

Implementation of a Multifactorial Fall Intervention Model in Hospital: a Longitudinal Before-and-after Controlled Study From 2015 to 2018

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Abstract

Background: Falls are serious public health problems associated with irreversible health consequences and substantial economic burden. To effectively reduce the incidence of falls and mitigate fall-related injuries, we designed and verified a multifactorial fall intervention model.

Methods: The current study was a longitudinal before-and-after controlled investigation including 3 phases with clinical characteristics of fall patients retrospectively identified in phase 1, a multifactorial fall intervention model designed in phase 2 and prospectively evaluated in phase 3. Phase 1 and 2 were conducted based on 153,601 hospitalized patients between January 2015 and December 2016. Phase 3 was carried out based on 171,776 hospitalized patients between January 2017 and December 2018. The Pearson Chi-squared test was used to compare categorical variables and the Mann-Whitney non-parametric test was utilized for one-way ordered data.

Results: In phase 1, baseline characteristics of 491 fall patients revealed that inpatients falls were highly associated with the age, medication and disease. In phase 2, a new multifactorial fall intervention model covering measures for fall prevention, fall-onset management and continuous improvement was developed. Phase 3 recorded a total of 396 falls and demonstrated a remarkably declined fall rate (Reduction in falls by 0.09%, $p < 0.001$) and fall rate per 1000 patient-days (Reduction in falls/1000 patient-days by 0.07‰, $p < 0.001$) as compared with phase 1. The adjusted incident rate ratio of fall was 1.443 (95%CI: 1.263-1.647) (Phase 1 vs. Phase 3). Furthermore, the occurrence and the severity of fall injuries in phase 3 were significantly lower than that in phase 1 ($Z = -4.426$, $p < 0.001$). More specifically, the number of uninjured falls accounted for 42.42% in phase 3 in comparison of 32.99% in phase 1.

Conclusions: This multifactorial fall intervention model exhibited favorable effect on reducing the occurrence of fall and fall injuries.

Contributions To The Literature

The current study identified inpatients' falls were highly associated with the age, medication, clinical symptoms and disease of patients, and obviously characterized by time, place and activity events.

This research designed a new multifactorial fall intervention model which included measures for pre-fall prevention, fall-onset management, and continuous improvement after falls occur.

The multifactorial fall intervention model was proved to be significantly effective in decreasing the occurrence of falls and the severity of fall injuries.

Introduction

Falls are reported to be the most common adverse events in hospitals, accounting for 20–30% of all incident reports.(1, 2) Due to unfamiliar environment, diseases and treatments, hospitalization increases

fall risks.(1, 3) In terms of hospital departments, geriatric and rehabilitation wards have higher rates of falls than surgical or acute care wards.(3) Falling can lead to different degrees of injury, prolong hospital stay, increase hospitalization costs, and even lead to legal disputes between the hospital and patients.(4–7) Approximately 30% of in-hospital falls were associated with various degrees of physical injuries.(8) Even non-injurious falls may result in psychological stress, functional decline and increasing the morbidity of second falls.(9, 10)

In the past 20 years, considerable attention has been paid to reduce fall incidence and fall-related injuries in hospital settings. In particular, the exploration of fall prevention measures has attracted a large number of investigators.(11, 12) Related research has also yielded many meaningful results, such as the progress of a series of fall assessment tools and the improvement of fall prevention measures for use in hospitals. (13–19) Correspondingly, the importance of interventions when falls occur and after falls are often overlooked. However, interventions for falls should be multiprocess interventions involving fall prevention, fall-onset management and improvement measures after falls. In addition, many studies are only devoted to exploring the role of single factor changes in the prevention and treatment of falls.(20) Falls are multifactorial accidents, and interventions for falls should also include management of multiple risk factors.(21, 22) In order to effectively reduce the occurrence of falls and mitigate the injury caused by falls, we designed and verified a multifactorial fall intervention model. To our knowledge, this is the first systematic multifactorial fall intervention model that includes measures for pre-fall prevention, fall-onset management, and continuous improvement after falls. Our study included three phases investigation with phase 1 identifying fall patients characteristics, phase 2 proposing the multifactorial fall intervention model based on the results of phase 1, and phase 3 implanting and verifying the model in a hospital setting.

Method

The current study was performed following the STROBE checklist.

Study design

Our study was a longitudinal, before-and-after controlled study consisting of three phases of investigation. Phase 1 retrospectively identified clinical characteristics of fall patients, phase 2 designed the multifactorial fall intervention model and phase 3 prospectively evaluated the model.

Phase 1: Identification of clinical characteristics of in-patient falls

During phase 1, we included all patients from 26 departments for fall risk assessment after admission. Fall related information was collected by reviewing relevant fall medical records, nursing records and reports of adverse events as well as interviewing fall patients, family members of patients, doctors in charge of patients, and medical staff on duty.

Phase 2: Analysis of clinical characteristics and reflection on existing defects to derive a multifactorial fall intervention model including fall prevention, management and continuous improvement measures

Please see Supplementary File 1 for detailed description of the Phase 2.

Phase 3: Evaluation of the efficacy of the multifactorial fall intervention model in reducing fall rate and fall injuries

The new multifactorial fall intervention model was tested on patients admitted between January 2017 and December 2018 in the same hospital. After the patient fell, the nurse in charge or on duty filled out the Fall Cause Analysis Scale and recorded detailed data. When summarizing the data, the incidence of fall, the rate of fall injury and other clinical characteristics of falls in 2017–2018 were calculated and compared with the data of phase 1. In addition, we also collected and compared the number of complaints from fall patients, the number of compensations for fall patients and compensation amount for fall patients in phase 1 and phase 3.

Setting and Participants

Between January 2015 and December 2018, a total of 325,377 in-patients with 3,525,150 days of hospitalization of 26 departments in Zigong First People's Hospital (Zigong, China) were included for study. Among them, phase 1 and 2 were conducted based on 153,601 hospitalized patients with 491 recorded in-patient falls between January 2015 and December 2016. Phase 3 was carried out based on 171,776 hospitalized patients with 396 reported in-patient falls between January 2017 and December 2018.

All admitted patients in 26 departments in our hospital between 2015 and 2018 were included in the study. Since fall assessment and signing of informed consent to prevent falls are standard procedures in our hospital at the time of admission, all admitted patients were automatically enrolled in this study.

Variables

Please see Supplementary File 1 for detailed description.

