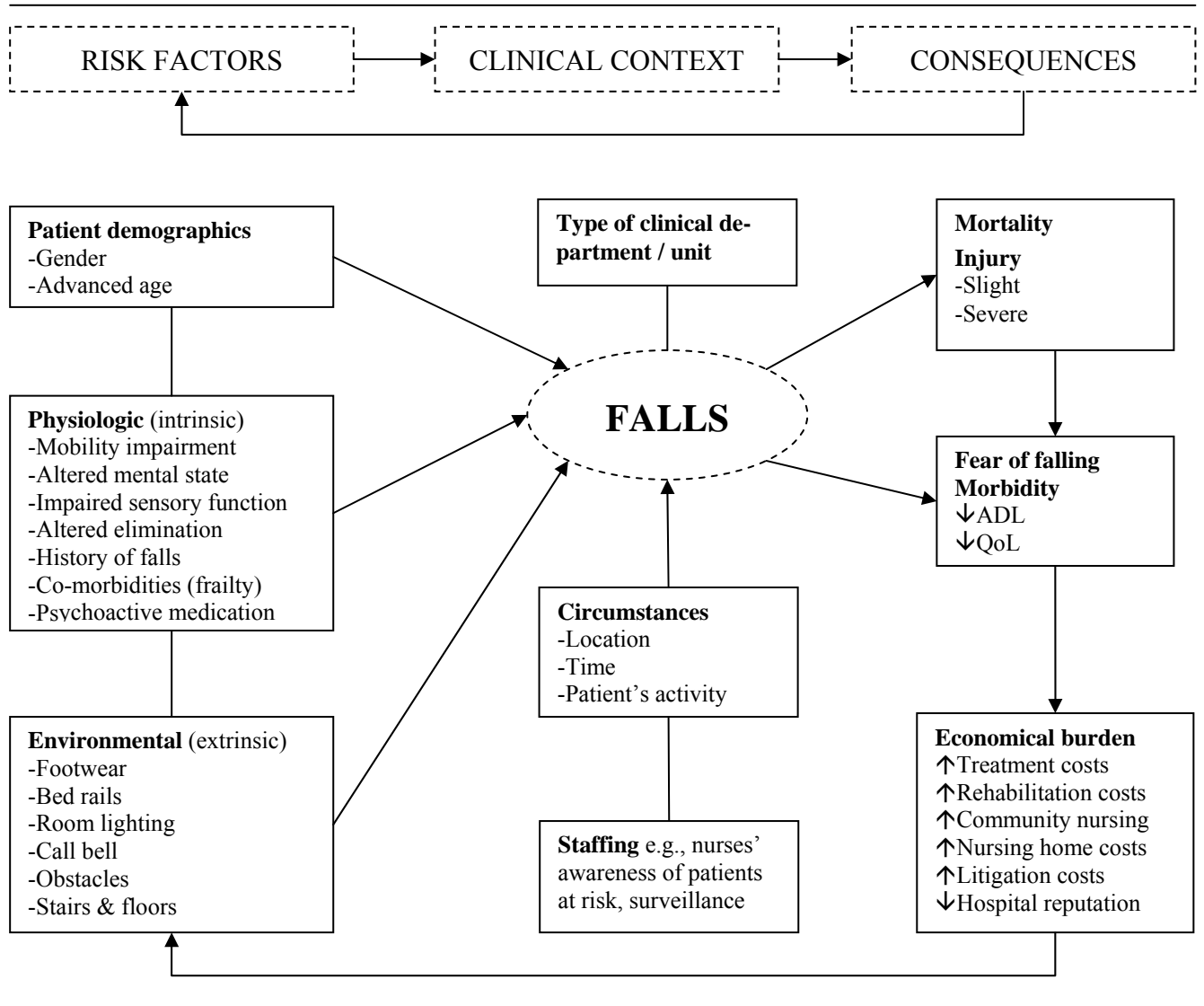
ADL=Activities of Daily Living; QoL=Quality of Life

Fall risk assessment in hospitalized patients

In the last 25 years numerous hospital fall risk assessment scales such as the Morse Fall Scale [94], Schmid's Fall Risk Assessment Tool [95], Hendrich's Fall Risk Model [96], Oliver's STRATIFY [97] and others have been developed [86, 87, 98]. In one study [98], 21 fall risk assessment instruments were reviewed, and 13 of these were nursing assessment tools used for hospital in-patients while the rest are functional assessment tools which are used mainly in out-patient settings. A review summarized 47 papers on fall risk assessment tools published from 1981 to 2001 [86]. The reviews showed that few of the numerous developed, modified or utilized fall risk assessment tools were based on a rigorous research design. Overall, the majority of these tools were developed based on literature review, expert opinion or on incident reviews. Few have undergone testing of reliability and validity. The times to complete nursing assessment tools in hospital settings varied from 4 minutes up to 11 minutes per patient. For the few that assessed inter-rater reliability, agreements ranged from 83% to 100%. In addition, reported sensitivity and specificity ranged from 43% to 100% and from 38% to 88% respectively [98]. The most recent systematic review included only risk assessment tools for hospital in-patients subjected to prospective validation such as the Morse Fall Scale [99] or the STRATIFY [97]. Again, it appeared that even the best of the risk assessment tools failed to classify a high percentage of fallers in the hospital [87].

Falls prevention programs in hospital settings

Since in-patient falls and associated injuries frequently occur in hospital settings various initiatives have been undertaken to prevent these often harmful events in order to provide safe patient care. A first review in the 1980's of 6 studies on in-patient fall risk profiles and interventions to prevent in-patient falls in hospital settings gave some indications of potentially successful approaches. The few intervention studies conducted in acute care settings such as in medical, orthopedic and geriatric-psychiatric units showed a reduction in the incidence of falls [100]. Yet, the methodological quality of these studies was poor i.e. pre-experimental designs. Interventions to prevent patient falls included frequent patient assessments (e.g., identify risk for falls), direct care (e.g., properly fitting shoes, toileting patients) environmental interventions (e.g., beds in low position) and patient/staff education. Based on this evidence, the authors concluded that reductions of falls in these studies seemed to have been achieved through raised consciousness of staff rather than through specific changes in clinical practice [100].

Further research as summarized in a systematic literature review on fall prevention programs in acute care settings from 1988 to 1998 including 21 intervention studies [101] and demonstrated that fall risk assessments, specific care interventions (e.g., assisted ambulation, toilet training), providing a safe environment, and patient and staff education including systematic reporting of the fall incidents were effective in decreasing the incidence of falls. It appears that the impact of the programs may be due to increased attention and presence of staff caring for the patients rather the specific interventions [101]. Despite these favorable results, methodological weaknesses such as the observational study designs including studies with historical controls supported the need for testing the interventions within a randomized controlled trial (RCT) design.

Stronger evidence of effectiveness was provided by a meta-analysis in 2000. This meta-analysis included three controlled trials and seven prospective studies with historical controls [102]. Risk assessment of in-patients was included in all 10 of the studies and was the first step of the intervention programs. The second step was the implementation of interventions in at risk patients. These interventions were mostly provided by nurses. Examples of the interventions examined included proactive assistance, high risk stickers, safety equipment and patient education. When results were pooled across studies, there was a 25% reduction in the rate of falls. Methodological issues remain the use of historical controls. Moreover, adherence with the intervention was not evaluated. Future hospital fall prevention programs should therefore pay more attention to study design and implementation issues [102].

It appears that the challenges today are not only to test the effectiveness of hospital fall prevention programs and their impact in these settings using RCT's, but to also evaluate implementation strategies and the sustainability of these programs in clinical practice. No such studies have been done so far.

1.4 Identified gaps and rationale for the proposed studies on hospital in-patient falls

In summary, the following identified gaps in the literature that should be the focus of future research and will guide the proposed research program of this dissertation.

First, falls are AE's to be studied. Although various studies have explored circumstances of in-patient falls in hospitals such as injury rates, clinical patient characteristics or fall risk factors, little information is reported about fall characteristics in different clinical departments of single acute care hospitals.

Second, fall risk assessment is the first step in intervention programs. Despite the availability of a substantial number of assessment instruments for identifying hospitalized patients at risk for falling, their generalizability is limited since few have been prospectively tested in populations other than those for which they were developed. The accuracy of such tools when used in daily clinical practice in other hospital settings remains unclear and need to be tested.

Third, although various multifactorial fall prevention programs in acute care settings have been launched, evidence of their effectiveness is limited and is often conflicting. In addition, there is little research on the sustained impact of hospital programs on fall rates and associated injuries in daily clinical practice.

Given the several gaps remaining to be filled in the evidence base on in-patient falls, the following research program is proposed to highlight three areas of hospital in-patient falls. First, the nature of in-patient falls in the hospital setting including circumstances, patient characteristics and associated consequences in different clinical departments will be explored in depth including the influence of lunar cycles on patient fall rates. Second, the clinical value of systematic identification of patients at risk for falling will be examined in different hospital settings. Third, the effectiveness of a structured fall prevention program will be evaluated a) under study conditions and b) when implemented as an interdisciplinary program over an extended period of time. The proposed research program has potential to fill international gaps in current knowledge as mentioned above, as well as filling a knowledge gap within Switzerland where only a few studies have addressed the issue of hospital in-patient falls [34, 38, 103-105].

1.5 References

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2   STUDY AIMS

Given the gaps in the evidence regarding hospital in-patient falls as discussed before, the aims of this research program are therefore following:

- To describe characteristics of in-patient falls across clinical departments of a single hospital (Chapter 3).

- To explore on associations between in-patient falls and lunar cycles (Chapter 4).

- To evaluate the diagnostic value of the Morse Fall Scale for identifying in-hospital patients at risk for falls (Chapter 5).

- To determine the predictive properties of a fall-risk assessment tool (STRATIFY) administered at a patient's bedside by nurses in different hospital settings (Chapter 6).

- To evaluate the effectiveness of a nurse-led fall prevention program in view of incidence of patient falls (Chapter 7).

- To examine in-patient fall rates and consequent injuries before and after the implementation of an interdisciplinary hospital fall prevention program (Chapter 8).

3 CHARACTERISTICS OF IN-PATIENT FALLS IN DIFFERENT HOSPITAL DEPARTMENT

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3.1 Abstract

Objectives To examine characteristics associated with hospital in-patient falls across clinical departments

Design 5-year retrospective, population based study

Setting Departments of internal medicine, geriatrics and surgery in a 300-bed urban public hospital.

Methods Secondary analysis of an in-patient fall data base, and administrative patient data base. Data were summarized using frequencies, proportions, means, standard deviations or medians and analyzed accordingly using Chi-square and analysis of variance procedures as appropriate.

Results A population of 34,972 hospitalized patients (mean age: 67.3, SD±19.3 years; female 53.6%, mean length of stay: 11.9 SD±13.2 days) was observed. In total, 2,512 patients (7.2%) experienced at least one fall during their hospital stay (24.8%, 8.8% and 1.9% of the patients from the departments of geriatrics, internal medicine and surgery, respectively). The hospital fall rate per 1,000 patient days was 8.9 falls (geriatrics: 11.7, internal medicine: 11.3, and surgery: 2.9). Comparison of fallers and non-fallers revealed that fallers were on average 13.5 years older, consisted of 3.8% more females and stayed on average 13.1 days longer in the hospital. The median time of hospitalization until patients experienced a first fall was 7 days. Two third (64.8%) of the patients who fell were not injured, 30.1% experienced minor injuries and 5.1% major injuries. Three out of four patients (75.7%) fell in their bedrooms. Patients fell most often while ambulating (43%) and transferring (35%). Fall risk factors in patients who fell included: impaired mobility (83.1%), impaired cognition (55.3%), use of psychotropics (25.4%), and use of narcotics (38.6%). Half of the patients (50.1%) who fell while hospitalized had a pre-hospital history of falls.

Conclusion In-patient falls in hospitals are common especially in departments of geriatrics and internal medicine. Characteristics of falls in relation to the time, location, and consequences are similar to findings of previous studies. While fall rates varied significantly from one department to the other likely due to differences in patient case mix; associated injuries differed only slightly across the departments. However, one in three falls result in at least a minor injury. In-patient falls should therefore be regarded as an important safety issue especially for patients with already diminished health status. Attention should be given to early identification of patients at risk and implementation of effective interventions to prevent patient falls and minimize fall related injuries.

Key words In-patient falls, hospital,

3.2 Introduction

Falls among hospitalized patients are common with rates varying from 2.4 falls per 1000 patient days in large tertiary university hospitals up to 9.1 falls per 1000 patient days in geriatric hospital departments [1-9]. Fall related injuries occur in up to 50% of the in-patients who fall, and up to 10% of these patients experience a major injury [1, 3, 4, 6, 10-13]. Various studies have elaborated on the circumstances of falls in hospital settings. Fifty to 88% of the falls occurred in the patient's room [5, 9, 14-17] often when patients were unattended leading to more than 80% of falls being unwitnessed [7, 18]. Time of falls shows that 42% to 52% of the falls occurred during the day time [9, 11]. Differences in fall frequencies were observed among nursing shifts with 30% to 51% during the day shift, 27% to 35% during the evening shift, and 12% to 35% during the night shift [4, 13, 17, 19, 20]. In other studies, peaks in the frequency of falls were seen between 10am and 11am, between 1pm and 2pm, and between 7pm and 8pm [7, 21]. The type of activities that hospitalized patients were involved in when falls occurred included bed-related activities in 23% to 39% of falls [3-5, 16, 22]. Other fall related activities included: walking (e.g., going to the bathroom) in 10% to 42% [3-5, 7, 16, 22, 23] or transferring (e.g., standing up, sitting down) in 7% to 24% of falls [3, 16, 22, 24].

Several risk factors for falls in hospitalized patients have been consistently identified such as: gait instability, agitated confusion, urinary incontinence/frequency, fall history, and the use of drugs such as sedative/hypnotics [25, 26]. Although various studies have explored circumstances of falls and characteristics of affected patients in detail, little information is reported about fall characteristics in different clinical departments of single acute care hospitals. Since characteristics of hospitalized patients vary across clinical settings, fall rates, associated injuries and circumstances may vary too. The aim of this study was therefore to examine characteristics of hospital in-patient falls across clinical departments.

3.3 Methods

Design, setting and sample

This population based study was conducted in a 300-bed urban public hospital in the City of Zurich, Switzerland. Inpatient fall data and administrative patient data from adult hospitalized patients (>24 hours stay) from January 1999 through December 2003 from the clinical departments of internal medicine (122 beds), geriatrics (78 beds) and surgery (100 beds) were retrospectively analyzed.

Data collection and ethical considerations

In-patient falls have been systematically registered in this hospital since 1998 using a standardized fall incident report form (FIR) [17]. Falls are defined as "an event in which a patient suddenly and involuntary comes to rest on the floor with or without physical injury". In addition, patients found lying on the floor are considered as having fallen, if no other reason is identified. In-patient falls were reported by registered nurses within 24 hours of the event and include a patient interview regarding circumstances of the fall. The information about the fall event, which was collected with the FIR, is described in Table 1. All fall data and patient data from the designated hospital departments were analyzed by the quality management department. Informed patient consent was not obtained since fall event data were collected regularly as part of the hospital quality management program. The institutional ethical review board of the City hospitals of Zurich approved this study.

Statistical analysis

Calculation of frequency distributions and summary statistics including means, standard deviations, medians, inter-quartile ranges and proportions were performed to describe the variability in patient demographics, in-patient falls, fall related injuries and associated circumstances across hospitals departments. Patient fall data including prevalence of risk factors were calculated using data of the patients first fall to maintain independence from repeated events. Chi-square tests were used to compare circumstances and characteristics of the patient falls including injuries and gender among departments. Analyses of variance were used to compare age, length of stay, and fall rates per 1,000 patient days. P-values of $< .05$ were considered statistically significant. All analyses were performed with SPSS for Windows, version 12.0 (SPSS Inc., Chicago, Ill).

Table 1: Items of the fall incident report form

Patient information

Age

Gender

Department and unit

Details of the fall

Date of the fall

Time of the fall

Location of the fall (e.g., bed room, bath room)

Type of the fall (e.g., while walking)

Severity of injury (i.e., none, minor*, major‡)

Type of injury (see legend of severity of injuries)

Risk factors present prior to the fall

Mobility impairment (e.g., unsteady gait)

Impaired cognition (e.g., confused, forgetfulness)

History of falls (Two or more falls within last 6 months)

Use of psychotropic medication (e.g., sedatives)

Use of narcotic medication

Elimination pattern (e.g., incontinence, urge voiding)

Unsafe footwear (e.g., socks, stockings, barefoot)

*Pains, brushes, haematoma, lacerations, ‡Fractures, internal head injuries, luxations

3.4. Results

Characteristics of the patient population

The population under study included 34,972 hospitalized patients (mean age: 67.3±19.3 years; female 53.6%, mean length of stay: 11.9±13.2 days). Half of these patients (49.7%) were hospitalized in the department of internal medicine, 42.4% in the surgical department, and 7.9% in the geriatrics department. Patient characteristics, including gender, age, and length of hospital stay differed significantly between the three departments (Table 2). The primary medical diagnosis of the hospitalized patients fell into the following diseases groups of the International Classification of diseases (ICD-10): 19.4% had diseases of the digestive system, 17% had diseases of the circulatory system, 13.7% fell into the category of injuries and poisoning, 7.4% had diseases and disorders of the respiratory system, 6.1% had neoplasm's, and the remainder were scattered across other diagnostic categories. The diagnostic categories differed across the departments (Table 3).

Table 2: Patient characteristics

	Total (n=34,972)	Medicine (n=17,386)	Geriatrics (n=2,765)	Surgery (n=14,821)	P-values
Females (%)	18,745 (53.6)	9,469 (54.5)	2,010 (72.7)	7,278 (49.1)	<0.001†
Age in years*	67.3±19.3	70.4±17.3	83.0±7.8	60.6±20.4	<0.001‡
Age groups (%)					
18 – 64 yrs.	36.6	29.2	1.7	51.8	<0.001†
65 – 79 yrs.	30.8	34.2	28.2	27.3	
80 yrs. and more	32.6	36.6	70.1	20.9	
Length of stay(days)*	11.9±13.2	10.8±9.3	36.1±25.4	8.6±8.1	<0.001‡

*Mean ± SD, †Chi-square, ‡ANOVA

Characteristics of patient who fell and frequencies of falls

Of the 34,972 hospitalized patients, 2,512 (7.2%) experienced a total of 3,842 falls. One thousand eight hundred and four (71.8%) of these patients fell once, and 708 patients (28.2%) fell two times or more accounting for 53% of all falls. Age, gender and length of stay of the hospitalized patients who fell differed significantly from those patients who did not fall. Among patients with no falls, the mean age was 66.3±19.4 years, 53.4% were female and the mean length of stay was 10.6±10.9 days. Patients who fell at least once had a mean age of 79.8±12.2 years, 57.2% were female and their mean length of stay was 23.7±21.2 days. Significant differences in these

characteristics were also found between fallers and non-fallers within each of department except for gender in the geriatrics department (Table 4).

The proportion of patients who fell differed across the clinical departments: 24.8% (n=663) in geriatrics, 8.8% (n=1,550) in internal medicine and 1.9% (n=299) in surgery (P <0.001). The overall fall rate was 8.9 falls per 1,000 patient days, with significant differences between the clinical departments (11.7 falls/1000 patient days in geriatrics, 11.3 falls/1000 patient days in internal medicine, and 2.9 falls/1000 patient days in surgery (P <0.001).

