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ORIGINAL ARTICLE

Selected Risk Factors of Falls in Hospitalized Patients: A Case-Control Study

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Abstract

THEORY: Patients falls have a multifactorial character and typically have multiple causalities.
GOAL: The goal of the study was to identify risk factors for falls of hospitalized patients.
METHODOLOGY: This was a case-control study. The study included 222 patients who experienced a fall during their hospitalization (cases) and 1,076 patients who did not fall during their hospitalization (controls). The study involved four hospitals in the South Bohemian Region of the Czech Republic. The study took place during the 2017 calendar year.
RESULTS: The average age of patients who experienced a fall was 77.9 years. The group of cases included 5-times more patients with a history of falls than the controls. Patients who fell were in higher risk of falls than patients in the control group at hospital admission. The group of cases also had a higher prevalence of confused and restless patients; however, the group did not include a statistically significantly higher number of incontinent patients, patients with eating and drinking disorders, or patients with intravenous therapy than the control group.
CONCLUSION: Interventions aimed at prevention of falls should be included in care plans, especially for older patients, patients who have fallen in the past, patients who have movement restriction, patients with cognitive dysfunction, and patients with increased need of assistance with basic daily activities.

INTRODUCTION

Hospitalized patient falls are a worldwide problem. Hospitalization itself increases the risk of falls. Patients find themselves in a strange environment, are ill, and undergoing a number of medical interventions all of which increase the probability of a fall. Older patients are a particularly vulnerable group (Kannus *et al.* 2005; Öztürk *et al.* 2017). Patients over 65 years have three times higher risk of falls in a hospital than in their home environment (American Geriatrics Society 2001). Falls with medical consequences increase the cost of therapy and extend hospitalization time (Aryee *et al.* 2017). According to the national information system of the Institute of Medical Information and Statistics of the Czech Republic (ÚZIS 2017), falls, as well as decubitus ulcers, are the most frequently reported incidents during hospitalization. To develop an effective fall prevention program for hospitals, it is important to fully understand the causes, and the mechanisms of falls.

A fall can be defined as an unwanted incident during which a person lands on the ground or a lower-situated surface (JCR 2007; Jarošová *et al.* 2014). According to the commonly used fall classification scheme developed by Janice M. Morse (1987), falls can be divided into three groups. Most falls that occur in hospitals are physiologically expected falls. They are falls affecting patients at high risk of a fall. Risk factors for falls can usually be easily identified in such patients. They include primarily internal risk factors, e.g., impaired physical and mental condition of the patient, pathological walking, repeated balance disturbances (Slouka *et al.* 2018, Frei *et al.* 2015), incontinence, or use of high-risk medications. These risks can be effectively prevented by appropriate supervision of the patient and by implementing a suitable fall prevention intervention. The second group of falls includes physiologically unexpected falls. They affect patients who have fallen despite having been evaluated as having a low risk of falls. Many of these falls are associated with sudden seizures, syncope, or brain stroke. The third group of falls includes accidental falls affecting patients who are considered at low risk of falls. Such falls usually have external causes, e.g., because of an inadequate external environment, inappropriate shoes, or engaging in risky activities (Rubenstein & Josephson 2006). Preventive and corrective actions for accidental falls should be aimed at minimizing patient injuries associated with falls and prevention of a repeated fall. These needs are addressed by providing a safe external environment for patients (AHRQ 2018).

It is obvious that patient falls are multifactorial and have many causes. Patients who fall during hospitalization often have a large number of mutually interacting risk factors (Oliver *et al.* 2010). Standardized methods for assessing fall risk factors include a list of risk factors that can be divided into two main groups (Marschollek *et al.* 2012). The first group includes internal factors (related to the patients themselves) and the second group includes so-called external factors based on hospital protocols and policies, and the actions of medical workers, particularly those involved in direct nursing care (Severo *et al.* 2014). A systematic screening of risk factors contributes to reducing the risk associated with falls, any of which could have serious, or even fatal, consequences (Severo *et al.* 2014). *The goal of the study was to identify risk factors for falls of hospitalized patients.*