Data source

Fall related information was collected by reviewing relevant medical records, nursing records and reports of adverse events as well as interviewing fall patients, family members of patients, doctors in charge of patients, and medical staff on duty.

Statistical methods

The Pearson Chi-squared test was used to compare categorical variables between phase 1 and phase 3 (Patient characteristics, fall rate and fall rate per 1000 patient-days). Mann-Whitney non-parametric test was utilized for one-way ordered data (Fall-related injuries). Based on the logistic regression analysis, we assessed the role of each factor in increasing the risk of falling and adjusted results. Data analyses were

performed on SPSS 26.0. P value < 0.05 was considered statistically significant and all tests were two-sided.

The medical ethics committee of hospital has approved the project.

Results

Phase 1

Four hundred and ninety-one falls (3.2‰) were recorded. Among them, 329 patients suffered grade 1 and above injuries and 49 patients were assessed as grade 3 injuries. Analysis of baseline characteristics of falling patients revealed that inpatients' falls were highly associated with the age, medication, clinical features and disease of patients. More than half of the falls (57.84%) occurred among patients aged 65 and over. Noticeably, in addition to the elderly, 47 falls of children aged 0–6 were also recorded, which accounted for a relatively high percentage (9.57%). According to medication records, 480 patients with falls were found to take drugs during hospitalization prior to the fall. Antihypertensive drugs (39.58%), analgesics (15.63%) and hypoglycemic drugs (15.42%) were the most common used drugs in decreasing order of frequency. In terms of clinical features, the most common symptoms of fall patients were hypodynamia (40.69%), dizziness (23.33%) and anemia (10.31%). As for diseases of fall patients, circulatory system diseases (20.32%) were the most common, followed by metabolic system diseases (17.98%) and nervous system diseases (15.20%). As recorded, fall patients were mainly from the department of neurology (13.24%), respiratory medicine (12.83%) and pediatrics (10.18%).

In addition, in-patient falls were also obviously characterized by time, place and activities. In-patient falls peaked between 2 am and 8 am (36.86%) and between 4 pm and 6 pm. About places of falling, most falls were found at the bedside or in the washroom (73.52%). Correspondingly, most people were toileting or moving around the bedside before they fell down (78.82%).

Baseline characteristics of fall patients were shown in Table 1 and Fig. 1.

Phase 2

The specific research progress of the fall intervention model is shown in supplementary file 1.

Leadership and work-team

Our fall intervention team led by the head nurse of the department, with doctors, nurses, rehabilitation teachers and care-taking staff as core members.

Fall risk assessment

The original fall risk assessment tool in our hospital refer to the Thomas Fall Risk Assessment Scale and the Johns Hopkins Fall Risk Assessment Tool. Based on our first phase of clinical data summary and

literature reading, we designed and improved the fall assessment tool and further tested its effectiveness in a large base sample (Fig. 2).

Work-flow

Our fall intervention process covered three parts, including fall prevention process, fall management process, and long-term continuous improvement measures (Fig. 3). The work-flow of each part and the details of modifications were elaborated in detailed method section (supplementary file 1)

Phase 3

A total of 396 falls occurred in 171,776 inpatients between 2017 and 2018 (phase 3) as compared with 491 falls detected in 153,601 hospitalized patients between 2015 and 2016 (phase 1) (Reduction in falls by 0.09%, $p < 0.001$). The result of logistic regression analysis showed that patient's age was significantly associated with fall. Before adjusted, patients who did not receive intervention of our model had a higher odds of falls than those who received intervention (Incident rate ratio: 1.388, 95%CI: 1.216–1.585). After adjusted for age, the incident rate ratio was 1.443 (95%CI: 1.263–1.647). Furthermore, the fall rate per 1000 patient-days in 2017–2018 was significantly lower than that in 2015–2016 (Reduction in falls/1000 patient-days by 0.07‰, $p < 0.001$). The result of Mann-Whitney U test revealed that the implement of our multi-factorial fall intervention model remarkably decreased the occurrence and the severity of fall injuries in phase 3 as compared with phase 1 ($Z = -4.426$, $p < 0.001$). More specifically, the number of uninjured falls accounted for 42.42% in phase 3 in comparison of 32.99% in phase 1. In terms of injured falls, the proportion of mild fall injuries in phase 3 was higher than that in phase 1 (32.58% vs 27.49%), and the rate of severe fall injuries decreased in phase 3 comparing with phase 1 (3.79% vs 9.98%). In addition, the number of complaints and compensation cases and the amount of compensation for fall patients in 2017–2018 have reduced sharply compared with 2015–2016.

There was no significant difference in fall rates between high risk and low risk groups during phase 1 (Fall rate: 0.12% vs 0.07%, $p = 0.104$). However, during phase 3, patients in high risk group had higher odds of falls compared with patients in low risk group (Fall rate: 0.05% vs 0.01%, $p = 0.015$). Patients assessed as high risk received intensive intervention during phase 3. The number of falls decreased in patients treated with the intensive intervention during phase 3 than those without intensive intervention during phase 1 (Reduction in falls by 0.07%, $p = 0.029$).

In addition, the new intervention model displayed a sensitivity of 64.3% and a specificity of 86.8% with the area under the curve of 0.821 (96%CI: 0.757–0.885).

The comparison of inpatient falls and fall injuries between phase 3 and phase 1 was shown in Table 2. A summary figure highlighting the study findings was shown in Fig. 4.

Table 2

Comparison of Inpatient falls and fall injuries between phase 1 (2015–2016) and phase 3 (2017–2018).

	Phase 1 (2015–2016)	Phase 3 (2017–2018)	Rate Difference (%)	<i>P</i> value	Adjusted incident rate ratio
Total No. of falls	491	396			
Gender (M / F)	267/224	214/182		0.946	
No. of repeated falls	17	13	0.18	0.833	
Fall rate (No. of patients with falls/ total No. of patients)	474/153601	383/171776	0.09	< 0.001	1.443 (95%CI: 1.263– 1.647), p< 0.001
Fall rate per 1000 patient-days (No. of falls/ 1000 patient-days)	491/1693485	396/1831665	0.07	< 0.001	
Fall injuries				< 0.001	
Severity grade 0	162	168	-9.43		
Severity grade 1	135	129	-5.08		
Severity grade 2	145	84	8.32		
Severity grade 3	49	15	6.19		
Death	0	0			
Gender (M/ F)	194/140	128/100		0.665	
No. of complaints from fall patients	16	5	2.00	0.052	
No. of compensations for fall patients	12	3	1.69	0.053	
Compensation amount for fall patients (¥)	339,579	10,000			
High risk (Fall rate, %)	0.12	0.05		0.029	
Low risk (Fall rate, %)	0.07	0.01		0.002	
P value	0.104	0.015			

Discussion

Overall, the implementation of the multifactorial fall intervention model reduced the incidence of falls in our hospital from 0.31–0.22% and decreased the incidence of falls per 1000 patient-days from 0.29‰ to 0.22‰. In addition, the uninjured rate of falls also increased from 32.99–42.42%.

