Contents lists available at ScienceDirect

Australian Critical Care

Review Paper

The association between unexplained falls and cardiac arrhythmias: A scoping literature review

Taneal Wiseman, PhD, Grad Diploma Critical Care, RN [*]
Vasiliki Betihavas, PhD

Sydney Nursing School, University of Sydney, NSW, Australia

ARTICLE INFORMATION

ABSTRACT

Background: Falls in older adults are common. Age is a risk factor for falls and with an ageing population, presentation to the emergency department (ED) resulting from falls is rising. Reasons for falls in older adults are numerous and include cardiac arrhythmias. However, older patients who present with falls do not appear to be routinely screened for cardiac arrhythmias.
Objectives: To determine the association between cardiac arrhythmias and unexplained falls in older adults presenting to the ED and to identify the processes for cardiac screening in patients presenting to the ED after an unexplained fall.
Methods: A scoping literature review was conducted because of the scarce number of primary research articles using an investigational design to undertake a detailed systematic review. Several databases were searched using the search terms: emergency department; trauma centers; arrhythmias cardiac; fall; and accidental fall.
Data sources: A structured and systematic search using MEDLINE, Embase, and PubMed was conducted from 2002 to December 2017.
Results: Five quantitative studies were included in this review that reported on adults who presented to the ED after an unexplained fall. Several factors associated with falls and cardiac arrhythmias were extracted from the data. These included age, past history of falls, current medications, comorbidities, electrocardiography, and other cardiac findings.
Conclusion: Falls in the elderly population account for a significant number of presentations to the ED. A number of known factors are associated with falls in elderly patients, including cardiovascular causes, yet specific individualised factors are largely unknown. There is no routine screening process for the identification of cardiovascular risk factors in those who present to the ED with an unexplained fall. Further research is needed to identify specific cardiac factors associated with the risk of unexplained falls in this patient cohort and to transfer these findings into a routine screening process.

1. Introduction

Falls are defined as an incident that causes the individual to involuntarily rest either on the ground or at a level lower than that from which they fell.[1] Fall-related injury from varying heights is a leading cause of emergency department (ED) presentations both nationally and internationally. In Australia, falls constituted 40% of all hospital presentations between 2006 and 2007, with adults older than 64 years accounting for 55% of these presentations.[2] Adults in this age group are anticipated to fall at least once throughout their lifespan and account for one-quarter of the New South Wales (NSW) population presenting to the ED for fall-related injuries.[3] Rates of fall-related hospitalisations have also risen by 2.5% annually between 1998 and 2012.[4] In those older than 64 years who have sustained fall-related injuries, there is significant morbidity, and the high annual cost associated with hospitalisation is estimated to exceed $600 million in Australia.[5] Falls are also identified as a leading cause of mortality in this patient cohort.[5–7] While there are a number of known risk factors associated with falls in the elderly including cardiovascular disease, dementia, vertigo, mechanical factors, vision impairment, balance, and a

* Corresponding author.
E-mail addresses: Taneal.wiseman@sydney.edu.au (T. Wiseman), Vasiliki.betihavas@sydney.edu.au (V. Betihavas).

history of falls, the evidence linking falls and nonfatal cardiac arrhythmias is scant.[2,8,9] As a result of the high number of fall-related hospital presentations, risk of injury, mortality rate, and associated financial burden, there is a noteworthy amount of research investigating falls in the elderly and a number of national and international strategies aimed at preventing falls in the elderly.[5,10,11] Despite this, the association between nonfatal cardiovascular arrhythmias and unexplained falls appears underrecognised.[9]

Similar to falls, cardiac-related symptoms are also a significant health concern in those older than 64 years. Cardiac abnormalities also constitute a significant portion of ED presentations, with 328, 562 cases of atrial fibrillation (AF) being identified in Australia in 2014.[12] AF is associated with other cardiac morbidities including cardiac failure and death and has also been linked to the risk of falls.[13,14]

The relationship between cardiac arrhythmias and syncope is well documented, and these factors have been greatly researched and identified as having a significant link.[15,16] Syncope differs from a fall and is defined as a rapidly occurring transient loss of consciousness accompanied by a quick and spontaneous return to usual level of consciousness.[17] Often a fall is associated with syncope. However, despite research that has spanned over a 30-year period focused on cardiac monitoring and falls, the association between falls and syncope and cardiac abnormalities remains unclear.[18–20] Furthermore, recent literature has now argued that syncope has been previously mistaken and diagnosed as a fall[9,21,22] further adding to the ambiguity.

With an ageing population and age being a risk factor for both falls and cardiac arrhythmias, fall-related hospitalisations and healthcare expenditure will potentially rise. This review, therefore, was conducted to understand and describe what is known about the relationship between unexplained falls from standing and cardiac arrhythmias and to guide future research and clinical practice.

