Intervention to Reduce Falls on an Intermediate Care Unit

Lindsay M. Egbert

Under Supervision of

Janet Selway

Second Reader

Kristen Rawlett

Clinical Site Representative

Barbara Bosah

A DNP Project Manuscript
Submitted in Partial Fulfillment of the Requirements for the
Doctor of Nursing Practice Degree

School of Nursing, University of Maryland
May 2024

Author Note

Disclosures: Lindsay Egbert is employed by the facility where the project site is located. There are no known conflicts to disclose.

Abstract

Problem & Purpose: During FY2022, a surgical intermediate care unit (IMC) in a large, tertiary academic medical facility did not meet fall prevention goals and reported 14 falls, six with injury; 57% unwitnessed, 36% had contributing cognitive or behavioral factors, and 14% fell from the chair. The purpose of this quality improvement initiative was to implement, and achieve compliance with, a chair alarm setup protocol, and to reduce the incidence of unit falls. **Methods**: The intervention included a chair alarm setup for every patient room as part of a pre-admission room readiness standardized process. Prior to receiving a patient into a room, unit nursing and supporting staff installed ready-to-use chair alarms into patient chairs, complete with alarm sensor pad, chair alarm, and confirmed working batteries. The project lead (PL) completed one-on-one staff education for 90.9% of all unit staff members and provided education to all staff via email. Unit champions (UCs) were designated to help improve compliance. Visual reminders were placed on the unit assignment boards. The PL and UCs audited clean and ready rooms using a link and QR code generated by the REDCap® software. Fall data was obtained from hospital quality reports and verified with unit leadership. **Results**: During the project, the PL and UCs completed 79 audits on pre-admission rooms; 87.67% of audited rooms had ready-to-use chair alarms set up. In the 14 weeks pre-project, three patient falls occurred on the IMC; two occurred during the project period. These two falls did not occur from the chair. **Conclusions**: This pilot study demonstrated promising findings for IMC staff adherence to a pre-admission chair-alarm protocol. High support staff turnover, inadequate supplies, and staffing constraints were likely barriers to 100% protocol adherence. Education of all new staff and improved stocking of alarm supplies promotes project sustainability.

Keywords: fall, reduce, intervention, chair alarm, protocol, room readiness

Intervention to Reduce Falls on an Intermediate Care Unit

Falls in the hospital are a significant problem within the U.S. healthcare system. According to the Agency for Healthcare Research and Quality (AHRQ), there are between 700,000 and 1,000,000 hospital inpatient falls in the U.S. every year (AHRQ, 2021). Hospital falls result in injury about 23% to 42% of the time, with 2% to 9% being serious injuries (Najafpour et al., 2019). Falls increase hospital length of stay by six to eight days, increase costs of hospitalization for patients, and increase costs for hospitals if the fall is considered preventable (Melin, 2018; Najafpour et al., 2019). A large, tertiary academic medical facility experienced a 26.9% increase in its inpatient fall rate from the fiscal year 2021 (FY2021) to FY2022. One unit identified as needing improvement was an Intermediate Care Unit (IMC) located within the hospital. The IMC did not meet its fall reduction goals for FY2022, with a total of 14 falls, six of which resulted in injury.

The purpose of this quality improvement initiative was to implement, and achieve compliance with, a chair alarm setup protocol, and to reduce the incidence of unit falls.

Available Knowledge

A literature search was performed of available randomized controlled trials, systematic reviews with or without meta-analyses, quasi-experimental studies, case-control studies, and quality improvement studies using the PubMed, EMBASE, SCOPUS, and google scholar databases from 2016 until present. A randomized controlled trial conducted by Barker et al. (2016) implemented a nurse led fall prevention program, referred to as the 6-PACK program, on 24 acute care hospital units. The 6-PACK program included implementation of a fall risk assessment tool to be completed for each patient per shift, and the implementation of at least one of the following interventions for high fall risk patients: falls alert sign, safe toileting measures,

keeping walking aids in reach, the use of low beds, or bed/chair alarms (Barker et al., 2016). The study results demonstrated a significantly increased use of all of the 6-PACK interventions and risk assessment tool on the intervention units compared to control units (incidence rate ratio 3.05, 95% CI 2.14, 4.34, $p < .001$). Fall rates were not significantly different on the units, however, control units still utilized standardized fall prevention measures, including some of the same measures used in the 6-PACK program (Barker et al., 2016).

A systematic review of five randomized controlled trials conducted by Avanecean et al. (2017) studied the effects of patient-centered fall interventions on the incidence and rates of falls in the acute care setting. Three of the five studies demonstrated a significant reduction in fall rates with the implementation of fall interventions that were tailored to the individual's risk factors (Avanecean et al., 2017). The evidence is promising, as it demonstrates the importance of understanding what puts patients at risk for falls, and that certain patient populations may require specific interventions (Avanecean et al., 2017).

A cross-sectional, observational study conducted by Staggs et al. (2020) sought to explain what patient- and hospital unit-specific factors impacted the prevalence of bed or chair alarm use in the acute care setting. The results demonstrated that alarms were more likely to be implemented when patients were identified as having poor judgement with their mobility, a need for ambulatory assistance, a recent fall, or an altered mental status (Staggs et al., 2020). Logistic regression was used to predict the percentage of expected alarm use for each unit in the study. However, many of the patterns of alarm use did not fit this predicted model based on patient characteristics, indicating that the use of the bed or chair alarm was largely in part driven by unit culture and protocol (Staggs et al., 2020).

Mileski et al. (2019) conducted a systematic review of academic journals that evaluated alarm or alarming device efficacy on fall reduction in long-term care facilities. Successful alarm intervention was dependent on the proper implementation and use of the devices, which was dependent on appropriate device training (Mileski et al., 2019). The review also concluded that in individuals with cognitive impairments, the use of an alarm device was the most impactful intervention in fall reduction (Mileski et al., 2019). The use of alarms were more effective as part of a fall prevention plan, not as a single intervention alone, in reducing falls (Mileski et al., 2019).

A quality improvement study conducted by Estupinan et al. (2018) found that falls were occurring due to pain medication usage, and the failed implementation of bed and chair alarms. A pre-intervention survey found that nursing staff were lacking knowledge in these areas, and reported that they were not using the bed or chair alarms because they were not easily accessible (Estupinan et al., 2018). A conveniently located fall prevention kit was implemented for patients indicated to be a high fall risk on admission to an acute oncology unit (Estupinan et al., 2018). Staff were provided with handouts and an education session for fall risk awareness (Estupinan et al., 2018). The results demonstrated an increased compliance with the use of chair alarms, and a decreased incidence of falls (Estupinan et al., 2018).

Appendix A and B contain the evidence review table and evidence synthesis, respectively.

Rationale

The Promoting Action on Research Implementation in Health Services (PARIHS) Framework plans, guides, and evaluates the successful implementation (SI) of evidence-based interventions in healthcare (Bergström et al., 2020). The SI encompasses three major concepts: evidence, facilitation, and context (Bergström et al., 2020). Implementation is more likely to be

successful when high-quality evidence is present, patients and providers support the intervention, skilled facilitation of implementation exists, and when the culture of the healthcare facility supports implementation through leadership and performance feedback (Duan et al., 2022). Conversely, when one concept does not reach its highest potential, the others may still work to produce SI (Duan et al., 2022). SI of this fall prevention intervention will succeed as literature, healthcare providers, and patients support fall reduction. The unit is part of an academic system that supports evidence-based practice, continuing education, patient-centered care, and active participation in performance feedback measures. The application of the PARIHS Framework for this DNP project can be seen in Figure 1.

Methods

Context-Setting

The IMC comprises 18 beds on two separate floors that are staffed by the same pool of nurses, and unlicensed assistive personnel (UAPs) such as patient care technicians, student nurses, mobility techs, and unit secretaries. The IMC has 36 nurses and 19 UAPs that service adult patients undergoing various surgical procedures. Many of the patients on the IMC are at an increased risk for falls due to medication usage, limitations in movement, medical devices, or cognitive and/or behavioral impairments (Schoberer et al., 2022).

The current facility policy requires completion of a fall risk assessment at least once a shift, on admission, with a change in patient status, or after a fall. The hospital policy currently requires standard fall prevention interventions for all patients, no matter the calculated fall risk. Standard interventions include nonskid footwear, high fall risk door signage, ensuring all personal belongings and call bell are within reach, keeping the bathroom or night light on if able, medication reconciliation, de-cluttering of the environment, keeping the bed in the low position

with the brake on, keeping two side rails up on the bed, and ensuring that the chair brake is on. If a patient is considered a high fall risk, the policy states that all standard interventions should be in place, plus high fall risk interventions as appropriate. These include a high fall risk bracelet, utilizing a bed/chair alarm, patient and family education, consideration of PT/OT consult, and discussing the fall prevention plan with the team.

A root cause analysis (RCA) examined the etiology of falls on the IMC and can be seen in Appendix C. The RCA and retrospective review of fall reports determined that about 57% of falls were unwitnessed, 36% of falls had contributing cognitive or behavioral factors, and 14% of all falls occurred from the chair. Senior clinical nurses on the unit found that compliance with fall intervention implementation may not be optimal. They noted assembly requirements and inconsistent availability of alarm components as barriers to chair alarm use. Currently there is no policy to setup chair alarms prior to admission in every patient room.

Context and Culture

A senior clinical nurse completed a cultural assessment of the IMC in 2022 using the Alberta Context Tool (ACT) to determine organizational context, facilitators, and barriers to SI (Schadewaldt et al., 2019). The results of the ACT showed higher scores for the perception of leadership, frequency of interdisciplinary interactions, culture, feedback and evaluation, and social capital. The areas with higher scores correlate with a positive perception of unit leadership, a positive and supportive work environment, the use of routine performance evaluation and feedback, and a perceived sense of teamwork (Squires et al., 2015). The ACT showed lower scores for the perception of time, adequate staffing, and resource availability. Following the COVID-19 pandemic, the unit has seen high nurse turnover rates, an influx of travel nurses, and staff floating from supplemental staffing or other units. In addition, the

hospital has faced considerable fluctuations in supply availability. These post-pandemic changes may be partially responsible for the lower scores seen on the ACT.

Intervention

The intervention was the implementation of a chair alarm use room readiness, unit-based protocol. The protocol included a chair alarm setup for every patient room as part of a pre-admission room readiness standardized process. Prior to receiving a patient into a room, nurses and/or UAPs installed a ready-to-use chair alarm into the patient chair, complete with alarm sensor pad, chair alarm, and confirmed, working batteries. The unit had an existing pre-admission room readiness setup that included two working suction setups, and a bag-valve mask. The selected intervention did not complicate the staff's existing workflow and targeted some of the root causes associated with falls among this patient population as well as possible variances in chair alarm usage on the IMC.