Compared with our previous fall intervention system, a significant improvement of this model is to prevent falls in high risk patients from multiple aspects, which are composed of not only nurses, but actively involving doctors, patients and family members and care taking staff. Nurses have always been the main force in the prevention and control of falls.(23) However, through analyzing the characteristics of fall patients, we found that falls were closely related to many factors, including doctors' treatment, patients' and their families' consciousness of preventing falls and environmental factors. And the control of these factors is far beyond the ability and responsibility of the nurse, it is more necessary for doctors, patients and their families and care-taking staff to perform their respective duties for these factors. It is important for doctors to pay particular attention to medication for patients at high risk of fall, and to adjust medications according to the result of patient's fall assessment. Previous studies showed that up to 85% of falls occur when patients are alone.(8, 24) A randomized controlled trial demonstrated that providing education to patients enabled them to conduct safe behaviors in hospital and effectively alert staff that they need assistance, especially when alone.(13) Family members' perception of patients' risk of fall is an important factor affecting patients' fall, especially for children, the elderly and patients with cognitive impairment.(25, 26) Hospital falls of elderly patients have been widely reported. As for children, fall is the most common injury mechanism for children, consisting about one-third of accidental injuries. (27, 28) Our study identified that children between the ages of 0 and 6 as having a high risk of falling, which was consistent with previous reports.(29, 30) Falls from furniture and stairs are important causes of children falls in hospital.(30) Therefore, greater awareness of risk factors in family members and medical staffs is required to predict and prevent falls in children.

With regard to environmental factors, many high-quality researches suggested marked reduction in fall risk after physical environmental intervention offered to high risk patients.(31, 32) Our analysis of the characteristics of fall patients in phase 1 showed that 34.42% of falls occurred in the washroom, as the wet floor greatly increased the risk of falling. To specifically reduce the risk factors for falls in the environment, care-taking staff were required to regularly evaluate and improve the patient's physical environment.

Few studies have focused on the importance of continuous improvement measures after falls, but they are effective interventions to further prevent repeated falls. According to the literature report, approximately 10% of elderly patients experienced recurrent falls within a year that posed a subsequent health risk.(33) In our study, 17 out of 474 fall patients had repeated falls at our hospital between 2015 and 2016. Given that falling again will cause more serious physical and psychological harm to the patient, it is crucial to have continuous improvement measures after falls, which organize medical staff to analyze and improve the deficiencies of previous interventions, minimizing the likelihood of a patient falling again. In addition to regular review of fall cases, our continuous improvement measures also

include supervision and inspection of fall care by the leading team, aiming at promoting the improvement of fall prevention in hospitals in the long term.

The rate of falls was increased in several departments including D. of TCM, D. of oncology, D. of endocrinology and D. of rehabilitation. Noticeably, the patients in these departments were accompanied by relatively serious diseases, and the burden of medical staff was relatively arduous. To a certain extent, it had increased the difficulty of medical staff in preventing falls and managing falls, so it might cause an increase in the incidence of falls. In addition, the majority of patients in these departments were older patients, who were at higher risk of falling than patients in other departments. Moreover, several patients in the department of endocrinology were involved in hypoglycemia with a higher risk of falls. In the rehabilitation department, there were more patients with physical dyskinesia in urgent need of sports rehabilitation, and their risk of falling was relatively high.

This study has limitations. First of all, we used a before and after intervention control rather than a randomized control over the same time period. We believed that the original fall intervention system had many deficiencies and was not suitable for continued use. Therefore, it's dangerous to set the original fall intervention system as a control group. In addition, the comparison of results before and after the new intervention system allows us to find changes in the fall of specific departments. To further validate and modify our model, we plan to compare the model with the currently accepted fall intervention systems in subsequent clinical trials. Secondly, our revised system is a multifactorial fall intervention model without specifying the effectiveness of a single intervention. Since falls are associated with many factors, we believe that only by intervening simultaneously from multiple perspectives can we minimize falls. As for its applicability, hospitals can learn from our model and improve upon their existing fall intervention systems. Lastly, the intervention was not conducted blind, which might introduce reporting bias. However, compared with the previous system, the reporting procedure in the revised intervention model was way more stringent. Regular supervision also ensured that falls were reported truthfully.

Our fall intervention model has several advantages. Firstly, compared with the existing fall management systems, our model forms a complete fall intervention work-flow including measures for pre-fall prevention, fall-onset management, and continuous improvement after falls to minimize the incidence of fall. Specifically, few studies pay attention to the continuous improvement after falls. However, this is quite important for learning lessons to improve measures and prevent second fall. Secondly, the approach we used in developing and applying the intervention were easy to implement. For medical staff and care-taking staff, measures for fall risk factor assessment and management are all familiar medical operations. Our model is to form a work flow to fully ensure that their work is orderly and correct. In addition, involving patients and their families in falling interventions in the form of written and oral education is also a common method in medicine to protect patients' health together with medical staff. Thirdly, our fall intervention model was constructed based on a large sample of more than 320,000 inpatients, which reflects the reliability of its effectiveness to some extent.

Conclusions And Implications

In conclusion, the results of our study indicated that the revised multifactorial fall intervention model was effective in reducing falls and fall injuries. Further study is needed to verify whether our model is functional and determine if the model is effective in a longer period of time. Seven hospitals have introduced our models and are currently undergoing testing.

Declarations

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

COMPETING INTERESTS

All authors declare no editorial or financial conflict of interest.

FUNDING

No external funding.

AUTHORS' CONTRIBUTIONS

Conceptualization, Y.L.; Data collection and curation, C.L., H.W., T.W., Y.Z. and Y.Z.; Investigation, C.L and L.G.; Methodology, Y.L., C.L. and L.G.; Software and visualization, H.W.; Writing-Original Draft Preparation, L.G. and C.L.; Writing- Review & Editing, Y.L.