MATERIAL AND METHODS

In early 2016, the Faculty of Health and Social Sciences, University of South Bohemia, České Budějovice (ZSF JU), the Pharmaceutic Faculty, Hradec Králové, the Charles University, Department of Social and Clinical Pharmacy (FaF UK), and selected hospitals in the South Bohemian Region started a project aimed at monitoring falls and analyzing fall risk factors with a focus on falls caused by medications. The project involved four hospitals in the South Bohemian Region, specifically the České Budějovice Hospital, the Písek Hospital, the Tábor Hospital, and the Jindřichův Hradec Hospital. During 2016, the *"Monitoring of risk factors of falls and their analysis"* was developed, and during 2017, professional teams (physicians and nurses) entered data on fall cases. All hospitalized patient falls were monitored at the four centers, concentrating on the wards with the highest incidence of falls from each of the cooperating hospitals. Most frequently they included internal wards, subsequent care wards, long-stay wards, rehabilitation wards, but also psychiatric, surgical, and lung wards. A total of 16 wards from four hospitals were involved in the project. In 2017, the average incidence of falls in the selected wards amounted to 12 falls/1000 patients.

Data entered into the database are quite extensive. We strived to monitor the broadest possible number of risk factors. The database requisites can be divided into several topic areas:

1) Patient assessment before the fall
2) Patient assessment after the fall
3) Therapeutic diagnoses
4) Therapeutic preparations
5) Pharmacist interventions
6) Corrective actions implemented by the attending physician, including the physician's feedback regarding the pharmacist's recommended interventions

Data from the database allowed determination of patient risk factors before a fall and assessment of the patient after a fall, including proposed corrective actions. An indisputable benefit of an electronic database consists of its interactivity. The information concerning the risk of falls, in relation to the pharmacotherapy, was immediately evaluated by a clinical pharmacist. The pharmacist from FaF UK determined the potential impact of pharmacotherapy on a fall and suggested possible medication changes. Based on the