There are a number of terms used to describe 'falls', but for the purpose of this article, the term 'unexplained falls' will be used to ensure consistency.[23]

2. Objectives of the review

The objective of this review was to determine the association between cardiac arrhythmias and unexplained falls in older adults presenting to the ED and to explore the processes by which adult patients who present to the hospital after an unexplained fall are screened for cardiac arrhythmias. More specifically, the review objectives were the following:

- To ascertain cardiac factors associated with the risk of unexplained falls in this patient cohort;
- To identify the criteria for cardiac screening in patients presenting to the ED after an unexplained fall.

3. Review method

A scoping literature review was conducted as there were a scarce number of primary research articles using an investigational design to undertake a detailed systematic review. Scoping reviews involve the identification of what is currently known on a topic, what is not yet known, and using this for translation to policy and practice.[24]

The scoping review enabled the authors to gain understanding on the current state of knowledge of the research topic, to identify the need to undertake a systematic literature review, and to summarise what is known on the topic and disseminate the findings.[24]

Given the limited availability of research that outlined the association between cardiac arrhythmias and unexplained falls and the diverse methodologies used, the authors deemed this method most appropriate for the current review. The inclusion of all types of literature enables the authors to review existing literature and produce findings to enhance that of other literature.[25] The inclusion and exclusion criteria are as follows:

3.1. Inclusion criteria

- Primary research articles or case studies where the primary presentation of the participants to the ED was the result of an unexplained fall
- Research articles written in English.
- Research articles that included patients aged 16 years and older
- Research articles published between 2002 and 2017

3.2. Exclusion criteria

- Research articles that included patients who had presented to the ED with an unexplained fall that was secondary to medication administration
- Research articles where the cohort was patients aged <16 years
- Research articles written in a language other than English.

Articles were screened by two authors (T.W. and V.B.) across the time period 2002—2017 from Embase, MEDLINE, and PubMed databases, plus handsearching of key references and grey literature. Combinations of the following search terms were used to identify appropriate articles: emergency department or emergency ward, trauma centers, fall, accidental fall, syncope, cardiac arrhythmias, and falling. The time frame of 2002—2017 was chosen as this was deemed to include any clinically current developments in cardiac screening of this patient cohort after fall injuries.

Initially, the search resulted in 405 abstracts, seven of which were duplicates across the two databases. The two authors (T.W. and V.B.) reviewed the 405 titles and abstracts available and applied the inclusion and exclusion criteria.

All abstracts meeting the criteria resulted in accessing full-text versions, and these studies were read and re-read by the authors (T.W. and V.B.) in conjunction with inclusion and exclusion criteria to ensure reliability and accuracy. After review of full-text articles by the two authors and a thorough selection process that included the application of an 11 point critical appraisal tool,[26] five articles were included in the review.

Handsearching of key articles was also conducted (T.W. and V.B.) and this resulted in one further article for inclusion (see Fig. 1). Data extraction was completed independently by each author, and during this phase, the review authors met regularly to discuss evolving queries that were resolved through consensus.

The authors met regularly throughout the process to discuss and review the findings to guarantee concordance (T.W. and V.B.). Data were synthesised and categorised from each of the included articles according to study type and aim, methods, study sample, interventions and screening tools, and major findings and/or outcomes of the study. A table was formulated to manage the data according to the categories listed previously (see Table 1).