Table 3: Prevalence (%) of primary medical diagnosis (ICD-10 diagnostic category))

	Medicine (n=17,386)	Geriatrics (n=2,765)	Surgery (n=14,821)	P-value[†]
Infectious, Parasitic (I)	4.6	0.9	1.0	<0.001
Neoplasm	5.9	1.9	7.2	<0.001
Endocrine, Metabolic	3.4	1.8	1.0	<0.001
Mental, Behavioural	5.7	12.6	0.1	<0.001
Nervous System	4.4	8.0	0.3	<0.001
Circulatory System	25.3	16.6	7.3	<0.001
Respiratory System	12.7	3.2	2.0	<0.001
Digestive System	13.2	2.4	29.8	<0.001
Skin	0.6	1.9	4.7	<0.001
Musculo-Skeletal	5.8	6.0	4.7	<0.001
Genito-Urinary	4.5	1.4	5.5	<0.001
Symptoms, Signs	6.7	5.6	1.3	<0.001
Injury, Poisoning	1.2	22.0	26.7	<0.001
External causes	1.6	1.8	4.0	<0.001
Factors influencing health status	1.5	12.3	2.1	<0.001
Other (	2.8	1.6	2.3	<0.001

[†]Chi-square,

Underlined numbers indicate the highest percentages observed in each of the departments

Time of falls

More than the half of the patients (54.5%) fell during the first week of hospitalization. This was true across the clinical departments for internal medicine (65.0%) and surgery (59.9%), but not for geriatrics (27.6%). The median time from admission until a patient fell was 7 days. While time to the patient's first fall was quite similar in the departments of internal medicine (5 days)

and surgery (6 days), first falls occurred significantly later in the geriatrics department (16 days; $P < 0.001$). The occurrence of falls was also examined in relation to nursing shifts and 33.6% of the patients fell during the day shift (7am to 3pm), 29.1% during the evening shift (3pm to 11pm), and 37.3% during the night shift (11pm to 7am), with significant differences between the departments (Table 5). At the geriatrics department 27.3% of the patients fell during the night shift compared to 40.6% and 42.1% in the departments of internal medicine and surgery, respectively. Overall, the times of falls fluctuated over the 24 hours of the day with different peaks seen in each of the three clinical departments: internal medicine from 11PM to 1AM; geriatrics from 5PM to 7PM and in surgery from 10PM to midnight (Figure 1).

Figure 1: Percentage of falls per hour of the day over 5 years
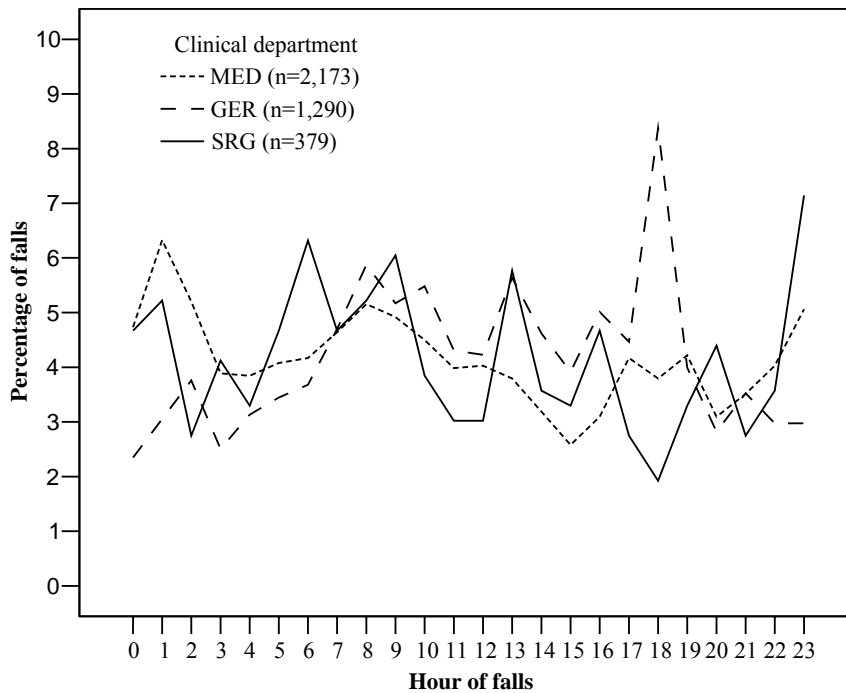
Location of the falls

Most of the patients (75.7%) fell in their rooms while 15.2% fell in the bathrooms and 4.9% fell in the corridors of the units. Four percent and 0.2% of the patients fell in other rooms within and outside the department units respectively. The locations of patient falls did not differ significantly across the clinical departments except that more patients of the geriatrics department fell at corridors and other places within the units and less in own bedroom, compared with the departments of internal medicine and surgery (Table 5).

Table 4: Patient demographics and characteristics of non-fallers and fallers

	Non-fallers (n=32,460)	Fallers (n=2.512)	P-value
Age (years)*			
Medicine	69.7±17.4	78.3±12.9	<0.001‡
Geriatrics	82.7±7.8	84.1±7.6	<0.001‡
Surgery	60.3±20.3	77.7±14.4	<0.001‡
Total	66.3±19.4	79.8±12.2	<0.001‡
Gender (%) female			
Medicine	54.8	51.3	0.009†
Geriatrics	73.1	71.5	0.431†
Surgery	49.0	55.0	0.042†
Total	53.4	57.2	0.001†
Length of stay (days)*			
Medicine	10.0±8.3	19.2±13.6	<0.001‡
Geriatrics	31.6±21.4	49.1±31.1	<0.001‡
Surgery	8.3±7.5	19.7±19.8	<0.001‡
Total	10.6±10.9	23.7±21.2	<0.001‡

*Mean ±SD, †Chi-square, ‡ANOVA

Types of falls

A majority of the patients (42.5%) fell while ambulating, 34.6% while transferring (standing up/sitting down), and 20.2% of the patient falls were bed or chair related. In 3% of the patients, activity associated with the falls could not be determined. Overall, the activity associated with patient falls differed significantly between the clinical departments. Patients fell while ambulating and transferring most often at the geriatrics department, while patients fell out of a bed or a chair most often at the surgical department (Table 5).

Consequences of falls

Two third of the patients (64.8%) who fell sustained no injuries. In 30.1% of the patients, minor injuries such as pains, bruises, scratches, haematoma, or superficial wounds were observed. Five percent (5.1%) of the patients sustained major injuries such as 33 fractures of hands, arms, or ribs, 31 hip fractures, 12 intra cranial bleedings, and 72 other injuries (e.g. luxations, multiple haematoma). While the proportion of patients with minor injuries differed only slightly across

the departments, in the geriatric department twice as many of the patients (7.7%) experienced major injuries compared to the department of medicine (3.8%), (Table 5).

Table 5: Circumstances and consequences of falls

	Total (n=2,512)	Medicine (n=1,550)	Geriatrics (n=663)	Surgery (n=299)	P-value
Time of fall –Shift (%)					<0.001†
Day shift (7am-3pm)	33.6	31.4	38.6	33.4	
Evening shift (3pm-11pm)	29.1	27.9	34.1	24.6	
Night shift (11pm-7am)	37.3	40.6	27.3	42.1	
Location (%)					<0.001†
Bedroom	75.7	77.7	69.5	78.6	
Bathroom	15.2	15.0	15.8	15.1	
Corridor	4.9	4.1	8.0	2.3	
Other place in unit	4.0	3.0	6.3	3.7	
Other place in hospital	0.2	0.1	0.3	0.3	
Type of fall (%)					<0.001†
Ambulating	42.5	43.7	41.2	39.1	
Transferring	34.6	33.0	40.4	30.4	
Falling out of bed/chair	20.2	20.5	16.4	27.1	
Unknown	2.7	2.8	2.0	3.3	
Severity of injury (%)					0.001†
No injury	64.8	65.0	65.5	62.5	
Minor injury	30.1	31.2	26.8	31.4	
Mayor injury	5.1	3.8	7.7	6.0	

†Chi-square

Prevalence of risk factors in patients who fell

The prevalence of fall risk factors in the 2,512 patients at the time of their first fall included: impaired mobility (83.1%), impaired cognition (55.3%), use of psychotropics (25.4%), and use of narcotics (38.6%). Half of the patients who fell (50.1%) had a history of falls prior to hospitalization. With the exception of cognitive impairment and narcotic use, the prevalence of fall risk factors differed significantly between the three clinical departments (Table 6). The number of risk factors prevalent in patients at the first time of a fall varied: 4.5% of the patients who fell

presented no risk factor, 17.2% had one, 28.7% had two, 28.8% had three, and 20.8% of the patients had 4 or more risk factors. The number of risk factors per patient who fell differed significantly across the three departments except for those patients who had 3 risk factors at the time of their first fall (Table 7).

Table 6: Prevalence of risk factors in patients first falls

	Total (n=2,512)	Medicine (n=1,550)	Geriatrics (n=663)	Surgery (n=299)	P-value†
Impaired mobility	83.1	81.0	89.9	79.0	<0.001
Impaired cognition	55.3	55.2	55.9	54.8	0.940
History of falls	50.1	43.0	69.6	45.5	<0.001
Use of narcotics	38.6	37.9	41.6	35.5	0.128
Altered elimination	38.4	37.5	44.5	31.5	0.005
Impaired vision	32.4	29.2	36.0	38.8	0.007
Unsafe footwear	27.5	30.2	22.8	24.0	0.001
Use of psychotropics	25.4	21.5	37.6	18.4	<0.001

†Chi-square

Table 7: Number of prevalent risk factors in patients first falls

	Total (n=2,512)	Medicine (n=1,550)	Geriatrics (n=663)	Surgery (n=299)	P-value†
No risk factors (%)	4.5	4.4	2.0	10.7	<0.001
1 risk factor (%)	17.2	18.5	12.4	21.1	<0.001
2 risk factors (%)	28.7	32.0	22.8	24.4	<0.001
3 risk factors (%)	28.8	28.5	29.9	28.1	0.779
4 and more risk factors (%)	20.8	16.6	32.9	15.7	<0.001

†Chi-square

3.5   Discussion

This study describes the characteristics of in-patient falls across the clinical departments of internal medicine, geriatrics and surgery in an urban public hospital. During the 5-year study period, 2,512 of the hospitalized patients (7.5%) experienced a total of 3,842 falls during their hospitalization. Patient characteristics including gender, age and length of stay and circumstances and consequences of falls such as location, times, types of falls, and injuries sustained varied significantly across the three departments. Our study confirms earlier findings [9, 19] that patients who fell while hospitalized were older and were hospitalized longer than those who did not fall.

Fall rates and frequencies

In our study, the fall rate at the hospital level was 8.9 falls per 1,000 patient days. This was twice as high as in other settings with 2.7 falls to 4.7 falls per 1,000 patient days [1, 3-5, 11, 15]. In addition, our fall rates per 1,000 patient days at department levels were 11.3 falls in internal medicine and 11.7 falls in geriatrics compared with reported rates of 3.0 falls to 6.1 falls per 1,000 patient days in medicine departments [11, 12, 27], and 7.1 falls to 9.1 falls in geriatric departments in other hospitals [4, 13, 28]. Other hospitals reported that from 1 in 5 up to 1 in 3 patients who fell, fell more than once [5, 29, 30], a number close to the 28.2% of patients who fell more than once in our hospital. Another study [27] of medical patients reported that only 19% of patients were multiple fallers whereas we found that 1 in 4 patients had multiple falls in our medical department. In our geriatrics department, 41.3% of the patients fell more than once, consistent with the findings of others who reported that 30%-43% of the patients had more than one fall [13, 28, 31]. In surgical departments of other hospitals, observed fall rates were 2.2 falls to 3.2 falls per 1,000 patient days [4, 11], which are similar to our 2.9 falls/patient days. These lower rates may be due to surgical patients either being on bed rest, being mobilized only with nursing supervision or some patients having less fall risk factors. These patients may have an increased surveillance by nurses during their relatively short hospital stay. It was observed in this study and reported elsewhere [5] that patient falls occurred more frequently in medical units than in others, and are highest in geriatrics. The high in-patient fall rates in the departments of medicine and geriatrics of our hospital could be explained by a high proportion of older patients with both an acute medical condition and co-morbidities which may reflect their frailty and prolonged recovery time and risk factors profile.

Circumstances

In our study, more than half of all patient falls occurred within the first week of hospitalization compared to 29% and 38% in other studies [3, 32]. In a geriatric clinic [8], 27% of the patient falls occurred within the first week, similar to the 27.6% in the geriatric department of our hospital. The time of falls among the three clinical departments fluctuated over the 24 hours of the day. Our observed peaks in the night and in the evening did not match with other studies. In addition, different proportion of falls within working shifts may be influenced by diagnostic and therapeutic procedures, patient activities and staff organization. Other studies reported patient falls per working shift with 26% and 39% from 7am to 3pm, 29% and 35% from 3 pm to 11pm and 30% and 39% from 11pm to 7am [1, 19] These patterns of falls per shift are within the range of our findings of 33.6%, 29.1% and 37.3% at the hospital level. The higher proportion of patient falls during the night shift may reflect the patients' unfamiliarity with the hospital environment at night and not seeking assistance since they don't want to disturb either room mates or nurses. For medical departments, other hospitals reported that 48% to 49% of patient falls occurred during the night shift (10pm to 8am) [9, 27], while during that time span 53.4% of the patient falls occurred in our department of medicine. At our geriatric department, 38.6% of patient falls occurred during the day shift (7am-3pm), 34.1% occurred during the evening (3pm-11pm), and 27.3% during the night shift (11pm-7am). A previous study reported that 54%, 37%, and 9% of falls occurred during the day, evening and night shifts [13]. During the day shifts and evening hours, patients are usually most active with ambulating, toileting, and other activities including meal times, therapy sessions and spending time with visitors. Our study showed that three in four of the patient falls occurred in their rooms, and 15.2% in bathrooms. These findings are similar with other studies, reporting 65% to 85% [11, 15, 19], and 11% to 29% of falls occurring in these locations, respectively [4, 11, 15]. In other hospitals, 76% to 79% of patient falls in medicine departments occurred in their rooms and in 15% to 18% in bathrooms [9, 27]. These findings are similar with our observations in internal medicine with 77.7% of falls in patient room and 15% in bathroom. These results may be explained by the fact that patients spend most of their time in their bedrooms e.g., to recover from their illness, awaiting diagnostics and therapeutic procedures. In our hospital, most of the patients (42.5%) fell while ambulating and 34.6% occurred while transferring (with the highest risk for transfer on the geriatrics department; 40.4%), while every fifth patient fall was bed or chair related. In other studies 10%-42% of the falls occurred while patients were ambulating and 11-39% were bed related [4, 5, 11, 19]. Another study of medical patients reported that 33% of falls were bed related and 28% occurred during ambulation [9] compared to our findings of 20.5% and 43.7% respectively. In geriatric

settings 38% to 48% of the falls occurred while patients were ambulating [8, 13], 22% were bed-related [13], and 10.9% were chair related [8]. In our geriatrics department 41.2% of the patients fell while ambulating, and 16.4% were bed or chair related.

The similar proportion of patient falls during ambulation and transferring across hospital and department settings may reflect the inherent risk associated with executing dynamic actions such as remobilization after illness and while in a state of reduced physical fitness regardless of the hospital setting.

Injuries

In the present study, two third of the patients were not injured after they fell, while three in ten patient falls resulted in minor injuries and five in hundred patient who fell sustained major injuries. This is similar to data from other hospitals which observed rates of minor injuries between 26% and 39% [1, 5, 10, 24], and major injuries rates between 2.3% and 11.5% [1, 3-5, 10, 33]. Another study [9] reported that 21.6% of medical patients sustained minor injuries after falling while 1.5% had major injuries, which is lower than the rates of 30.4% and 3% respectively in patients from our department of internal medicine. In geriatric departments of other hospitals, rates of minor injuries range from 24% to 37% and major injuries from 1.4% to 5% [8, 13, 28]. Our rate of minor injuries (26.8%) is similar to that reported in other studies while our rate of major injuries (7.7%) is slightly higher. The relatively high percentage of patients with major injuries at the geriatric department may reflect the frailty of these patients given their mean age of 84 years, accumulation of risk factors and prolonged hospital stay due to recovery and rehabilitation time needed time. Unfortunately no injury rates of surgical patients of other hospitals have been reported. Overall, the injury rates of minor and major injuries are similar across the various hospital settings.

Fall risk factors

Although our findings do not provide a fall risk profile of all hospitalized patients, as only fall risk has assessed for fallers (e.g., impaired mobility, impaired cognition, use of narcotics and psychotropics and a history of previous falls), our findings are consistent with risk factors reported in the literature [25, 26]. Other studies have reported that 19% to 81% of patients who fell had impaired mobility [10, 11, 19], and 11% to 44% had impaired cognition including disorientation and confusion [4, 10, 11, 19]. The prevalence of cognitive impairment due to altered mental status in more than half of our patients who fell did not differ significantly across the clinical departments. Our findings are not surprising, since this risk factor is most prevalent in patients

who fell as it was seen in 7 of 9 hospital studies in one review [25] and in 29 of 32 studies in another review [34]. Psychotropic medication used was observed in 56% of the patients and 22 % of patients had a history of previous falls [11]. In another study in a department of medicine [27], 79% of patients who fell had impaired mobility, 53% were taking psychotropics such as sedatives, 43% had impaired cognition and 24% were on narcotics. In our department of internal medicine, impaired mobility was observed in 81% of the patient falls, impaired cognition in 55.2%, narcotic use in 37.9%, while only 21.5% were on psychotropics. In other geriatric settings, 42% of the patients who fell used psychotropics such as tranquilizers [13], and 38.8% were confused [8] compared to 37.6% of the patients taking psychotropics and 55.9% being confused in our geriatric department. One in 3 patients who fell in our geriatric department had 4 or more risk factors present, which may explain their proneness to falls.

Limitations

The limitations of this study were mainly due to its retrospective design. First, the reliability of the FIR had not been evaluated since its introduction in 1998. Therefore, registering patient falls and associated characteristics may vary (inter-rater reliability) due to a huge number of involved nurses including subsequent new employees. Although, a high number of falls were recorded during the observation period, underreporting can not be entirely avoided. Second, risk factors for falls e.g., impaired mobility or impaired cognition are based on nurses' observation guided by definitions provided in the FIR rather than by standard test procedures such as Get-Up-and-Go Test or Mini Mental Status Examination. In addition, information about the observed risk factors was only available for patients with falls. Consequently, we do not know the prevalence of these risk factors profile among patients who did not fall. Third, this study did not consider time effects given the 5-year observation period. It is possible that fall rates or the characteristics of patients who fell varied over time due to changes in clinical practices.

Conclusions

Hospital in-patient falls are common especially in departments of geriatrics and internal medicine. The relevance of our study is due to the provision of observational data on characteristics of patient falls. To our knowledge, such detailed findings from three different clinical departments of one hospital are not reported elsewhere in the literature. The findings of this study in relation to the time, location, and consequences of falls are similar to those reported in national and international studies. However, fall rates and related injuries varied significantly from one department to the other, probably due to differences in patient characteristics. Since one in three in-

patients falls results in at least one minor injury, in-patient falls are a safety issue for hospitals especially by patients who already have diminished health status. Attention should be given to the early identification of this vulnerable patient group and to the implementation of effective interventions to prevent patient falls in order to at least minimize fall related injuries. We recommend that future studies examine the efficacy of the identification of patients at risk for falling and of fall-related interventions in reducing falls and fall related injuries in hospitalized patients.

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4 ARE PATIENT FALLS IN THE HOSPITAL ASSOCIATED WITH LUNAR CYCLES? A RETROSPECTIVE OBSERVATIOANL STUDY

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4. 1 Abstract

Background Falls and associated negative outcomes in hospitalized patients are of significant concerns. The etiology of hospital inpatient falls is multifactorial, including both intrinsic and extrinsic factors. Anecdotes from clinical practice exist in which health care professionals express the idea that the number of patient falls increases during times of full moon. The aim of this study was to examine in-hospital patient fall rates and their associations with days of the week, months, seasons and lunar cycles.

Methods 3,842 fall incident reports of adult in-patients who fell while hospitalized in a 300-bed urban public hospital in Zurich, Switzerland were included. Adjusted fall rates per 1'000 patient days were compared with days of the week, months, and 62 complete lunar cycles from 1999 to 2003.

Results The fall rate per 1000 patient days fluctuated slightly over the entire observation time, ranging from 8.4 falls to 9.7 falls per month (P=0.757), and from 8.3 falls on Mondays to 9.3 falls on Saturdays (P=0.587). The fall rate per 1000 patient days within the lunar days ranged from 7.2 falls on lunar day 17 to 10.6 falls on lunar day 20 (P=0.575).

Conclusions The inpatient fall rates in this hospital were neither associated with days of the week, months, or seasons nor with lunar cycles such as full moon or new moon. Preventive strategies should be focused on patients' modifiable fall risk factors and the provision of organizational conditions which support a safe hospital environment.