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References

1. Dykes PC, Carroll DL, Hurley A, Lipsitz S, Benoit A, Chang F, et al. Fall prevention in acute care hospitals: a randomized trial. *JAMA*. 2010;304(17):1912-8.
2. Oliver D, Britton M, Seed P, Martin FC, Hopper AH. Development and evaluation of evidence based risk assessment tool (STRATIFY) to predict which elderly inpatients will fall: case-control and cohort studies. *BMJ*. 1997;315(7115):1049-53.

3. Schwendimann R, Buhler H, De Geest S, Milisen K. Characteristics of hospital inpatient falls across clinical departments. *Gerontology*. 2008;54(6):342-8.
4. Guirguis-Blake JM, Michael YL, Perdue LA, Coppola EL, Beil TL. Interventions to Prevent Falls in Older Adults: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. *JAMA*. 2018;319(16):1705-16.
5. Czerwinski E, Bialoszewski D, Borowy P, Kumorek A, Bialoszewski A. Epidemiology, clinical significance, costs and fall prevention in elderly people. *Ortop Traumatol Rehabil*. 2008;10(5):419-28.
6. Nilsson M, Eriksson J, Larsson B, Oden A, Johansson H, Lorentzon M. Fall Risk Assessment Predicts Fall-Related Injury, Hip Fracture, and Head Injury in Older Adults. *J Am Geriatr Soc*. 2016;64(11):2242-50.
7. Gill TM, Williams CS. Likelihood of Sustaining an Injury in the Setting of Multiple Falls. *J Am Geriatr Soc*. 2019;67(1):119-23.
8. Hill AM, Hoffmann T, Hill K, Oliver D, Beer C, McPhail S, et al. Measuring falls events in acute hospitals-a comparison of three reporting methods to identify missing data in the hospital reporting system. *J Am Geriatr Soc*. 2010;58(7):1347-52.
9. Phelan EA, Ritchey K. Fall Prevention in Community-Dwelling Older Adults. *Ann Intern Med*. 2018;169(11):ITC81-ITC96.
10. Cina-Tschumi B, Schubert M, Kressig RW, De Geest S, Schwendimann R. Frequencies of falls in Swiss hospitals: concordance between nurses' estimates and fall incident reports. *Int J Nurs Stud*. 2009;46(2):164-71.
11. Moncada LVV, Mire LG. Preventing Falls in Older Persons. *Am Fam Physician*. 2017;96(4):240-7.
12. Mackey DC, Lachance CC, Wang PT, Feldman F, Laing AC, Leung PM, et al. The Flooring for Injury Prevention (FLIP) Study of compliant flooring for the prevention of fall-related injuries in long-term care: A randomized trial. *PLoS Med*. 2019;16(6):e1002843.
13. Hill AM, McPhail SM, Waldron N, Etherton-Ber C, Ingram K, Flicker L, et al. Fall rates in hospital rehabilitation units after individualised patient and staff education programmes: a pragmatic, stepped-wedge, cluster-randomised controlled trial. *Lancet*. 2015;385(9987):2592-9.
14. Hempel S, Newberry S, Wang Z, Booth M, Shanman R, Johnsen B, et al. Hospital fall prevention: a systematic review of implementation, components, adherence, and effectiveness. *J Am Geriatr Soc*. 2013;61(4):483-94.
15. Oliver D, Hopper A, Seed P. Do hospital fall prevention programs work? A systematic review. *J Am Geriatr Soc*. 2000;48(12):1679-89.
16. Wongrakpanich S, Danji K, Lipsitz L, Berry S. STOP-FALLING: A Simple Checklist Tool for Fall Prevention in a Nursing Facility. *J Am Med Dir Assoc*. 2019;20(7):916-8.
17. Oliver D, Daly F, Martin FC, McMurdo ME. Risk factors and risk assessment tools for falls in hospital in-patients: a systematic review. *Age Ageing*. 2004;33(2):122-30.

18. Cameron ID, Dyer SM, Panagoda CE, Murray GR, Hill KD, Cumming RG, et al. Interventions for preventing falls in older people in care facilities and hospitals. *Cochrane Database Syst Rev*. 2018;9:CD005465.
19. Klenk J, Becker C, Palumbo P, Schwickert L, Rapp K, Helbostad JL, et al. Conceptualizing a Dynamic Fall Risk Model Including Intrinsic Risks and Exposures. *J Am Med Dir Assoc*. 2017;18(11):921-7.
20. Gillespie LD, Robertson MC, Gillespie WJ, Sherrington C, Gates S, Clemson LM, et al. Interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev*. 2012(9):CD007146.
21. Hopewell S, Adedire O, Copsey BJ, Boniface GJ, Sherrington C, Clemson L, et al. Multifactorial and multiple component interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev*. 2018;7:CD012221.
22. Cameron ID, Kurrle S. Preventing falls in elderly people living in hospitals and care homes. *BMJ*. 2007;334(7584):53-4.
23. Reuben DB, Gazarian P, Alexander N, Araujo K, Baker D, Bean JF, et al. The Strategies to Reduce Injuries and Develop Confidence in Elders Intervention: Falls Risk Factor Assessment and Management, Patient Engagement, and Nurse Co-management. *J Am Geriatr Soc*. 2017;65(12):2733-9.
24. Staggs VS, Mion LC, Shorr RI. Assisted and unassisted falls: different events, different outcomes, different implications for quality of hospital care. *Jt Comm J Qual Patient Saf*. 2014;40(8):358-64.
25. Ryu YM, Roche JP, Brunton M. Patient and family education for fall prevention: involving patients and families in a fall prevention program on a neuroscience unit. *J Nurs Care Qual*. 2009;24(3):243-9.
26. Vonnes C, Wolf D. Fall risk and prevention agreement: engaging patients and families with a partnership for patient safety. *BMJ Open Qual*. 2017;6(2):e000038.
27. Sinclair SA, Xiang H. Injuries among US children with different types of disabilities. *Am J Public Health*. 2008;98(8):1510-6.
28. Kennedy RA, Carroll K, Hepworth G, Paterson KL, Ryan MM, McGinley JL. Falls in paediatric Charcot-Marie-Tooth disease: a 6-month prospective cohort study. *Arch Dis Child*. 2019;104(6):535-40.
29. Monson SA, Henry E, Lambert DK, Schmutz N, Christensen RD. In-hospital falls of newborn infants: data from a multihospital health care system. *Pediatrics*. 2008;122(2):e277-80.
30. Pomerantz WJ, Gittelman MA, Hornung R, Husseinzadeh H. Falls in children birth to 5 years: different mechanisms lead to different injuries. *J Trauma Acute Care Surg*. 2012;73(4 Suppl 3):S254-7.
31. Tricco AC, Thomas SM, Veroniki AA, Hamid JS, Cogo E, Strifler L, et al. Comparisons of Interventions for Preventing Falls in Older Adults: A Systematic Review and Meta-analysis. *JAMA*. 2017;318(17):1687-99.
32. Letts L, Moreland J, Richardson J, Coman L, Edwards M, Ginis KM, et al. The physical environment as a fall risk factor in older adults: Systematic review and meta-analysis of cross-sectional and cohort studies. *Aust Occup Ther J*. 2010;57(1):51-64.