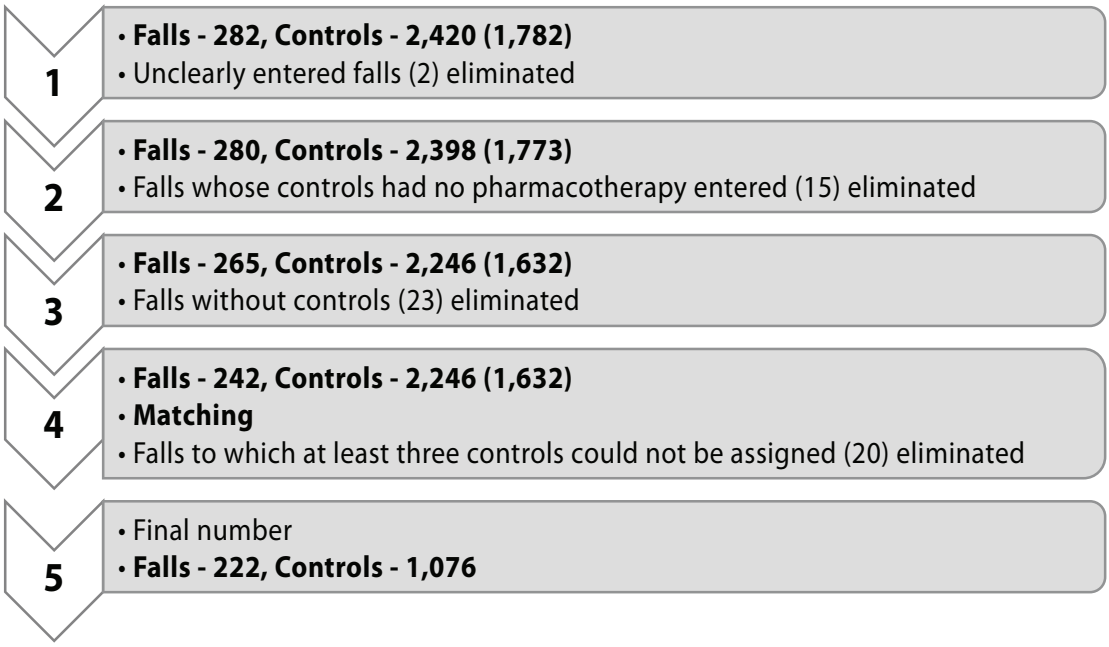

Fig. 1. Selection of cases of falls and controls
The numbers in brackets stand for unique controls. That means that one fall patient was assigned to only one unique control only. Although one patient could be entered as a control to multiple falls, 1,076 controls stand for 1,076 unique patients.

analysis, the attending physician was able to propose timely preventive-corrective actions that contributed to minimizing the influence of medicines on the patient's risk of falling again.

Even though the acquired data gave us a comprehensive view of fall risk factors, the capacity of the article does not allow us to focus on all risk factors. Therefore, we used the results only to evaluate the fall risk factors that were related to the patient assessment before the fall and to their health condition.

With respect to each fall, a control group of patients was entered into the database. The patients in the control group did not fall during their hospitalization.

Analysis of cases and controls

A group of patients with fall (cases) and a group without fall (controls) were selected for this case-control study. The fall group (with falls) (FG) and the control group (without fall) (CG) consisted of patients who were hospitalized in selected hospitals in the South Bohemian Region in 2017.

CG patients were selected in two stages. For each fall, a physician selected an average of 8.7 patients (10 were required) with similar characteristics and who had not fallen during hospitalization, for the CG. Selection criteria included the following variables:

1) hospitalization in the same ward and at the same time
2) the same gender
3) the same period of hospitalization ± 5 days (as for the subsequent care ward, the long-stay wards, or psychiatric wards, the hospitalization period was extended to ± 28 days)
4) the same age ± 10 years
5) the same number of medicines ± 5 medicines

In 2017, there were 282 cases of patients with falls and 2,420 controls. To select and subsequently test the best-comparable CG, controls were carefully matched with cases. Before undertaking control-case matching, two ambiguously entered cases, 15 falls whose controls had no pharmacotherapy entered, 23 cases of falls without controls, and 20 cases of falls to which at least three controls could not be assigned were eliminated (see Figure 1).

Then the controls were paired with the cases. In light of the frequent fluctuations inside the limited patient pool, related to the impossibility of individual wards to control pseudoreplication (i.e., the suggestion that a patient be used as a control several times within different hospitalizations or the suggestion that a patient be used as a control even though the same patient had been registered as "fall" in another hospitalization), the data output still consisted of a comprehensive network of matched falls and controls. A subsequent reduction was aimed at transforming the network into a bipartite graph while preserving the following principles:

1) An individual who occurred in the role of fall and control at the same time was preferred in the role of fall and all nodes proposing such individual as control were eliminated.
2) Multiple falls by the same patient were not considered pseudoreplications for the purpose of matching.

The result of case-control matching consisted of matching of each fall with five control patients with the closest possible age and number of medicines. The optimization ensured the comparability of falls and controls with respect to age ($p = 0.405$, Cohen's d = 0.0085). The difference in the number of medicines was significant

Tab. 1. Relationship between the incidence of falls and selected risk factors

Fall risk factors	Value X^2	Df	P	Stat. signif.	Association level
Fall in case history	98.063	3	<0.001	***	**0.324**
Risk of fall at admission	6.893	1	<0.05	*	0.073
Self-care level acc. to Barthel test	18.451	3	<0.001	***	0.119
Self-care level acc. to Barthel test - re-screening	12.966	3	<0.01	**	**0.187**
Categorization of patient's independence by insurance company	15.853	4	<0.01	**	0.111
Patient's mobility before fall	16.875	4	<0.01	**	0.114

X^2 - chi-square; p - independence test; df - degrees of freedom, n.s. - statistically insignificant difference, * - statistically significant difference at a significance level of α = 0.05, ** - statistically significant difference at a significance level of α = 0.01, *** - statistically significant difference at a significance level of α = 0.001.