4.2   Background

Falls occur frequently in hospitalized patients. Patient fall rates in hospital settings vary from 2.2 to 9.1 falls per 1000 patient days depending on patient populations and disease groups [1-7]. The etiology of falls in hospitalized patients is multifactorial consisting of both intrinsic and extrinsic risk factors [8-10]. Studies on hospital falls that focus on occurrences over time are limited to the frequencies of falls during the hours of the day [1, 5-7, 11, 12], and to specific time spans e.g. number of falls within the first week of hospitalization [2, 4, 7, 13]. Reasons for the fluctuation in fall-rates over time have been debated, but never scientifically researched. There exist anecdotes from health care professionals in our clinical practice that express the idea that the number of patient falls increasing during times of full moon. One survey indicated that specifically mental health professionals including psychologists, nurses and others held the personal belief that lunar phases affect patient's behavior [14]. However, only one study could be found which reports an increased frequency in patient accidents in a hospital, of which 90% were patient falls, during times of full moon and new moon [15]. Associations between lunar cycles and health conditions, however, such as increased phone call rates by females to a crisis-call centre, higher frequency in misbehaviors in institutionalized patients, greater behavioral deterioration in patients with schizophrenia, increased occurrence in gout attacks, and higher frequencies in the number of appointment requests in thyroid outpatients; rates of gastrointestinal bleeding; multiparae delivery rates; and numbers of births, have been reported [16-23].

Several beliefs, theories and hypotheses regarding lunar impact on the human body have been generated throughout the history of human kind. Assumptions such as the "Gravitational pull hypothesis" or the "Tidal force hypothesis" were extensively analyzed but their impact on the human organism could not be empirically substantiated [24]. A series of studies have rejected the hypothesis of a lunar influence on human health in view of the following: suicide rates [25, 26]; violent behavior and aggression [27, 28]; agitation in nursing home residents [29]; use of psychiatric community services [30]; psychiatric hospital admissions [31]; frequency of admissions to emergency care [32]; volume of patients admitted to emergency departments [33]; cardiopulmonary arrests in emergency departments [34]; incidence of myocardial infarction and sudden cardiac death [35]; onset of spontaneous pneumothorax [36]; survival time for breast cancer patients [37]; number of surgical complications [38]; postoperative nausea and vomiting [39]; workload on labor and delivery wards [40]; and number of deliveries [41].

There is evidence stating that professionals believe there are correlations between falls and times of the full moon, although an association between patient falls during hospitalization and lunar cycles, especially the influence of the full moon, has not yet been scientifically explored. We

hypothesized that no relationship exists between falls in hospitalized patients and lunar cycles. The aim of this study was therefore to examine in-hospital patient fall rates and their associations with days of the week, months, seasons and lunar cycles.

4.3   Methods

Study sample and setting

We conducted a retrospective analysis of all registered in-patient falls amongst the adult patients hospitalized on the general internal medicine, surgery and geriatric rehabilitation wards of a 300-bed public hospital, which provides medical services for the inhabitants of the Northern part of the city of Zurich, Switzerland. The observation period was from January 1, 1999 to December 31, 2003. Ethical approval was granted by the Ethics Committee of the City hospitals of the City of Zurich.

Variables and measurements

Patient falls were defined as "an incident in which a patient suddenly and involuntary came to rest upon the ground or surface" and were registered regularly by the nurses discovering the fall. We retrieved the number of registered patient falls occurring during hospital stay from the incident report data system of the quality management department, and screened administrative patient data to determine daily number of hospitalized patients, individual length of patient stay, and daily bed occupancy rates. We identified the dates of the synodic lunar months within the study period, based on the European Southern Observatory Munich Image Data Analysis System (ESO-MIDAS). One synodic lunar month counts 29.53 days (29 d. 12 h. 44 m.) which is the period of time required for the moon to travel from one position relative to the sun as seen from the Earth (e.g. full moon) and return to the same position. The day counts started with the new moon at day 0 until the full moon between day 14 and 15 and ended before the next new moon on day 28 or day 29.

Data analysis

We calculated fall rates per 1000 patient days to adjust for number of falls per day and number of hospitalized patients per day. To examine the pattern of fall rates over time, we calculated mean (including standard deviations (SD), and 95% confidence intervals (CI)) fall rates per day of the week, month and season throughout the study period. To model the rate of falls per 1000

patient days with lunar days, days of the week, and months as predictor variables, we used a general linear model. Statistical tests and confidence intervals were calculated two sided, and p-values <0.05 were considered statistically significant. All analyses were performed using SPSS (12.0).

4.4 Results

The 5 year study period included 1,826 observation days. During this time a total of 34,970 patients were hospitalized (mean age: 67.3 (SD 19.3) years, female: 53.6%), accounting for 431,149 patient days. Mean length of stay was 12.3 (SD 14.4) days. The hospital bed occupancy rate was 86.2% (Median: 86.6%). Overall, a total of 3,843 falls were registered, affecting 2,512 (7.2%) patients.

Number of hospitalized patients

The number of hospitalized patients per day ranged over the entire study period from 182 to 279 with a mean of 236 patients (SD 17, median 237). The mean number of hospitalized patients per day of the week varied significantly from 221 (SD 14) on Sundays to 244 (SD 16) on Thursdays (p<0.001). The mean number of hospitalized patients per month varied significantly from 220 (SD 17) per day in August to 247 (SD 16) per day in February (p<0.001).

Figure 1 Mean fall rates per month (1999-2003)
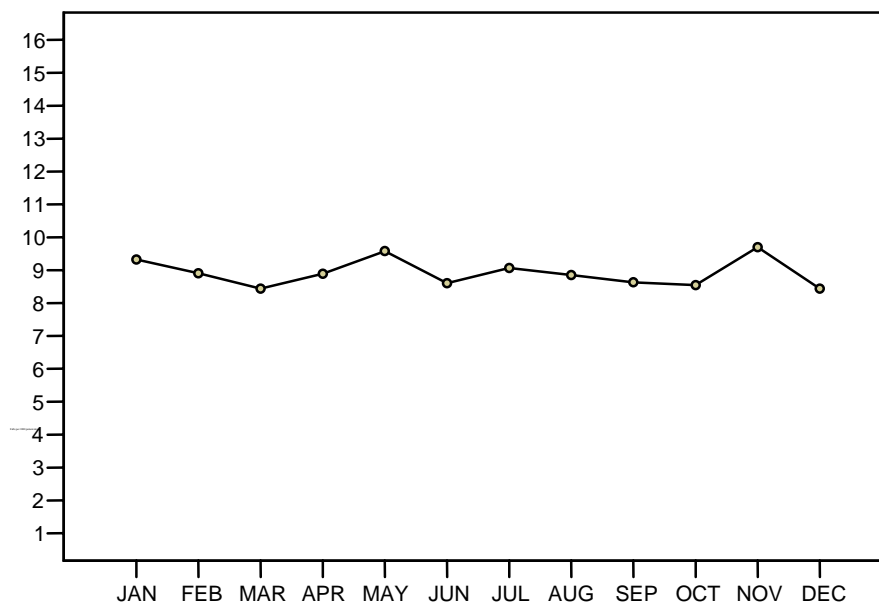
Incidence of patient falls over time

Throughout the study period, the frequency of daily falls ranged from zero to eight falls. The overall mean fall rate was 8.9 (SD 6.4) falls per 1000 patient days. Per day of the week, the mean fall rate ranged from 8.3 (SD 6.9) falls per 1000 patient days on Mondays to 9.3 (SD 6.7) falls per 1000 patient days on Saturdays (df 6; F=.778; p=.587). Per month, the mean fall rate ranged from a low of 8.4 (SD 6.1) falls per 1000 patient days in December to a high of 9.7 (SD 6.8) falls per 1000 patient days in November (df 11; F=.682; p=.757) (Fig. 1).

The mean fall rate per 1000 patient days per season of the year varied although not significantly: The lowest rate was in Autumn, with 8.7 (SD 6.2) falls/1000 patient days; In Winter there were 9.0 (SD 6.2) falls; the highest rate of falls was in Spring with 9.1 (SD 6.8), and in Summer there were 9.0 (SD 6.2) (df=3: F=0.213; p=0.887).

Falls, lunar cycle, and variation in time

Sixty two complete synodic lunar cycles were observed during the study period. The first full moon was observed on January 2, 1999 (first new moon: January 17, 1999) and the last full moon was seen on December 8, 2003 (last new moon: December 23, 2003). Within the days of the lunar cycle, the variation in mean fall rates per 1000 patient days was not significant. The lowest rate was 7.2 (SD 6.0) falls on lunar day 17, and the highest rate was 10.6 (SD 6.3) falls on lunar day 20 (df 29; F=.929; p=0.575) (Fig. 2).

Figure 2 Mean fall rates per lunar day (1999-2003)
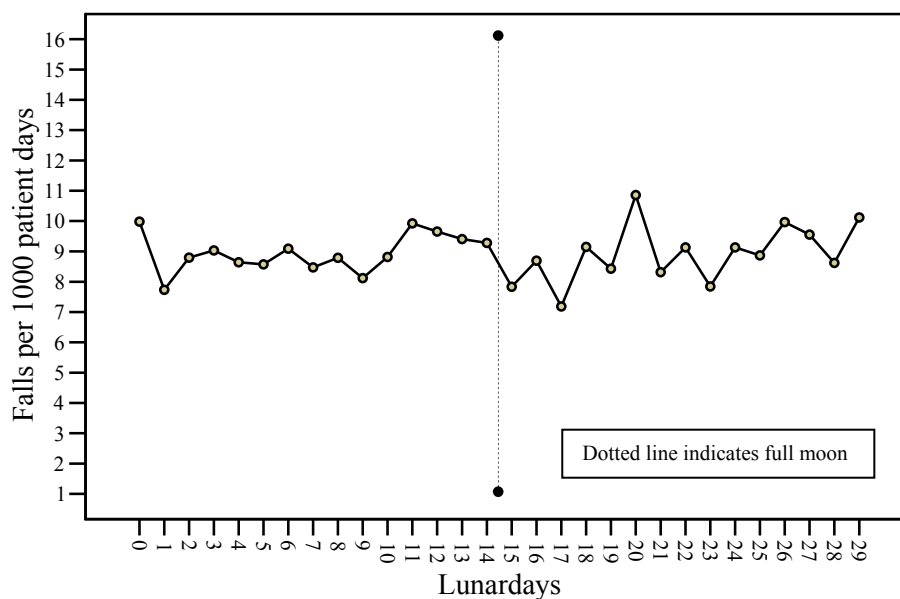
The fall rates per 1000 patient days, lunar days, and variation in time including days of the week, and months of the year, showed neither a statistically significant main effect, nor a statistically significant interaction between the variables under study (Table 1).

Table 1 Associations between falls/1000 patient days, lunar cycle, days of the week & month

	df	F-value	P-value
Corrected model[a]	1503	0.989	0.560
Lunar day	29	0.973	0.509
Days of the week	6	0.545	0.773
Month	11	0.368	0.967
Day of the week & month	66	1.040	0.403
Lunar day & days of the week	174	1.077	0.283
Lunar day & month	318	1.046	0.345
Lunar day, days of the week & month	899	0.949	0.721

[a] $R^2 = 0.822$ (adjusted $R^2 = -.010$)

4.5 Discussion

Throughout the 5 year study period, no significant association was found in the incidence rate of hospital in-patient falls occurring during the time period of the full or new moon, neither was periodicity demonstrated for days of the week, months or seasons of the year. Despite significant fluctuations of the hospital's patient occupancy per day of the week and month, the patient fall rates remained relatively stable during the entire study period.

Our results contrast with the one other study that addressed the relationship between patient falls and lunar cycles [15]. Sutton et al reported significant findings in view of increased accident rates during the seven days prior to a full moon and the seven days prior to the new moon. In contrast, we examined whether there were associations between fall rates per day during the lunar cycle, throughout 62 lunar cycles.

In general, our findings are concordant with all other studies that, as with our study, did not show an association between lunar days and patient related events such as hospital admissions, emergency department visits, accessing psychiatric services, and violent behavior [28, 30-33].

We assume that the belief of some health care professionals that frequency of in-hospital fall accidents increases with the time of the full moon rely on non-specific, non systematic observations within the realm of everyday practice. Such beliefs are probably influenced by lay press

reports that highlight bizarre unusual activities when the moon is full [42]. Empirical evidence shows that the etiology of falls during hospitalization is multifactorial. Clinically identifiable risk factors such as impaired mobility, impaired mental status, special toileting needs, psychotropic medications, and a past history of falling have been consistently found to be relevant for predicting future falls [8, 10, 43]. Of note is that it has recently been shown that hospital system related factors such as nurse staffing and nurse skill mix also influence the frequency of patient falls [44-46]. The challenge for healthcare professionals will be to support patient safety and quality of care by early identification of patients at risk for falling, and implement interventions to prevent falls and related injuries.

Conclusions

The in-patient fall rates were neither associated with days of the week, months, or seasons, nor with lunar cycles such as the full moon or new moon. Preventive strategies should be focused on assessment of patients' modifiable fall risk factors, and the provision of organizational conditions which support a safe hospital environment.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

RS contributed to the conception, design, data collection, analysis, interpretation of data, and drafted the manuscript. FJ contributed to the data collection and analysis. SDG contributed to the design, interpretation of data, and critical revision of the manuscript. KM contributed to the analysis, interpretation of data, and manuscript preparation. All authors gave final approval for this version of the manuscript to be published.

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5 EVALUATION OF THE MORSE FALL SCALE IN HOSPITALIZED PATIENTS

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5.1   Introduction

Several risk factors associated with falls in hospitalized patients have been identified [1, 2]. Although, a substantial number of assessment instruments for identifying hospitalized patients at risk for falling exists [3], their generalizability is limited [4] since only few [2, 5] have been tested settings other than those in which they were originally developed. The Morse Fall Scale (MFS) has been evaluated in different hospital settings [6-9] and has been used in a variety of patient populations [10-16]. In search of an appropriate tool to identify admitting patients for risk for falling, the MFS appears to be most elaborated in view of its extensive development and testing in different hospital populations compared to others [3, 4]. Its easy applicability in clinical practice additionally supported our decision. However, no investigation to date has reported results of different cut-off scores of the scale. This study aimed to evaluate the diagnostic value of different MFS cut-offs to determine which score would be most useful in identifying in-hospital patients at risk for falls.

5.2   Methods

This prospective cohort study utilized baseline data collected during a 4-month fall intervention study performed at two units of the department of internal medicine of a 300-bed urban public hospital in Switzerland. The data were collected on consecutively admitted adult patients (≥18 years, >48 hours in hospital) who presented a wide range of medical conditions.

Since the study hospital is situated in the German speaking part of Switzerland, the MFS was translated into German (MFS-G) and piloted with six registered nurses to determine their understanding of wording of items. Inter-rater reliability was examined and the level of agreement was 84% (K= 0.68). The scale consists of six items reflecting risk factors for falling such as: (1) history of falling, (2) secondary diagnosis, (3) ambulatory aids, (4) intravenous therapy, (5) type of gait, and (6) mental status. The total score ranges between 0 and 125 [17, 18]. For further details of the scale please see Appendix 1.

All registered nurses on the designated study units received a 30-minute group instruction on the use of the MFS-G as part of the implementation of the in-hospital fall risk screening program. The primary nurses completed the MFS-G for each newly hospitalized patient within 24 hours of admission. Patient falls during hospitalization were registered with a standardized fall incident report form that was implemented earlier in this hospital [19].

A fall was defined as "an incident in which a patient suddenly and involuntary came to rest upon the ground or surface"[20]. Patient demographics and clinical characteristics (i.e. gender, age, length of stay, and medical diagnosis) were extracted from the hospital administrative patient data base. The study was approved by the local ethics committee. Descriptive statistics such as frequencies, percentages as well as mean and standard deviations were calculated for demographic and clinical characteristics of the patients.

The diagnostic value of the MFS-G scores ranging from 20 to 70 was explored using receiver operating characteristic (ROC) curves, with an area under the curve (AUC) analysis based on admission MFS-G scores, and using patients who fell while hospitalized as the "gold standard". Sensitivity analysis, including specificity, positive and negative predictive values and accuracy were performed for the different cut-off scores of the MFS-G. Chi square statistics were calculated for the estimation for risk of falling with odd ratios and 95% confidence intervals. All data were analyzed with SPSS for Windows, version 12.0 (SPSS Inc., Chicago, Ill)

5.3   Results

A total of 386 patients (female: 59.6%) with a mean age of 70.3 (SD: 18.5) years, and a mean length of stay of 11.3 (SD: 8.9) days were included in the study. Forty-seven (12.2%) patients experienced a total of 69 falls. For patient demographics, clinical characteristics including primary medical diagnosis, and risk factors for falls (MFS-G items) please see Appendix 2.

The percentage of the patients identified as at risk for falling at admission varied with the MFS-G cut off scores used, and ranged from 89.4% (cut off score: 20 points) to 20.7% (cut off score: 70 points). According to the different cut off scores, the sensitivity ranged from 91.5% to 38.3%, the specificity from 81.7% to 10.9%, the positive predictive values from 12.5% to 22.5%, and the negative predictive values from 90.2% to 95.7% (Table 1).

Table 1: Predictive validity of MFS-G Cut off scores at admission (n=386)

Cut off scores	20	25	35	45	50	55	60	65	70
Sensitivity	91.5%	91.5%	91.5%	80.9%	80.9%	74.5%	68.1%	44.7%	38.3%
Specificity	10.9%	13.9%	16.5%	53.4%	58.7%	65.8%	70.2%	79.4%	81.7%
PPV*	12.5%	12.8%	13.2%	19.4%	21.3%	23.2%	24.1%	23.1%	22.5%
NPV†	90.2%	92.2%	93.3%	95.3%	95.7%	94.9%	94.1%	91.2%	90.5%
Accuracy	20.7%	23.3%	25.6%	56.7%	61.4%	66.8%	69.9%	75.1%	76.4%
AUC‡	.512	.527	.540	.671	.698	.701	.691	.620	.600

*Positive predictive value †Negative predictive value ‡Area under the ROC curve

High false positive rates (i.e. patients who were classified as at risk for falling but did not fall) ranging from 87.5% (cut off score: 20 points) to 75.9% (cut off score: 60 points) were observed. The area under the ROC curve ranged from 0.512 to 0.701, and the accuracy of the MFS-G ranged from 20.7% to 76.4% (Table 1). The most optimal cut-off point for the MFS-G was found to be 55, which showed a fairly good sensitivity of 74.5%, (95% CI: 60.5% - 84.7%) an acceptable specificity of 65.8% (95% CI: 60.1% - 70.6%) and a high negative predictive value (94.9%), with an acceptable accuracy of 66.8%. The ROC curve with an arrow indicating the highest peak with the cut-off of 55 points for the MFS-G is demonstrated in Figure 1. With a cut off score of 55 points, 23.2% of the patients were screened positive and presented a relative odds ratio of 5.6 (95% CI: 2.8 – 11.2) for falling.

Figure 1 –ROC curve with AUC of the MFS-G (n=386)
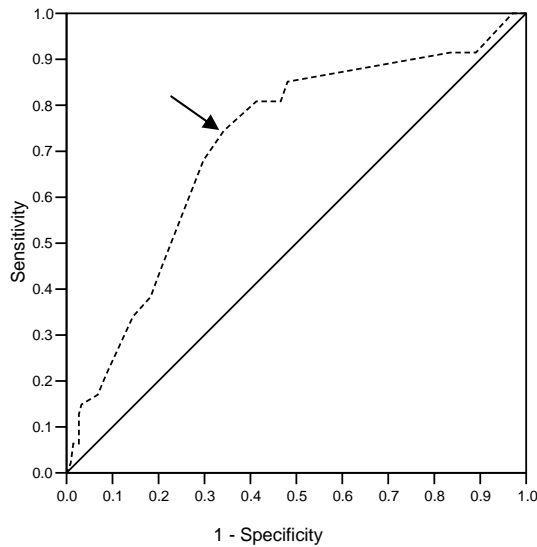
5.4 Discussion

This study constitutes a prospective test of the sensitivity, specificity and predictive value of the MFS-G in hospitalized patients. The 12.2% proportion of patients who fell in the present study lies between rates reported in previous studies of 15.7%, 29.6% [6, 9] and 5% and 4% [7, 21]. The variation in fall rates may reflect the different types of settings, sample sizes, patient characteristics, and reporting practices. The MFS-G demonstrated moderate ability to predict patients risk for falling using a cut off score of 55 points as evidenced by an AUC of 0.701 in a sample of internal medicine patients.