4. Findings

There were a total of five articles included in the review. Across the studies, there were a total of 6294 patients aged 50 years and older who had presented to the ED after an unexplained fall. The
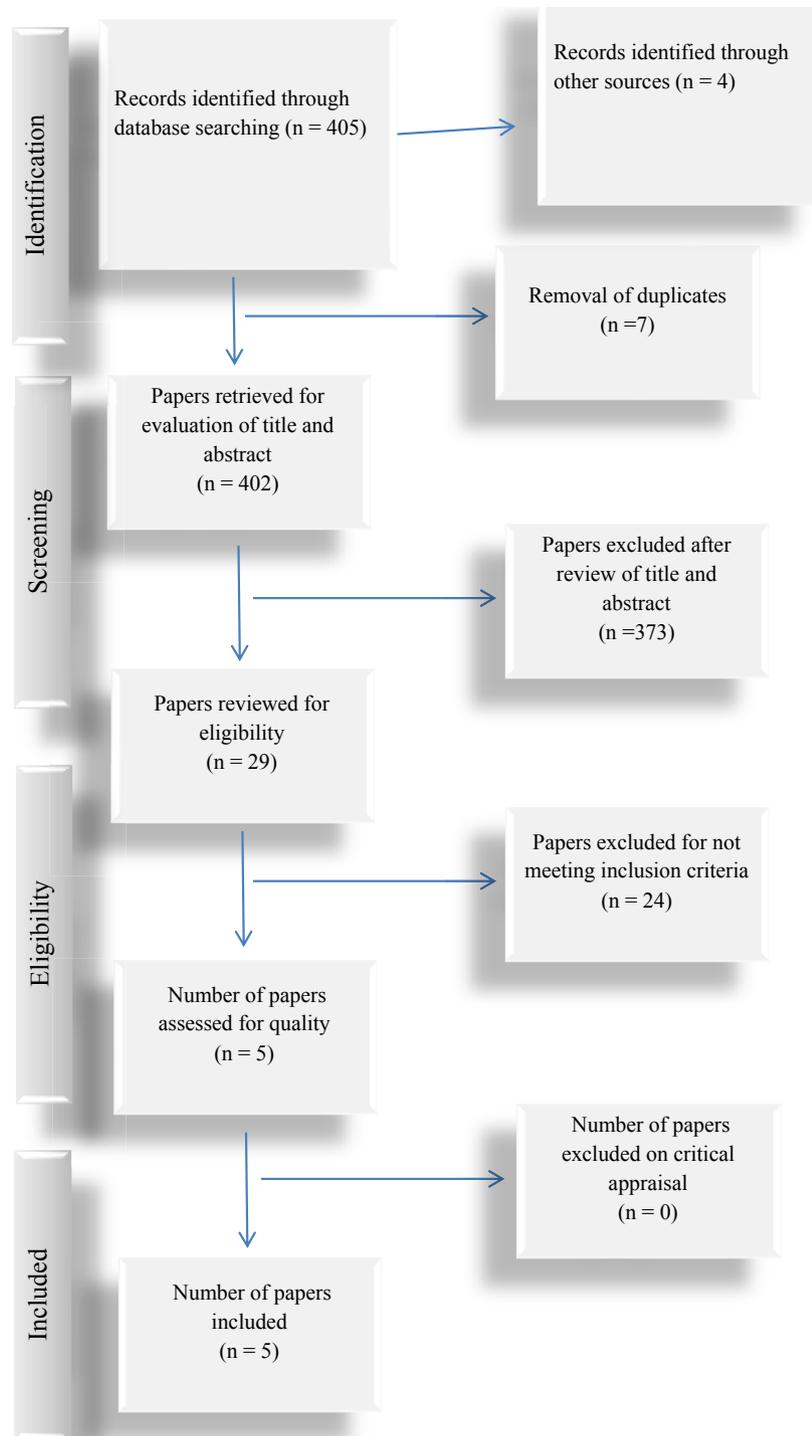
Fig. 1. Decision trail of included studies describing the association between unexplained falls and cardiac arrhythmias.

included studies were of varying quantitative designs and were conducted in the USA, Ireland, UK, and Taiwan.

Following the process of data analysis, several factors associated with patients presenting to the ED after an unexplained fall and cardiac arrhythmias were extracted from the data. These are as follows: age and other comorbidities, history of unexplained falls, medications, and electrocardiography (ECG) and cardiac findings (see Table 2). The factors are discussed further in the following section.

4.1. Age and other comorbidities

Age is a risk factor for unexplained falls and is associated with multiple comorbidities. These two risk factors combined increase the likelihood of unexplained falls. Traditionally those aged older than 64 years are classified as elderly; however, this review identified that adults aged 50 years and older were at risk of unexplained falls. Sanders[13] identified that older adults were more likely to experience an unexplained fall, particularly if they had a history

Table 1
Study characteristics of included studies.