($p < 0.001$). Nevertheless, the small effect size (Cohen's d = 0.21791) is still present. An absolute statistical correspondence in the number of medicines between falls and controls could not be ensured even by optimization in which the number of medicines was the only criterion.

After case-control matching, there were **222** patients with falls during hospitalization in the FG and **1,076** patients with similar characteristics in the CG.

Characteristics of the sets of cases and controls

Both sets were virtually identical in the area of gender. The FG included 48.2% males and 51.2% females. The CG included 48.0% males and 52.0% females. The maximum deviation was 0.2%.

The average age of patients in the FG was 77.9 years and the average age of patients in the CG was 77.8 years. The continuous data (age) were transformed into the following age groups: 1) 20–60 years; 2) 61–70 years; 3) 71–80 years; 4) 81–90 years; 5) 91+ years. The highest proportion of respondents was in the 71–80 years group (FG 25.2%; CG 33.6%) and in the 81–90 years group (FG 45.5%; CG 42.4%). A greater deviation was only registered in the 71–80 years group (the CG was 8.4% larger); in the other age groups, it did not exceed a difference of 3.1%.

Ethical aspects of the study

The study was approved by the Ethics Committee of the Faculty of Health and Social Studies at the University of South Bohemia, by the Ethics Committee of the Pharmaceutic Faculty of Charles University, and by the management of the four hospitals involved. The acquired data were handled in compliance with Act No. 101/2000 Coll., on personal data protection, as amended. The confidential and anonymous character of the gathered data was ensured. The database was protected against misuse (data leakage). Patients were identified by their initials and medical report numbers. Access to the database was restricted. Each person accessing the database (grant researcher, physician, nurse, clinical pharmacist, and administrative employee of the hospital) had a unique password. People with access only had access to a specific data group; for example, physicians and the nurses could only access patients on the ward on which they worked.

Statistical data processing

Data were processed in the SPSS and SASD programs. Selected statistical relationship were further analyzed at the 5% significance level using chi-square test. The level of association was determined using the Cramer V value or the Phi value.

RESULTS

A statistically significant difference between the group of patients who fell, and the control group was found. The FG contained an almost 5x higher number of those whose case history included more than one fall in the previous 12 months (25.7%) than the CG (5.2%). At the same time, the CG contained significantly more patients without falls in the previous 12 months (41.2%) than the FG (28.8%).

Patients who fell were also at a significantly higher risk of falls at the time of admission (82.0%) compared to the CG (73.6%).

At admission, all patients were also assessed using the Barthel test of activities of daily living. Each patient was put into one of four possible categories based on independence: (1) highly dependent, 0 to 40 points; (2) middle-degree dependent, 45 to 60 points; (3) slightly dependent, 65 to 95 points; or (4) independent, 100 points. The FG contained significantly more patients who were middle-degree dependent (28.8%) than the CG (18.1%); while the CG contained almost 2x more patients classified as independent (15.4%) than FG (8.1%).

When re-screening with the Barthel test of activities of daily living during hospitalization similar results were found. The FG contained approximately 2x more patients who were middle-degree dependent (34.6%) than the CG (17.9%); while the CG contained almost 5x more patients who were independent (7.6%) than the FG (1.3%).

Tab. 2. Relationship between the incidence of falls and patient mental conditions before a fall

Patient's mental condition	Value X^2	Df	P	Stat. signif.	Association level
Confused	61.624	1	<0.001	***	**0.218**
Restless	31.487	1	< 0.001	***	0.156
Demented	0.515	1	0.477	n.s.	–
Anxious	1.038	1	0.312	n.s.	–

X^2 - chi-square; p - independence test; df - degrees of freedom, n.s. - statistically insignificant difference, * - statistically significant difference at a significance level of α = 0.05, ** - statistically significant difference at a significance level of α = 0.01, *** - statistically significant difference at a significance level of α = 0.001.