Using the originally identified cut off score of 45 points only 26% patients in another study [21] were identified as being at risk for falling, while the same cut off score identified 51% patients as being at risk for falling in the present study. This difference may be explained by the heterogeneity of the other sample, with patients enrolled from acute, rehabilitation and long-term care units while the present study may reflect a more homogenous sample in relation to fall risk factors despite a variety of medical diagnoses. Additionally, in the original prospective study [21], the fall risk status of the patients was assessed at different points of time during their hospital stay, while in the present study all patients were screened for risk of falling at admission. This and the prospective follow up during the patient's hospital stay allowed calculating of the diagnostic value of the MFS-G in relation to its predictive power.

Only one other study [9] scored patients at admission and performed ROC analysis. In that study, a MFS cut off score of 45 points identified 75% of the patients as at risk for falling with a false positive rate of 82%. The same cut off in this study resulted in a false positive rate of 81%, but decreased slightly to 77% with a cut off of 55 points. O'Connell and Myers [9] concluded, based on an AUC of 0.621 that the MFS had low ability to discriminate patients who fell and those who did not fall. However, the high positive rate may reflect a limitation of this study since the effects of fall interventions subsequently implemented with some of the patients identified as being at risk for falling were not considered.

Furthermore, the performance of falls incident reporting may be inflated by virtue of the study being conducted (Hawthorne effect). Finally, changes in the patient's health condition, which may have altered risk factors for falls were not considered. While the high NPV's (e.g. 95% of the non falling patients were not at risk for falling) may give appropriate reassurance for patients with low risk for falling, the scale seems to be of limited operational value since PPV is only between 12% and 24%. We therefore recommend that the MFS undergo local validation to determine the best cut off score for a given setting before it is used clinically. Screening patients for risk of falling, should lead to more targeted assessment and modification of risk factors using multifactorial interventions [22, 23]. However, since the effectiveness of hospital fall prevention programs that incorporate fall risk assessment leads to a 25% or less reduction in fall rates [24], the idea of looking at reversible risk factors in all patients and reassessing their risk following a fall may be an appropriate approach [2].

Key point

- The MFS should be used to screen hospitalized patients at risk for falling only after local validation to determine best cut off scores in a given setting.

Acknowledgment

Conflicts of interest

The authors have no conflicts of interest to declare.

5.5   References

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Appendix 1: Morse Fall Scale (Morse *et al*. 1989) (Items and scores)

Items			Score
1. History of Falling	No	= 0	
	Yes	= 25	_____
2. Secondary Diagnosis	No	= 0	
	Yes	= 15	_____
3. Ambulatory Aid	None/bedrest/nurse assist	= 0	
	Crutches/cane/walker = 15		
	Clutching onto furniture	= 30	_____
4. Intravenous therapy/heparin lock	No	= 0	
	Yes	= 20	_____
5. Gait	Normal/bedrest/wheelchair = 0		
	Weak	= 10	
	Impaired	= 20	_____
6. Mental status	Oriented to own ability	= 0	
	Overestimates/forgets limitations	=15	_____
	Total		_____

Appendix 2: Table with patient demographic and clinical characteristics

	(n=386)
Gender – Female (%)	230 (59.6)
Age (years)*	70.3 ± 18.5
Length of Stay (days)*	11.3 ± 8.9
Number of fallers (%)	47 (12.2)
MFS-G Score at admission*	48.0 ± 23.6
Primary diagnosis categories (ICD-10)	
Circulatory (%)	98 (25.4)
Symptoms & signs (%)	54 (14.0)
Respiratory (%)	46 (11.9)
Digestive (%)	38 (9.8)
Musculo-skeletal (%)	31 (8.1)
Endocrine, metabolic (%)	22 (5.7)
Mental behavioral (%)	19 (4.9)
Neoplasm (%)	19 (4.9)
Other diagnostic categories (%)	59 (15.3)
MFS-G Items	
History of falling (%)	117 (30.3)
Secondary diagnosis (%)	361 (93.5)
Intravenous therapy (%)	289 (74.9)
Need of ambulatory aids (%)	56 (14.5)
Impaired Gait (%)	132 (34.2)
Impaired mental status (%)	83 (21.5)

*Mean ± SD

6 FALL PREDICTION IN INPATIENTS BY BEDSIDE NURSES USING THE STRATIFY INSTRUMENT: A MULTI CENTER STUDY

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6.1 Abstract

Falls commonly occur among hospitalized elderly patients. To better predict a patient's risk of falling, we assessed the predictive value of the STRATIFY instrument, a simple fall-risk assessment tool, when administered at a patient's hospital bedside by nurses. Our prospective multi-center study was carried out in six Belgian hospitals during a 3-month period. A total of 2568 patients (mean age: 67.2 y ± 18.4; female: 55.3%) that were admitted to four surgical (n = 875; 34.1%), eight geriatric (n = 687; 26.8%), and four general medical wards (n= 1006; 39.2%) were included in our study upon their hospital admission. All patients were hospitalized for at least 48 hours. Nurses completed the STRATIFY within 24 hours after admission of the patient. Falls were documented on a standardized incident report form. The number of fallers was 136 (5.3%), accounting for 190 falls. The STRATIFY showed good sensitivity (≥85%) and high negative predictive value (≥99%) for the total sample, for patients admitted to general medical and surgical wards, and for patients younger than 65 years. The STRATIFY, however, showed moderate (67%) to low (57%) sensitivity and high false negative rates (33% and 43%) for patients admitted to geriatric wards and for patients 65 years or older. Thus, although the STRATIFY satisfactorily predicted the fall risk of patients admitted to general medical and surgical wards and patients younger than 65 years, it failed to predict the fall risk of patients admitted to geriatrics wards and patients 65 years and older.

6.2   Introduction

Falls frequently occur among hospitalized patients. Depending on hospital type and patient population, fall rates have been estimated between 2.2 and 12 falls per 1000 patient days.[1–8] Approximately 30% of these falls lead to minor injuries such as scrapes or bruises, and up to 15% lead to serious injuries such as fractures, brain injuries, and even death. Other fall-related consequences may include fear of falling, social isolation, anxiety and depression, and loss of confidence. Falls are also associated with an increased length of hospital stay and an increased risk of admission to long-term care facilities.[2, 9–14] In addition, inpatient falls may elicit guilt among staff and complaints (including litigation) from patients or their families.[15–18]

Commonly identified risk factors for falls in hospitalized patients include gait instability, altered mental state (e.g., agitated delirium), urge incontinence, a history of falling, and use of 'culprit' drugs, especially sedatives and hypnotics.[19]

Several intervention studies aimed at preventing in-hospital falls have been conducted in various countries and across different hospital settings. Because these studies implemented multifactorial prevention strategies (including risk assessment, targeted interventions, and monitoring in different hospital settings and countries), inconsistent findings have resulted.[20] One important component of in-hospital fall prevention programs is targeted intervention of high-risk patients. Several simple risk assessment tools have been developed to identify these patients, predicting falls with sensitivity and specificity of more than 70%.[19, 21, 22] A widely used tool is the St. Thomas's Risk Assessment Tool in Falling Elderly Inpatients (STRATIFY), a simple risk assessment tool consisting of five items that address risk factors for falling: (1) history of falling, (2) patient agitation, (3) visual impairment affecting everyday function, (4) need for frequent toileting, and (5) transfer ability and mobility.[23] Although STRATIFY has gained much attention since its development, it has mainly been tested in a controlled setting (e.g., completion of the instrument by a trained person) and in older non-surgical inpatients.[23–26] Prospective studies based on various hospital settings and routine clinical use are lacking.[19]

Thus, the aim of the current study was to evaluate the predictive properties of the STRATIFY when it is administered at a patient's bedside by nurses in different hospital settings (surgical versus non-surgical).

6.3 Methods

Design and Sample

Our prospective multi-center study was performed in six Belgian hospitals. In each hospital, we selected two to three different units (general medical, surgical, and/or geriatric wards). Our study sample of consisted of consecutively admitted adult patients (≥19 years) who were hospitalized for more than 48 hours. To be for our study, surgical patients had to be pre-scheduled for elective surgery.

Data Collection and Variables

Between November 2003 and March 2004, primary nurses from each participating hospital collected data for three consecutive months. Research project staff informed hospital representatives about the study, including the provision of study materials (e.g., the STRATIFY instrument and the incident report form), and gave them oral and written instructions detailing the data collection strategy to ensure data quality and uniformity. The Committee of Nursing Ethics from the Faculty of Medicine, Catholic University of Leuven (Belgium) approved the study.

STRATIFY

STRATIFY is a convenient tool that consists of five questions: (1) Did the patient present to the hospital with a fall or has he or she fallen in the past six months? (yes = 1, no = 0; we added the clause 'has he or she fallen in the past six months' to the original STRATIFY); (2) Do you think the patient is agitated? (yes = 1, no = 0); (3) Do you think the patient is visually impaired to the extent that everyday function is affected? (yes = 1, no = 0); (4) Do you think the patient is in need of frequent toileting? (yes = 1, no = 0); and (5) Does the patient have a transfer and mobility score of 3 or 4? (yes = 1, no = 0). Transfer is scored as follows: 0 = unable; 1 = major help needed (1–2 helpers and/or physical aids needed); 2 = minor help needed (verbal or physical); 3 = independent. Mobility is scored as follows: 0 = immobile; 1 = independent with the aid of wheelchair; 2 = walks with the help of one person; 3 = independent. The total STRATIFY score corresponds to the sum of all present risk factors and can range between 0 and 5. The higher the score the greater the risk a patient has of falling.

Nurses completed the STRATIFY within 24 hours of the patient's hospital admission and indicated the time they completed the instrument.

Demographics and Clinical Characteristics

Age, gender, reason for admission, and length of hospital stay were documented by the primary nurses. Falls that occurred after risk screening with STRATIFY were documented by the attending nurse on a specifically designed incident report form. A fall was defined as "any event that results in a person coming to rest unintentionally on the ground or on a surface lower than his or her original position."

Statistical Analyses

Descriptive statistics (frequencies and percentages) were calculated for nominal variables. Means and standard deviations were calculated for continuous variables. To explore the predictive validity of the STRATIFY in identifying patients as 'fallers' or 'non-fallers,' we constructed receiver operating characteristic curves (ROC). We also calculated sensitivity, specificity, positive and negative predictive values, and accuracy for all cut-off scores (ranging from 0 to 5). Analyses were performed for the total sample, for each of the different ward types (general medical, surgical, geriatric wards) and for two age groups (patients younger than 65 years and those 65 years and older). We performed Kaplan-Meier survival analyses to compare the length of hospital stay before the first fall incident of the fallers from the three different wards to that of the fallers of the two age groups. All statistical analyses were performed using SPSS® for Windows (version 11.5). The nominal significance level was set at $p < 0.05$.

6.4 Results

Patient Characteristics

We screened 2739 patients for risk of falling. One hundred seventy-one patients (6.2%) were excluded from the analysis because of incomplete assessment (n =138) and/or not meeting the inclusion criteria (n =33). Of the 2568 included patients, 1006 (39.2%) were obtained from four general medical wards, 875 (34.1%) from four surgical wards, and 687 (26.8%) from eight geriatric wards. One thousand six hundred two (62.3%) patients were 65 years or older. The mean age of the total sample was 67.2 years (SD 18.5) and 1420 (55.3%) patients were female (Table 1). The main reasons for hospital admission were orthopedic disorders (13.7%), digestive disorders (12.8%), cardiovascular disorders (10.8%), respiratory disorders (8.5%), and previous fall incidents (7.3%). Demographic and clinical patient characteristics across the different ward types and age groups are displayed in Table 1

Table 1: Demographic and Clinical Characteristics of Patients Tabulated by Type of Admission Ward and Age Group

	Total sample n = 2568	General medical ward n = 1006	Surgery ward n = 875	Geriatrics ward n = 687	≥ 65 y n = 1602	< 65 y n = 966
Mean age in years (SD)	67.2 (18.4)	64.1 (18)	58.2 (17.1)	83.1 (7.5)	79.3 (7.8)	47 (12.2)
Female – n (%)	1420 (55.3)	512 (50.9)	436 (49.8)	472 (68.7)	975 (60.9)	445 (46.1)
Mean LOS (SD)	10.2 (11.4)	8.7 (10)	5.6 (5.7)	18.5 (14)	13 (12.6)	5.7 (6.8)
Main reason for admission – n (%)	1. orthopedic 351 (13.7)	1. digestive 181 (18)	1. orthopedic 299 (34.2)	1. fall 113 (16.4)	1. digestive 192 (12)	1. orthopedic 186 (19.3)
	2. digestive 328 (12.8)	2. neurological 117 (11.6)	2. cardiovascular 145 (16.6)	2. respiratory 112 (16.3)	2. Respiratory 186 (11.6)	2. digestive 136 (14.1)
	3. cardiovascular 278 (10.8)	3. respiratory 104 (10.3)	3. diagnosis 76 (8.7)	3. digestive 82 (11.9)	3. Cardiovascular 179 (11.2)	3. cardiovascular 99 (10.2)
	4. respiratory 218 (8.5)	4. cardiovascular 100 (9.9)	4. urologic 68 (7.8)	4. orthopedic 43 (6.3)	4. Fall 170 (10.6)	4. diagnosis 78 (8.1)
	5. fall 188 (7.3)	5. Pain 76 (7.6)	5. digestive 65 (7.4)	5. general decline 43 (6.3)	5. orthopedic 165 (10.3)	5. ORL 59 (6.1)
	6. neurological 149 (5.8)	6. diagnosis 65 (6.5)	6. ORL 62 (7.1)	6. confusion 38 (5.5)	6. neurological 102 (6.4)	6. unknown 57 (5.9)
	7. diagnosis 145 (5.6)	7. fall 48 (4.8)	7. Fall 27 (3.1)	7. cardiovascular 33 (4.8)	7. urologic 70 (4.4)	7. pain 48 (5)
	8. urologic 107 (4.2)	8. social 37 (3.7)	8. gynecologic 23 (2.6)	8. social 32 (4.7)	8. diagnosis 67 (4.2)	8. neurological 47 (4.9)
	9. pain 105 (4.1)	9. oncologic 37 (3.7)	9. unknown 16 (1.8)	9. neurological 30 (4.4)	9. general decline 64 (4)	9. urologic 37 (3.8)
	10. oncologic 71 (2.8)	10. hematologic 33 (3.3)	10. dermatologic 13 (1.5)	10. oncologic 28 (4.1)	10. pain 57 (3.6)	10. respiratory 32 (3.3)
	11. other 628 (24.4)	11. other 208 (20.6)	11. other 81 (9.2)	11. other 133 (19.3)	11. other 350 (21.7)	11. other 187 (19.3)
Number of falls (n)	190	60	10	120	168	22
Number of fallers - n (%)	136 (5.3)	46 (4.6)	8 (0.9)	82 (11.9)	123 (7.7)	13 (1.3)

Fall Incidence and Time until the First Fall

In total, 136 (5.3%) patients fell at least once during their hospitalization, accounting for a total of 190 falls. The number of fallers and the number of fall accidents were highest in geriatric wards and for patients 65 years and older (Table 1).

The mean length of hospital stay before the first fall was significantly longer for fallers admitted to geriatric wards than for those admitted to surgical and general medical wards. No difference was observed between those over 65 years of age and those under 65 years of age (Figure 1 and Table 2).

Table 2: Mean Length of Hospital Stay Before the First Fall of Patients Tabulated by Type of Admission Ward and Age Group (n=130)*

	Mean length of stay until first fall (95% CI)	P-value[†]
Clinical ward type		
Geriatric wards (n = 78)	11 (9–13) days	<0.001
Surgical wards (n = 8)	3 (1–5) days	
General medical wards (n = 44)	5 (4–7) days	
Age group		
≥ 65 years (n = 117)	9 (7–10) days	0.987
< 65 years (n = 13)	8 (5–12) days	

*Six patients were excluded from analysis: 2 patients had hospital stays exceeding 88 days; 4 patients had no data on the time when the fall occurred.

[†]The log rank test was used to test the equality for mean length of stay between the different ward types and between the age groups.

Predictive Value

Figure 2 summarizes the ROC analyses of our data. ROC analysis of the total sample revealed an area under the curve (AUC) of 0.78 (CI = 0.74 – 0.82). For general medical, surgical, and geriatric wards, AUC values were 0.75 (CI = 0.68 – 0.81), 0.84 (CI = 0.70 – 0.98), and 0.67 (CI = 0.61 – 0.73), respectively. For patients 65 years of age or over and for those under 65 years of age, AUC values were 0.71 (CI = 0.67 – 0.75) and 0.89 (CI = 0.80 – 0.98), respectively.