Author/year/country	Study type/aim	Method	Study sample	Intervention and screening tool	Major findings/outcomes
Sanders, N. A., Ganguly, J. A., Jetter, T. L., Daccarett, M., Wasmund, S. L., Brignole, M., & Hamdan, M. H[13] 2012 USA	Retrospective cohort study Aim: to determine if atrial fibrillation (AF) is associated with falls in this patient cohort	Screening of patient records at the emergency department (ED) of the University of Utah. Patients divided into nonaccidental and accidental falls groups for data collection and analysis	Patients aged >65 years who presented to a single ED after fall from standing height (n = 442)	Screening of electronic data provided by the hospital ED to identify risk factors associated with falls	Patients aged 80 years or younger with a history of AF were at greatest risk of nonaccidental falls (2.5 times greater than those without a history of AF)
Bhangu, J., McMahon, C. G., Hall, P., Bennett, K., Rice, C., Crean, P., ...& Kenny, R. A.[20] 2016 Ireland	Single center, prospective, observational cohort study. Primary aim: identification of cardiac arrhythmia associated with a fall or syncope. Secondary aim: identification of cardiac arrhythmia independent of falls or syncope	Patients presenting to an ED in Dublin were screened for inclusion. After comprehensive geriatric and cardiovascular screening, an implantable loop recorder (ILR) was inserted to identify the diagnostic value of the ILR in detection of arrhythmias in falls. Participants kept weekly symptom diaries, with biweekly phone follow-up Participants reviewed at six monthly intervals for up to 12 months	Fallers aged >50 years with two or more unexplained falls presenting to ED (n = 70)	Insertion of an ILR to detect arrhythmia overtime. Initial assessments performed on all patients included Falls Efficacy Scale, Timed Up and Go Test, balance and mobility assessment, cardiovascular assessment, and medical history	20% falls were directly attributable to cardiac arrhythmia 71.4% of unexplained falls had a cardiac arrhythmia that was not present at the time of ED presentation with mean arrhythmia detection time at 47.3 days' after presentation Patients with a cardiac arrhythmia more likely to fall during follow-up than those who did not
Davison, J., Brady, S., & Kenny, R. A[28] 2010 UK	Prospective case–control study. Aim: to compare electrocardiographic (ECG) abnormalities in patients with recurrent falls and case control group. To determine if 24- hour ambulatory ECG identifies arrhythmias associated with falls	24-h ambulatory ECG recordings were compared in patients with recurrent falls presenting to the ED and the case–control group (no fall or syncope). ECG abnormalities were categorised as major (e.g. ventricular arrhythmia) and minor (e.g. atrial arrhythmia).	Patients aged 65 years and older who presented to the ED with a fall or fall-related injury. Participants also sustained an additional fall in the preceding 12 months for inclusion (n = 128 fallers and n = 100 case controls)	All participants had a detailed history and cardiac assessment Both groups fitted with a 24-h ambulatory ECG recorder and asked to record symptoms and activities during the recording period in a diary, including time, symptoms, and associated factors. Analysis of tapes detecting abnormalities were assessed	Palpitations occurred in 10% of fallers and 13% of controls. No difference between the two groups in prevalence of abnormalities. 24-h ECG monitoring not useful in identifying causes of falls in people aged 65 years and older
Bhat, P. K., Pantham, G., Laskey, S., Como, J. J., & Rosenbaum, D. S[14] 2014 USA	Retrospective cohort study Aim: to identify clinical markers in patients with traumatic falls that may predict cardiac-related syncope	Review of patients presenting to the ED of a level 1 trauma center between 2000 and 2009	Patients aged 18 years and older presenting to a large urban trauma center ED after syncope and traumatic fall (n = 180) were screened.	Data collection using hospital registry to obtain patient demographics, circumstances and type of fall, and medical history. A security-protected hospital database was used	Cardiac-related causes were found in 13% of study participants, and 54% had an unidentified cause of syncope and traumatic fall Highest predictors of cardiac syncope were coronary artery disease, age >65 years and pathological Q waves. Continuous ECG monitoring with telemetry and Holter monitor more useful than ECG alone in identifying cardiac causes of syncope and traumatic falls
Hung, C. Y., Wu, T. J., Wang, K. Y., Huang, J. L., Loh, E. W., Chen, Y. M., ... & Tang, Y. J[27] 2013 Taiwan	Cross-sectional design Aim: to establish if cardiac comorbidities and medication use are associated with falls in older adults with a history of AF	Screening of inpatients over 2 years who were admitted for fall evaluation and management at a tertiary medical center in Taiwan	Inpatients aged 75 years and older admitted to a geriatric evaluation and management unit in Taiwan (n = 401). These were divided into two groups, those with AF and those without	Medical records reviewed to identify any comorbidities, past medical history including medication use and information from a Comprehensive Geriatric Assessments including numerous assessment and screening tools	Significantly higher prevalence of falls in patients with AF than in those without 58.4% of patients had a history of falls 16.5% of patients have a history of AF. Among the AF patients, 47 (71.2%) had a history of falling Benzodiazepines were associated with high falls prevalence but not cardiovascular drugs

Table 2
Summary of findings.

Study	Criteria for cardiac screening	Cardiac factors associated with the risk of falls	Implications for practice
Sanders et al.[13]	Complaint of a fall; accidental fall vs nonaccidental fall	Age and comorbidities • History of AF • Age <81 years Medications; Electrophysiology and cardiac findings	Extrinsic (environment) and intrinsic (person) risk factors contribute to fall in older persons, with increased prevalence in older adults with AF
Bhangu et al.[20]	Recurrent fallers with two or more unexplained falls presenting to an ED; Mini Mental State Exam>24	Electrophysiology and cardiac findings • Cardiac arrhythmia Age and Comorbidities • Hypertension (HT); depression; arthritis; and hypercholesterolaemia • History of cardiovascular disease	Patients with a cardiac arrhythmia who present to an ED with an unexplained fall may not have the arrhythmia at presentation
Davison et al.[28]	Presented to an ED with a fall or fall-related injury in the last 12 months	History of falls • Sustained an additional fall in the preceding 12 months; Age and comorbidities Medications	Medical Hx to be considered; assessment required to determine if there is a correlation between presentation (fall) and heart rhythm
Bhat et al.[14]	Presentation of traumatic fall to an ED with subsequent syncope event	Age and comorbidities • >65 yrs; • History coronary artery disease Electrocardiography and cardiac findings • pathological Q waves	ECG screening tool that can offer information for further investigation; however, ECG alone is limited in identifying patients who fell due to a cardiac arrhythmia
Hung et al.[27]	Patients admitted for geriatric syndrome and fall evaluation	Age and comorbidities • History of AF; • History of HT; • High GDS score Medications: • Polypharmacy; • Benzodiazepine use	Benzodiazepine use; Hx of paroxysmal AF and HT were independent predictors for fall in adults with Hx of AF.

AF, atrial fibrillation; ED, emergency department; ECG, electrocardiographic; GDS, geriatric depression scale.

of AF (p < 0.001). Similarly, Davison[27] compared adults with a history of recurrent falls with adults who had no prior history of unexplained falls and identified that the mean age of those with recurrent falls were older compared with those with no prior history of unexplained falls (p = 0.065).