Implementation Strategies and Tactics

Key stakeholders were identified and included the unit manager, assistant manager, the unit's Safety, Quality, and Service (SQS) Council, senior clinical nurses, the unit's inventory specialist, staff nurses, and staff UAPs. Guidance and feedback regarding the intervention strategy was discussed with a leader from the facility's Fall Prevention Steering Committee, the unit manager, assistant manager, SQS council, and inventory specialist. Four unit champions (UCs) were selected prior to the start of the project. The UCs were members of the SQS council, or senior clinical nurses. Two additional UCs were incorporated during the project implementation period.

Educational materials were created by the PL. The education materials were printed, laminated, and reviewed with staff during one-on-one in person signoff. An electronic copy of

the same education materials was sent via email with a blurb of information on the project implementation, to all staff via the unit manager's weekly email update. The printed materials included information on the who, what, when, where and why of the quality improvement project. The print outs provided images on the individual components of the chair alarm setup, proper battery installation, and the correct way to setup the chair alarm. Proper alarm setup was identified by Mileski et al. (2019) to be key to the success of the chair alarms in fall prevention. Staff were provided with step-by-step instructions, in addition to the visuals, on the setup process. Staff were instructed to place a new chair alarm pad in the chair and connect it to the chair alarm. The chair alarm batteries were to be checked by turning the power on, and checking that the alarm works by pressing on to the chair pad and releasing. The education materials discussed proper maintenance and reuse of chair alarms. This included education on the chair alarm pads being single-patient use only, and that the chair alarms themselves can be wiped down with facility approved cleaning wipes with caution to avoid excessive moisture to the speaker area. Staff were provided with education on how to properly install batteries, when to change batteries, and how to know when battery power was low. One-on-one education was completed by either the PL or UCs. A list of all current nurses and UAPs was generated, and staff signed the list when they completed the training.

Visual aids were made available on the units. The visual aids were placed on both assignment white boards and included a picture of the proper chair alarm setup with an informational who, what, where, when, and why blurb. The PL utilized the facility messaging system to communicate with UCs and charge nurses to encourage proper chair alarm setup for clean and ready rooms. Reminders about the project, and results when appropriate, were

disseminated to staff monthly, via either staff meetings or monthly process improvement meetings.

Measures

The structure goal of this quality improvement project was to achieve 100% availability of functional chair alarms for all clean and ready patient rooms on the IMC during the implementation period. Prior to project initiation, the PL worked with the unit manager and inventory specialist to ensure the chair alarm materials were readily available. The unit has two supply closets, with variations in par levels of the chair alarm, and chair alarm pads. Of note, it was found that the supply closets were stocked with both chair alarm pads, and bed pads that are not necessary on the unit as all beds have built in wall alarms. The bed pad alarms are not able to be used in the chairs, so the par levels were adjusted to include three chair alarms in each closet, and ten chair alarm pads to be maintained by materials management. The Chair Alarm Room Readiness Setup Tool, seen in Appendix D, is comprised of four questions to determine that the chair alarm was setup correctly. Although the tool was designed by the PL, and is not an existing validated tool, it is derived from the correct product assembly requirements. Each question asks about a different component of the chair alarm setup. If the results of the audit included that a pad was missing, the PL could follow up to see if it was due to a supply issue.

The process goal was the setup of functional chair alarms in 100% of all audited clean and ready rooms on the IMC. The Chair Alarm Room Readiness Setup Tool was generated by the PL to audit the proper chair alarm setup in each room. A URL link and QR code were generated using the Research Electronic Data Capture (REDCap®) software for improved accessibility to the tool (Harris et al., 2019). The percentage of correctly setup rooms was calculated each week as a function of the number of correctly setup audited rooms divided by the

total number of audited rooms. The outcome goal was to have zero falls during the project's implementation period. Fall incidence was measured using the fall reports generated by the National Database of Nursing Quality Indicators (NDNQI) that were readily accessible on the facility's intranet page. More real time fall occurrence incidences were discussed with the PL by unit leadership, as the NDNQI reports are not available weekly.

Ethical Considerations

This project was designated as non-human subjects research through the facility's Institutional Review Board. Patient privacy and confidentiality was ensured as data was only collected on rooms prior to patient admission. All data was collected, recorded, and stored in the password protected, dual-authenticated HIPAA-compliant REDCap® software. Stored data was accessible only to the PL and project faculty.

Results

Staff Education

One-on-one staff education was completed for 90.9% of all IMC staff. All staff were sent the education materials via the unit manager's weekly update email on the date the project went live, regardless of one-on-one signoff status. Originally, the goal was to complete all one-on-one staff education prior to the project implementation start date of September 18, 2023. The one-on-one education had proven to be particularly effective in terms of ensuring that the staff has received the material, and signed off that they understand what is required. However, it was challenging to achieve 100% compliance due to staff vacationing, some staff being part time, and scheduling conflicts. Due to this, the PL and unit manager decided to allow the education period for one-on-one signoff to continue until September 30, 2023.

Chair Alarm Setup

During the project, the PL and UCs completed 79 audits on pre-admission rooms, which demonstrated that 87.67% of audited rooms had ready-to-use chair alarms set up. The average number of weekly room audits was 5.6 per week throughout the 14-week implementation period. A run chart was utilized to track compliance in relation to the project goal (Figure 2). There is one astronomical point noted on week six, where only 28.57% compliance was achieved with proper chair alarm setup. Prior to the start of week seven, the PL reached out to UCs to determine any reasons for this extreme variation in the data. It was noted that the unit had been without UAPs for several consecutive shifts due to employee turnover, and that the supply closet had run out of chair alarm pads. The PL followed up with the unit manager, as well as the unit-based inventory specialist. The inventory specialist escalated to ensure that the par levels were being maintained. Two additional UCs were identified at this time.

Although there was no special cause variation noted on analysis of the run chart, the percentage of compliant weekly audits indicated high staff adherence to the intervention. As pre-admission chair alarm setup was not required prior to this intervention there was no pre-project data to compare with. It would have been helpful to know the total number of discharges during the implementation period, as that would help better determine the degree of staff adherence.

Falls

Fall incidence was retrospectively tracked on a weekly basis using a run chart (Figure 3). There was a total of two falls during the 14-week implementation period, compared to a total of three falls during the 14-weeks prior to the implementation period. These two falls were noted by unit leadership to have not occurred from the chair. The two falls also occurred during weeks 13 and 14, which had a decreased total number of weekly audits nearing the holiday time. Although

there was no special cause variation noted here, it is promising that the two falls that did occur were not from the chair.

Discussion

There were several identified facilitators and barriers to project implementation. The high percentage of staff adherence may have resulted from several facilitators. Staff education was important to implementation success as well as fall prevention. In a study by Ayton et al., (2017) nursing staff found that the use of education and training helped improve compliance with implemented fall prevention interventions. In a systematic review and meta-analysis, Morris et al. (2022) found that clinician education as a fall prevention intervention resulted in statistically significant fall rate reduction. Extending the one-on-one staff education period may have enhanced adherence. However, even with the assistance of UCs, 100% one-on-one staff education was not obtained. A total of five employees did not receive one-on-one signoff, all of which were UAPs. Only one of the five UAPs was a full-time staffed UAP.

Challenges faced included the lack of UAP staff and employee turnover. The IMC lost several full time, experienced UAPs throughout the implementation period. The unit's inventory specialist, who had been a key stakeholder and asset to the project, left towards the last several weeks of the implementation period. Her contributions were pivotal to ensuring adequate par levels of chair alarm materials. Adherence was also affected by limitations in supply availability. Even with the increased par levels for chair alarm pads and communication with materials management, there were times when the incorrect pads were stocked on the unit, or staff ran out of alarm pads. Chair alarm audits were unable to be completed for every clean and ready room after patient discharge. The PL and UCs were not able to always be on the unit, and the majority of UCs worked during the day shift time frame.

Falls present a substantial financial burden on medical facilities. On average, a fall costs a total of $62,521 (Dykes et al., 2023). The regular use of chair alarm supplies may initially present an increase in financial burden. The chair alarm box itself costs $317.37, and is reusable, as are the batteries. The alarm pad is not multi-patient use, but costs only $70, which should help to reduce the overall costs associated with increased supply demand. The project intervention was designed with sustainability in mind, as it builds off existing room readiness practices on the unit. These room readiness practices are the responsibility of all staff including UAPs, which helps to reduce the burden placed directly on bedside nurses. Including the pre-admission chair alarm setup as a part of mandatory, unit-specific new employee training will help to improve the intervention's sustainability.

Conclusions

This project shows promising findings and feasibility for the use of a pre-admission chair alarm setup protocol for fall prevention. High staff compliance with the chair alarm setup, although not at 100%, was consistent with the findings in the literature when staff education was used as a part of the fall prevention intervention. As this was a pilot, quality improvement project, future studies should focus on identifying the total number of patient discharges during the implementation period. This would allow for a better assessment of audit compliance. During the implementation period no falls occurred from the chair. Although the goal was to reduce all falls, the intervention was specific to the chair. The study did not measure chair alarm use as a primary or secondary outcome. Further studies may be needed to determine if the increased chair alarm availability associated with the pre-admission chair alarm setup protocol would increase chair alarm use. Further statistical analysis would be required to determine a causal relationship between the implementation of a pre-admission chair alarm setup protocol and fall reduction.

References

Agency for Healthcare Research and Quality [AHRQ]. (2021). *Preventing falls in hospitals*. The Department of Health and Human Services. Retrieved January 18, 2023, from https://www.ahrq.gov/patient-safety/settings/hospital/fall-prevention/toolkit/index.html.

Avanecean, D., Calliste, D., Contreras, T., Lim, Y., & Fitzpatrick, A. (2017). Effectiveness of patient-centered interventions on falls in the acute care setting compared to usual care: A systematic review. *JBI Database of Systematic Reviews and Implementation Reports, 15*(12), 3006-3048. DOI: 10.11124/JBISRIR-2016-003331. Retrieved from https://journals.lww.com/jbisrir/Fulltext/2017/12000/Effectiveness_of_patient_centered_interventions_on.14.aspx?casa_token=H1mJLE9G1BEAAAAA:xxNcpQPvj_8EgyaLbCcZyVSesfRkCOSXnneS5wl8gTbaCBKo-EYVa_hPfmNW6Zj_SETUvbUxnhBnuu2RwLBW7TMr.

Ayton, D. R., Barker, A. L., Morello, R. T., Brand, C. A., Talevski, J., Landgren, F. S., Melhem, M. M., Bian, E., Brauer, S. G., Hill, K. D., Livingston, P. M., & Botti, M. (2017). Barriers and enabler to the implementation of the 6-PACK falls prevention program: A pre-implementation study in hospitals participating in a cluster randomized controlled trial. *PLoS ONE, 12*(2), e0171932. DOI:10.1371/journal.pone.0171932 Retrieved from https://eds-s-ebscohost-com.proxy-hs.researchport.umd.edu/eds/pdfviewer/pdfviewer?vid=5&sid=6f20bdcc-27d7-42c2-ba06-74d9b015ffd0%40redis.