Figure 1: Kaplan-Meier survival analysis of the length of hospital stay before the first fall incident of patients according to age group and type of admission ward.
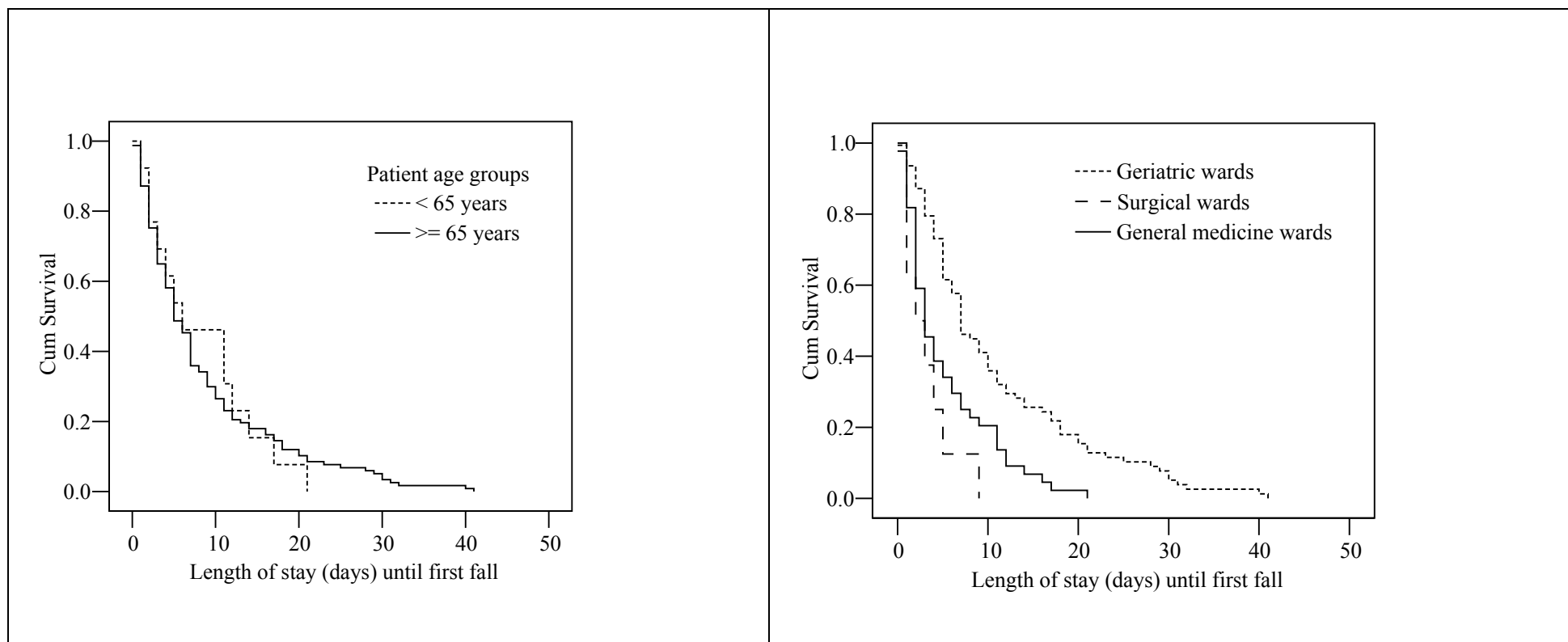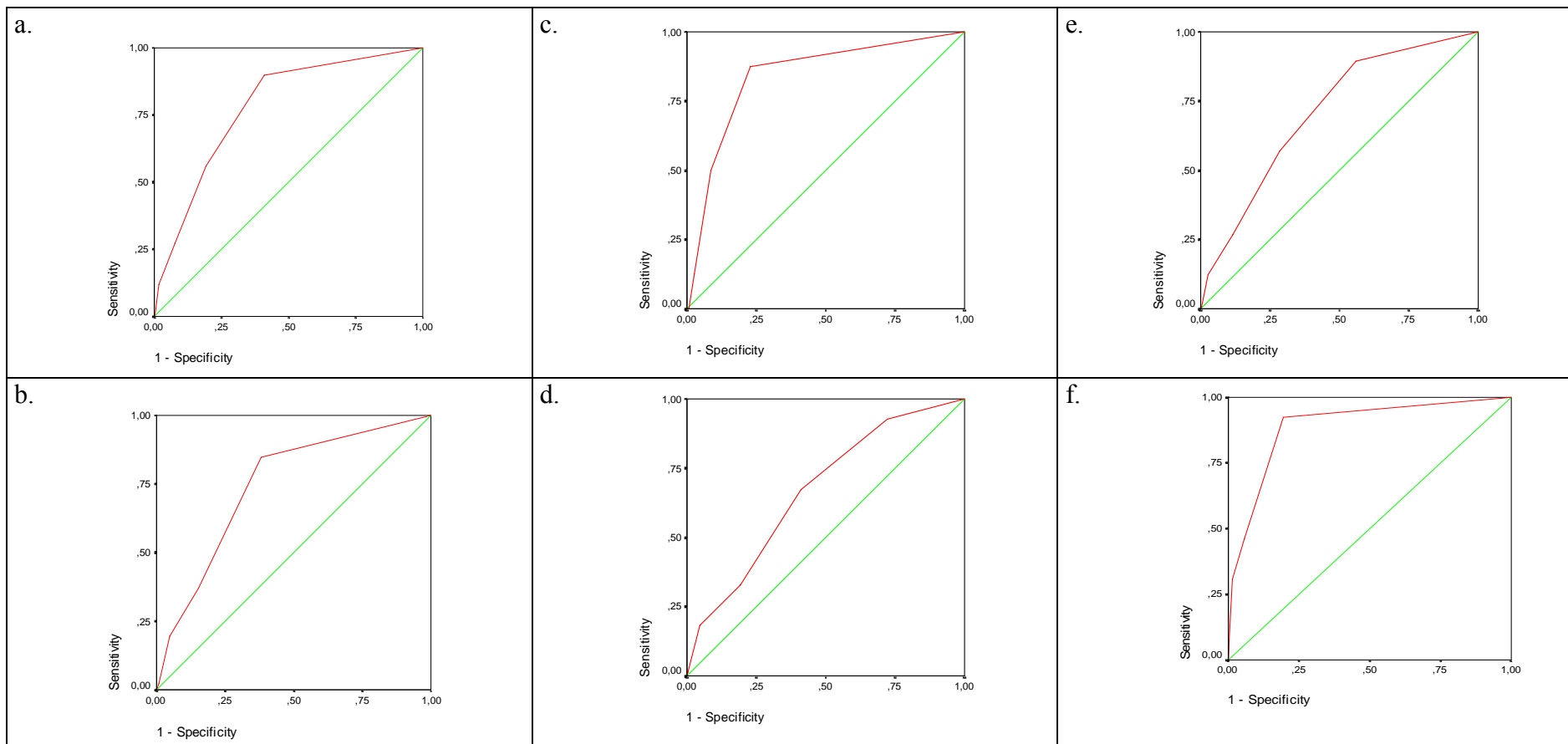
Figure 2: ROC curves. (a) Total patient sample. (b) Patients admitted to general medical wards. (c) Patients admitted to surgical wards. (d) Patients admitted to geriatric wards. (e) Patients aged 65 years and older. (f) Patients younger than 65 years.

Based on the ROC analyses and the predictive values for the different cut-off points, the optimal STRATIFY cut-off score was found to be one (1) for the total sample, for patients admitted to general medical and surgical wards, and for patients younger than 65 years. The optimal cut-off score was two (2) for patients admitted to a geriatric ward and for patients aged 65 or older (Table 3).

The STRATIFY showed good sensitivity (≥ 85%) and high negative predictive value (≥ 99%) for the total sample, for patients admitted to general medical and surgical wards, and for those younger than 65 years. The STRATIFY had a moderate sensitivity (67%) and high false negative rates (33%) for patients admitted to geriatric wards. Sensitivity dropped to 57% and the false negative rate increased to 43% for patients aged 65 years or more. Overall, positive predictive values were low (≤ 18%) (Table 3).

Table 3: Predictive Properties of the STRATIFY Instrument in All Patients, Patients in Different Wards, and Patients of Different Age Groups

Patient population	Sensitivity	Specificity	PPV	NPV	FPR	FNR	Accuracy
Total sample (optimal* cut-off score = 1)	90%	59%	11%	99%	41%	10%	61%
General medical (optimal* cut-off score =1)	85%	62%	10%	99%	38%	15%	63%
Surgical (optimal* cut-off score = 1)	88%	77%	3%	100%	23%	12%	77%
Geriatrics (optimal* cut-off score = 2)	67%	59%	18%	93%	41%	33%	60%
≥ 65 years (optimal* cut-off score = 2)	57%	72%	15%	95%	28%	43%	70%
< 65 yrs (optimal* cut-off score = 1)	92%	81%	6%	100%	19%	8%	81%

*Balancing sensitivity and specificity. PPV=Positive predictive value, NPV=Negative predictive value, FPR=False positive rate, FNR=False negative rate

Time Needed to Complete the STRATIFY

Most nurses needed less than one minute to complete the STRATIFY for patients admitted to general medical (92%) and surgical wards (97%) and for those younger than 65 years (96%). For 15% of patients 65 years or older and for 23.5% of those admitted to geriatric wards, the assessment time was typically between 2 and 5 minutes.

6.5 Discussion

In the present multi-center study, we assessed the predictive properties of the STRATIFY. Bedside nurses completed the STRATIFY for different patient groups, including patients of different ages that were admitted to medical, geriatric, or surgical wards. For patients admitted to general medical or surgical wards as well as for those younger than 65 years, the STRATIFY appeared to predict inpatient falls quite well. With a sensitivity of at least 85% and a specificity ranging between 59% and 81%, the proportion of false negative fallers (no-risk-score patients who fell) and false positive fallers (risk-score patients who did not fall) was clinically acceptable (8–15% and 19–41%, respectively). However, the STRATIFY was significantly less predictive in patients over 65 years of age or in patients admitted to geriatric wards.

The predictive value of the STRATIFY in other studies varied remarkably with sensitivities ranging from 54% to 93%, specificities ranging from 45% to 88%, and positive and negative predictive values ranging from 11% to 62% and 90% to 98%, respectively.[23–26] These studies included older patients admitted to acute geriatric, medical, or rehabilitation wards. The optimal cut-off score varied between ≥2 and ≥3.[23, 24, 26] Papaioannou et al. tested the STRATIFY with a modified scoring system (e.g., item weighting).[25] On the other hand in the current study, optimal cut-off scores varied between ≥1 and ≥2, depending on patient and setting characteristics. These findings support the hypothesis from Oliver et al. that the feasibility and usefulness of this type of tool should be tested for each specific setting, before being integrated in a falls prevention program.[19]

The low sensitivity and high false negative rates of the STRATIFY that we found in patients admitted to geriatric wards and individuals older than 65 years might be explained by the average length of hospital stay, which was longer in these patient groups compared to that of the other groups. In addition, patients in geriatric wards experienced their first fall significantly later on in their hospital stay than did those in general medical or surgical wards. This may reflect the fact that the risk of falling in geriatric patients increases with increasing length of hospital stay. Rehabilitation may increasingly expose geriatric patients to an increased risk of falls. Moreover, their risk of falling, as measured on admission, may not be representative of their risk of falling during their subsequent hospital stay. In this regard, the STRATIFY should probably be repeated during patients' hospital stay whenever their functional status changes. Depending on the clinical setting, scoring patients for fall risks might be appropriate either on a regular basis or when the patients' health status changes; this is especially important for patients with an extended hospital stay.[23]

Although risk-screening instruments may be useful components of a falls prevention program, their diagnostic power is limited.[19] Low positive predictive values, as shown in the present study for all settings and age groups, may dilute any efforts to prevent falls. Thus, interventions should target common, modifiable risk factors.[19] On the other hand, the high negative predictive value of STRATIFY, as we consistently found in our study, allows STRATIFY to identify individuals who are very unlikely to fall.

Our study has a number of limitations. Firstly, preventive measures taken by the bedside nurses might have influenced the results by preventing some of the falls. Future studies should control for these interventions when testing the predictive validity of risk assessment instruments by using alternative designs.[27] Secondly, the low prevalence of falls, especially of surgical ward patients, may have contributed to the low positive predictive values we found in this study. The higher the prevalence of falls the greater the probability that a patient receiving an at-risk score will fall. Studies of patient samples with various fall rates are therefore indicated to test the robustness of our findings. Finally, we did not formally test the inter-rater reliability between nurses of the different participating hospitals. As indicated by Papaioannou et al., the use of tool items that allow for different interpretations (e.g., agitation) may compromise reproducibility, which might result in some inconsistencies in scoring the STRATIFY.[25] Further testing is needed to improve reproducibility.

We conclude that the STRATIFY is a convenient instrument to use at admission to predict the risk of in-hospital falls of general medical and surgical ward patients and of patients 65 years of age and younger. For older patients and geriatric ward patients, however, the STRATIFY failed to predict in-hospital falls. For older patients with prolonged hospital stays, it remains to be clarified whether repeated use of the STRATIFY tool would enhance its clinical utility.

6.6   References

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7   FALL PREVENTION IN AN ACUTE CARE HOSPITAL SETTING REDUCES MULTIPLE FALLS

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7.1 Abstract

In hospitalized older patients falls are common. Prevention in-hospital falls is an important goal in avoiding poor patient outcomes. In this quasi-experimental study, the authors evaluated the effectiveness of a nurse-led fall prevention program in a 300-bed Swiss hospital. 409 patients (internal medicine) were included; intervention group (n=198), usual care group (n=211). The program consisted of a training of nurses in the use of the Morse Fall Scale, and the implementation of 15 selected preventive interventions. In the intervention group the proportion of patients at risk for falls was higher (p=0.048), and fewer patients with multiple falls were observed (p=0.009). The intervention program showed an effect in preventing multiple falls but not first falls. The prolonged mean time to a first fall in a subgroup of fallers in the intervention group may indicate an increased awareness of the nurses and the appropriateness of the interventions used.

7.2 Background

Between 15% and 90% of the reported adverse events or accidents in hospitalized patients are falls depending on hospital type and reporting methods (Aisen, Iverson, Schwalbe, Weaver, & Aisen, 1994; Ash, MacLeod, & Clark, 1998; Goodwin & Westbrook, 1993; Groves, Lavori, & Rosenbaum, 1993; Jones & Smith, 1989; Kilpack, Boehm, Smith, & Mudge, 1991; Mayo, Gloutney, & Levy, 1994; Raz & Baretich, 1987; Tutuarima, van der Meulen, de Haan, van Straten, & Limburg, 1997). Furthermore, approximately 2% to 12% of the patients experience a fall during their hospital stays (Mahoney, 1998; Tack, Ulrich, & Kehr, 1987; Vlahov, Myers, & al-Ibrahim, 1990). Fall rates per 1,000 patient days in acute hospitals vary from 2.2 to 8.9 depending on patient populations and disease groups (Halfon, Eggli, Van Melle, & Vagnair, 2001; Mayo et al., 1994; Mitchell & Jones, 1996; Schwendimann, 1998; Sullivan & Badros, 1999; Tutuarima et al., 1997). Consequences of falls in hospitals include minor to severe injuries (Alexander, Rivara, & Wolf, 1992; Evans, Hodgkinson, Lambert, & Wood, 2001; Goodwin & Westbrook, 1993), fear of falling by patients, and subsequent activity restriction (Murphy, Williams, & Gill, 2002; Vellas, Wayne, Romero, Baumgartner, & Garry, 1997), prolonged hospital stays (Bates, Pruess, Souney, & Platt, 1995), increased health care costs (Alexander, Rivara, & Wolf, 1992; Englander, Hodson, Terregrossa, 1996), and legal liability (Fiesta, 1998).

In Switzerland, about one third of the non-hospitalized individuals older than 65 years fall every year (Gostynski, Ajdacic-Gross, Gutzwiller, Michel, & Herrmann, 1999) with more than 60,000 falls requiring medical attention. Treatment costs of falls are about 250 million Swiss francs per

year, which is equivalent to 196 million U.S. $ (Beer, Minder, Hubacher, & Abelin, 2000; Hubacher & Ewert, 1997). The etiology of the majority of falls in and outside of the health care institutions appears to be multidimensional, resulting from interplay of intrinsic and environmental factors (Morse, 1997; Rubenstein, Josephson, & Osterweil, 1996; Tinetti, McAvay, & Claus, 1996). Case-control and cohort studies have shown that the most common risk factors for falls in hospitalized patients are impaired mental status, special toileting needs, impaired mobility, and history of falling, psychotropic medication, and advanced age (Evans et al., 2001). Restraint use in hospitalized patients also increases the risk of falling (Arbesman & Wright, 1999; Shorr et al., 2002).

Problem statement

Prevention of in-hospital falls is an important goal in avoiding poor outcomes in elderly hospitalized patients. To prevent falls in hospitals, an integrated, multifactorial approach is recommended including a) identification of patients at high risk for falling; b) implementation of strategies to minimize risk for falls; c) ongoing monitoring of fall rates; d) and education of staff, patients and visitors about fall prevention (Evans, Lambert, Wood, Kowanko, 1998; Morse, 1997; Rutledge, 1998; Schwendimann, 2000; Tideiksaar, 2002). Various fall prevention programs in acute care settings have been launched. Yet, evaluation of the effectiveness of the programs is limited and shows conflicting findings (AGS, 2001; Gillespie, Gillespie, Cumming, Lamb, & Rowe, 2000; Oliver, Hopper, & Seed, 2000).

The authors' work in 1998 focusing on incidence of falls within a department of internal medicine of a city hospital in Switzerland showed 413 falls in 314 patients out of a total of 3,400 patients, resulting in 32% minor and 4% severe injuries (Schwendimann, 1998). In other studies injury rates range from 4% and 50% (Goodwin & Westbrook, 1993; Sutton, Standen, & Wallace, 1994; Vassallo, Azeem, Pirwani, Sharma, & Allen, 2000). These findings urged the hospital management to launch an intervention program to reduce patient falls in the authors' institution. The aim of this study was to evaluate the effectiveness of a nurse-led fall prevention program in view of incidences of patient falls. It was hypothesized that the use of the intervention protocol would result in a difference in the number of patient falls between the intervention and usual care group of at least 30%.

7.3   Methods

Study Design

This study used a quasi-experimental design.

Setting

The setting selected for the study was a 300-bed teaching hospital in Zurich, Switzerland. The hospital offers medical care to an urban population of 160,000, and comprises departments of internal medicine, surgery, and geriatric rehabilitation, as well as outpatient departments (e.g., emergency, dialysis center, physiotherapy, and oncology). In 1999, a total of 6,950 inpatients were treated in this hospital, accounting for 87,400 patient days with an average length of stay of 13 days. The two study units consisting of 22 beds each were similar. Both units treated patients with a variety of internal medicine pathologies. The architectural set-up (e.g. patient room sizes, toilet location, corridor length); and the availability of technical equipment (e.g., lighting, devices) was also comparable. Standardized medical and nursing care procedures (e.g., frequency of observation of vital signs, and treatment protocol for heart failure) and staffing level and skill mix of the health care professionals (i.e., physicians, nurses, and other personnel) also were similar between units. Overall nurse staffing in each unit consisted of 12 full-time equivalent registered nurses (RN), three nursing students (SN), and three nursing assistants (NA). Daily mean nurse per patient ratio (NPR) in both units was 1 to 3.2 during the day shift; 1 to 4.7 during the evening shift, and 1 to 9.5 during the night shift, respectively.

Sample

The sample consisted of patients consecutively admitted to one of two nursing units (Unit A and Unit B) within the Department of Internal Medicine. The criteria for including patients in the current study were a hospital stay of at least 48 hours, and admission to one of the two participating units. All patients admitted to Unit A constituted the intervention group, and those admitted to Unit B were assigned to the usual-care group. Informed consent of patients for participation was not obtained because the patients would not be exposed to harmful activities, and usual care was guaranteed. The study was approved by the ethical review board of the city hospitals of Zurich.

Usual care

Usual care as delivered in this setting is defined as medical and nursing care according to professional standards of physicians and nurses and specific hospital regulations for the patients within the internal medicine department. For nurses, usual-care processes were structured according to the five functions of nursing care, as defined and introduced to nurses in Switzerland by the Swiss Red Cross. These refer to 1) support or taking care of the patient in activities of daily living; 2) accompanying patients in situations of crisis and terminal illness; 3) assistance in preventive, diagnostic and therapeutic procedures; 4) assistance in preventing illness and accidents; promoting and maintaining health; and participation in rehabilitation; and 5) assistance in improving the quality and effectiveness of care, the development of the profession, and collaboration in research. Usual care in every day practice is organized according to the steps of the nursing process. Nursing care, delivered by the primary nurses, is based on either physicians' orders or assessment of nursing-related patient needs, patient preferences, and the implementation of care needed to support the patient in activities of daily living. Environmental safety (i.e., modifying the hospital environment) was provided for every patient regardless of fall risk status or group assignment, however not in a systematic manner.

Intervention

This study used a multi-component intervention which was delivered between April and July 1999 including a fall risk assessment and a protocol of nursing interventions aimed at reducing the risk of falls. In addition to these two main components, the intervention was further strengthened by a fall incident reporting system to collect systematically relevant data after a fall occurred. Nurses were trained with regard to the protocol to enhance their knowledge and skills and to enhance their competence with the protocol. Each of these elements is discussed in detail below.

Fall Risk Assessment Fall risk assessment was performed using the Morse Fall Scale (MFS) (Morse, 1997). This scale consists of the following six items referring to: history of falling; presence of a secondary diagnosis; intravenous therapy or intravenous lock; type of gait; use of walking aids; and mental status.

Interventions to Prevent Falls in Hospitalized Patients Based on recommended nursing interventions to prevent patient falls (McCloskey, 1996; Morse, 1997; Rutledge, 1998; Schwendimann, 2000; Tideiksaar, 1996), a selection of 15 interventions was implemented (Table 1) into the individual nursing care plan. This intervention protocol was directed toward modifying the hospital environment, supporting the patient's activities, and increasing staff awareness especially in patients identified at high risk of falling (MFS ≥55).

Table 1: Intervention protocol procedures

Identification of Physical Deficits

The nurse observes/assesses the patient's ability to ambulate, to stand up, to transfer, and to climb in and out of bed, including toilet/commode use.

Identification of Mental Deficits

The nurse assesses the patient's estimation of own abilities, using the call bell, asking for assistance, awareness of support needs, use of devices as instructed.

Orientation to Hospital Environment and Schedules

The nurse informs the patient about physical "setup" in patient room, ward, and the daily routines (e.g. meal time, physicians visit).

Placement of Call Bell, Light and Articles

The nurse checks/places patient's articles, personal belongings within easy reach in every shift (e.g. water, phone, urinal).

Positioning Bed Height

The nurse keeps bed in lowest position, except during care activities.

Stabilize Rolling Furniture

The nurse locks wheels on wheelchairs, beds, commodes, and gurneys.

Avoidance of Obstacles

The nurse keeps patient's room, passages, and doorways free from furniture, devices, and equipment.

Safe footwear and clothing

The nurse observes/ensures adequate fit of shoes, "Anti-slip-socks" if appropriate.

(Cont.) Table 1: Intervention protocol procedures

Assist with Transfer and Ambulation

The nurse assists/supports unsafe, frail patients, into/out of bed, chair, and while walking. She instructs use of handrails.

Assist with Toileting

The nurse assists patients with toileting at frequent, individualized scheduled times, including the use of toilet (e.g. sitting down, getting up, self-cleaning). She observes urgency, commode use at night if appropriate.