In addition, Bhat et al.[14] identified in their study of adult patients that those who presented after an unexplained fall and ensuing cardiac syncope were more likely to be aged older than 65 years than those age 65 years and younger (74 years vs 63 years, p < 0.01). This was consistent with Hung et al.[28] who found that patients in their study who were screened after an unexplained fall and who had a history of AF were older. Furthermore, from multivariate logistic regression, age was identified as an independent risk factor for falls in adults with AF (p = 0.086).

Adults with multiple comorbidities, including cardiac arrhythmias, are at a greater risk of falling.

Sanders[13] identified that 61% of older adults who experienced a nonaccidental fall had a history of AF compared with 44% of older adults with no history of AF (p = 0.009). Furthermore, study participants in the same study who had experienced an accidental fall had a higher prevalence of a history of AF (p = 0.01).[13] Neurological disorders such as seizure disorders, stroke, dementia, Parkinson's disease, and multiple sclerosis were predictors of nonaccidental falls.

Hung et al.[28] established in their study of patients admitted to hospital after an unexplained fall that 71.2% of the patients with AF had a history of unexplained falls. Hung et al.[28] also found that a history of paroxysmal AF was identified as an independent risk factor for falls in adults with current AF (p = 0.025).

Davison[27] detected that adults with a history of falls compared with adults with no history of unexplained falls were likely to have a history of hypertension (odds ratio [OR] 1.6, 95% confidence interval [CI] 1.0–2.4) and diabetes (OR 2.8, 95% CI 1.1–7.3). Additionally, Hung et al.[28] identified that a previous history of

hypertension was an independent risk predictor for unexplained falls in adults with a history of AF (OR 9.49, 95% CI 1.19–75.57, p = 0.034).

Bhat[14] screened 180 patients who had presented with a traumatic, unexplained fall, and subsequent syncopal event. Several independent predictors of cardiac syncope were identified in the patients who presented with a traumatic fall, including the presence of pathological Q waves, a history of coronary artery disease, and age more than 65 years (C-statistic 0.80 ± 0.04).[14]

Hung et al.[28] in their sample of older adults aged older than 75 years observed that a higher score in the geriatric depression scale which is a self-reporting tool to identify symptoms of depression was a further independent factor for unexplained falls in older adults (p = 0.048).

5. History of unexplained falls

Adults with a history of unexplained falls have an increased risk of further unexplained falls, and many recurrent fallers had associated ECG abnormalities.

Bhangu[20] identified that the mean number of unexplained falls per study participants was between 2 and 12 in 1 year and that 83% of these patients had an underlying cardiac arrhythmia and were more likely to experience a further unexplained fall after the first fall (p = 0.0012).

Davison[27] compared a group of patients with recurrent unexplained falls with a control group who had no history of falls. They determined that the number of unexplained falls in the group of adults with a history of recurrent unexplained falls was significant, ranging from two to 50 unexplained falls.[20]

Hung[28] also identified that the prevalence of recurrent unexplained falls in adults with AF was significantly higher than that in those without AF and found that more than 70% has a history of unexplained falls. Unexplained recurrent falls had a linear

relationship (p per trend = 0.020) to a number of independent risk factors for unexplained falls including benzodiazepine use, hypertension, and paroxysmal AF.[29]

6. Medications

Adults who take benzodiazepine and multiple medications are at an increased risk of unexplained falls.

Sanders[13] identified that polypharmacy use was more prevalent in older adults with nonaccidental falls compared with patients with accidental falls (66% vs 55% p = 0.02). This was comparable to Hung[28] who also found a higher prevalence of polypharmacy use in adults with a history of falls compared with the incidence of polypharmacy use in nonfallers (p = 0.027). Significantly, benzodiazepine use was identified as an independent predictor for unexplained falls in adults with AF (p = 0.003).

7. ECG and cardiac findings

Adults with abnormal ECG readings, particularly arrhythmias, are at an increased risk of unexplained falls. Furthermore, cardiac arrhythmias in patients with unexplained falls are often delayed and not apparent at the time of presentation to hospital after an unexplained fall.

In the study by Bhangu,[20] participants were fitted with an implantable loop recorder. The implantable loop recorder determined that cardiac arrhythmias were detected at a mean time of 47.3 days (standard deviation 48.25) after implantation (after fall-related presentation to the ED). Of the participants, 20% had an unexplained fall attributable to a cardiac arrhythmia which was identified later.[20]

In addition, Davison[27] compared adults with a history of falls with adults with no history of falls and found that there was no statistical significance in the difference in 24-h ECG monitoring abnormalities between the two groups and suggested that short-term ECG monitoring is not helpful in identifying cardiac causes of falls in people aged 65 years and older.

Bhat[14] identified that cardiac syncope in the patients who presented with traumatic falls was attributed to the following cardiac abnormalities found on Holter monitor use and telemetry: brady-dysrhythmias, trifascicular block, supraventricular tachycardia, AF, ventricular tachycardia, pulmonary embolism, and severe aortic stenosis.