Barker, A. L., Morello, R. T., Wolfe, R., Brand, C. A., Haines, T. P., Hill, K. D., Brauer, S. G., Botti, M., Cumming, R. G., Livingston, P. M., Sherrington, C., Zavarsek, S., Lindley, R. I., & Kamar, J. (2016). 6-PACK programme to decrease fall injuries in acute hospitals:

Cluster randomized controlled trial. *BMJ, 352*(h6781). http://dx.doi.org/10.1136/bmj.h6781.

Bergström, A., Ehrenberg, A., Eldh, A. C., Graham, I. D., Gustafsson, K., Harvey, G., Hunter, S., Kitson, A., Rycroft-Malone, J., & Wallin, L. (2020). The use of the PARIHS framework in implementation research and practice- A citation analysis of the literature. *Implementation Science, 15*(1), 1-51. https://doi.org/10.1186/s13012-020-01003-0.

Cho, E. H., Woo, Y. J., Han, A., Chung, Y. C., Kim, Y. H., & Park, H. (2020). Comparison of the predictive validity of three fall risk assessment tools and analysis of fall-risk factors at a tertiary teaching hospital. *Journal of Clinical Nursing (John Wiley & Sons, Inc.), 29*(17/18), 3482-3493. DOI: 10.1111/jocn.15387. Retrieved from https://doi-org.proxy-hs.researchport.umd.edu/10.1111/jocn.15387.

Cortés, O. L., Piñeros, H., Aya, P. A., Sarmiento, J., & Arévalo, I. (2021). Systematic review and meta-analysis of clinical trials. *Medicine, 100*(41), e27467. https://doi.org/10.1097/MD.0000000000027467.

Duan, Y., Iaconi, A., Wang, J., Perez, J. S., Song, Y., Chamberlain, S. A., Shrestha, S., Choroschun, K., Hoben, M., Beeber, A., Anderson, R. A., Cummings, G. G., Lanham, H. J., Norton, P. G., Estabrooks, C. A., & Berta, W. (2022). Conceptual and relational advances of the PARIHS and i-PARIHS frameworks over the last decade: A critical interpretive synthesis. *Implementation Science, 17*(1), 1-25. https://doi.org/10.1186/s13012-022-01254-z.

Dykes, P. C., Curtin-Bowen, M., Lipsitz, S., Franz, C., Adelman, J., Adkison, L., Bogaisky, M., Carroll, D., Carter, E., Herlihy, L., Lindros, M. E., Ryan, V., Scanlan, M., Walsh, M. A., Wien, M., & Bates, W. (2023). Cost of inpatient falls and cost-benefit analysis of

implementation of an evidence-based fall prevention program. *JAMA Health Forum, 4*(1), e225125. Doi:10.1001/jamahealthforum.2022.5125. Retrieved from https://jamanetwork.com/journals/jama-health-forum/fullarticle/2800748#:~:text=During%20the%2074%2Dmonth%20study,%2464%20526%20(Table%203).

Estupinan, A., Lord, M., Crumblish, H., and Risher, C. R. (2018). Fall prevention: A deliberative nursing process. *Journal of Gerontology & Geriatric Research, 7*(5), DOI: 10.4172/2167-7182.1000487

Harris, P.A., Taylor, R. Minor, B. L., Elliott, V., Fernandez, M., O'Neal, L., McLeod, L. Delacqua, G., Delacqua, F., Kirby, J. & Duda, S. N. (2019). The REDCap consortium. Building an international community of software partners. *Journal for Biomedical Informatics, 95,* 103208. https://doi.org/10.1016j.jbi.2019.103208.

Li, T., Wilson, C. M., & Basal, Y. (2017). Reliability of an installed chair exit alarm system for fall prevention: A double-blind randomized controlled trial. *Journal of Acute Care Physical Therapy, 8*(4), 141-152. DOI: 10.1097/JAT.0000000000000067

Melin, C. M. (2018). Reducing falls in the inpatient hospital setting. *International Journal o Evidence-Based Healthcare, 16*(1), 25-31. DOI: 10.1097/XEB.0000000000000115

Mileski, M., Brooks, M., Topinka, J. B., Hamilton, G., Land, C., Mitchell, T., Mosley, B., & McClay, R. (2019). Alarming and/or alerting device effectiveness in reducing falls in long-term care (LTC) facilities? A systematic review. *Healthcare (Basel), 7*(1), 51. https://doi.org/10.3390/healthcare7010051.

Morris, M. E., Webster, K., Jones, C., Hill, A.-M., Haines, T., McPhail, S., Kiegaldie, D., Slade, S., Jazayeri, D., Heng, H., Shorr, R., Carey, L., Barker, A., & Cameron, I. (2022). Interventions to reduce falls in hospitals: A systematic review and meta-analysis. *Age and Ageing, 51*(5). Retrieved from https://doi-org.proxy-hs.researchport.umd.edu/10.1093/ageing/afac077.

Najafpour, Z., Godarzi, Z., Arab, M., & Yaseri, M. (2019). Risk factors for falls in hospital in-patients: A prospective nested case control study. *International journal of health policy and management*, *8*(5), 300–306. https://doi.org/10.15171/ijhpm.2019.11.

Schadewaldt, V., McElduff, B., D'Este, C., McInnes, E., Dale, S., Gunaratne, A., Squires, J., Cadilhac, D. A., & Middleton, S. (2019). Validating the Alberta Context Tool in a multi-site Australian emergency department nurse population. *PLoS ONE, 14*(4), 1-16. https://doi.org/10.1371/journal.pone.0215153.

Schoberer, D., Breimaier, H. E., Zuschnegg, J., Findling, T., Schaffer, S., & Archan, T. (2022). Fall prevention in hospitals and nursing homes: Clinical practice guideline. *Worldviews on evidence-based nursing*, *19*(2), 86–93. https://doi.org/10.1111/wvn.12571.

Seow, J. P., Chua, T. L., Aloweni, F., Lim, S. H., & Ang, S. Y. (2022). Effectiveness of an integrated three-mode bed exit alarm system in reducing inpatient falls within an acute care setting. *Japan Journal of Nursing Science, 19*(1), e12446. https://doi.org/10.1111/jjns.12446.

Squires, J. E., Hayduk, L., Hutchinson, A. M., Mallick, R., Norton, P. G., Cummings, G. G., & Estabrooks, C. A. (2015). Reliability and validity of the Alberta Context Tool (ACT) with professional nurses: Findings from a multi-study analysis. *PLoS ONE, 10*(6), 1-17. doi:10.1371/journal.pone.0127405

Staggs, V. S., Turner, K., Potter, C., Cramer, E., Dunton, N., Mion, L. C., & Shorr, R. I. (2020). Unit-level variation in bed alarm use in US hospitals. *Research in Nursing & Health, 43,* 365-372. DOI: 10.1002/nur.22049. Retrieved from https://onlinelibrary-wiley-com.proxy-hs.researchport.umd.edu/doi/pdfdirect/10.1002/nur.22049.

Titler, M. G., Conlon, P., Reynolds, M. A., Ripley, R., Tsodikov, A., Wilson, D. S., & Montie, M. (2016). The effect of a translating research into practice intervention to promote use of evidence-based fall prevention interventions in hospitalized adults: A prospective pre-post implementation study in the U.S. *Applied Nursing Research, 31*, 52-59. https://doi.org/10.1016/j.apnr.2015.12.004.

Figure 1

PARIHS Framework to Guide Successful Implementation

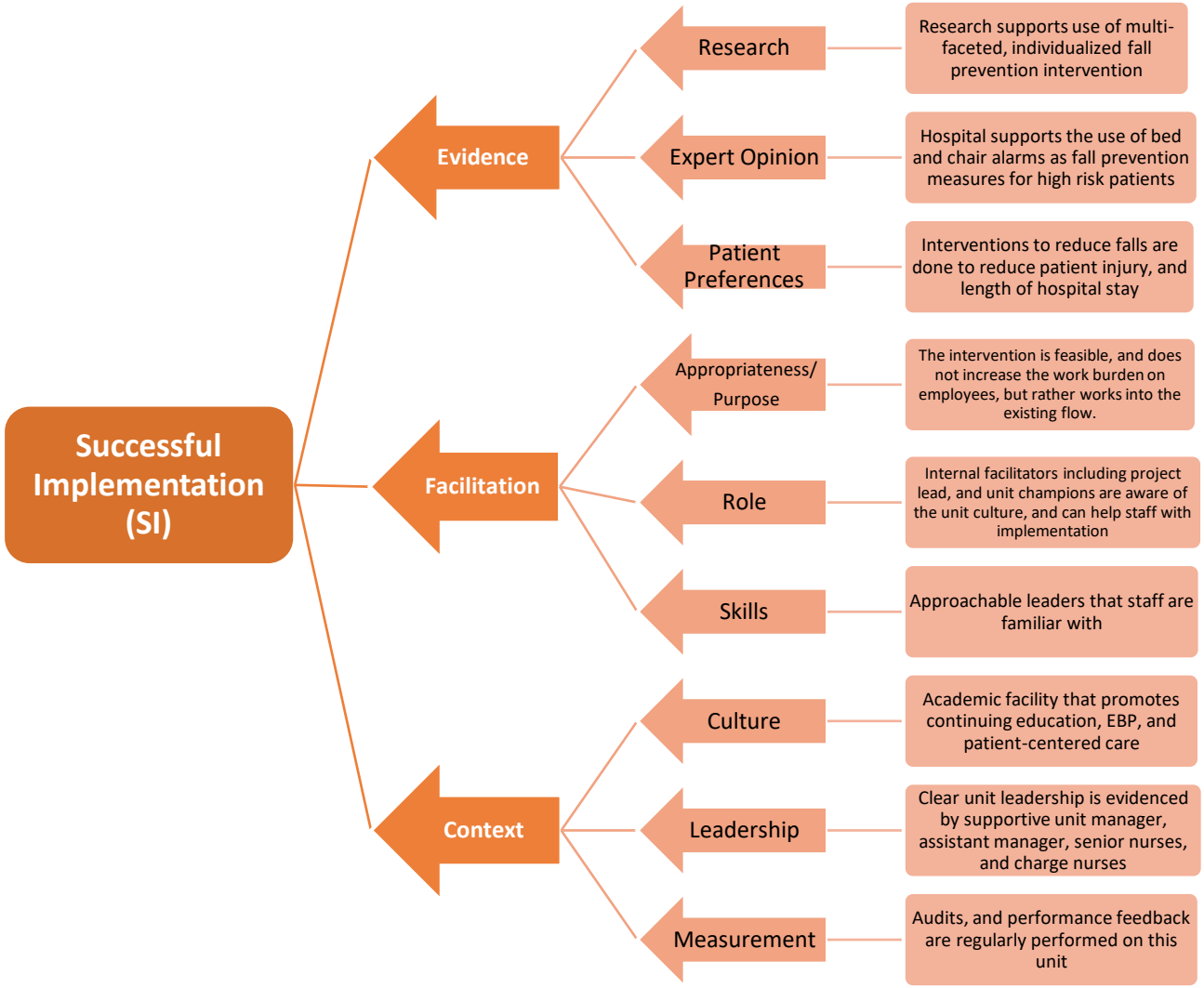


Figure 2

Run Chart Demonstrating Percentage of Audited Clean and Ready Rooms Compliant with Chair Alarm Setup