Optimize the Use of Assistive Devices

The nurse instructs patients in use of devices, maintains devices in good order, and includes physiotherapist if appropriate.

Physical Exercises

The nurse ensures/establishes adequate exercise routines (i.e. walking, climbing stairs), and includes physiotherapist if appropriate.

Monitor Confused Patients

The nurse observes disoriented patients, informs next shift, and places patients near the nursing station.

Observe Possible Side Effects of Medication

The nurse ensures review of psychoactive medication with referral to the physician.

Warning Signs for High-Risk Patients

The nurse puts yellow high-fall-risk-flag on patient's chart and bed, informs health care team member and relatives about fall risk.

Information and education of the nursing team Two weeks before the start of the study, both care teams received independent verbal information regarding the study and data collection procedures (e.g., the use of MFS, the registration of falls), in a single 30-minute session. In addition, the registered nurses in the intervention group (n= 17) received a 2-hour in depth instruction in small groups (n=4). The state of the art on incidence, risk factors and preventive strategies of fall prevention was explained. Importance of documentation, and registering and evaluating patient falls were further explained.

Additional, bi-weekly 30-minute audits were held with the nurses in the intervention group, by the principal investigator, throughout the study to exchange experiences and enhance adherence to the intervention protocol. Within these audits, patient cases (e.g., those with high fall risk or those who recently fell) were reviewed and appropriate interventions were discussed. Additionally, at the end of the study the nurses were asked for their professional opinion about the importance and effectiveness of the applied interventions. The nurses in the usual-care group received only the information regarding use of the MFS. The MFS instrument in the usual care group did not specify scores indicating fall risk status.

Variables and Measurements

Demographic (e.g., gender, age) and clinical data (e.g., diagnostic categories, length of stay) were collected from medical and administrative files.

Falls

A fall was defined as "an incident in which a patient suddenly and involuntary came to rest upon the ground or surface" (Gibson, 1987). The fall incident reports included demographics; clinical characteristics of the patient; date, time, location and circumstances of the fall event; injuries; predominant fall risk factors according to the MFS; type of medications; and footwear.

Morse Fall Scale

Fall risk scores were calculated using MFS scores in relation to the following six criteria: history of falling (No = 0; Yes = 25); presence of a secondary diagnosis (No = 0; Yes = 15); intravenous therapy or intravenous lock (No = 0; Yes = 20); type of gait (normal/bed rest/wheelchair = 0; weak = 10; impaired = 20); use of walking aids (None/bed rest/nurse assists= 0; cane/crutches/walker = 15; use of furniture = 30); and mental status (self awareness of own ability = 0; overestimates/forgets limitations = 15). Possible scores range between 0 and 125 points, with higher scores indicating a higher fall risk. Sensitivity and specificity of the MFS to determine the occurrence of falls in hospitalized patients, using fall data as a gold standard, was found to be 78% and 83% respectively when using a cut-off score of 45 points or more to indicate high risk for falls (Morse, Black, Oberle, & Donahue, 1989).

To enhance the diagnostic value of the MFS, a 55-point cut-off was tested in a study with 137 inpatients in the designated intervention unit prior to the start of the intervention. A cut-off of 55 points showed a sensitivity of 84%, and a specificity of 73% respectively. Inter-rater reliability showed a moderate value (Kappa .68). The MFS was administered in approximately 1 to 2 min-

utes per patient and was perceived as an easy procedure. Based on these preliminary results, a score of $\geq$55 points on the MFS was used for this study to indicate a high fall risk. Fall risk was described dichotomously by referring to a presence of fall risk, or not, for at least one observation time during patients hospital stay.

Data Collection Procedures

Nurses collect MFS data at admission and every third day thereafter throughout the hospital stay. In addition, fall incident reports were filled out by the registered nurses within 24 hours of a patient fall including an immediate fall risk assessment with the MFS. Three-day intervals were accepted to fit best into daily nursing routines, and to best reflect changes in clinical patient characteristics. These changes were indications for further implementation or continuation of the interventions. Following patient discharge, the MFS forms and the completed intervention protocols were sent to the principal investigator for entry into the database.

Statistical Analysis

The sample size calculations revealed that in order to have a statistical power of 80%, an effect size of 30% difference of fall incidence between the intervention and the usual care group and α of 5%, at least 100 patients had to be included in each group. Patient fall rates per 1,000 patient days were calculated as the number of patient falls (numerator), number of patient days (denominator) multiplied by 1,000 (Morse & Morse, 1988). In the bivariate analysis, baseline data were compared using Chi-square for categorical data (e.g., gender, diagnostic categories, fall risk characteristics) and student t-test for continuous data (e.g., age). To compare characteristics of the intervention and usual-care groups, the Chi-square-test was used for categorical data (i.e., number of fallers, single/multiple falls, type of falls, shift time of falls, type of injury) and Mann-U-Whitney test for the fall rate per 1,000 patient days. Survival analysis with Kaplan Meier statistics was used to compare time to first fall in patients of the intervention and usual-care group. All statistical procedures were performed using the Statistical Package for the Social Sciences Version 10.1 (SPSS Inc., Chicago, IL) for Windows (Microsoft, Redmond, WA).

7.4 Results

During the 4-month study period, 440 patients were admitted to the two designated study wards. Of these, 31 patients did not meet the inclusion criteria of being hospitalized for more than 48 hours and were therefore excluded from analysis. A total of 409 patients (60% females, mean age 70.6 ± 18.2 years) were included in the study. No differences in baseline, clinical and fall risk characteristics were found between the intervention (n=198) and usual care (N=211) groups, except for age (Table 2).

Table 2: Demographics, baseline clinical and fall risk characteristics

	Intervention group (n=198)	Usual care group (n=211)	P-value
Gender			
Female	65.2%	55.5%	0.055 †
Male	34.8%	44.5%	
Mean age (SD) years	72.5 (17.3)	68.9 (18.9)	0.041 ‡
Mean length of stay (SD) days	12.4 (9.3)	11.0 (8.7)	0.117 ‡
Diagnostic categories			0.411 †
Infectious	2.0%	6.3%	
Neoplasm	5.6%	4.4%	
Endocrine, metabolic	5.6%	5.9%	
Mental, behavioral	6.1%	3.9%	
Circulatory system	28.1%	25.4%	
Respiratory system	12.2%	12.2%	
Digestive system	10.2%	8.8%	
Musculo-skeletal	10.2%	5.9%	
Genito-urinary system	3.1%	3.4%	
Symptoms, signs	11.2%	13.7%	
Others	5.6%	10.2%	

(Cont.) Table 2: Demographics, baseline clinical and fall risk characteristics

Fall risk factors at admission			
History of falling	28.1%	31.7%	0.243 †
Ambulatory aid			
None/bed rest/nurse assist	82.7%	87%	
Crutches/cane/walker	8.2%	7.7%	0.303 †
Furniture for support	9.2%	5.3%	
Gait			
Normal/bed rest/wheelchair	60.2%	69.2%	
Weak	19.4%	17.8%	0.110 †
Impaired	20.4%	13.0%	
IV-Therapy/Heparin lock	68.4%	73.6%	0.273 †
Secondary medical diagnoses	93.9%	89.9%	0.101 †
Mental state			
Oriented to own ability	76%	81.7%	0.099 †
Overestimates/forget limits	24%	18.3%	
MFS score ≥55 at admission	40.8%	36.1%	0.290 †

† Chi-square test; ‡ t-test

Fall Risk

The overall proportion of patients with a high fall risk at least at one time period during the hospitalization was significantly higher in the intervention group (n=107, 54.0%) compared with the usual care group (n=93, 44.1%; p= 0.048). The duration of fall risk expressed in patient days tended to be higher in the intervention group (mean = 5.1±7.8 days) compared to the usual care group (mean = 3.8±7.0 days) (p = 0.076).

Fall Incidence

A total of 50 (12.2%) out of 409 patients accounted for a total of 82 falls resulting in an overall fall incidence rate of 17.2 falls per 1000 patient days. The proportion of falls was lower in the intervention group compared to the usual care group; 38% (31/82 falls) vs. 62% (51/82 falls), but the 25 patients who fell in each of the two groups did not differ significantly comparing the proportion of fallers in the intervention group (12.6%) with the usual care group (11.8%; p=0.88) (Table 3). No statistical difference was found for fall rates per 1000 patient days between the intervention group and usual care group (p=0.34).

Table 3: Fall incidence, consequences and circumstances

	Intervention group (n=198)	Usual care group (n= 211)	P-value
Proportion of patients who fell	25 (12.6%)	25 (11.8%)	0.880†
Proportion of patients with multiple falls	5 (20%)	14 (56%)	0.009†
Falls per 1000 patient days	11.5	15.7.	0.342*
Number of falls	31	51	
Injuries after falls	(n=31)	(n=51)	
None	68%	70%	0.302†
Mild injuries	32%	24%	
Severe injuries	0	6%	
Timing of falls	(n=31)	(n=51)	
Day shift	45%	31%	0.012†
Evening shift	23%	55%	
Night shift	32%	14%	
Type of falls	(n=28) 3 unknown	(n=43) 8 unknown	
Walking	22%	53%	0.046†
Standing up or sitting down	46%	26%	
Fall out of bed or chair	32%	21%	

†Chi-square test * Mann-U-Whitney test

Incidence of Multiple Falls

Differences were observed between patients who fell once and those who have fallen twice or more between both groups. A greater proportion of patients who had ≥2 falls were in the usual care group (14 patients accounted for 40 falls) as compared to the intervention group (5 patients accounted for 11 falls) (56% vs. 20%) as displayed in Table 3 (p=0.009). Kaplan Meier survival analysis showed no statistically significant differences to prolonged time for a first fall after hospital admission between the fallers of the intervention group and the usual care group. Both study groups with 25 fallers each, showed a similar rate of first falls within day 1 to day 4 following admission. Additionally, three fallers from the intervention group experienced a first fall after day 20 of hospitalization, and were therefore identified as outliers.

To further explore the tendency of a difference in prolonged time to a first fall between the fallers in the two study groups, all patients with a fall before day 5 were excluded (n=26), as well as the three outliers, resulting in a group of 21 fallers. Analysis of these fallers revealed a significant difference in a prolonged time to a first fall of 12 days in the intervention group compared to 7 days in the usual care group (Table 4).

Table 4: Time of first falls during hospital stay

All fallers (n=50)	Intervention group (n=25)	CI 95%	Usual care group (n=25)	CI 95%	P-value$f$
Time until first fall (mean)	9 days	5-14 d.	6 days	4-7 d.	0.230
Subgroup of fallers (n=21)	(n=9)		(n=13)		
Time until first fall (mean)	12 days	9-15d.	7 days	6-9 d.	0.008

f Kaplan Meier statistic
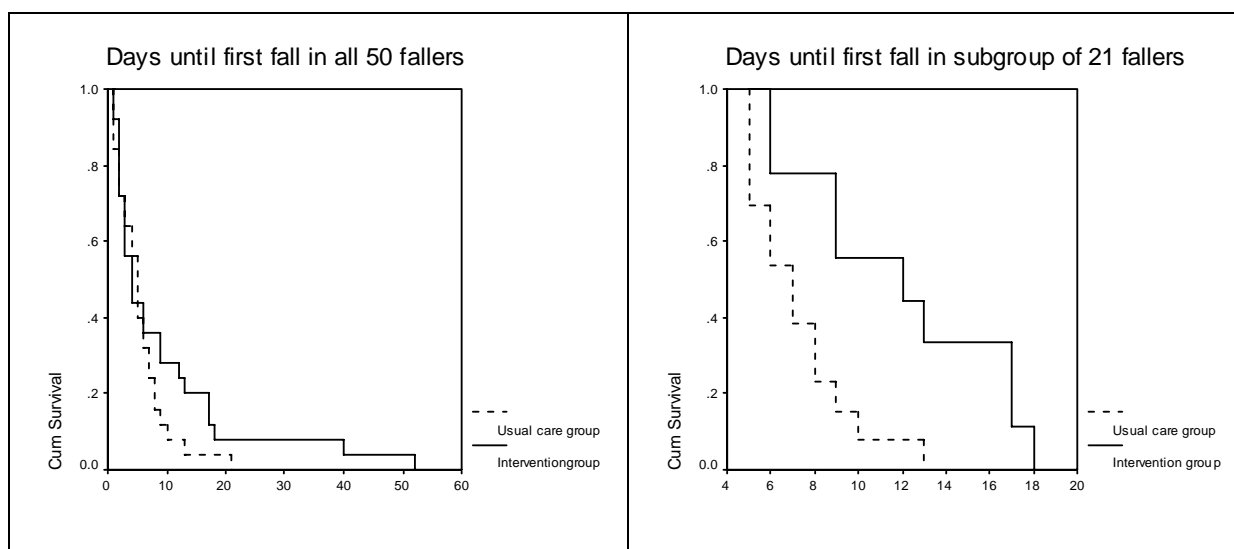
Fall Consequences, Time, and Type of falls

Although no significant difference was found between the two units, three severe injuries (e.g. fractures) were seen in the usual care group whereas none occurred in the intervention group (Table 3). Overall, patients fell most on evening shifts (35 falls, 42.7%) compared to day shifts (30 falls, 36.6%) and night shifts (17 falls, 20.7%). Patients in the usual care group fell most in the evening shifts, whereas patients in the intervention group fell most during day shifts. Overall,

most patient falls occurred while walking (41%), compared to standing up or sitting down (34%), or falling out of beds and chairs (25%). Patients in the usual care group fell significantly more while walking compared to the intervention group, who fell more while standing up or sitting down (Table 3).

7.5 Discussion

In this quasi-experimental study, the authors evaluated the effectiveness of a nurse-led fall prevention program in an acute care hospital in Zurich, Switzerland. The two groups were similar in all baseline characteristics except regarding age. The strength in the methodology of this study lies in the direct observation of two comparable nursing units and patient groups within the same time period. Although, the difference of 24% in the total number of falls between the two groups did not fully support the stated hypothesis of a 30% difference between the intervention and the usual care group, two clinically relevant effects were observed in the intervention group. a) Fewer multiple falls, and b) increased length of time until a first fall between day 5 and 20 following admission,

Fall prevention programs have shown effectiveness in community settings and long term care faculties (AGS, 2001; Gillespie et al., 2000). In contrast, in hospitals, intervention programs to prevent falls have not yet been proven to show consistent and sustained effectiveness (Oliver et al., 2000), as confirmed by some findings of the current study.

Beneficial effects of fall prevention programs in hospitalized patients have been shown in several studies in view of fewer falls (Brady et al., 1993; Cohen & Guin, 1991; Hill, Johnson, & Garrett, 1988; Huda & Wise, 1998; Mitchell & Jones, 1996; Morton, 1989; Mosley, Galindo-Ciocon, Peak, & West, 1998; Schmid, 1990) or fewer fall related injuries (Heslin, 1992). These studies used historical controls. Poor adherence with the intervention protocols were reported in these studies (Bakarich, 1997; Huda & Wise, 1998). These programs implemented newly developed and not yet validated fall risk tools (Berryman, Gaskin, Jones, Tolley, & MacMullen, 1989; Cannard, 1996; Forrester, McCabe_Bender, & Tiedeken, 1999; Hendrich, Nyhuis, Kippenbrock, & Soja, 1995; Hernandez & Miller, 1986; Oliver, Britton, Seed, Martin, & Hopper, 1997). A meta-analysis of 21 published hospital fall prevention programs, showed a pooled effect of about 25% reduction in fall rates (Oliver et al., 2000). Fall risk assessment with specific tools is usually recommended as an initial and ongoing part of a prevention program (Evans et al., 1998; Morse, 1997; Perell et al., 2001). In this study, patients with a high fall risk were primarily identified with the MFS at admission and/or during hospital stay. The intervention protocol was initiated in

patients identified to have a high fall risk. A larger proportion of patients with high fall risk were observed in the intervention group including patients with a higher age which is a marker for higher fall risk in hospitalized patients (Evans et al., 2001), however this did not result in higher fall rates in this group. These results may indicate an effect of the training of the nurses in the intervention group and the effectiveness of the delivered interventions. Additionally, adherence to the protocol could be observed in the daily documented nursing interventions in the patient records. A first fall is an important marker for subsequent falling (Gaebler, 1993; Graafmans et al., 1996; Luukinen, Koski, Kivela, & Laippala, 1996; Tinetti, Williams, & Mayewski, 1986). In the current study multiple falls were prevented, due to an increased awareness of the nurses after a first fall. Although nurses' awareness throughout the study period has not yet been directly assessed, the audits performed in the intervention group throughout the intervention period supported the perception of change in professional attitudes in nurses toward fall management. This is consistent with other studies showing reduced fall rates in combination with increased staff awareness rather then specific preventive strategies (Whedon & Shedd, 1989). Additionally, the nurses expressed positive opinions about the importance and effectiveness regarding the interventions applied in this study, which supports the idea of an increased awareness toward the population at risk during the study period.

More falls during night shifts were observed in the intervention group, and more falls in the usual care group occurred during day and evening shifts. Others (Bakarich et al., 1997; Sweeting, 1994) found also higher incidence of falls, from 38% to 45%, during the night shifts. These differences in falls resulted often due to toileting in an unfamiliar environment in which an "older" patient did not call for assistance. It was not able to be determined what factors affected the differences in the timing of falls. For example, guided ambulation and exercises as described in the intervention protocol may enhance the patients' ability to walk independently and, thus, expose them to a higher fall risk. In the usual care group more than the half of the falls occurred in the evening shift; a "time of transition" for patients with physiological weaknesses at the end of the day which can further increase the risk of falls. Other studies did not show significant variations in falls among shifts (Ash et al., 1998; Schwendimann, 1998). While more falls occurred in the usual care group while patients are standing and walking (53% vs. 22%), more falls occurred in the intervention group while patients are standing up or sitting down (46% vs. 26%). This may reflect a different clinical condition at the time point of the fall event in both groups regarding their mobility.

The tendency for an individual to have a prolonged mean time for a first fall, as shown in the intervention group, must be interpreted with caution because the analysis included only a sub-

group of 21 fallers. Nevertheless, this may reflect the increased awareness of the nurses following the repeated fall risk assessment. It could be a result of an alteration in the patient's clinical condition during the course of the hospital stay. However, the findings indicate that the intervention program is not successful in preventing falls during the first four days of hospitalization, while some effect can be seen thereafter. The authors' experience with this intervention protocol has lead to the development and implementation of a hospital wide intervention fall prevention program, which is currently being evaluated.

Limitations

The study presented has several limitations: First, the findings may have been contaminated by an exchange of information related to the intervention protocol between the nurses of the two teams; second, the study was conducted within one hospital department during a time period of 4 months; third, the delivery of interventions was not supervised or observed, and fourth, an environmental effect was not examined.

Conclusions

This fall prevention program showed an effect in preventing multiple falls but not first falls. The intervention program offered an approach to the nurses to deliver preventive care in patients with a high fall risk and systematic monitoring of fall events. As a whole, the study outcomes revealed an effect of the intervention protocol in decreasing the number of falls after a first fall had occurred. The positive effect of the intervention has been shown in patients registering a greater fall risk indicated by the MFS and older age. The prolonged mean time to a first fall in a subgroup of fallers in the intervention group may indicate an increased awareness of the nurses and the appropriateness of the interventions used. Preventing falls in the hospital setting is a complex task involving patients with an unstable health condition, many of whom have a high fall risk. There is a need for further studies of multifactorial approaches to preventing falls in hospitals. These should include interventions targeting risk factors as well as actions to change professional behaviors in the health care team, focusing on sustained surveillance of the group of high fall risk patients in the hospitals.

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8 FALLS AND CONSEQUENT INJURIES IN HOSPITALIZED PATIENTS: EFFECTS OF AN INTERDISCIPLINARY FALLS PREVENTION PROGRAM

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8.1 Abstract

Background Patient falls in hospitals are common and may lead to negative outcomes such as injuries, prolonged hospitalization and legal liability. Consequently, various hospital falls prevention programs have been implemented in the last decades. However, most of the programs had no sustained effects on falls reduction over extended periods of time.