The second aim of this scoping review was to explore the processes by which patients who presented to the ED after an unexplained fall were screened for cardiac arrhythmias. This scoping review identified that there is no current screening process to identify cardiac arrhythmias contributing to patients who present with unexplained falls.

7.1. Implications for practice

The intent of this literature review was to determine the association between cardiac arrhythmias and unexplained falls in older adults presenting to the ED and to explore the processes by which adult patients who present to the hospital after an unexplained fall are screened for cardiac arrhythmias. From the review, five factors associated with adults who presented to the ED with a fall and a cardiac arrhythmia emerged: age and other comorbidities, history of unexplained falls, medications, ECG, and cardiac findings.

Age was detected as a risk factor for unexplained falls in adults. Four of the five studies identified that the older the person, the greater the risk for experiencing an unexplained fall.[30] Regardless of age, the finding that age is a risk factor for unexplained falls is consistent with previous literature.[31]

The study by Sanders et al. discovered that adults between 65 and 81 years were at the greatest risk of experiencing a fall compared with adults >81 years. However, in contrast, Australian data have identified that fall-related hospitalisations between 1998 and 2012 for older adults have increased by an average of 2.5% annually with the greatest increase in adults older than the age of 85 years.[32] International literature also supports Australian data highlighting that age is a risk factor for falls, and the frequency of falls increases with age.

A history of unexplained falls was a risk for experiencing further falls. The study by Hung et al. further identified that adults with a history of falls and underlying AF had a linear relationship with the total number of independent risk factors for falls. Despite the knowledge that both unexplained falls and cardiac arrhythmias are related to high hospital presentations and have significant associated morbidity and mortality,[2] there appears to be a distinct lack of a routine screening process for cardiac arrhythmias in patients presenting to the ED after an unexplained fall.[33] Similarly, in an international study by Rogenstein,[34] ED clinicians acknowledged that patients who present with AF are not routinely screened for fall risk or a history of unexplained falls. The lack of screening indicates that adults who currently present with either AF or an unexplained fall do not activate a routine screening process. The review by Alboni et al.[35] argues for the initial assessment of an adult presenting with a fall to be undertaken similarly to that of an adult presenting with syncope. This includes a multifactorial assessment and multifactorial treatment for adults who present with falls which incorporates cardiac assessment and gait, cognitive assessment, and environmental factors such as surface assessment and footwear. This corresponds with the Australian Commission on Safety and Quality in Health Care which also stresses the importance of a multifactorial approach that includes ongoing screening and prevention strategies from presentation to the ED, admission, and when clinically indicated.[36]

The finding that not all cardiac abnormalities are present on ECG at presentation is evident in the study by Bhangu[20] who identified that patients with an underlying cardiac arrhythmia were not identified at presentation to the ED but 47.3 days after presentation. In addition, Davison[27] identified that 24-h ECG monitoring on presentation did not identify cardiac abnormalities as a cause for the unexplained fall. Furthermore, Bhat[14] acknowledged that an in-depth assessment that includes telemetry and Holter monitoring was more advantageous than an ECG performed in isolation. This is consistent with other literature that has identified several classifications for AF: first diagnosed; paroxysmal; persistent; long-standing persistent; and permanent AF and silent AF which is common in elderly populations and is often asymptomatic initially unless identified early before it progresses to symptomatic episodes.[37,38] Patients who present to the ED with paroxysmal AF, for example, may not have their arrhythmia identified on the initial ECG because of the transient nature of the type of AF.[38] Furthermore, the authors argue of clinical incongruity in the diagnosis of syncope in patients presenting to ED with AF. The link between unexplained falls and cardiac arrhythmias such as AF and the knowledge that these arrhythmias are not always recognised on the initial ED presentation highlights a need for ongoing cardiac monitoring and possible referral to specialists for ongoing review beyond the initial acute presentation.

This review identified that older adults with comorbidities such as cardiovascular disease, including a history of AF, neurological disorders, diabetes, and depression, are at an increased risk for unexplained falls. Yet, fall-related programs focus on prevention strategies for mechanical falls and appear to pay less attention to the prevention of unexplained falls associated with other comorbidities. As the risk of unexplained falls in the ageing population

continues to grow, there is an increased need to improve clinical processes, screening, and decision-making.[39]

Polypharmacy use by older adults was also found in this review to be a risk factor for falls, in particular, the use of benzodiazepines alongside other medications.[28] This is consistent with prior literature that showed that the risk of unexplained falls in the elderly significantly increased with polypharmacy use, in particular, when the polypharmacy included the administration of benzodiazepines.[40,41]

This review has identified an association between unexplained falls and cardiac abnormalities. However, routine cardiac screening of adults who present with an unexplained fall or routine fall risk assessment of adults who present with a cardiac abnormality does not appear to occur in practice. This is a significant finding with implications for clinical practice and highlights the need for clinically applicable cardiac screening processes for patients who present after an unexplained fall.

Each of the reviewed studies did not identify a routine screening process for identification of cardiac arrhythmias in patients presenting to the ED after a history of unexplained falls. The implications for clinical practice indicated that consideration needs to be given to patients who present with either a cardiac arrhythmia such as AF or an unexplained fall. This patient cohort needs to be screened for their fall risk including comorbidities identified from this review, history of falls, and long-term cardiac monitoring.