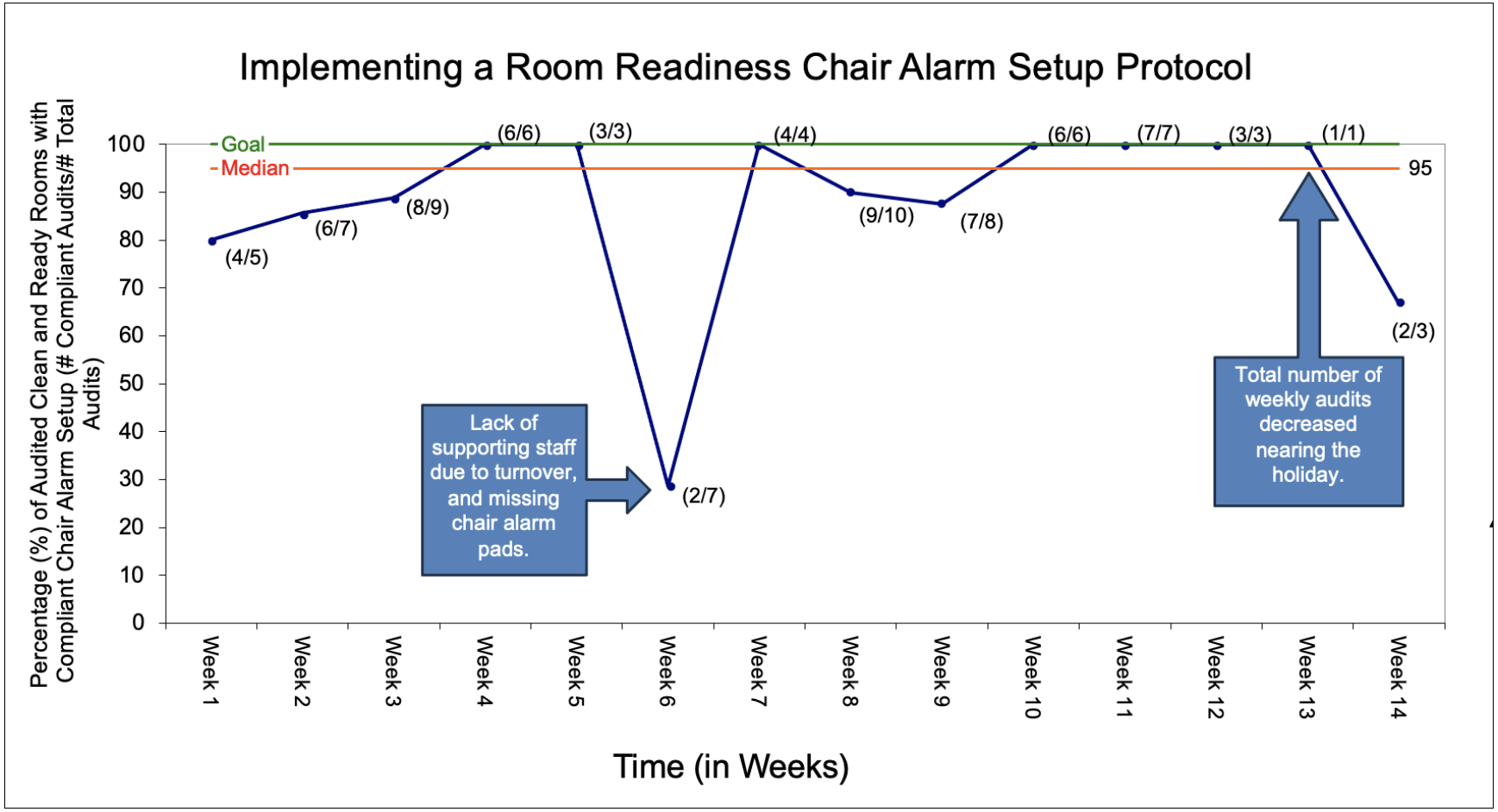
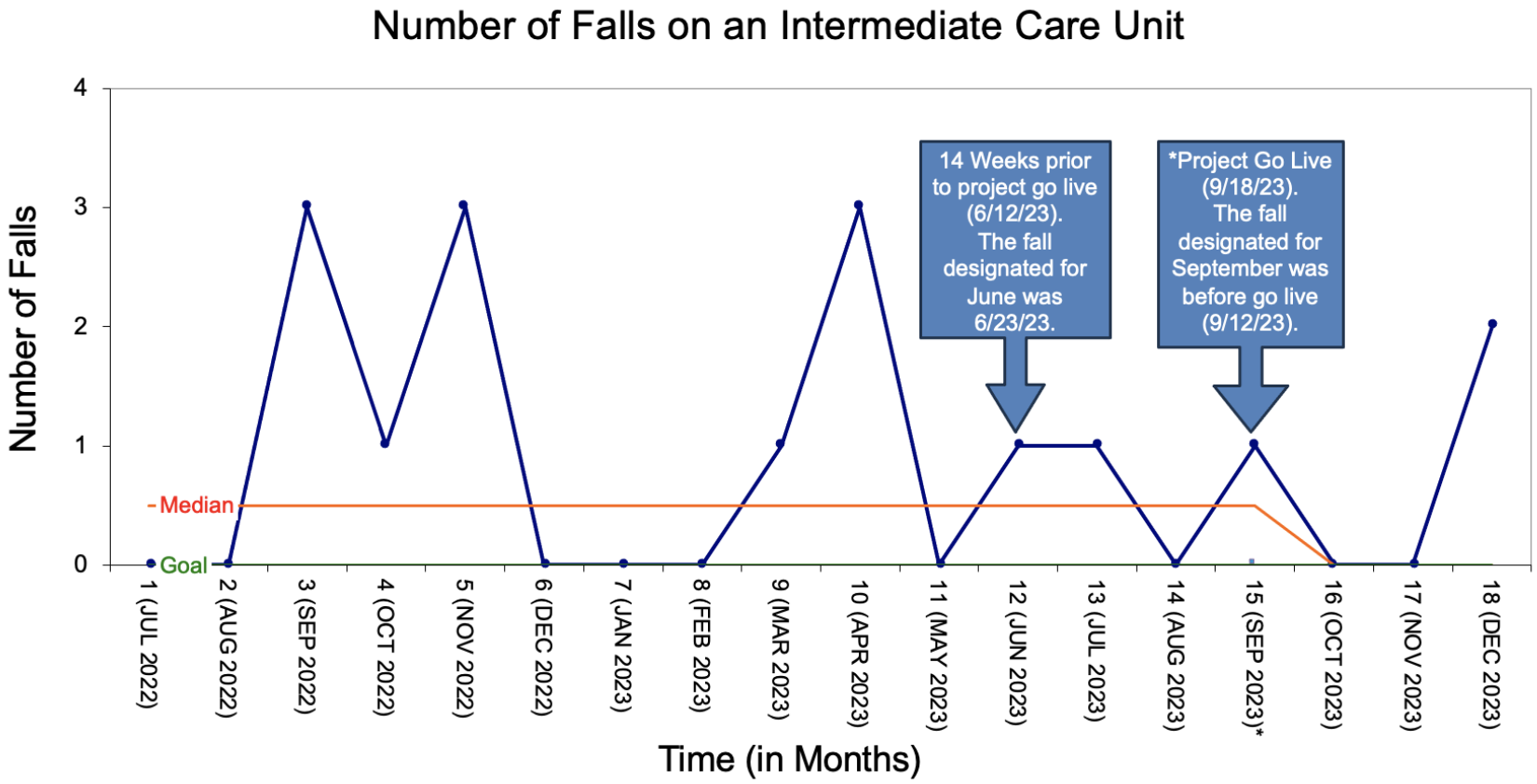


Figure 3

Run Chart Demonstrating Fall Incidence



Appendix A

Evidence Review Table

Citation #1: Cortés, O. L., Piñeros, H., Aya, P. A., Sarmiento, J., & Arévalo, I. (2021). Systematic review and meta-analysis of clinical trials. *Medicine, 100*(41), e27467. https://doi.org/10.1097/MD.0000000000027467 **Level**: IA	
Purpose or Hypothesis	The purpose of this study was to perform a systematic review, and meta-analysis of the available research to determine if fall prevention sensors were successful in preventing falls in hospitalized elderly individuals.
Type of Evidence Research Design	Systematic review and meta-analysis of only randomized controlled clinical trials
Sample Population, Size, Setting	**Sampling Technique**: All studies used randomization system; three used random numbers, one utilized cluster randomization; PRISMA diagram to describe selection of studies in systematic review, searched databases IEEE Xplore, Cochrane Library, Scopus, PubMed, MEDLINE, and Science Direct **Eligible Participants**: hospitalized adults, any medical or surgical diagnosis/condition, any service; studies limited to only randomized controlled clinical trials; studies published in English between 2006 and 2013 **Setting**: Hospitalized patients, including a study in a geriatric unit, a study on a critical care unit and geriatric unit, a study on 16 urban medical surgical units, and a study on a stroke and dementia hospital unit **Excluded**: Articles were excluded if they were not RCTs, did not use movement-change sensors as an intervention, had a low sample size, and if events were not reported with outcomes **Accepted**: Four RCT's included; included total of 29,691 patients **Control**: 17,922 patients; No dropouts reported **Intervention**: 11,769 patients; one study reported a 5.6% dropout in their intervention group, no other dropouds reported **Power Analysis/Achieved**: Meta-analysis, Heterogeneity: Tau^2=0, Chi^2=3, df=3 (P=0.39), I^2=0%; Test for overall effect: Z=2.43 (P=0.02) **Group Homogeneity**: study did not disclose homogeneity of individual study groups
Intervention Procedures	**Control Protocol:** Standard hospital fall prevention measures, no use of movement-change sensor **Intervention Protocol:** All included studies utilized the implementation of a movement-change sensor during the patient's hospitalization. The sensor could be on the patient's person, or attached to the patient's bed, or chair. **Treatment Fidelity:** Completion of systematic review was completed by two independent reviewers. Reviewers independently selected studies, and used the Cochrane Collaboration tool to determine bias risk for each selected study. RCT quality was assessed using the Jadad scale.
Primary Outcome and Measures	**Dependent Variable (DV):** The primary outcome was the first fall experienced by hospitalized patients in the included studies.