Methods This study used a serial survey design to examine in-patient fall rates and consequent injuries before and after the implementation of an interdisciplinary falls prevention program (IFP) in a 300-bed urban public hospital. The population under study included adult patients, hospitalized in the departments of internal medicine, geriatrics, and surgery. Administrative patient data and fall incident report data from 1999 to 2003 were examined and summarized using frequencies, proportions, means and standard deviations and were analyzed accordingly.

Results A total of 34,972 hospitalized patients (mean age: 67.3, SD±19.3 years; female 53.6%, mean length of stay: 11.9±13.2 days, mean nursing care time per day: 3.5±1.4 hours) were observed during the study period. Overall, a total of 3,842 falls affected 2,512 (7.2%) of the hospitalized patients. From these falls, 2,552 (66.4%) were without injuries, while 1,142 (29.7%) falls resulted in minor injuries, and 148 (3.9%) falls resulted in major injuries. The overall fall rate in the hospitals' patient population was 8.9 falls per 1,000 patient days. The fall rates fluctuated slightly from 9.1 falls in 1999 to 8.6 falls in 2003. After the implementation of the IFP, in 2001 a slight decrease to 7.8 falls per 1,000 patient days was observed (p=0.086). The annual proportion of minor and major injuries did not decrease substantially after the implementation of the IFP. From 1999 to 2003, patient characteristics changed in terms of slight increases (female gender, age, consumed nursing care time) or decreases (length of hospital stay), as well as the prevalence of fall risk factors increased up to 46.8% in those patients who fell.

Conclusions Following the implementation of an interdisciplinary falls prevention program, neither the frequencies of falls nor consequent injuries decreased substantially. Future studies need to incorporate strategies to maximize and evaluate ongoing adherence to interventions in hospital falls prevention programs.

8.2 Background

Patient falls in hospitals are common and affect approximately 2% to 17% of patients during their hospital stay [1-5]. Fall rates vary from 1.4 up to 17.9 falls per 1,000 patient days depending on hospital type and patient populations [5-17]. Fall related injuries occur in 15% to 50% of the patients, including major injuries such as fractures or lacerations in 1% to 10% [1, 6, 8, 9, 13-15, 18-21]. Furthermore, falls may lead to fear of falling with subsequent activity restriction [22, 23], prolonged hospital stay [24], and legal liability [25]. Various hospital falls prevention programs have been implemented in the last decades [26, 27]. Unfortunately, none of these studies has demonstrated a sustained effect over years [26]. In one study, a 25% reduction of falls-related injuries was reported over a 5 year period following the implementation of a prevention program [28]. In 1999, a nurse led falls prevention program implemented in our hospital showed decreasing multiple falls [29]. Consequently, the hospital management launched the development and implementation of an interdisciplinary falls prevention program in 2000 in the departments of internal medicine, geriatrics and surgery. The present study aimed to examine in-patient fall rates and consequent injuries before and after the implementation of the interdisciplinary falls prevention program.

8.3 Methods

Design, setting and sample

This observational study used a serial survey design and was conducted from January 1st in 1999 to December 31st in 2003 in an urban public teaching hospital in the City of Zurich in Switzerland. The 300-bed hospital provides medical services for 160,000 inhabitants and includes three clinical departments: 1) internal medicine (122 beds), 2) surgery (100 beds), and 3) geriatrics (78 beds). The population observed consisted of adult patients (18 years and older), hospitalized for more than 24 hours in one of the three departments. Patients of the emergency department and intensive care unit were not included. The study was approved by the ethical review board of the City hospital of Zurich.

The interdisciplinary falls prevention program

Since 1998, in-patient falls were systematically registered using the fall incident reporting system. The development and implementation of the fall incident reporting system is described in detail elsewhere [15]. The interdisciplinary falls prevention program (IFP) is designed to provide a safe environment for the hospitalized patients and to reduce the occurrence of falls and consequent injuries It was developed using evidence from an earlier nurse-led fall prevention protocol [29] and literature findings. The IFP protocol consists of three essential elements (Table 1): first, all patients were briefly screened for fall risk as part of the regular nursing assessment upon admission; second, patients considered at risk for falling were examined by a physician; and third, general safety measures and specific interventions to prevent patient falls and subsequent injuries, were routinely implemented.

In 2000, the IFP was introduced in the departments of internal medicine, geriatrics, and surgery. The IFP protocol included 30-minutes of lectures and the provision of the protocol guidelines for nursing staff, physicians, and physiotherapy staff of the participating units. Newly employed personnel were informed "on the job" how to follow the IFP protocol in daily clinical practice. Finally, a falls prevention committee, representing the involved health care professionals was installed to audit the progression of the IFP twice a year.

Data collection and measurement

The data collection period covered the time before, during and after the implementation of the IFP. Socio-demographic (e.g., age, gender) and clinical characteristics (e.g., length of stay, medical diagnosis) of the studied patients were extracted from the administrative data sets. In-patient falls were reported within 24 hours of occurrence by registered nurses, using the standardized fall incident report form. A fall was defined as "an event in which a patient suddenly and unintentionally came to rest on the floor". Other data collected with the fall incident form were: department, patient demographics, circumstances of the fall, prevalence and severity of injuries, and prevalence of risk factors for falls (i.e. history of falls, impaired mobility, impaired cognition, use of narcotics, and use of psychotropics).

Table 1: Components of the interdisciplinary falls prevention program

		Referring discipline
Screening & Assessment	Screening of all patients at admission for risk of falls: –History of falls (i.e. 2 or more falls in the last 6 months) –Impaired mobility (e.g., unsteady, weak gait) –Impaired cognition (e.g., confused, forgetful)	Primary nurse
	Examination of patients considered at risk for falling: – Note circumstances and consequences of earlier falls – Examine patients for acute or chronic medical condition(s) – Review medications – Assess gait, balance, vision, neurological function, and mental status	Physician
Safety interventions	Interventions for all patients to provide safety in the hospital: – Orient patients to surroundings / "set up" of room – Place call bell and personal belongings within reach – Keep bed in low position – Ensure safe footwear and adequate fit of clothing – Provide nightlight at bedside – Ensure walking aids (devices) are fitted and used appropriately – Lock wheels on wheelchairs, beds, night commodes	Primary nurse Nursing staff
Specific interventions	Interventions in patients considered at risk for falling: – Modification of medication – Instruction of patients (family) about risk factors – Post fall risk sign in patient's record – Assist unsteady patient with ambulating – Toilet patient regularly – Use half-length side rails instead of full length side rails – Exercise program, gait/balance training – Provision of hip-protectors	Physician Primary nurse Nursing staff Physiotherapy staff
Monitoring	Reassessment of those patients who fell – Evaluation of circumstances and consequences of the fall – Reassessment of patient risk factors for falls – Continuing or implementation of preventive interventions	Physician Primary nurse

Statistical analysis

Frequency distributions and summary statistics including proportions, means, and standard deviations were utilized to describe patient characteristics, the prevalence of patient falls and associated characteristics across hospitals departments and years. Fall rates per 1,000 patient days were calculated using falls as the numerator and patient days as the denominator. A general linear model was used to model the rate of falls per 1,000 patient days each 6 months from 1999 to 2003. Demographic and clinical patient characteristics were compared between the clinical departments and between the years under study using Chi-square and analysis of variance as indicated in the tables. All statistics were performed using SPSS for Windows, version 12.0 (SPSS Inc., Chicago, Ill).

8.4 Results

Patient characteristics

During the study period 36,295 patients were hospitalized, of which 1,323 patients (3.6%) were excluded for further analysis since they were not hospitalized for more than 24 hours in one of the designated clinical departments. In total, 34,972 hospitalized patients were observed (mean age: 67.3, SD±19.3 years; female 53.6%, mean length of stay: 11.9±13.2 days, mean nursing care time per day: 3.5±1.4 hours). 11,402 patients aged 80 years and older represented 32.6% of the hospitalized population and accounted for a total of 196,591 patient days (45.6%). The most common of the patient's primary medical diagnoses within the ICD-10 diagnostic categories were as follows: digestive system (19.4%), circulatory system (17.0%), injury/poisoning (13.7%), respiratory system (7.4%), and neoplasm (6.1%).

Half of the patients (49.7%) were hospitalized in the department of medicine, 42.4% in the surgical department, and 7.9% in the geriatrics department, reflecting the size of the departments. Patient characteristics including gender, age, length of hospital stay, and nursing care time per patient differed significantly between the three departments (Table 2).

Table 2: Patient characteristics

	Total (n=34,972)	Medicine (n=17,386)	Geriatrics (n=2,765)	Surgery (n=14,821)	P-values
Females (%)	18,745 (53.6)	9,469 (54.5)	2,010 (72.7)	7,278 (49.1)	<0.001†
Age in years*	67.3±19.3	70.4±17.3	83.0±7.8	60.6±20.4	<0.001‡
Age groups (%)					
18 – 64 yrs.	36.6	29.2	1.7	51.8	<0.001†
65 – 79 yrs.	30.8	34.2	28.2	27.3	
80 yrs. and more	32.6	36.6	70.1	20.9	
Length of stay(days)*	11.9±13.2	10.8±9.3	36.1±25.4	8.6±8.1	<0.001‡
NCT§ (hours)*	3.5±1.4	3.3±1.5	3.7±1.6	3.6±1.3	<0.001‡

*Mean ± SD, §Nursing care time per patient day, †Chi-square, ‡ANOVA

Frequencies of in-patient falls

Overall, a total of 3,842 falls affected 2,512 (7.2%) of the hospitalized patients. One thousand eight hundred and four (71.8%) patients fell once, 439 (17.5%) fell twice, and 269 (10.7%) fell three times or more. Those patients who fell more than once accounted for 53% (n=2,038) of all falls. The numbers and percentages of patients who fell per department were 1,538 (8.8%) in medicine, 685 (24.8%) in geriatrics, and 289 (1.9%) in surgery. The overall fall rate was 8.9 falls per 1,000 patient days (geriatrics: 11.7 falls, internal medicine: 11.3 falls, and surgery: 2.9 falls). The fall rates per 1,000 patient days fluctuated slightly from 9.1 falls in the first half of 1999 to 8.6 falls in the second half in 2003. After the implementation of the IFP a slight decrease down to 7.8 falls per 1,000 patient days was observed in the first half of 2001 (Figure 1).

However, the observed fluctuations in fall rates over the years under study did not reach statistical significance (p=0.086). There were no significant differences over time in individual departments (data not presented).

Figure 1 Hospital in-patient fall rates per half year from 1999 to 2003
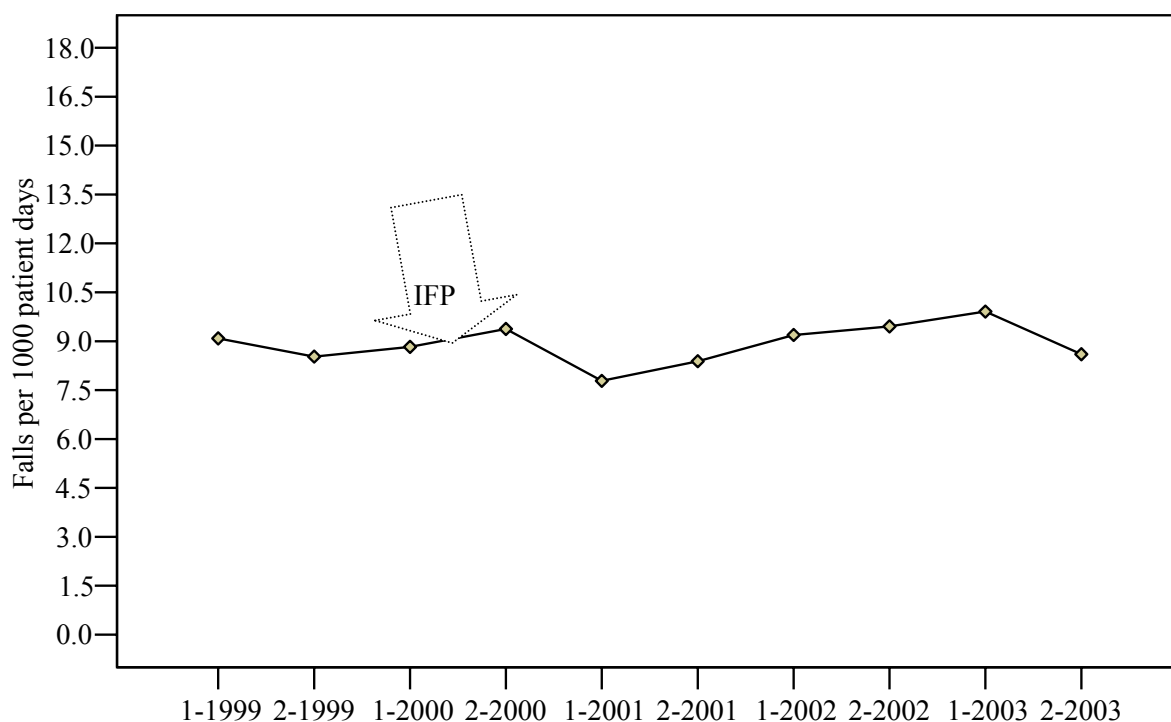
IFP = Implementation of the interdisciplinary fall prevention program

Severity and type of injuries and evolution over time

From the 3,842 falls, 2,552 (66.4%) remained without injuries, while 1,142 (29.7%) falls resulted in minor injuries (pains, bruises, scratches, haematoma, superficial wounds), and 148 (3.9%) falls resulted in major injuries such as 33 fractures of hands, arms, or ribs, 31 hip fractures, 12 intra cranial bleedings, and 72 other injuries (e.g. luxations, multiple haematoma). The prevalence of minor and major fall related injuries differed significantly in the departments of internal medicine (30.4%, 3.0%), geriatrics (28.0%, 5.0%), and surgery (31.9%, 5.0%) (Chi square, 12.603, df 4, p=0.013). The prevalence of minor and major fall related injuries differed significantly across the years (Table 3). Fewer minor injuries were observed in 2003 compared to 1999, and more major injuries were observed in 2003 compared to 1999.

Table 3: Prevalence of fall related injuries from 1999 to 2003 (N=3,842 falls)

	1999	2000	2001	2002	2003	P-value†
Number of falls	763	779	689	806	805	
No injuries (%)	64.9	63.4	68.1	67.7	68.1	0.169
Minor injuries (%)	32.6	32.7	26.0	28.9	28.1	0.015
Major injuries (%)	2.5	3.9	6.0	3.3	3.9	0.014

†Chi-square

Evolution of patient characteristics from 1999 to 2003 (Figure 2)

The proportion of female patients from 1999 to 2003 tended to increase from 52.7% to 54.2% (p=0.235). The mean age of the patients increased from 66.2 ± 19.6 years to 67.8 ± 19.2 years (p< 0.001), and the mean nursing care time per patient increased from 3.4 ± 1.4 to 3.7 ± 1.4 hours per day (p< 0.001) from 1999 to 2003. The mean length of the patient's hospitalization decreased from 12.5 ± 14.7 days in 1999 to 11.7 ± 12.6 days in 2003 (p< 0.001). In those 2,512 patients who fell, the following risk factors were prevalent at the time of their first fall: impaired mobility (83.1%), impaired cognition (55.3%), history of previous falls (50.1%), use of narcotics (38.6%), and use of psychotropics (25.4%). The prevalence of these fall risk factors rose significantly from 1999 to 2003. Impaired mobility increased by 8.3% (p=0.003), impaired cognition by 16.9% (p<0.001), use of psychotropics by 11.5% (p<0.001), and use of narcotics by 18% (p<0.001), as well as history of falls as a marker for future falls increased by 12.3% (p<0.001).

Figure 2: Annual prevalence of risk factors in patients who fell (N=2,512)
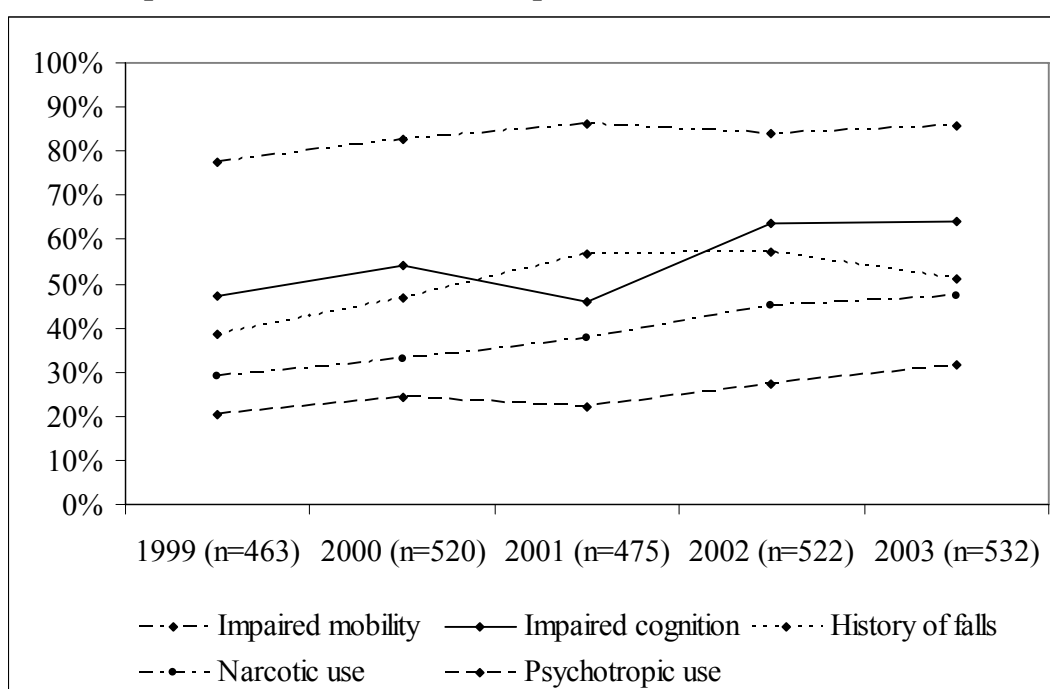
8.5 Discussion

This study examined fall rates, consequent injuries and characteristics of hospitalized patients before and after the implementation of an interdisciplinary falls prevention program. The frequencies of falls, consequent injuries, and clinical patient characteristics varied between the departments of internal medicine, geriatrics and surgery. Following the implementation of the IFP, no reduction of in-patient fall rates and no reduction in consequent injuries were observed within individual departments or in the hospital. During the observation period, the mean length of hospital stay decreased slightly, while the mean nursing care time per patient day increased: both trends may reflect a higher workload for healthcare staff. Additionally, one in three patients was 80 years and older, and in those patients who fell while hospitalized, the prevalence of risk factors for falls increased significantly from 1999 to 2003. These may reflect altered patient characteristics, which lead to proneness to falling.

In this general urban hospital setting, overall fall rates per 1,000 patient days (e.g., 8.9 falls) were higher compared to other studies reporting rates between 2.7 and 4.1 falls per 1,000 patient days [8-10, 18, 30]. Fall related injuries were seen in 33.6% (3.9% major) of our patients, a proportion that was similar to others reported in the literature [10, 18, 31]. It appears that irrespective of fall rates, the percentage of patients with consequent injuries remain relatively stable.

Since falls and consequent injuries affect patient safety and may damage a hospital's reputation, various falls prevention programs have been implemented [26, 27]. Recently, a 30% and a 28% reduction of falls and subsequent injuries in a sub-acute hospital setting were reported from a randomized controlled trial [32]. These effects were attributed to a targeted multiple intervention program. Another intervention program in elderly patients in a community hospital resulted in a 21% reduction of falls at 6 months postintervention, while no effect was noted for fall related injuries [33]. A falls prevention program in a rehabilitation hospital setting (quasi-experimental study) reported reductions of falls by 15.3%, fewer fallers by 29.7%, and fewer patients with fall related injuries by 51.1% within a 1 year period [34]. Unfortunately, the benefit of the program did not remain significant after correcting for length of stay. In addition, after the implementation of a nurse led falls prevention program in a large general district hospital, fall related injuries were reduced by 25% over a 5-years period, while the number of falls did not change [28]. In another prospective observational study, the intervention effects of ward based quality circle teams in a rehabilitation hospital resulted in a significant reduction of fall rates per 1'000 patient days comparing 3 years of pre-intervention with 3 years post intervention [35]. In most of these former studies, patients have benefited from falls prevention programs within 6 and 12 months in terms of fewer falls and related injuries [26, 32, 34], but only two non-experimental studies [28,

35] reported positive effects exceeding one year. In the current study neither a sustained reduction of falls nor a decrease in consequent injuries was observed within the 3 years after the implementation of the IFP. This raises questions about whether the interventions of the program was not effective, adherence to the intervention protocol was poor and if the altered patient characteristics may have neutralized intervention effects.