At the same time, patients were also divided by independence into five categories determined by the health insurance company: (1) fully independent; (2) partially independent; (3) requiring increased supervision; (4) immobile/dependent; and (5) unconscious. The FG contained significantly more patients who required increased supervision (59.0%) than the CG (46.6%); while the CG contained more than 2x more patients who were fully independent (10.8%) than the FG (4.5%). According to nursing records, the FG contained significantly more patients who walked with assistance or escort (22.5%) than the CG (14.7%).

Our statistical analyses ascertained whether a given risk factor statistically significantly increased the probability of a fall as well as on evaluating the level of association. The force of the risk factor was determined using the Cramer V value or the Phi value, where the following applies: the higher the value, the higher the association level (force of effect on the risk factor). The two strongest patient fall risk factors were a previous fall in the case history (0.324) and a reduced level of self-care (0.187), Table 1.

The FG contained a statistically higher proportion of confused persons (36.0%) than the CG (13.9%). At the same time, a statistically significant connection between falls and a patients' restlessness was recorded. The FG included 3x more restless persons (15.8%) than the CG (5.2%). According to the assessment of the level of association of risk factors, confusion had a stronger impact on the risk of a fall (0.218) than the restlessness (0.156).

Statistically significant differences were not found in the prevalence of dementia and anxiousness between the FG and CG, Table 2.

Compared to the FG, the CG included a statistically higher number of patients who started rehabilitation (FG 30.6%; CG 40.8%) and used compensation aids (FG 14.4%; CG 21.9%).

The mathematical-statistical analysis did not find any significant differences in the frequency of other risk factors. Nevertheless, the FG had a higher relative frequency of problems with food and liquid intake (FG 12.2%; CG 10.6%), fecal or urinary incontinence (FG 30.6%; CG 29.5%), and intravenous therapy (FG 25.7%; CG 24.3%), Table 3.

DISCUSSION

Fall prevention programs in hospitals must address multiple issues since patient falls are caused by a variety of risk factors (Horová *et al.* 2017; Hajduchová *et al.* 2016 ; Brabcová *et al.* 2015). Within the hospital environment, it is very important to identify high-risk patients when they are admitted for hospitalization (Aryee *et al.* 2017). The best-known standardized assessment of fall risks is the Morse Fall Scale for Identifying Fall Risk Factors (Morse *et al.* 1989) or STRATIFY the Scale for Identifying Fall Risk Factors, Oliver *et al.* 1997. Our study evaluated the fall risk of all patients at admission using the Morse evaluation. The study showed that the Morse evaluation scale provides valid data. FG patients, who were at higher risk of falls at admission, were signifi-

Tab. 3. Relationship between the incidence of falls and other risk factors

Risk factors of falls	Value X^2	Df	P	Stat. signif.	Association level
Problems with food and liquid intake	0.467	1	0.498	n.s.	–
Intravenous therapy	0.200	1	0.658	n.s.	–
Urinary/fecal incontinence	0.121	1	0.732	n.s.	–
Start of rehabilitation	7.994	1	< 0.01	**	0.078
Use of compensation aids	6.350	1	< 0.05	*	0.070

X^2 - chi-square; p - independence test; df - degrees of freedom, n.s. - statistically insignificant difference, * - statistically significant difference at a significance level of α = 0.05, ** - statistically significant difference at a significance level of α = 0.01, *** - statistically significant difference at a significance level of α = 0.001.

cantly more likely to fall than patients. However, each hospital environment is unique, and no assessment tool can cover all risk factors. Studies by Oliver *et al.* (2008) and Aryee *et al.* (2017) demonstrated to have a low predictive value of standardized scales. It is desirable for each hospital ward to consider the specific risk factors of its patients in preventing of falls.