	DV Measure: The sum of the results were calculated. A random effects model was used to estimate grouped effect and confidence interval (CI of 95%), and the relative risk of fall (RR, 95% CI) was calculated.
Results/ Conclusions	In the intervention group, 351 (3%) of 11,817 patients fell, and in the control group, 429 (2.4%) of 17,972 patients fell (RR estimation 1.19, 95% CI 1.03, 1.37, P=.02). It was concluded from this systematic review and meta-analysis that the use of movement-change sensors increased the risk of falling in elderly, hospitalized patients by 20%. The particular sensors used in the included studies had many pitfalls. The alarm mechanism of each of the sensors varied, and only one study utilized a sensor alarm that could only be turned off when attended to by nursing staff.
Citation #2: Titler, M. G., Conlon, P., Reynolds, M. A., Ripley, R., Tsodikov, A., Wilson, D. S., & Montie, M. (2016). The effect of a translating research into practice intervention to promote use of evidence-based fall prevention interventions in hospitalized adults: A prospective pre-post implementation study in the U.S. *Applied Nursing Research, 31*, 52-59. https://doi.org/10.1016/j.apnr.2015.12.004. **Level:** IIB	
Purpose or Hypothesis	This study sought to determine if an evidence-based fall prevention intervention that targeted patient-specific fall risk factors was effective in reducing falls, and injuries from falls for adult medical-surgical inpatients
Type of Evidence Research Design	Prospective pre-post implementation cohort design (Quasi-experimental) Framework: Translation Research Model developed from Roger's Diffusion of Innovation Framework
Sample Population, Size, Setting	**Sampling Technique**: Random selection using SPSS on each unit; Trained research assistants confirmed that the randomly selected articles met the study criteria **Eligible Participants**: Patient medical record inclusion criteria consisted of the following: ≥ 21 years of age, resident on the study unit for ≥ 24 hours, and received care on the selected unit while data was being collected. **Setting**: The study took place across 13 adult medical-surgical units, within three community hospitals in the Midwest region of the U.S. over 18 months **Excluded**: Critical care, obstetrics, and pediatric units were excluded **Accepted**: Patient medical records n=390 **Control**: 390 patient medical records reviewed prior to intervention **Intervention**: 390 patient medical records reviewed following intervention implementation **Power Analysis/Achieved**: Researchers did not discuss **Group Homogeneity**: Average age of patients 65.6 (SD=2.8), majority, 68%, were scored as moderate or major illness severity category for both pre- and post- intervention
Intervention Procedures	**Control Protocol**: Pre-intervention measures were not discussed **Intervention Protocol**: The Translating Research Into Practice (TRIP) intervention was implemented over 15 months on the selected study units. The TRIP intervention was multi-faceted. Researchers met with nurse managers and CNO's, chose unit-based champions, provided train-the trainer programs, quick reference guides, educational posters, staff education, site visits, audits with feedback, and monthly teleconferences. **Treatment Fidelity**: The Translation Research Model from Roger's Diffusion of Innovation Framework was used to guide the implementation of the TRIP intervention. Prior research was also used to help guide implementation of the intervention.

Primary Outcome and Measures	**DV**: The primary outcome for the first aim of this study were fall rates, fall injury rates, and types of fall injuries. The researchers provided the definition of a fall to be an unplanned descent to the floor, and provided descriptions and examples of the different types of fall injuries. The types of fall injuries could be described as minor, moderate, major, or death. **DV Measure**: The number of falls was calculated on each unit by multiplying the number of inpatient falls by 1000, and dividing by total number of inpatient days. Similarly, the empirical rate of falls with injury was calculated using the same formula as above, except replacing the number of inpatient falls with the number of inpatient falls with injury.
Results/ Conclusions	The study found that the TRIP intervention decreased fall rates by 22% (p=0.09), which was not statistically significant, and the types of falls went from primarily major and moderate, to minor. There was no reduction in rates of falls with injury. Researchers found that there was a statistically significant improvement in use of fall prevention interventions for mobility, toileting, cognition, and injury risk reduction (p<0.001). The study concluded that identifying individual patient risk factors is clinically important to reducing patient fall risks
Citation #3: Morris, M. E., Webster, K., Jones, C., Hill, A.-M., Haines, T., McPhail, S., Kiegaldie, D., Slade, S., Jazayeri, D., Heng, H., Shorr, R., Carey, L., Barker, A., & Cameron, I. (2022). Interventions to reduce falls in hospitals: A systematic review and meta-analysis. *Age and Ageing, 51*(5). Retrieved from https://doi-org.proxy-hs.researchport.umd.edu/10.1093/ageing/afac077. **Level: IIA**	
Purpose or Hypothesis	This study sought to determine the efficacy of fall prevention interventions on in-hospital fall rates, and fall risk for adult patients.
Type of Evidence Research Design	Systematic review and meta-analysis of experimental research
Sample Population, Size, Setting	**Sampling Technique**: Database search of Medline, CINAHL, PsycInfo, Embase, AMED, PEDro, and Cochrane using designated search terms. A PRISMA diagram was included to show the search refinement process. The Cochrane Risk of Bias 2 Instrument, and the Cochrane Cluster Randomized Parallel Group Trials 2 Instrument were used to evaluate risk of bias, and randomization techniques for RCTs and cluster RCTs. Fifteen of the studies included did not utilize randomization in their design. **Eligible Participants**: Studies included must have been published in English, included a falls intervention in a hospital setting, and used falls as a primary or secondary outcome with data reported. Additionally, only RCTs, quasi-randomized, cluster RCT, comparative studies, or quasi-experimental studies were included in the review. Eligible participants must be adults. **Setting**: Hospital setting **Excluded**: n=230, studies made it to evaluation for eligibility; n=187, records excluded **Accepted**: n=43, included in review; n=23, included in meta-analysis **Control**: n=42 studies that utilized control group **Intervention**: n=43 studies utilizing intervention group

	Power Analysis/Achieved: Meta-analysis; Test for Heterogeneity and Overall Effect performed for education interventions (Rate of Falls I^2=12% (P=0.29), Z=-2.19 (p=0.03); Falls Risk I^2=4% (P=0.31), Z=-3.2 (P=0.001)), assistive devices, rehabilitation and exercise therapies, environmental factors, and multi-factorial interventions. **Group Homogeneity**: Supplemental data for the included studies displayed control and intervention groups average age, gender, and average length of stay in days. Descriptive statistics were not available.
Intervention Procedures	**Control Protocol**: Usual fall prevention care, specifics not included, varied per study **Intervention Protocol**: Single intervention, or multi-factorial intervention; interventions included (a) direct patient or clinician education, (b) environmental modifications, (c) use of assistive devices, (d) systems, service models, social context, leadership, policies, or procedures for fall prevention, (e) rehabilitation, physiotherapy, physical activities, or therapeutic exercises, (f) medication management, or (g) diet modifications. **Treatment Fidelity**: Bias risk assessment completed independently by three reviewers, and by a fourth consulting reviewer. Risk assessments included the Cochrane Risk of Bias 2 Instrument, the Cochrane Cluster Randomized Parallel Group Trials 2, and the Joanna Briggs Institute (JBI) Critical Appraisal Tool. Strength of evidence was evaluated using the GRADE instrument. Exercise interventions were evaluated using the Consensus on Exercise Reporting (CERT) checklist.
Primary Outcome and Measures	**DV**: There were two primary outcomes evaluated. The first being the rate ratio (RaR), representing the reduction in the fall rate. The second being the reduction in falls risk, or like likelihood of falling in the intervention group versus the control group. **DV Measure**: The RaR was extracted from the studies along with the 95% confidence intervals (CI). The reduction in falls risk was measured using odds ratio, and if the study reported a 95% CI it was included. Review Manager was used to calculate an OR and 95% CI if it was not reported in the study. Review Manager was also used to run the meta-analysis, via the generic inverse variance method. Forest Plots were used to display the results of the meta-analysis.
Results/ Conclusions	Patient and clinician educated significantly reduced fall rates (RaR= 0.7 [0.51-0.96], P= 0.03) and the odds of falling (OR= 0.62 [0.47-0.83], P=0.001). Multi-factorial interventions did not produce statistically significant reduction in fall rates, however, they did grossly show a trend in reduction of falls.
Citation #4: Seow, J. P., Chua, T. L., Aloweni, F., Lim, S. H., & Ang, S. Y. (2022). Effectiveness of an integrated three-mode bed exit alarm system in reducing inpatient falls within an acute care setting. *Japan Journal of Nursing Science, 19*(1), e12446. https://doi.org/10.1111/jjns.12446. **Level:** IIB	
Purpose or Hypothesis	The purpose of this study was to determine if utilizing an integrated three-mode bed exit alarm system would reduce inpatient hospital falls next to the bed in the acute care setting.
Type of Evidence Research Design	Retrospective before-and-after study
Sample Population, Size, Setting	**Sampling Technique**: Cluster Sampling **Eligible Participants**: All patients hospitalized on the selected unit during the selected time frame were included.

	Setting: This study took place in three units within a 1,700-bed, acute, tertiary care teaching hospital in Singapore. The units selected were similar physically, and in terms of nursing discipline and care practices. The study took place from October 2015 to June 2017. **Excluded**: Patients were excluded if their hospitalization time crossed from the pre-intervention period into the post-intervention period. 187 patients were excluded. **Accepted**: n=17,398 patients **Control**: n=7,474 patients **Intervention**: n=9,924 patients **Power Analysis/Achieved**: Not discussed **Group Homogeneity**: Researchers selected three units with similar characteristics. Characteristics of the total population, pre- and post- groups combined, were displayed in a table. The average age of all included patients was 63 years old (SD, 16), with 52% of the population being male.
Intervention Procedures	**Control Protocol**: The nine-month control period took place from October 2015 to June 2016. Beds without exit alarm systems were used during the control phase, and were similar in design and specification. **Intervention Protocol**: The twelve-month post-implementation period took place from July 2016 to June 2017. The Hill-Rom 1000 Medical-Surgical bed was used. This bed has a built-in bed exit alarm system, with three different detection mode settings. Staff nurses were provided with thorough education on how to use the beds, however, the detection mode setting was chosen based on nursing judgement. **Treatment Fidelity**: Treatment fidelity may have been compromised as the researchers were not able to monitor compliance among nursing staff in regards to activating the bed exit alarms. Additionally, there was no policy or procedure protocol in place for which detection setting to choose. Different settings were chosen based off of individual nursing judgement.
Primary Outcome and Measures	**DV**: The primary outcome was falls next to the hospital bed during hospital stay. **DV Measure**: The hospital utilizes a Risk Management System for healthcare providers to report fall events. Researchers pulled reports from this system, and verified the details of the reported fall information with unit managers and hospital quality control officers. A multivariable logistic generalized linear mixed-effects model was calculated to determine how effective the use of bed alarms was at preventing falls next to the hospital bed.
Results/ Conclusions	Implementation of the bed exit alarms reduced the incidence of falls from 0.23% (95% CI 0.10% to 0.51%) prior to implementation, to 0.11% (95% CI 0.05% to 0.25%) six months after implementation. The adjusted odds ratio for witnessing a fall at six months post-implementation was 0.50 (95% CI 0.27 to 0.94, p=0.031). The researchers concluded that future studies need to look into protocol for selection of a particular bed exit alarm mode setting, and should take into consideration the risk of alarm fatigue.
Citation #5: Li, T., Wilson, C. M., & Basal, Y. (2017). Reliability of an installed chair exit alarm system for fall prevention: A double-blind randomized controlled trial. *Journal of Acute Care Physical Therapy*, *8*(4), 141-152. DOI: 10.1097/JAT.0000000000000067 **Level:** IA	