Our study examined the effects of the IFP falls prevention program in daily clinical practice rather than under rigorous research conditions as it was done in other more successful falls prevention studies [32, 33]. The IFP consists of the elements reported in intervention studies and falls prevention programs which resulted in reduced fall rates and reduced injury rates. The design of the intervention protocol of the IFP used best available evidence for hospital settings [27, 36] and showed positive results in an earlier study [29]. In view of adherence to the protocol, it's assumed from the audits of the falls prevention committee that the physicians and nurses may not consistently practice the IFP. This argument is supported from a study in an acute care metropolitan hospital, with 43% non-adherence with the fall prevention protocol [37]. In another study, compliance with the program deteriorated over time and after 5 years fall rates increased back to the level before the program was implemented [38].

More specifically, in our study data were not available on how often the intervention protocol was followed including screening patients risk for falls and examination of those patients at risk for falls as well as the type of subsequent interventions was applied. This was not the case in another study too [33].

In view of altered patient characteristics it remains unclear if the observed increases in age and decreases of length of stay during the course of the study had an impact on the effectiveness of the program. The relatively high and stable fall rates before and after the IFP may be viewed with regard to a quotation of Bernard Isaacs that "a unit where nobody falls is a unit where nobody moves" [39]. This higher rate may reflect our hospital practice of early remobilization and forced ambulation of the patients in order to reach functional autonomy for hospital discharge as soon as possible. Positive effects of the hospital falls prevention program immediate after implementation may have been caused by an increased initial awareness of nurses rather than by the specific interventions for patients at risk for falling [27, 40]. In addition, the IFP was mandated in three different hospital departments each with numerous health care professionals. This approach could be inappropriate for some units since multi-factorial interdisciplinary interventions are often time consuming which may limit their practicability in a busy acute hospital setting.

If clinicians adherence to the intervention protocol was inconsistent, it remains unclear if this can be explained by a lack of commitment on the part of the physicians and the nurses, by insufficient knowledge about which patients were at risk for falling, or whether the high priority given to the acute care treatment of patients contributed to the multifactorial falls risk modification protocol being neglected. The clinicians may not have been adequately prepared and facilitated to integrate the intervention protocol into their daily routine and, therefore, no sustained change of the clinical practice was established. Translating evidence from research into practice remains a challenge. An appropriate approach such as action research [41] should be considered. Since action research is basically a self-reflective enquiry undertaken by participants (e.g., clinicians, researchers in hospital settings) in order to improve the rationality and justice of their own practices, their understanding of those practices, and the situations in which the practices are performed [42] it may support future attempts to improve interdisciplinary falls prevention practice.

Limitations

The following limitations of this study have to be considered. First, due to its serial survey design, characteristics of patients and the hospital organization were not controlled. Second, the fall risk profile of those patients who did not fall was not obtained, therefore it was unclear to what extend this population was at risk for falling. Third, adherence to the intervention protocol was not observed or recorded.

The audits may not have been sufficient to ensure sustained adherence to such a complex program because the commitment and clinical expertise of the individual nurses and physicians varied, and were additionally influenced by staffing, patient severity, and communication skills within the interdisciplinary team.

Conclusions

Following the implementation of an interdisciplinary falls prevention program, neither the frequencies of falls nor consequent injuries decreased substantially. Future studies need to incorporate strategies to maximize and evaluate ongoing adherence to interventions in hospital falls prevention programs.

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9   CONCLUSION AND PERSPECTIVES

This research program focused on the multifaceted topic of patient falls in the acute care hospital setting. Our research program was comprehensive as it not only includes retro- and prospective observational and quasi-experimental designs but also focused on translational research i.e. evaluating the implementation of evidence in daily clinical practice. Our intention to narrow the gaps in the state of the knowledge concerning hospital falls was achieved as follows. First, using a retrospective observational design we refined and elaborated the knowledge regarding differences in characteristics of in-patient who fell in departments of medicine, geriatrics and surgery within an urban public hospital. This study confirmed evidence of previous studies regarding frequencies, characteristics and circumstances of in-patient falls and consequent injuries. Second, using a retrospective correlational design we showed that hospital in-patient falls are *not* associated with lunar cycles in contrast with prevailing perceptions of health care professionals in favour of an association. Third, we added to the evidence regarding screening fall risk instruments such as the Morse Fall Scale and the STRATIFY. Our findings showed that the diagnostic value of these instruments is moderate at best and that these tools should be used with caution. Fourth, using a quasi-experimental design, we tested the efficacy of a multifactorial nurse led intervention program. This program has the potential to reduce multiple falls but not first falls in hospitalized medical patients. We assumed that this effect may have been due to increased staff awareness and the implementation of selected nursing interventions after a first patient fall occurred. Finally, the effectiveness of an interdisciplinary hospital fall prevention program in daily clinical practice was tested. In this implementation study neither fewer falls nor associated injuries were observed over the three year observation period. We assume that the failed effectiveness of the program was mainly related to inconsistent professional adherence to the intervention protocol. Yet, findings point to options for refining the intervention to increase its effectiveness. More specifically, we recommend a multilevel approach that also takes system factors such as nurse staffing, skills of clinicians, work environment into consideration. The use of action research methodology could provide a stronger methodological framework for success in implementing the intervention in daily clinical practice. These elements will be discussed in more detail below.

Strengths and weaknesses of the research program

The strength of this dissertation, as mentioned above, lies in the fact that the program included all stages of the research cycle (from observational studies to intervention studies to transitional research). One part that is still missing but which is planned in the near future is a study of the association between system factors such as nurse work environment and staffing and falls in hospitals. A weakness of our program is that we limited the study of risk factors and also the development of the intervention to patient and unit level factors. Moreover, our studies were performed in a single center which needs to be considered in the generalization of findings to other settings. A limitation of the retrospective observational study of the characteristics of in-hospital fallers is that no data were available on fall risk factors for non-fallers. Consequently, we were unable to identify patient characteristics associated with an increased risk for falling." Another limitation is that no data were collected on care providers' adherence to the fall risk assessment and intervention protocol.

Hospital characteristics, system factors and in-patient safety

Our data indicated and confirmed previous findings that in–patient falls remain a significant safety problem in hospital settings. Improving safety in hospitals requires a multilevel multidimensional approach. Promoting and establishing a safety culture requires involvement of all groups of health care providers. These health care providers also need to be supported in realizing patient safety and quality of care [1].

More specifically, system factors, patient characteristics and professionals' skills and performance all need to be taken into consideration in order to implement and sustain a falls prevention programs in hospital settings in daily clinical practice. Recent studies indicate that system characteristics of the nursing care organization, e.g. lower nurse staffing and poorer skill mix, are associated with in-hospital falls [2], although findings are not consistent concerning this relationship. While two studies reported that higher fall rates were associated with fewer nursing care hours per day and a lower percentage of registered nurses [3, 4] other studies did not find a significant association [5-8]. Nevertheless, patient fall rates have been considered an outcome indicator of quality of nursing care [9, 10]. Findings from the Swiss RICH-Nursing study suggest that system factors such as higher work loads and implicit rationing of nursing care are independently associated with higher nurse-reported fall rates [11]. It's assumed that high nursing workloads may contribute to higher numbers of falls because staff is unavailable to support patients' ambulation during busy shift times. A number of underlying system related factors have been identified as contributing to patient safety problems such as falls and related injuries. They includes: a) high patient volumes, b) unpredictable patient flow, c) multiple individuals involved

in the care of individual patients, d) use of many different types of equipment, e) the need for rapid care management decisions, f) communication problems with co-workers, g) high patient acuity, h) inexperienced caregivers, i) the use of diagnostic or therapeutic interventions with a narrow safety margin, k) communication barriers with patients and l) time-pressure [12].

Limited effects of interventions

The assumed inconsistent adherence of health care professionals to the intervention protocol of the hospital fall prevention program may have resulted in a lack of effectiveness and sustainability of the program. The following factors could have contributed to inconsistent adherence. First, changes in patients' health status during hospitalization may have resulted in interventions others preventing "at risk patients" from falling being prioritized to stabilize or improve their medical conditions. Second, the relatively short length of hospitalization may not have given clinicians the time needed to fully evaluate and intervene on patients' modifiable risk factors. Finally, hospital policy favors that providers generally focus on the management of the acute medical conditions which necessitated hospitalization in order to discharge patients as soon as possible rather than on the comprehensive management and tracking of chronic diseases which may increase patients' fall risk. Since the profile of common risk factors for falls in in-patients differs from that in the community [13], there may be two distinct groups of in-patients who fall (1) hospitalized patients with a period of transient risk as they recover from acute illness and (2) hospitalized patients who are "repeated fallers" with chronic gait instability and cognitive impairment [13].

It can be very difficult for nurses and physicians to deal with the chronic diseases, co-morbidities and frailty of many older patients. These often complex patient situations may be perceived as inevitable consequences of old age and given little professional attention as the primary acute diseases or exacerbation of illnesses are treated. Additionally, from a perspective of utilizing the falls prevention program in daily practice, the attention from project managers and stakeholders may not have been sufficient to give feedback and guide audit processes to support the teams in implementing the intervention protocol in daily practice. The implementation of our interdisciplinary falls prevention program was mainly based on oral and written information input to the nurses and physicians on the health care team. It appears that this approach, despite inclusion of representatives of the nursing units unit for the implementation process using an intervention protocol which consists of "state of the art" interventions did not consider the needs for team development and subsequent follow up to observe changes in the performance of clinicians and unit managers. Our experiences raise concerns that simply presenting research evidence about interventions such as those designed to prevent in-patient falls is not sufficient to change clinical practice.

Future studies need to work closely with professional teams, using a multilevel approach to promote changes in practice; briefly presenting chunks of information and "letting it go" is insufficient In particular, we would like to further address professional awareness of the problem of falls in hospitalized patients, and mechanisms to improve adherence to an evidence-based intervention protocol. We assume that improving clinicians' skills, motivation, and commitment are prerequisites to further develop on the interdisciplinary health care teams' abilities to assess and treatment of in-patients at risk for falling.

Multilevel approach needed

In order to enhance and optimize our hospital fall prevention program we suggest that future studies use a multilevel approach that incorporates more explicitly the known system related risk factors. The fall prevention program that we and others tested incorporated following dimensions: (1) assessment of all patients for common reversible risk factors, (2) an individualized intervention program for patients at risk that targeted identified risk factors, (3) reassessment of patients who fell during hospital stay, (4) attention to basic environmental safety especially in the bedside area, (5) targeted therapy for gait and balance, and (6) policies and education programs for hospital units [14]. These different dimensions have shown to be effective in reducing falls and related injuries [15-17]. The multilevel approach should include working closely with clinicians to identify the scope of the fall problem in clinical practice, to develop interdisciplinary solutions, to monitor implementation of the developed protocol, to evaluate outcomes, and to provide feedback on the impact of the intervention.

In addition to focusing of patient characteristics, multilevel research in the hospital setting needs to address dynamic organizational factors such as staffing, skill mix and professional performance. Finally, such an approach needs to focus on appropriate implementation strategies to meet the challenge of translating scientific evidence into clinical practice as well as to enable clinicians to establish sustainable clinical processes with positive patient outcomes.

Action research –a strategy to implement a multilevel approach

Translational research has gained momentum in health care due to increased awareness that translation of research evidence into daily clinical practice is a priority. Implementation of state of the art evidence requires a methodological approach that favors the involvement of local actors and takes into consideration the local organizational characteristics and customs. Action research is increasingly valued as an appropriate approach for the successful translation of complex intervention protocols into clinical practice. This method adds to and transcends traditional approaches to disseminating evidence such as the distribution of research reports, the organization of conferences and articles in scientific journals. It has also been shown to be superior to the top down linear approach to the implementation of evidence in practice that are not really embedded in the organizational culture and do not optimally activate the resources available in practice. Thus, action research is different, as it is centrally concerned with the lessons learned from practice development [18] and focuses on system change from the bottom up and top down. It involves doing research with and for people (e.g., clinicians, patients), in the context of its application (e.g., hospital units, daily practice), rather than undertaking research on them (e.g., distant data collection, executing rigorous research protocols). Action research is a form of self-reflective inquiry undertaken by participants in social situations in order to improve the rationality and justice of their own practice, their understanding of those practices, and the situation in which the practices are carried out [19]. This means, for instance, that nurses are actively involved in reviewing and reflecting on their usual practice for change such as assessing and responding to patients at risk for falling under busy working conditions.

Action research is not easily defined. The following definition sheds some light on what it entails: "Action research is a period of inquiry, which describes, interprets and explains social situations while executing a change intervention aimed at improvement and involvement. It is problem-focused, context-specific and future-oriented. Action research is a group activity with an explicit value basis and is founded on a partnership between action researchers and participants, all of whom are involved in the change process. The participatory process is educative and empowering, involving a dynamic approach in which problem identification; planning, action and evaluation are interlinked. Knowledge may be advanced through reflection and research, and qualitative and quantitative research methods may be employed to collect data. Different types of knowledge may be produced by action research, including practical and propositional. Theory may be generated and refined, and its general application explored through cycles of the action research process" [20].

The strength of action research lies in its focus on generating solutions to practical problems and its ability to empower practitioners –getting them to engage with research and subsequently to develop and implement activities for a specific setting. It appears that a bottom up involvement of clinicians has the potential to gain not only commitment of the participants to for change, but also facilitates understanding and better process performance as seen from other experiences [21]. Action research seems to be a promising approach to the implementation of a multilevel fall prevention program. Given the previous discussed dynamics in an acute hospital setting with its organizational features and professional performance, the need of a variety of methods to address these conditions is obvious. Action research uses of a range of methods such as in-depth interviews, questionnaires, documentary analysis, and participant observation to generate data about the clinician's perceptions e.g., of patients at risk for falling and professional to prevent patients from falling.

It's important to recognize that action research respond to naturally occurring events in practice, therefore, its not possible to know in advance what will happen. However, based on a systematic literature review on action research [20] its principal phases include exploration, innovation and evaluation. In view of a falls prevention program these phases may look like this:

Exploration (e.g., before a falls prevention program will be reinforced or newly implemented)

- Exploring patients experiences with falls (e.g., interviews, focus group technique).
- Exploring clinicians' experiences with patient falls.
- Set local experiences in wider context (e.g., regarding to other units, literature).
- Feedback patient experiences to multidisciplinary teams, explore what change if any the teams are ready for and set local experience in wider context (e.g., hospital).
- Explore what participants (clinicians, patients) may think what will help to handle the problem of patient falls and what barriers for change they may see.
- Establishing baseline measures (observations, falls monitoring, and audits, questioning the opinions of participants).

Innovation (implementing the state of the art falls prevention program)

- Analysis of data from the exploration phase (e.g., it can't be predicted what the change in the field will be because of natural occurrences and negotiations with participants).
- Giving indications to managers and participants what may happen and change through circles of activities (i.e., action research cycles).
- Learning how to talk with patients and colleagues of the multidisciplinary team.
- Build in action learning to support the change (will generates data about the issues).

Evaluation

– Repeating the baseline measures to see if changes occur over time (e.g., fall rates, clinicians' performance) including the minutes of meetings and audits.

– Interview key stake holders of what they feel what has been achieved or not and why?

– Discover if we do it again what would we do in a different way, what need to happen next.

– Analyze according baseline data.

Overall, use a reflective diary (which was kept throughout the study for writing up own experiences) to continuously reflect, feedback and analyzing and to be transparent to the outside world in order to be aware of biases as a researcher. In conclusion, action research incorporates three important elements: its participatory character (i.e., demand that participants perceive the need to actively change their practice), its democratic impulse (i.e., researcher works as facilitator of change and consult with participant on a regular basis), and its simultaneous contribution to social science and social change (i.e., developing knowledge more appropriate to day-to-day practice) [21, 22]. We adapted these principles to outline a tentative strategy to implement a hospital fall prevention program which could be tested in a future study (Table).

Table: Implementation of multilevel hospital falls prevention using action research*

Participation

- Identify willing volunteers (clinicians) to participate in a designing and evaluation a falls prevention program

- Agree an acceptable ethical code of practice: negotiate how to feedback to wider audience and in a way that the participants feel not vulnerable, negotiate what role the researcher (project manager) will take within the multidisciplinary team.

- Use of "bottom up" and "top down" approaches, working with all key stake holders including patients, practitioners, managers, negotiate what, and how much will be done by the researcher

Democracy

- Giving an equal voice to the involved people that represents their perspectives on their practice, view on the projects or problems e.g., with the topic of patient falls

- Feeding back findings to allow participants say whether the findings have resonance to them and if they are useful or relevant in their practice.

- Recognizing the expertise of patients and clinicians, ensuring equality of their knowledge and experience (e.g., equal relationship on "how their practice is seen, or how they would solve the problem or deal with the issue)

Contribution to social science and social change

- What lessons are learned from local change if any change will be set in a wider context?

- Facilitatied learning and improvement of the participants

- Use of a mixture of methods (e.g., qualitative, quantitative) and doing consultancy with the key stake holders (e.g., not focus on outcomes but on processes as well).

*Adapted from Meyer [19]

Additional topics of hospital falls

The evidence on in-patient falls gained from performing this series of studies also resulted in a number of new research questions that are perceived as worthwhile for further study. While reflecting on our research findings and experiences, several topics appeared in conjunction with literature and discussions with experts on the field. The following topics briefly outline these questions and ideas from the discourse of hospital in-patient falls.

First, patient falls seem to show similar patterns. For instance, when a patient falls repeatedly the circumstances (e.g., activities before the falls) appear show similar patterns [23-26]. It might be interesting to further explore this issue using the large hospital in-patient falls data base of patients who experienced multiple falls during hospitalization to either confirm or expand the knowledge for a hospital setting and to explore its implications for hospital falls prevention.

Second, the hospital where the presented program of research was conducted installed a "shock absorbing floor" in 2003 in all patient units in the geriatric department. Its effectiveness in view of fall related fractures remain unknown until today. In general, little is known about the use of such a "passive" intervention as part of a falls prevention program [27-30]. It would be worthwhile to explore the value of "shock absorbing floors" in a hospital. We may evaluate its impact on fall related fractures by comparing their prevalence before and after it was installed in the geriatric department. Moreover, it would be worthwhile to assess whether these floors could serve as a effective standard approach to protecting the physical integrity of patients at risk for injurious falls during hospitalization.

Third, since falls can not be entirely prevented given the dynamics of patients' autonomy and professional ethics of "do good and no harm" the question may arise, what number of falls a hospital organization must tolerate. Is it a rhetoric question in view of patient safety policies, professional standards and litigations when the hospital quality management asks "how many falls can we accept?" This issue may deserve more attention and should be explicitly addressed in the patient safety discourse e.g., by disclosure of reports on how hospitals are dealing with it. This challenge includes the difficulty of adequately prioritizing prevention of in-patient falls in busy acute care hospital settings which face a variety of health problems of patients during a relatively short hospitalization time, as well as translating scientific evidence into a real work life context and disseminate study findings into clinical practice.

Fourth, an area that needs more attention in research is the study of system factors such as staffing, and their potential influence on rates of falls and subsequent injuries in acute care hospital settings. We plan to explore the dynamic relations between empirical fall data and clinical patient characteristics in view of daily staff census, skill mix and patient turnover. We are current

using data from the Swiss-RICH nursing study [11] to compare nurses' views of patient falls with empirical data on the incidence of patient falls and associated injuries in participating hospitals.

Finally, further research is need on fall-related intervention. The effectiveness of the proposed multilevel interventions program as discussed above should be tested in multiple hospital settings. These research activities need to be elaborated within a wider geographic context e.g., such as the Prevention of Falls Network Europe. This network advances science through collaboration across Europe by introducing best practice trough change of health care procedures [31].

We conclude that our research program added to the existing knowledge on hospital in-patient falls, confirmed the given need for further research on implementation strategies and sustainable hospital falls prevention programs and outlined specific issues and additional topics of interest for clinicians, researchers, managers and health care politicians.

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