Patient falls have been found to be related to higher ages, falls in the case history, and to greater needs of assistance in activities of daily living (Öztürk *et al.* 2017; Majkusová & Jarošová 2014; Hayakawa *et al.* 2014). The average age the FG, monitored by our study, was 77.9 years. The FG also included 5 times more patients who had a fall in their case history compared to the CG. Patients with a history of falls should always be monitored for bone density and the number of fractures. The patient's environment should be adapted to reduce the risk of serious injuries after a fall. If the patient falls often, the consequences of fall must be minimized. Both patients and their family members should be educated about ways to reduce falls.

Our study confirmed a statistically significant connection between patients with impaired mobility and increased fall risk. The FG included a significantly higher number of those requiring more assistance in activities of daily living. They needed more assistance with walking and required more frequent checks by the nursing staff than the CG. In our opinion, the main advantage of regular patients checks by the nursing staff is proactively assessing the patient's needs, i.e., patient needs are anticipated and addressed before the situation is urgent. The nursing staff should assess pain, personal needs, position, accessibility and functionality of signaling device at hourly intervals and provide immobile patients with safety rails for the bed (Halm 2009; Araújo *et al.* 2018). Patients with impaired mobility need increased assistance from nursing staff during their entire hospital stay. Our study also confirms the importance of a timely start of rehabilitation and the provision of adequate compensation aids like forearm crutches or walkers. Although the FG included a higher number of patients with reduced mobility, the CG also included a statistically higher number of persons who started rehabilitation. CG patients made more use of compensation aids than FG patients, which shows the importance of timely rehabilitation and the benefits of compensation aids.

Our conclusions confirmed studies (Öztürk *et al.* 2017; Hubbard *et al.* 2017) that pointed out the connection between the fragility of geriatric patients and the increased risk of patient falls. Similarly, a retrospective study of causes of hospitalized patient falls by Majkusová and Jarošová (2014) recorded the highest incidence of falls in seniors aged ≥ 80 years. The study states that falls of hospitalized patients depend on the following factors: age, duration of hospitalization, health condition, and level of independence (Majkusová & Jarošová 2014).

A study by Hayakawa *et al.* (2017) pointed out that repeated falls (multiple falls in a patient's case history) constitute one of the independent risk factors for falls. A risk factor increasing the probability of multiple repeated falls consists of cognitive dysfunctions, particularly those impacting short-term memory. It is essential to identify and monitor patients with cognitive dysfunction. Confused patients, patients with delirium, dementia, psychoses, etc. are at a higher risk of falls (AHRQ 2018). In our study, the FG contained a statistically higher proportion of confused patients than the CG. At the same time, a statistically significant connection between falls and patient restlessness was also recorded — the FG included three times more restless patients than the CG. Dementia is not an uncommon problem among older patients. However, confusion may have an iatrogenic cause, e.g., rapid compensation of blood pressure or blood sugar levels after administration of anticholinergic medicines. Such medicines should be used with special care in older patients. Sometimes we also see confusion in patients who receive Selective Serotonin Reuptake Inhibitors (SSRI). Normally, we do not expect confusion in connection with such medicines; however, since it is an uncommon side effect and strongly depends on the individual response of the patient, the nurse's role in detecting SSRI-related confusion is indispensable in such cases. Individual patient responses to medications must always be monitored. Our results also showed that confusion was more common in the FG than in the CG. It seems that further education is needed regarding protocols for patients with signs of memory disorders or altered behavior. It would be very useful if nursing documentation traveled with the patient when patients are transported from one facility to another, so any neurological changes in newly arriving patients can be detected and addressed more quickly.