33. Nevitt MC, Cummings SR, Kidd S, Black D. Risk factors for recurrent nonsyncopal falls. A prospective study. JAMA. 1989;261(18):2663-8.

Table

Due to technical limitations, table 1 docx is only available as a download in the Supplemental Files section.

Figures

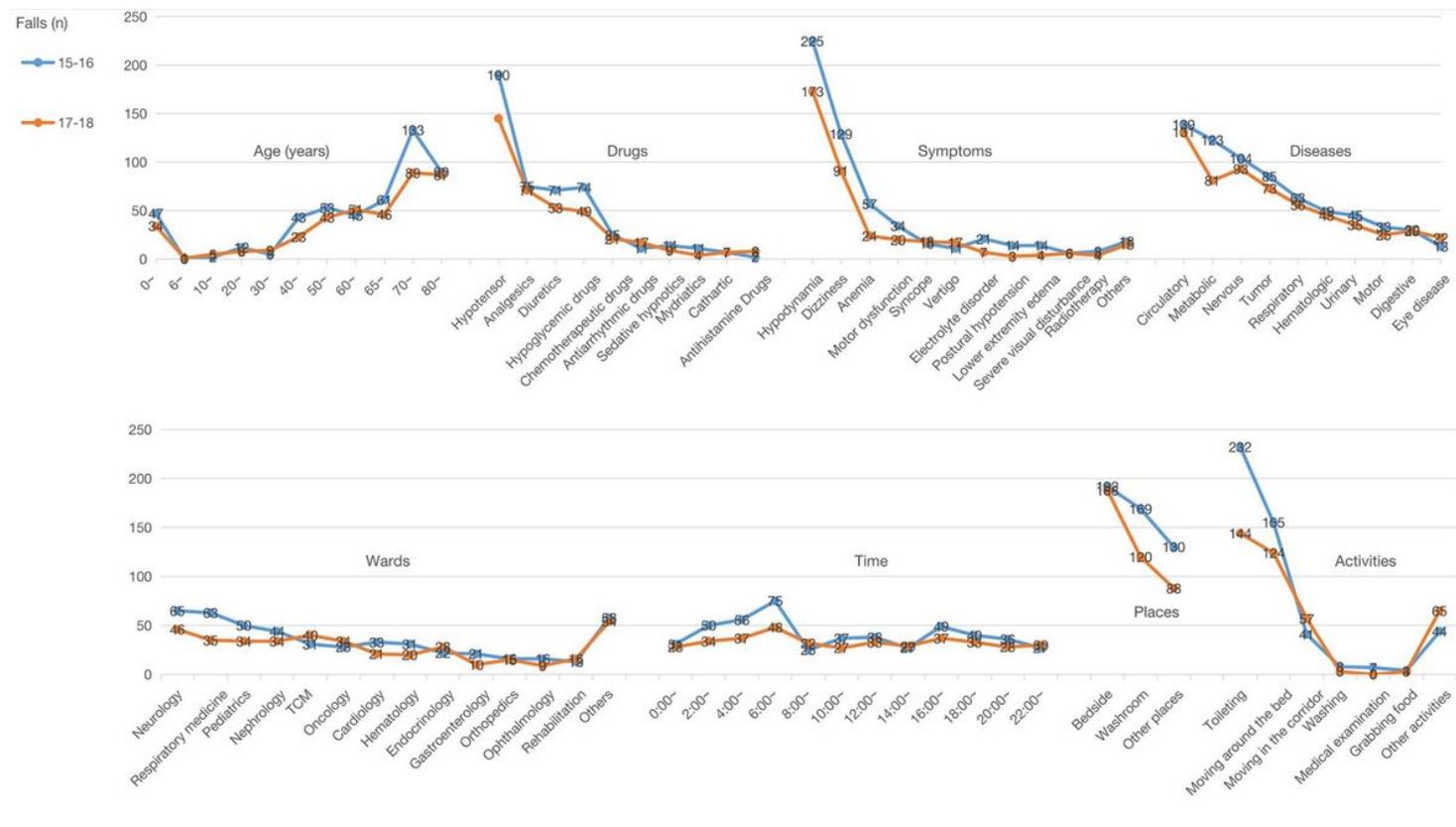


Figure 1

Baseline characteristics of fall patients in phase 1 and phase 3.