Purpose or Hypothesis	The purpose of this study was to compare reliability and accuracy of fall detection alarms. The study compared the Safe Sitting System, which is an installed chair alarm system that uses a timer, with a commercially available pressure-sensing chair alarm, and a magnetic clip-on alarm.
Type of Evidence Research Design	Single-center, double-blind, randomized controlled trial Within-subject design
Sample Population, Size, Setting	**Sampling Technique**: Voluntary response sampling, participants were randomized to a group using a randomization sheet generated by a Beaumont Research Institute biostatistician **Eligible Participants**: Healthy adults age 18-75 (sample had range of 19 to 60 years old), no permanent or temporary restriction to mobility, speaks and understands English; A Screening Eligibility Checklist was used to determine eligibility **Setting**: Study room in Beaumont Hospital in Troy, Michigan **Excluded**: Individuals were excluded if they had a pre-existing or orthopedic condition that requires physical assistance with personal mobility, and it they used an assistive device **Accepted**: A total of 75 subjects were used in the study, the subjects performed 9 different movements per chair **Control**: 675 sensor activating movements were observed **Intervention**: 675 sensor activating movements were observed **Power Analysis/Achieved**: Not discussed. However, results were statistically significant. **Group Homogeneity**: Descriptive statistics completed; Average age of group participants was 32.83 years (SD=10.52), with a range of 19-60 years old; Average height of group participants was 168.98 cm (SD=15.41) with a range of 144.80 cm to 265.20 cm; Average weight of group participants was 69.06 kg (SD=14.23) with a range of 40.80 kg to 106.60 kg
Intervention Procedures	**Control Protocol**: Both the intervention (Safe Sitting System) and control (pressure-sensing alarm system, and clip-on alarm) chair were in the same room, and covered with a white sheet. The facilitator brought in the subject and data collector once chairs were properly set up. The data collector provided instructions to the subjects in a chair without an alarm prior to sitting in the intervention and control chairs. The data collector provided verbal instructions and cues for each subject to perform the nine different movements in each chair. The data collector explained the procedure for the subject when sitting in each chair. **Intervention Protocol**: Same as above. The intervention chair utilized the Safe Sitting system alarm, which was built-in to the chair. This system has a timer function, but was not used in this study. **Treatment Fidelity**: Facilitator was used to ensure proper, consistent set up of chairs according to randomization guidelines. The data collector and subjects were blinded from the randomization procedures. Subjects were facing a mirror with tape marker measurements, to ensure that their movements were exact, and to limit variation between subjects. The selected movements within the chair were assessed for content validity by an experience panel of acute care physical therapists, occupational therapists, and registered nurses. Both alarm systems had the same tone.

Primary Outcome and Measures	**DV**: The study used a primary outcome of false negative alarms and false positive alarms. A false negative was considered when the alarm should have sounded, but did not. A false positive was considered when the alarm sounded, but should not have. **DV Measures**: Paired sign tests were used to determine differences between response appropriateness.
Results/ Conclusions	The results of the Safe Sitting System (SSS) chair sensor yielded a 2.7% false positive response rate, and a 0% false negative response rate. The control chair, a single-use pressure-sensor alarm, yielded a 31.2% false positive response rate, and an 8% false negative response rate. When tested with the SSS sensor, the secondary control chair had a 7.8% false positive response rate, and an 8% false negative response rate. When tested with just the primary control chair, the secondary control yielded a 9.3% false positive response rate, and an 8% false negative response rate. The difference in the alarm responses was statistically significant (P<.0001).
Citation #6: Cho, E. H., Woo, Y. J., Han, A., Chung, Y. C., Kim, Y. H., & Park, H. (2020). Comparison of the predictive validity of three fall risk assessment tools and analysis of fall-risk factors at a tertiary teaching hospital. *Journal of Clinical Nursing (John Wiley & Sons, Inc.)*, *29*(17/18), 3482-3493. DOI: 10.1111/jocn.15387. Retrieved from https://doi-org.proxy-hs.researchport.umd.edu/10.1111/jocn.15387. **Level:** IIIA	
Purpose or Hypothesis	The purpose of this study was to determine the best fall-risk assessment tool to be used for a tertiary teaching hospital by comparing sensitivity, specificity, and predictive validity. The study compared the Morse Fall Scale (MFS), the Johns Hopkins fall-risk Assessment Tool (JHFRAT), and the Hendrich II fall-risk model (HFRM).
Type of Evidence Research Design	Retrospective, case-control study
Sample Population, Size, Setting	**Sampling Technique**: Case-cohort sampling; Case:control ratio was 1:3 based on Grimes and Schulz and G-power statistics; Control group selection was matched to the case group using age, gender, surgery, department, and admission fall-risk score **Eligible Participants**: Subjects eligible for chart review were adult inpatients (>19 years old), who were admitted between June 1, 2014 and May 31, 2015 **Setting**: A 2,600-bed, acute care, tertiary teaching hospital **Excluded**: Units that did not include the Morse Fall Scale as a fall-risk assessment tool were excluded; those units were Pediatric, psychiatric, intensive care unit, emergency, and outpatient department units **Accepted**: 1,788 total adult, acute care, hospitalized patients **Control**: 1,341 patients **Intervention**: 447 patients **Power Analysis/Achieved**: Effect size of 0.2, power of 0.9, significance level of 0.05 **Group Homogeneity**: Statistical analysis of the general characteristics between groups indicated adequate matching due to the lack of statistically significant differences.
Intervention Procedures	**Intervention Protocol**: Fall data from patient safety reports for the case group was pulled during the set study dates. This data included the age, gender, surgery experience, department, and admission MFS fall-risk scores. Items from

	each fall-risk assessment tool was taken from nursing assessment records, fall-risk assessment records, medication administration records, nursing progress and assessment notes, and orders from the day of the fall. **Control Protocol**: The same information was pulled as the case group for the control group. However, the control data was pulled on the same date as the matched case group subject if they fell within ten days of admission. If the matched case subject fell after ten or more days of hospital admission, the matched control subject data was pulled on the tenth admission day. **Treatment Fidelity**: Data collection was performed by the two co-authors. Inter-rater reliability was achieved with a weighted kappa of 0.8 for the co-authors rating and review of all three fall-risk assessment tools.
Primary Outcome and Measures	**DV**: Predictive performance of fall-risk assessment tools **DV Measure**: Measured and compared the three risk assessment tools using odds ratio, sensitivity, specificity, positive predictive value, negative predictive value, Youden Index and are under the curve (AUC).
Results/ Conclusions	MFS had the highest predictive sensitivity of the three tools (59.28%), and the JHFRAT had the highest predictive specificity (89.71%). The JHFRAT had the highest positive predictive value at 48.51%, and the HFRM had the highest negative predictive value at 84.56%. The JHFRAT had the highest accuracy at 74.55%, followed by the HFRM at 72.82%, then the MFS at 63.54%. The univariate analyses of the relationship between MFS assessment items and falls concluded that mental status was the most likely indicator in predicting a patient fall (OR=5.90), with gait (OR=3.30), and use of ambulatory aid (OR=3.09) following behind. The HFRM tool had the highest predictive validity confirmed by the Youden index and AUC. Among all three tools, gait, dizziness or vertigo, mental status or impulsivity, and fall history were identified to be most significantly predictive for increased fall risk.
Citation #7: Barker, A. L., Morello, R. T., Wolfe, R., Brand, C. A., Haines, T. P., Hill, K. D., Brauer, S. G., Botti, M., Cumming, R. G., Livingston, P. M., Sherrington, C., Zavarsek, S., Lindley, R. I., & Kamar, J. (2016). 6-PACK programme to decrease fall injuries in acute hospitals: Cluster randomized controlled trial. *BMJ, 352*(h6781). http://dx.doi.org/10.1136/bmj.h6781 **Level:** IA	
Purpose or Hypothesis	The purpose of this study was to determine if a nurse led fall prevention intervention program (6-PACK program) had a significant effect on falls and fall related injuries.
Type of Evidence Research Design	Cluster randomized controlled trial
Sample Population, Size, Setting	**Sampling Technique**: Convenience sampling, units were then randomized to either the intervention or control groups **Eligible Participants**: units with a known fall problem were nominated by participating hospitals; average patient length of stay <10 days; if medical units had ≤1 low-low beds to each six standard beds, and if surgical units had ≤1 low-low beds to each 29 standard beds; current daily documentation does not include a fall risk assessment tool or intervention checklist **Setting**: 24 acute care medical-surgical units, in six Australian hospitals **Excluded**: No patient exclusion criteria; unit criteria is listed under eligible participants **Accepted**: 46,245 patients were admitted during the trial period January 2012 to March 2013, with accounting for readmissions 31,411 individual patients were included; 16 medical units, and eight surgical units

	Control: 12 units, 23,575 individual patient admissions, none loss to follow-up (n=0) **Intervention**: 12 units, 22,670 individual patient admissions, none loss to follow-up (n=0) **Power Analysis/Achieved**: For 80% power 12 intervention and 12 control units required/Achieved **Group Homogeneity**: Baseline characteristics were similar for both groups throughout the study period, included all data in a table
Intervention Procedures	**Control Protocol**: Control units continued to implement usual fall care and prevention measures such as non-slip socks, fall alert wrist bands, and constant patient observers as needed. **Intervention Protocol**: The 6-PACK program implemented a nine-item fall risk assessment tool, and six interventions. The interventions included a "fall alert" sign, bathroom supervision, keeping walking aids within reach, established toilet regimen, low-low bed use, use of bed/chair alarm. The program required a fall risk tool was completed each shift, application of "fall alert" sign, and implementation of one or more 6-PACK interventions by nurses. **Treatment Fidelity**: The program implementation process was aided by project management, program facilitators, a standardized implementation guide, hospital-based site clinical leader, unit champions, audits, reminders, and feedback. Trained assessors observed that interventions were being followed, and assessed this using a standardized tool.
Primary Outcome and Measures	**DV**: There were two primary outcomes for this study, falls and fall injuries. **DV Measure**: Falls and fall injuries were measured per 1000 occupied bed days.
Results/ Conclusions	Implementation of 6-PACK interventions was greater on the intervention unit compared to the control unit (incidence rate ratio 3.05, 95% CI 2.14 to 4.34; P<0.001). Fall rates (incidence rate ratio1.04, 0.78 to 1.37; P=0.796) and fall injuries (0.96, 0.72 to 1.27; P=0.766) were not significantly different between the intervention and control groups. However, the program increased the use of fall prevention interventions.
Citation #8: Avanecean, D., Calliste, D., Contreras, T., Lim, Y., & Fitzpatrick, A. (2017). Effectiveness of patient-centered interventions on falls in the acute care setting compared to usual care: A systematic review. *JBI Database of Systematic Reviews and Implementation Reports, 15*(12), 3006-3048. DOI: 10.11124/JBISRIR-2016-003331. Retrieved from https://journals.lww.com/jbisrir/Fulltext/2017/12000/Effectiveness_of_patient_centered_interventions_on.14.aspx?casa_token=H1mJLE9G1BEAAAAA:xxNcpQPvj_8EgyaLbCcZyVSesfRkCOSXnneS5wl8gTbaCBKo-EYVa_hPfmNW6Zj_SETUvbUxnhBnuu2RwLBW7TMr. **Level:** IB	
Purpose or Hypothesis	The purpose of this review was to determine if patient-centered interventions were effective at reducing falls in the acute care setting.
Type of Evidence Research Design	Systematic review of randomized controlled trials, without meta-analysis
Sample Population, Size, Setting	**Sampling Technique**: Included studies were randomized; articles were chosen via search criteria, and appraised **Eligible Participants**: Adults, ≥ 18 years of age, admitted to medical or surgical acute care units, studies needed to have interventions that are patient-centered, and geared towards fall reductions; n=187 articles were considered for eligibility