Patients who receive hypnotic drugs, sedatives, or other psychiatric drugs need increased supervision. In patients who take multiple medicines or patients who use medicines that increase the risk of falls, like analgesics, antipsychotics, anticonvulsants, and benzodiazepines, the attending physician should cooperate with a pharmacist to minimize the risk of falls. The pharmacist should have an opportunity to suggest a change in medication or a change in the dose of a medicine to reduce the patient's medicine-related fall risk. Medication Fall Risk Score and Evaluation Tools (Beasley & Patatanian 2009) serve to evaluate the risk of falls caused by medication. If the patient is at risk a medicine-related fall, then other risk factors should also be evaluated, for example, laboratory values of renal function, electrolyte values, hemoglobin or hematocrit, risk diseases, and the patient's mental condition (American Geriatrics Society 2012). This article does not assess the connection between medication and patient fall risk. Nevertheless, the project does monitor the impact of pharmacotherapy on the patient fall risk,

which will be addressed in future articles by the author's team.

A patient's acute and chronic health condition can also impact the risk of falls. A study by Bittencourt *et al.* (2017) found a statistically significant connection between an increased risk of falls and neurological hospitalization, as well as surgical hospitalization (surgical trauma). Furthermore, a connection between an increased risk of falls and the following health diagnoses was confirmed: diabetes mellitus, systemic arterial hypertension, vertigo, sight disorders, and fear of falling (Bittencourt *et al.* 2017). This article did not assess the connection between diseases and a patient's risk of falls; however, the project does monitor the impact of acute and chronic diseases on patient fall risk and will be addressed in future publications.

Additional fall risk factors include incontinence, the need for more frequent trips to the toilet, and infusion therapy (AHRQ 2018). Our study did not find a statistically significant higher prevalence of the above-stated risk factors in the FG. However, the FG included a higher relative frequency of prevalence of problems with food and liquid intake, fecal or urinary incontinence, and intravenous therapy.

STRENGTHS AND WEAKNESSES

This article was not intended to comprehensively address all the fall risks of hospitalized patients. Our project is focused on a careful assessment of risk factors associated with fall events including medication-related falls. The electronic database used in this study allowed us to tract fall events, analyze the root causes, and provide timely feedback to physicians and pharmacists regarding the potential for medication-related falls. The advantages of the selected study method (case-control study) are obvious. The cases were chosen from available patients, and the controls were chosen so that they corresponded as closely as possible to the characteristics of the cases. The causal factors of falls were identified relatively quickly, which allowed immediate preventive and corrective actions.

One of the main disadvantages of a case-control study involves its susceptibility to bias. Data validity could be burdened by bias when being entered into the falls database. The probability of such bias was minimized by the initial training of clinical workers on the method for entering data into the database and by a series of audits to evaluate the accuracy of data entered in the database by comparing it with data in patient health documentation. When matching cases and controls, unification could only be made for two factors (age and the number of medicines). Patients with and without falls were chosen from a hospital environment; therefore, the study conclusions are not representative of the whole population. Finally, the presence of a random error cannot be excluded.

CONCLUSIONS

Our results indicated that the fall risk factors for hospitalized patients include: age, a history of falls, mobility disorders, and impaired mental condition. This multifactorial nature needs to be reflected by the program of prevention of falls in the hospital. The program has to include a method of assessment of risk factors of fall for all patients at admission and re-assessment of fall risk factors whenever there is a change of the patient's health condition. The found risk factors are then integrated as a general part into the care plans. Comprehensive interventions that reduce the risk of falls necessarily have to be individualized according to the patient's specific risks (Stevens & Phelan 2013). If a patient falls, the hospital has a clear legislatively grounded procedure for reporting and dealing with the incident. The hospital management tries to identify the actual causes of falls and then suggests and practically applies preventive and corrective actions.

PRACTICAL APPLICATION

Our project, which is focused on an analysis of fall risk factors of hospitalized patients, has been running in hospitals in the South Bohemian Region since 2016. Since January 2018, a preventive program has been running in clinical centers in an effort to reduce the risk of patient falls. The program includes medical staff training, education of patients and their families, marking the patient's bed with fall risk warning pictogram, and provision of adequate compensation and safety aids. The falls prevention program is shielded by trained nurses and implemented for all patients at risk of falls. The monitoring and analyzing of falls, using the interactive database, continues in 2018 as well. In 2018, a fifth hospital in the South Bohemian Region, Strakonice Hospital, joined the project.

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