Given the distinct lack of both Australian and international-based articles investigating the association between unexplained falls and cardiac arrhythmias, it would be beneficial to conduct further studies based on EDs to gain local understanding of the scope of patients who present to the ED after an unexplained fall with an arrhythmia. This may also have implications for screening and practice.

7.2. Limitations of this review

No meta-analysis was undertaken as part of this review because of the diversity of the studies that met the inclusion criteria.[42] In particular, the methodology and interventions undertaken within each study differed and so a meta-analysis would not be appropriate.[43]

This scoping literature review focused solely on patients presenting to the ED after an unexplained fall and did not screen for patients who had fallen in a healthcare setting such as a hospital or an aged care facility. This limited the amount of studies included in the review.

Owing to the lack of Australian studies available, this review had a purely international focus and as such generalisability needs to be questioned with the need for further studies being required within an Australian context.

8. Conclusion

Unexplained falls in older patients are a significant contributor to presentations to the ED and result in a high rate of morbidity and mortality. This review identified a number of factors associated with unexplained falls in this patient cohort presenting to the ED after an unexplained fall, including cardiovascular causes such as nonfatal arrhythmias. Despite this, there is limited research on the specific link between unexplained falls and cardiac factors in patients presenting to the ED. Furthermore, there is no routine screening process and long-term cardiac follow-up for the identification of cardiovascular or other comorbid risk factors in those who present to the ED with an unexplained fall. Further research is necessary to identify specific cardiac factors associated with the risk of unexplained falls in this patient cohort who present to the ED with an unexplained fall and to transfer these findings into a routine screening process.

Ethical approval

No ethical approval has been sought as the article is a review of literature.

Funding

Acknowledgements

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.aucc.2018.08.003.

References

[1] Ageing WHO, Unit LC. WHO global report on falls prevention in older age. World Health Organization; 2008.

[2] Ambrose AF, Paul G, Hausdorff JM. Risk factors for falls among older adults: a review of the literature. Maturitas 2013;75(1):51–61.

[3] Watson WCA, Mitchell R. The incidence and cost of falls injury among older people in New South Wales 2006/07. Sydney: NSW Department of Health; 2010.

[4] Harvey L, Close J. Trends in fall-related hospitalisations, persons aged 65 years and over, NSW, 1998–99 to 2011–12. 2013.

[5] AIHW. Trends in hospitalised injury, Australia: 1999–00 to 2012–13. Injury research and statistics. Canberra: AIHW; 2015.

[6] Mangram A, Dzandu J, Harootunian G, Zhou N, Sohn J. Why elderly patients with ground level falls die within 30 Days and beyond. J Gerontol Geriatr Res 2016;5(289):2.

[7] Allen CJ, Hannay WM, Murray CR, Straker RJ, Hanna MM, Meizoso JP, et al. Causes of death differ between elderly and adult falls. J Trauma Acute Care Surg 2015;79(4):617–21.

[8] Chisholm KM, Harruff RC. Elderly deaths due to ground-level falls. Am J Forensic Med Pathol 2010;31(4):350–4.

[9] Jansen S, Frewen J, Finucane C, de Rooij SE, van der Velde N, Kenny RA. AF is associated with self-reported syncope and falls in a general population cohort. Age Ageing 2015;44(4):598–603.

[10] Australian Commision on Safety and Quality in Health Care. Preventing falls and harm from falls in older people. Canberra: ACSQHC; 2009.

[11] Chang JT, Morton SC, Rubenstein LZ, Mojica WA, Maglione M, Suttorp MJ, et al. Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials. BMJ 2004;328(7441):680.

[12] Ball J, Thompson DR, Ski CF, Carrington MJ, Gerber T, Stewart S. Estimating the current and future prevalence of atrial fibrillation in the Australian adult population. Med J Aust 2015;202(1):32–5.

[13] Sanders NA, Ganguly JA, Jetter TL, Daccarett M, Wasmund SL, Brignole M, et al. Atrial fibrillation: an independent risk factor for nonaccidental falls in older patients. Pacing Clin Electrophysiol 2012;35(8):973–9.

[14] Bhat PK, Pantham G, Laskey S, Como JJ, Rosenbaum DS. Recognizing cardiac syncope in patients presenting to the emergency department with trauma. J Emerg Med 2014;46(1):1–8.

[15] Colman N, Nahm K, Ganzeboom K, Shen W-K, Reitsma J, Linzer M, et al. Epidemiology of reflex syncope. Clin Auton Res 2004;14:i9–17.

[16] Soteriades ES, Evans JC, Larson MG, Chen MH, Chen L, Benjamin EJ, et al. Incidence and prognosis of syncope. N Engl J Med 2002;347(12):878–85.

[17] Moya A, Sutton R, Ammirati F, Blanc J-J, Brignole M, Dahm JB, et al. Guidelines for the diagnosis and management of syncope (version 2009). Eur Heart J 2009;30(21):2631–71.