	Setting: Acute care medical or surgical units **Excluded**: Studies with subacute rehab settings or nursing homes were excluded or if they did not include a patient-centered intervention; n=182 studies were excluded **Accepted**: n=5 accepted for systematic review **Control**: Usual fall prevention strategies **Intervention**: Patient-centered fall prevention interventions varied per study. **Power Analysis/Achieved**: Unable to perform meta-analysis. **Group Homogeneity**: Baseline group descriptive statistics were performed. Meta-analysis was unable to be performed due to the heterogeneity of the five included studies.
Intervention Procedures	**Control Protocol**: Usual fall prevention strategies **Intervention Protocol**: Patient-centered fall reduction interventions **Treatment Fidelity**: The systematic reviewers utilized the SUMARI appraisal instrument, and the SUMARI data extraction instrument from the Joanna Briggs Institute to evaluate the included studies.
Primary Outcome and Measures	**DV**: Falls, or fall rates; fall-related injuries were included as a secondary outcome **DV Measures**: The primary outcome measured was either the number of falls or the rate of falls depending on the study.
Results/ Conclusions	Of the five included RCTs in this systematic review, three showed statistically significant fall rate reduction when using care plans that were personalized and provided patient-centered education ($p<0.04$). None of the included studies showed a reduction in fall-related injuries between intervention and control groups ($p>0.5$).
Citation #9: Staggs, V. S., Turner, K., Potter, C., Cramer, E., Dunton, N., Mion, L. C., & Shorr, R. I. (2020). Unit-level variation in bed alarm use in US hospitals. *Research in Nursing & Health, 43,* 365-372. DOI: 10.1002/nur.22049. Retrieved from https://onlinelibrary-wiley-com.proxy-hs.researchport.umd.edu/doi/pdfdirect/10.1002/nur.22049. **Level:** IIIB	
Purpose or Hypothesis	The purpose of this study was to determine the status of bed and chair alarm use in hospitals, and what factors were associated with their use.
Type of Evidence Research Design	Cross-sectional, observational study
Sample Population, Size, Setting	**Sampling Technique**: Stratified random sampling of hospitals from the NDNQI **Eligible Participants**: See accepted **Setting**: Acute care units **Excluded**: The unit was not included in the study if they were only able to provide data on < 10 patients. **Accepted**: Information was obtained from 1489 patients from 59 units, in 57 hospitals **Control**: No control **Intervention**: No intervention, is observational study **Power Analysis/Achieved**: Not completed

	Group Homogeneity: Descriptive statistic studies were performed among the different patients from the different units and hospitals.
Intervention Procedures	**Control Protocol**: No control in this study type **Intervention Protocol**: There was no intervention in this observational study. **Treatment Fidelity**:
Primary Outcome and Measures	**DV**: There is no true DV, but the average expected alarm use was calculated for each unit. The rates of alarm use were also recorded. **DV Measures**: Patient-level propensity scores were calculated using logistic regression
Results/ Conclusions	The results demonstrated that alarms were more likely to be implemented when patients were identified as having poor judgement with their mobility, a need for ambulatory assistance, a recent fall, or an altered mental status. Logistic regression was used to predict the percentage of expected alarm use for each unit in the study. However, many of the patterns of alarm use did not fit this predicted model based on patient characteristics, indicating that the use of the bed or chair alarm was largely in part driven by unit culture and protocol.
Citation #10: Mileski, M., Brooks, M., Topinka, J. B., Hamilton, G., Land, C., Mitchell, T., Mosley, B., & McClay, R. (2019). Alarming and/or alerting device effectiveness in reducing falls in long-term care (LTC) facilities? A systematic review. *Healthcare (Basel), 7*(1), 51. https://doi.org/10.3390/healthcare7010051. **Level:** IIIB	
Purpose or Hypothesis	The purpose of this study was to review the effectiveness of alarms and alerting devices at reducing falls in the long-term care (LTC) setting.
Type of Evidence Research Design	Systematic review without meta-analysis of peer-reviewed literature
Sample Population, Size, Setting	**Sampling Technique**: PRISMA guidelines were used to identify articles for inclusion in the study. The Cumulative Index of Nursing and Allied Health Literature, Academic Search Complete, and PubMed were the indexed databases used to search for eligible articles. **Eligible Participants**: Articles must be in English, peer-reviewed, published in either academic journals or published by universities or colleges. Articles must have been published between 01/01/2011 to 12/31/2018. Included articles focused on the effects of alarms on fall prevention in the LTC setting. **Setting**: LTC **Excluded**: Articles were excluded if they did not follow scientific format or if they were not peer reviewed. 482 articles were reviewed by the authors, and 454 were excluded. **Accepted**: 28 articles **Control**: Not discussed in detail or in supplementary materials regarding used studies. **Intervention**: Varied between studies, the use of an alarm or alerting system **Power Analysis/Achieved**: Not discussed, systematic review **Group Homogeneity**: Not discussed in the article with regards to overall results.

Intervention Procedures	**Control Protocol**: Not discussed in the article, or literature review supplementation. **Intervention Protocol**: Use of alarms or alerting devices; Individual study protocols not listed. **Treatment Fidelity**: Interrater reliability with regards to article analysis was demonstrated with a kappa statistic of k=1, demonstrating strong reliability.
Primary Outcome and Measures	**DV**: Fall incidence as a function of alarm or alerting device use **DV Measures**: Varied per study
Results/ Conclusions	Alarms as a part of a fall prevention care plan, not a single intervention, have shown to help reduce falls. The review found that in individuals with cognitive impairments, alarm use showed the most impact in fall reduction. Alarm success was dependent on proper implementation, and correct implementation was noted as a common barrier theme.
Citation #11: Estupinan, A., Lord, M., Crumblish, H., and Risher, C. R. (2018) Fall prevention: A deliberative nursing process. *Journal of Gerontology & Geriatric Research, 7*(5), DOI: 10.4172/2167-7182.1000487 **Level:** VB	
Purpose or Hypothesis	The purpose of this pilot study was to determine if implementation of staff education about falls, and implementation of a fall prevention kit will reduce falls or fall related injury rates in patients on a surgical oncology unit.
Type of Evidence Research Design	Pilot study
Sample Population, Size, Setting	**Sampling Technique**: Convenience **Eligible Participants**: unit nurses and nurse techs were eligible for survey; and patients admitted to a surgical oncology unit, ≥ 65 years of age were eligible for pilot study **Setting**: 24-bed surgical oncology unit within an acute care facility **Excluded**: <65 years of age **Accepted**: 34 nurses and 13 nurse techs accepted for survey completion; 75 patients for chart review **Control**: Pre-implementation of patient fall prevention kit, use of current facility fall and injury prevention program **Intervention**: Implementation of patient fall prevention kit. **Power Analysis/Achieved**: Not discussed **Group Homogeneity**: Not discussed
Intervention Procedures	**Control Protocol**: Use of current facility fall and injury prevention program. **Intervention Protocol**: Education module, implementation of a fall prevention kit in eligible participants **Treatment Fidelity**: Undetermined, however, there were additional surveys being completed on the unit at the time of implementation of this survey
Primary Outcome and Measures	**DV**: Knowledge with regards to falls; actual fall incidence **DV Measures**: Post-implementation surveys with regards to knowledge; number of falls
Results/ Conclusions	The study identified falls were occurring due to pain medication usage, and failed implementation of bed and chair alarm use. A pre-intervention survey of nursing staff demonstrated limited knowledge in these areas, and that chair/bed alarms were not being used as they were not easily accessible. Fall risk kits were placed in high fall risk

	patient rooms on admission. The results demonstrated increased compliance with use of chair alarms, and decreased fall incidence.