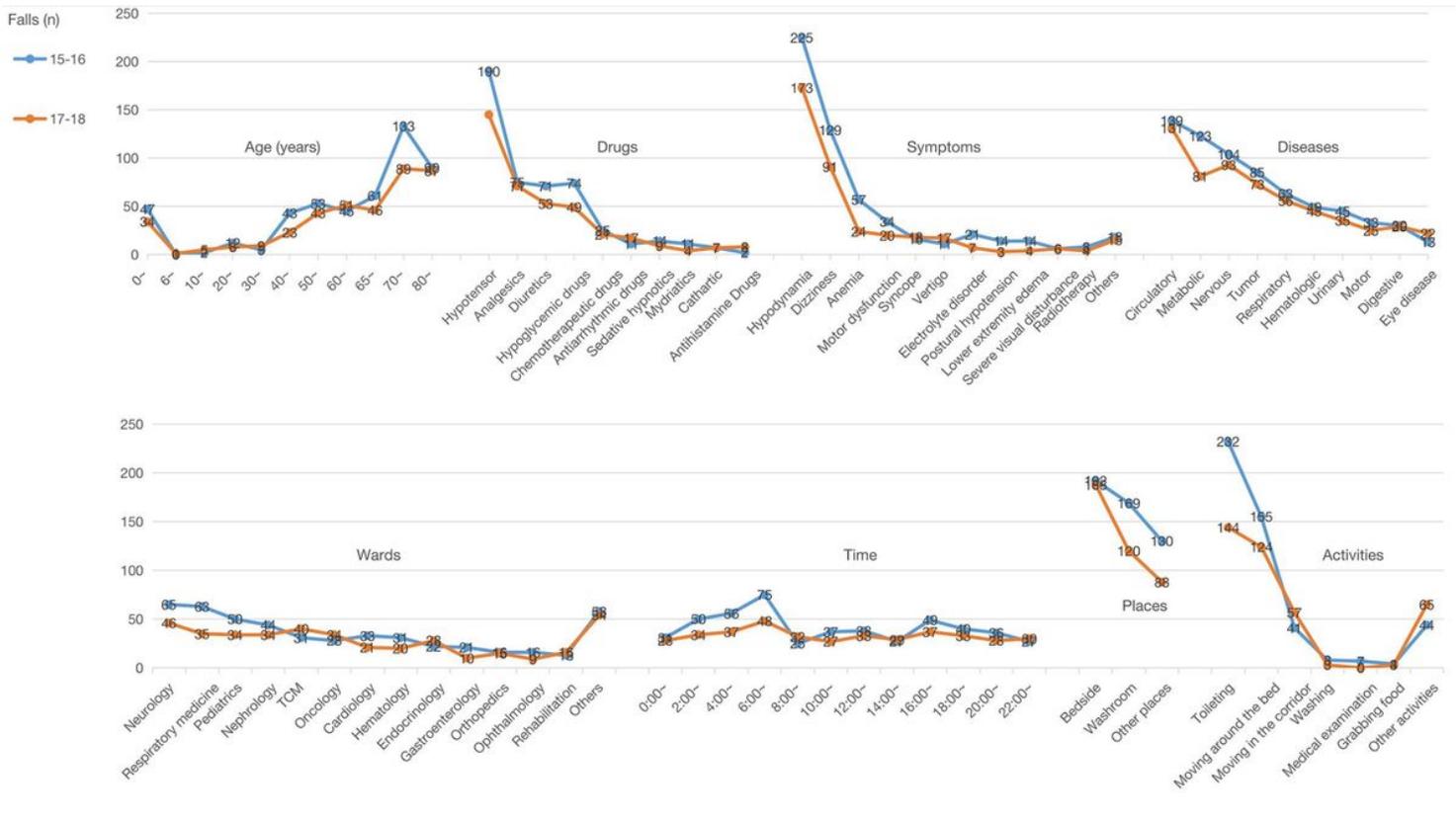


Figure 1

Baseline characteristics of fall patients in phase 1 and phase 3.

Modified Fall Risk Assessment Tool

Department: Bed: Name: Sex: Age: Admission number:

Item	Contents and score	Assessment Date	
Age	0~6: 1 6~64: 0 65~75: 1 76~80: 2 >80: 3		
Cognitive Function	Conscious: 0 Cognitive impairment: 1		
Ambulation Ability	Stable gait or Immobility in bed: 0 Gait instability or use of walker or wheelchair: 1		
Degree of self-care: excretion	Can use restroom alone: 0 Incontinence or frequent urination or diarrhea or need for assistance in toileting: 1		
Fall History (1 year before admission)	No: 0 Yes: 1		
High-risk Medication	No: 0 Yes: 1 Antihypertensive drugs, Analgesics, Diuretics, Hypoglycemic drugs, Chemotherapeutic drugs, Antiarrhythmic drugs, Sedative, Hypnotics, Antianxiety drugs, Antidepressants, Mydriatics, Cathartic, Antihistamine drugs 1 point for each item, up to 3 points		
High-risk Clinical Features	No: 0 Yes: 1 Hypodynamia, Dizziness, Anemia, Motor dysfunction, Syncope, Vertigo, Electrolyte disorder, Postural hypotension, Lower extremity edema, Severe visual disturbance 1 point for each item, up to 3 points		
Total Score			
Nurse Signature			
When score ≥ 4, family members consent and sign after education from the nursing staff			
Results (Discharge/Transfer/Death)	Fall	Yes/No	Nurse Signature: Date:
	Fall without injuries	Yes/No	
	Fall with injuries	Injury grades:	
		Prognosis:	

The total score ≥4 indicates that the patient is at potential high risk of falling.

Figure 2

The modified fall risk assessment tool.

Modified Fall Risk Assessment Tool

Department: Bed: Name: Sex: Age: Admission number:

Item	Contents and score		Assessment Date	
Age	0~6: 1 6~64: 0 65~75: 1 76~80: 2 >80: 3			
Cognitive Function	Conscious: 0 Cognitive impairment: 1			
Ambulation Ability	Stable gait or Immobility in bed: 0 Gait instability or use of walker or wheelchair: 1			
Degree of self-care: excretion	Can use restroom alone: 0 Incontinence or frequent urination or diarrhea or need for assistance in toileting: 1			
Fall History (1 year before admission)	No: 0 Yes: 1			
High-risk Medication	No: 0 Yes: 1 Antihypertensive drugs, Analgesics, Diuretics, Hypoglycemic drugs, Chemotherapeutic drugs, Antiarrhythmic drugs, Sedative, Hypnotics, Antianxiety drugs, Antidepressants, Mydriatics, Cathartic, Antihistamine drugs 1 point for each item, up to 3 points			
High-risk Clinical Features	No: 0 Yes: 1 Hypodynamia, Dizziness, Anemia, Motor dysfunction, Syncope, Vertigo, Electrolyte disorder, Postural hypotension, Lower extremity edema, Severe visual disturbance 1 point for each item, up to 3 points			
Total Score				
Nurse Signature				
When score ≥ 4, family members consent and sign after education from the nursing staff				
Results (Discharge/Transfer/Death)	Fall	Yes/No	Nurse Signature:	Date:
	Fall without injuries	Yes/No		
	Fall with injuries	Injury grades:		
		Prognosis:		

The total score ≥4 indicates that the patient is at potential high risk of falling.

Figure 2

The modified fall risk assessment tool.