[18] Gordon M. Occult cardiac arrhythmias associated with falls and dizziness in the elderly: detection by Holter monitoring. J Am Geriatr Soc 1978;26(9):418–23.

[19] Rosado JA, Rubenstein LZ, Robbins M, Alan S, Heng MK, Schulman BL, et al. The value of Holter monitoring in evaluating the elderly patient who falls. J Am Geriatr Soc 1989;37(5):430–4.

[20] Bhangu J, McMahon CG, Hall P, Bennett K, Rice C, Crean P, et al. Long-term cardiac monitoring in older adults with unexplained falls and syncope. Heart 2016;102(9):681–6.

[21] Jansen S, Kenny RA, de Rooij SE, van der Velde N. Self-reported cardiovascular conditions are associated with falls and syncope in community-dwelling older adults. Age Ageing 2014;44(3):525—9.

[22] Rafanelli M, Brignole M, Kenny RA. Syncope and unexplained falls in the elderly. Cardiac management in the frail elderly patient and the oldest old. Springer; 2017. p. 71—86.

[23] Watson W, Clapperton A, Mitchell R. The burden of fall-related injury among older persons in New South Wales. Aust N Z J Publ Health 2011;35(2):170—5.

[24] Anderson S, Allen P, Peckham S, Goodwin N. Asking the right questions: scoping studies in the commissioning of research on the organisation and delivery of health services. Health Res Pol Syst 2008;6(1):7.

[25] Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implement Sci 2010;5(1):69.

[26] Buckley S, Coleman J, Davison I, Khan KS, Zamora J, Malick S, et al. The educational effects of portfolios on undergraduate student learning: a Best Evidence Medical Education (BEME) systematic review. BEME Guide No. 11. Med Teach 2009;31(4):282—98.

[27] Davison J, Brady S, Kenny RA. 24-hour ambulatory electrocardiographic monitoring is unhelpful in the investigation of older persons with recurrent falls. Age Ageing 2005;34(4):382—6.

[28] Hung C-Y, Wu T-J, Wang K-Y, Huang J-L, Loh E-W, Chen Y-M, et al. Falls and atrial fibrillation in elderly patients. Acta Cardiol Sin 2013;29(5):436.

[29] Higgins JP, Green S. Cochrane handbook for Systematice reviews of interventions. Version 5.1. 0 (updated March 2011). The Cochrane Collaboration; 2011. Available from: www cochrane-handbook org. 2014.

[30] World Health Organization. WHO global report on falls prevention in older age. 2007. World Health Organization; 2015. p. 1—7.

[31] Kwan E, Straus S, Holroyd-Leduc J. Risk factors for falls in the elderly. Medication-related falls in older people. Springer; 2016. p. 91—101.

[32] Harvey L, Close J. Trends in fall-related hospitalisations, persons aged 65 years and over, NSW, 1998—99 to 2011—12. Sydney: Neuroscience Research Australia; 2013.

[33] Lee H-C, Huang KT, Shen W-K. Use of antiarrhythmic drugs in elderly patients. J Geriatr Cardiol JGC 2011;8(3):184.

[34] Rogenstein C, Kelly AM, Mason S, Schneider S, Lang E, Clement CM, et al. An international view of how recent-onset atrial fibrillation is treated in the emergency department. Acad Emerg Med 2012;19(11):1255—60.

[35] Alboni P, Coppola P, Stucci N, Tsakiridu V. Differential diagnosis between 'unexplained' fall and syncopal fall: a difficult or impossible task. J Cardiovasc Med 2015;16(2):82—9.

[36] Australian Commission on Safety and Quality in Health Care. In: ACSQHC, editor. Safety and quality improvement guide standard 10: preventing falls and harm from falls (october 2012). Sydney: ACSQHC; 2012.

[37] Kirchhof P, Benussi S, Kotecha D, Ahlsson A, Atar D, Casadei B, et al. 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS. Eur Heart J 2016;37(38):2893—962.

[38] Hussain S, C Jerry L. Syncope and atrial fibrillation: which is the chicken and which is the egg? J Atr Fibrillation 2015;8(4).

[39] Hartholt KA, van der Velde N, Looman CW, van Lieshout EM, Panneman MJ, Van Beeck EF, et al. Trends in fall-related hospital admissions in older persons in The Netherlands. Arch Intern Med 2010;170(10):905—11.

[40] Glab KL, Wooding FGG, Tuiskula KA. Medication-related falls in the elderly: mechanisms and prevention strategies. Consult Pharm 2014;29(6):413—7.

[41] Ziere G, Dieleman J, Hofman A, Pols HA, Van Der Cammen T, Stricker B. Polypharmacy and falls in the middle age and elderly population. Br J Clin Pharmacol 2006;61(2):218—23.

[42] Deeks JJ, Higgins J, Altman DG. Analysing data and undertaking meta-analyses. Cochrane handbook for systematic reviews of interventions. Cochrane Book Series; 2008. p. 243—96.

[43] Haidich A-B. Meta-analysis in medical research. Hippokratia Med J 2010;14(Suppl 1):29.