Appendix B

Evidence Synthesis Table

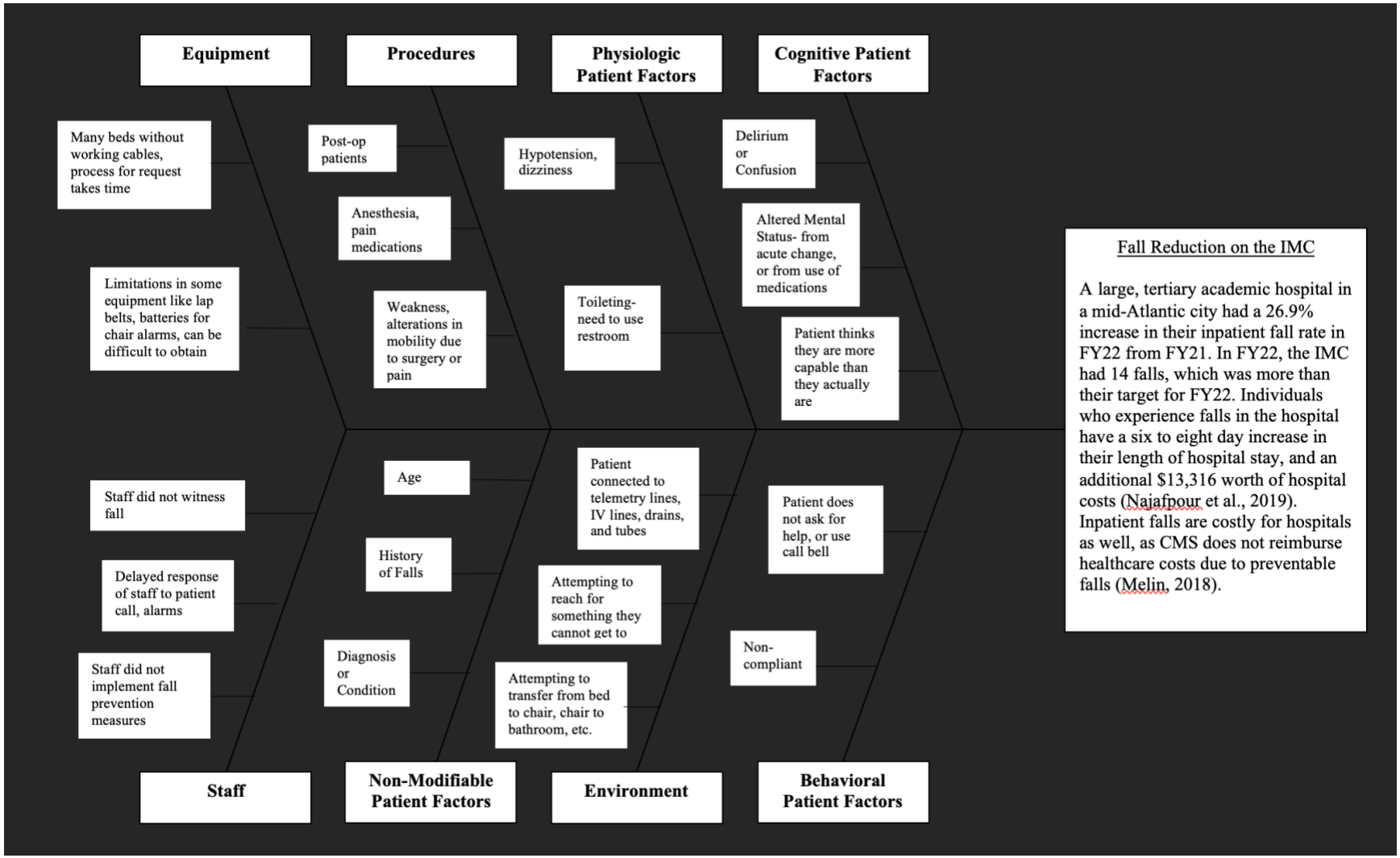
JHNEBP Model Level	Total Number of Sources	Author and Quality Rating of Each Study	Synthesis of Findings
Level 1 Experimental study Randomized Controlled Trial (RCT) Systematic review of RCTs with or without meta-analysis	1 Systematic Review and Meta-Analysis 2 Randomized, Controlled Trials 1 Systematic Review without Meta-Analysis	IA: Barker et al., 2016 IA: Cortés et al., 2021 IA: Li et al., 2017 IB: Avanecean et al., 2017	The systematic review and meta-analysis conducted by Cortés et al. (2021) determined that fall prevention sensors increased risk of falling in elderly hospitalized patients by 20%. However, there was variation among the types and mechanisms of the sensors used (Cortés et al., 2021). Only one of the sensor types used resembles what is currently available on the IMC. A double-blind, randomized controlled trial conducted by Li et al. (2017) evaluated the reliability and accuracy of an integrated chair alarm compared to alternative, commercially available chair alarms. The study concluded that this integrated chair alarm had a significantly lower amount of false negative, and false positive alarm responses when compared to traditional chair alarms (Li et al., 2017). This type of chair alarm is promising when considering the risk of false alarms, and alarm fatigue. A second randomized controlled trial conducted by Barker et al. (2016) concluded that a nurse-led intervention program helped increase fall prevention interventions, but did not reduce fall rates, or fall injuries. However, the control group was still able to utilize fall prevention measures (Barker et al., 2016). The systematic review conducted by Avanecean et al. (2017) included several RCTs that showed significant reduction in fall rates when interventions were patient-centered.

Level II Quasi-experimental studies Systematic review of a combination of RCTs and quasi-experimental studies, or quasi-experimental studies only, with or without meta-analysis	1 Systematic Review and Meta-Analysis 2 Quasi-Experimental Studies	IIA: Morris et al., 2022 IIB: Seow et al., 2022 IIB: Titler et al., 2016	The study conducted by Titler et al. (2016) concluded that the intervention of an evidence-based, multi-faceted intervention program reduced fall rates for adult medical-surgical patients by 22% (P=0.09, not significant). The severity of fall injuries decreased, but there was no statistically significant improvement in rates of falls with injury (Titler et al., 2016). Despite lack of statistical significane, researchers found that accounting for individual patient fall risk factors was clinically important in reducing patient falls (Titler et al., 2016). The systematic review and meta-analysis conducted by Morris et al. (2022) found that patient and clinician fall education interventions significantly reduced fall rates, and the odds of falling. Multi-factorial interventions showed a promising trend in reduction of falls (Morris et al., 2022). Seow et al. (2022) found that utilization of a hospital bed with an integrated three-mode bed alarm reduced falls from bed in their intervention group, and recommended continued research to take into consideration the risk of alarm fatigue.
Level III Non-experimental study · Systematic review of a combination of RCTs, quasi-experimental, and non-experimental studies, or non-experimental studies only, with or without meta-analysis · Qualitative study or systematic review of qualitative studies with or without meta-synthesis	1 Case-Control Study 1 Cross-Sectional, Observational Study 1 Systematic Review	IIIA: Cho et al., 2020 IIIB: Staggs et al., 2020 IIIB: Mileski et al., 2019	The study conducted by Cho et al. (2020) compared three different fall risk assessment tools, the MFS, the JHFRAT, and the HFRM. The study concluded that the HFRM tool had the highest predictive validity for falls, but also that among all the tools, items indicating gait impairment, dizziness or vertigo, altered mental status or impulsivity, and fall history were the most significantly predictive for increased fall risk (Cho et al., 2020). Staggs et al. (2020) found that the use of chair and bed alarms was dependent on unit practice more so than patient predictive factors. Mileski et al. (2019) found that the use of alarms as a part of a set of fall prevention interventions and proper alarm/alerting device use was important in the reduction of falls. Alarm use was particularly effective in reducing falls among individuals with cognitive impairments (Mileski et al., 2019).

Level IV Opinion of respected authorities and/or reports of nationally recognized expert committees/consensus panels based on scientific evidence			
Level V Evidence obtained from literature reviews, quality improvement, program evaluation, financial evaluation, or case reports · Opinion of nationally recognized expert(s) based on experiential evidence	1 Pilot Study	VB: Estupinan et al., 2018	The study identified knowledge deficits regarding contributing factors of falls, and that chair/bed alarms were not being used as they were not easily accessible. Fall risk kits were placed in high fall risk patient rooms on admission demonstrated increased compliance with use of chair alarms, and decreased fall incidence.
Overall Quality Rating w/rational and Recommendation: The overall quality rating of individual studies is good. However, the included quality studies do show some conflicting data. Several themes are present in the data with fairly consistent evidence. The studies include the clinical significance that individual patient factors, education as a part of the fall prevention interventions, and available hospital equipment have on fall reduction.			
Recommendations Based on Evidence Synthesis • Strong, compelling evidence, consistent results: solid indication for a practice change. • Good and consistent evidence – practice change • Good but conflicting evidence: questionable indication for practice change; consider risk/benefit analysis • Little or no evidence: no indication for practice change			

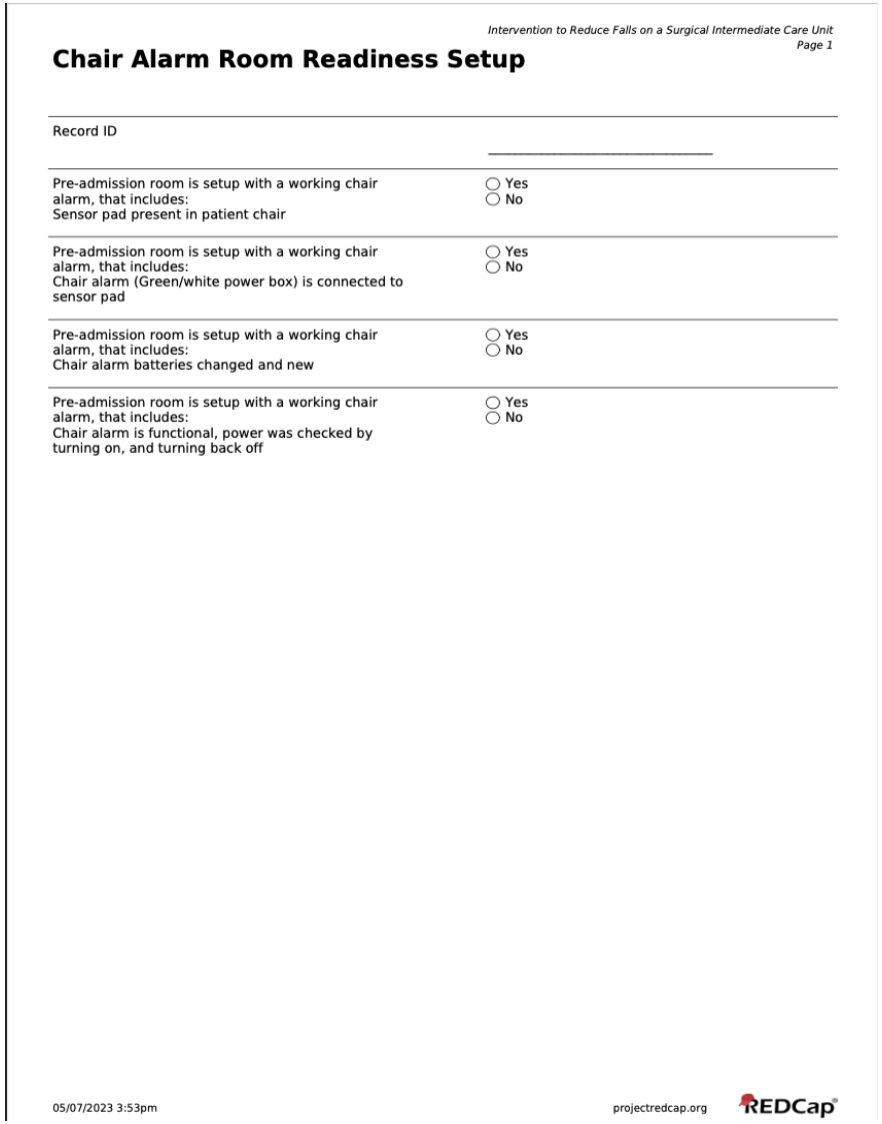
Appendix C

Root Cause Analysis of Falls on the IMC



Appendix D

Chair Alarm Room Readiness Setup Tool



Intervention to Reduce Falls on a Surgical Intermediate Care Unit
Page 1

Chair Alarm Room Readiness Setup

Record ID	_____
Pre-admission room is setup with a working chair alarm, that includes: Sensor pad present in patient chair	◯ Yes ◯ No
Pre-admission room is setup with a working chair alarm, that includes: Chair alarm (Green/white power box) is connected to sensor pad	◯ Yes ◯ No
Pre-admission room is setup with a working chair alarm, that includes: Chair alarm batteries changed and new	◯ Yes ◯ No
Pre-admission room is setup with a working chair alarm, that includes: Chair alarm is functional, power was checked by turning on, and turning back off	◯ Yes ◯ No

05/07/2023 3:53pm projectredcap.org REDCap