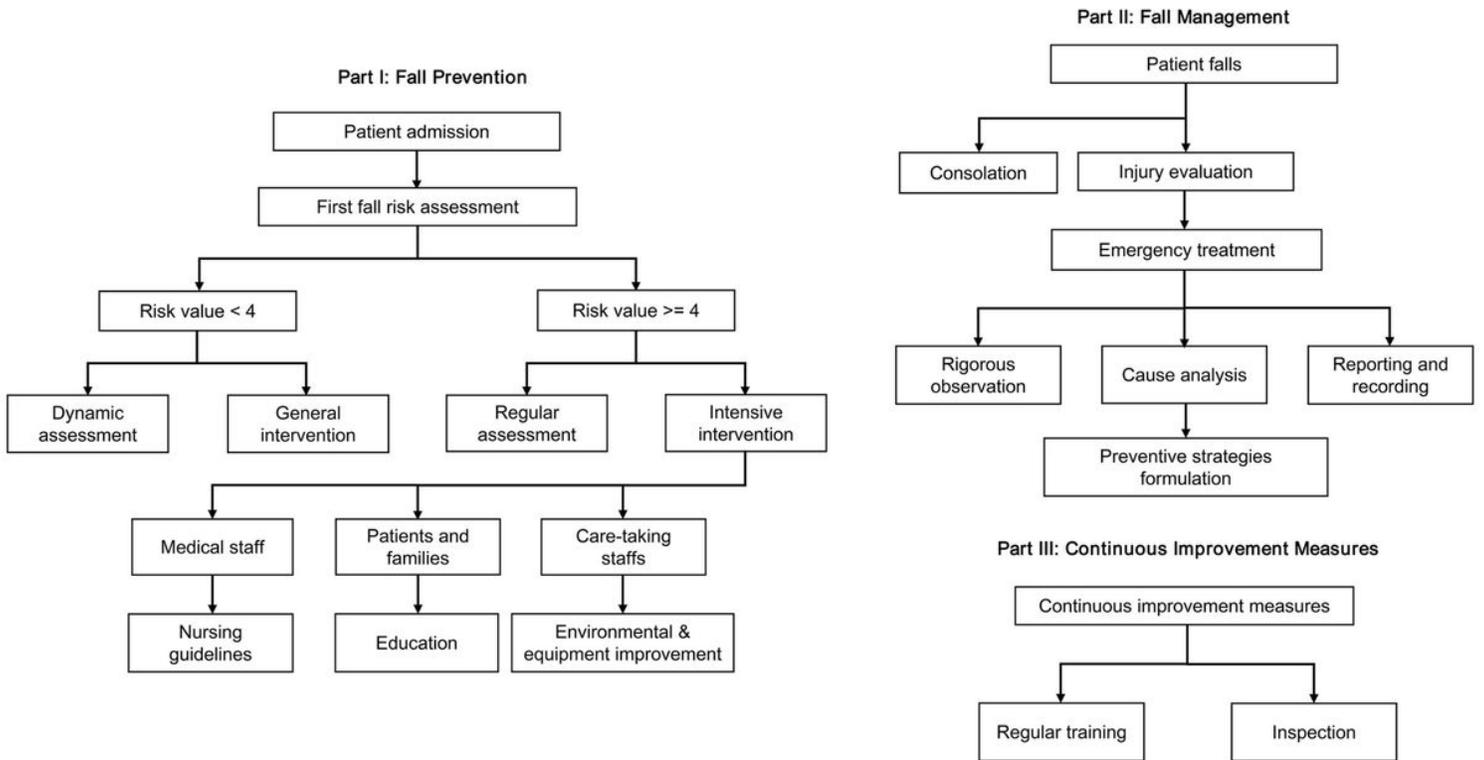


Figure 3

Multifactorial fall intervention work-flow: fall prevention, fall management and continuous improvement measures.

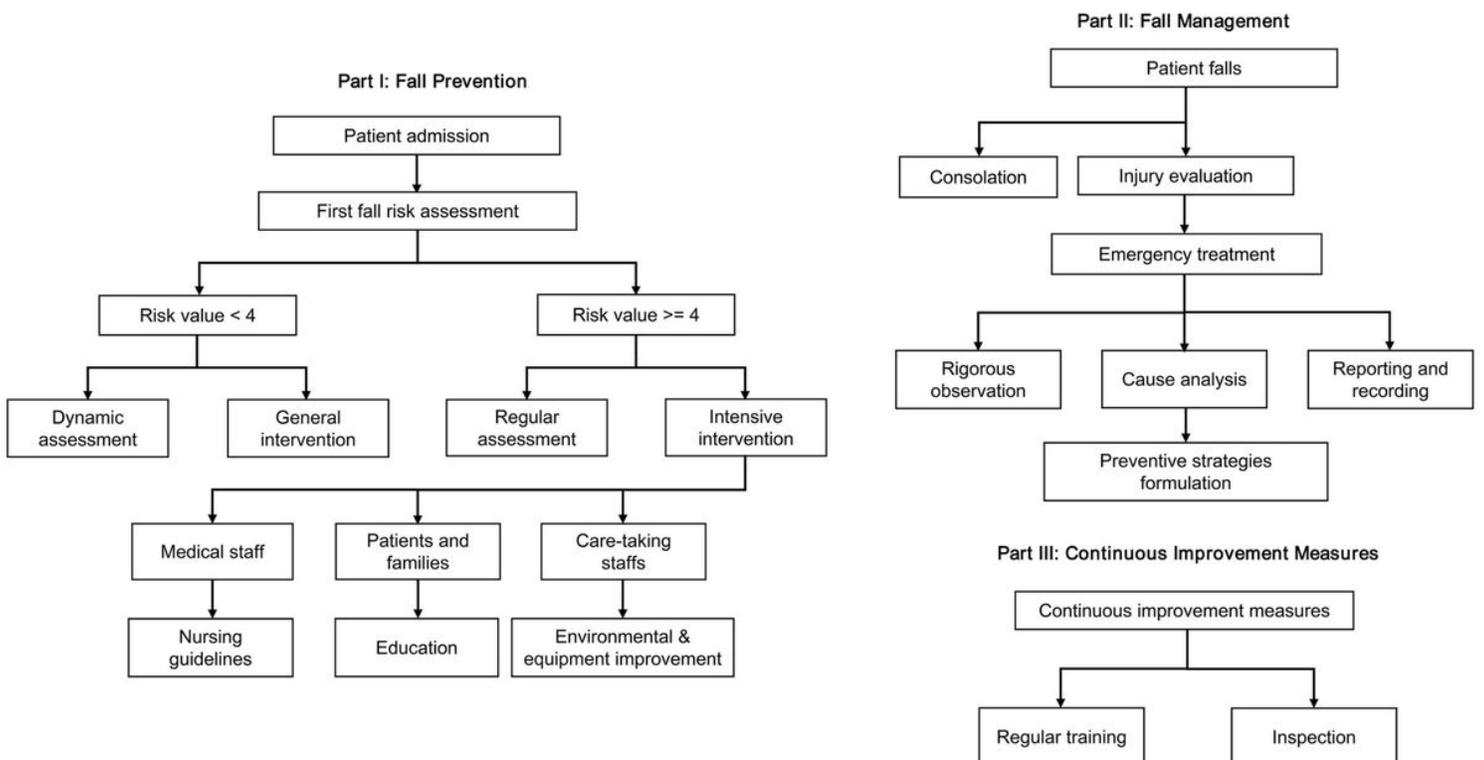


Figure 3

Multifactorial fall intervention work-flow: fall prevention, fall management and continuous improvement measures.

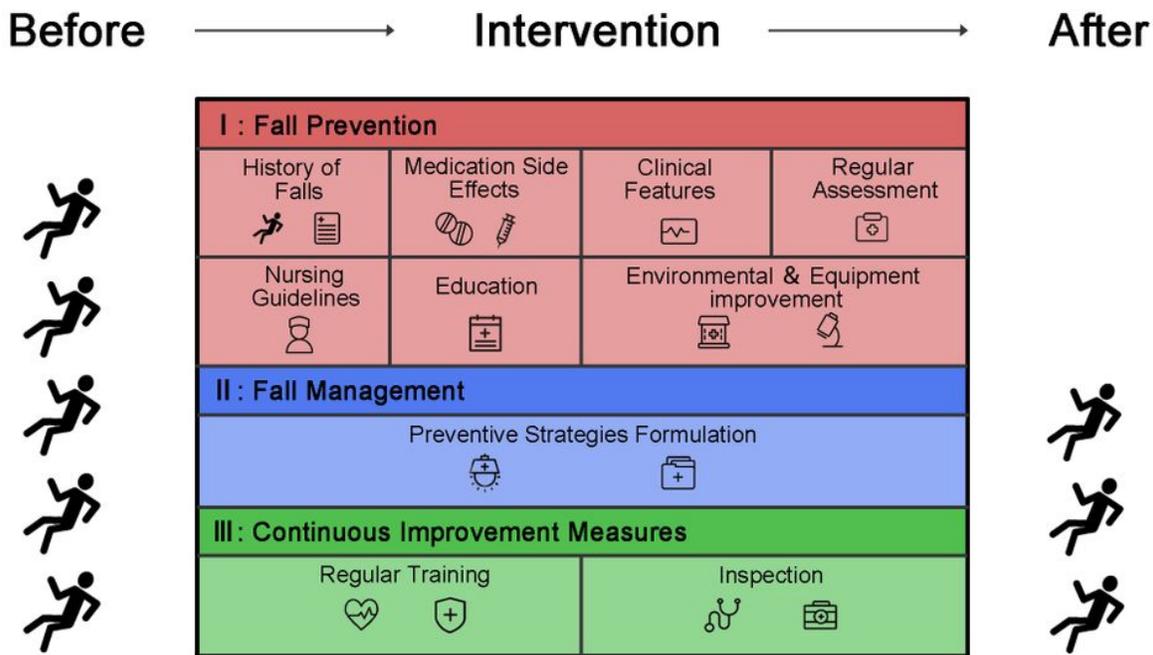


Figure 4

Summary figure highlighting the study findings.

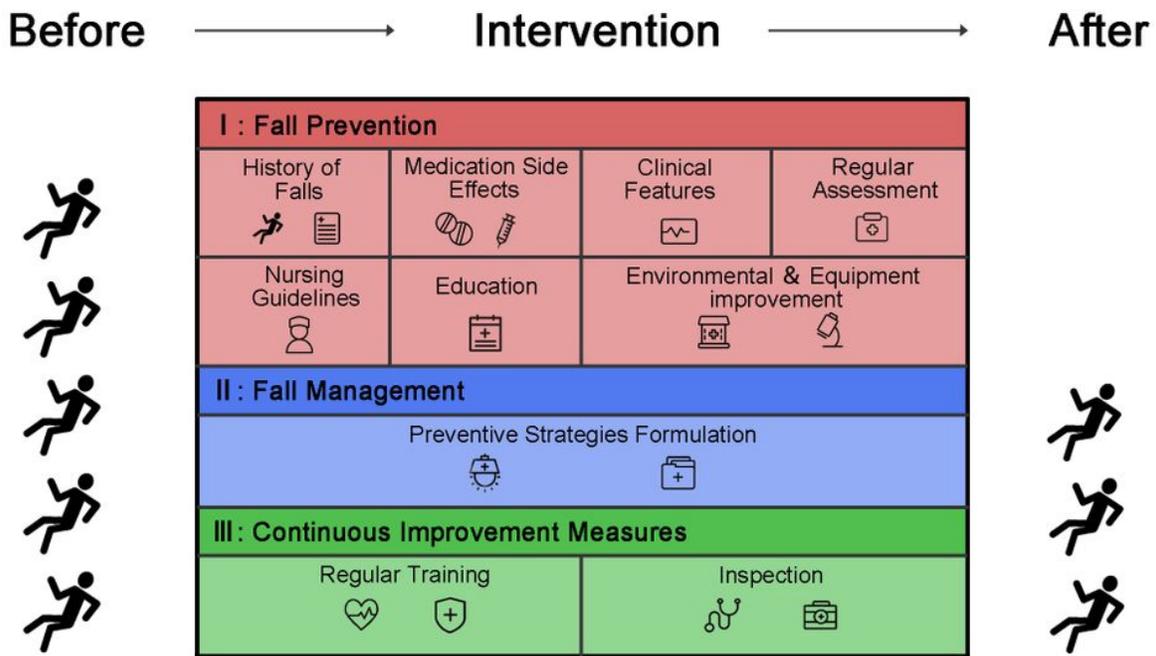


Figure 4

Summary figure highlighting the study findings.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Table1.docx](#)
- [Table1.docx](#)
- [S1detailedmethod.docx](#)
- [S1detailedmethod.docx](#)
- [S2fallcauseanalysisisscale.docx](#)
- [S2fallcauseanalysisisscale.docx](#)
- [S3listoffallrelatedhighriskdrugs.doc](#)
- [S3listoffallrelatedhighriskdrugs.doc](#)
- [S4preventivemeasures.doc](#)
- [S4preventivemeasures.doc](#)

- S5informedconsentform.docx
- S5informedconsentform.docx
- S6environmentalriskfactorsassessmenttool.docx
- S6environmentalriskfactorsassessmenttool.docx
- STROBEchecklistcombined.docx
- STROBEchecklistcombined.docx