SYSTEMATIC REVIEW

The effect of bedrails on falls and injury: a systematic review of clinical studies

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Abstract

Background: around one-fourth of all falls in healthcare settings are falls from bed. The role of bedrails in falls prevention is controversial, with a prevailing orthodoxy that bedrails are harmful and ineffective.

Objective: to summarise and critically evaluate evidence on the effect of bedrails on falls and injury

Design: systematic literature review using the principles of QuoRoM guidance.

Setting and Subjects: adult healthcare settings

Review Methods: using the keyword, bedrail, and synonyms, databases were searched from 1980 to June 2007 for direct injury from bedrails or where falls, injury from falls, or any other effects were related to bedrail use.

Results: 472 papers were located; 24 met the criteria. Three bedrail reduction studies identified significant increases in falls or multiple falls, and one found that despite a significant decrease in falls in the discontinue-bedrails group, this group remained significantly more likely to fall than the continue-bedrails group; one case-control study found patients who had their bedrails raised significantly less likely to fall; one retrospective survey identified a significantly lower rate of injury and head injury in falls with bedrails up. Twelve papers described direct injury from bedrails.

Discussion: it is difficult to perform conventional clinical trials of an intervention already embedded in practice, and all included studies had methodological limitations. However, this review concludes that serious direct injury from bedrails is usually related to use of outmoded designs and incorrect assembly rather than being inherent, and bedrails do not appear to increase the risk of falls or injury from falls.

Keywords: accidental fall, injury, restraint, rail, bedrail, cot-side, elderly

Introduction

Bedrails are marketed as safety devices to reduce patients’ risk of falling from bed. Their use is common internationally, with reported prevalence in hospitals ranging from 8 to 64% [1–5], and in nursing homes from 9 to 71% [6–13]. The commonest reason given by staff for bedrail use is falls prevention [1, 4, 6, 14].

Fall rates of 4–14 per 1,000 bed days have been reported from hospitals [14–24], and around 50% of care home residents fall at least once a year [16, 18, 24]. Such falls are associated with injury, fear of falling, functional impairment, prolonged length of stay, institutionalisation, complaints, litigation and excess costs [15, 22, 25]. Approximately one-fourth of these falls are from bed [4, 14, 18, 19].

The use of restraint is controversial; some papers on bedrails have automatically categorised bedrails as restraint, describing their use as unethical and thereby making any discussion of their effectiveness immaterial. Restraint may be defined as ‘the intentional restriction of a person’s voluntary movement or behaviour’ [16] and therefore bedrails used to stop a patient purposefully leaving their bed may be restraint, but used to prevent an accidental fall from bed, may not be restraint.

Although reviews of the wider literature on institutional falls or restraints [6, 15–19, 26–31] have included bedrails, the tendency is to group them with studies of belt, vest, cuff or chair restraints, and existing reviews specific to bedrails [32, 33] are not systematic or recent. Current practice
The effect of bedrails on falls and injury

We included combined studies of bedrail and non-bedrail restraints only where bedrail data could be separated. Studies were included if, as a minimum, the numbers of falls or injuries were provided. Multi-faceted falls reduction studies including a bedrail component were included only if changes in bedrail use were described.

Abstraction of data and outcomes and quality scoring

Trials were grouped by design type [40–42] and assessed independently for quality criteria by three reviewers using a well established quality criteria tool designed for appraising evidence from disparate study designs [43, 44]. Retrospective surveys, case series, and case studies were not individually assessed since their design equates to a null score. Falls rates were standardised from the data presented as falls per 1,000 occupied bed days.

Statistical methods

No additional tests of statistical significance were carried out, but tests of statistical significance within original papers or in previously published meta-analysis were abstracted for inclusion.

Results

Overall characteristics and design of included studies

Of the 472 abstracts retrieved in the initial search, 24 papers [7, 13, 45–48] were identified as meeting the inclusion criteria (Figure 1). Nine studies took place in hospitals [14, 47, 49, 52, 54, 55, 60, 63, 65], nine in nursing homes [7, 13, 45, 46, 48, 50, 57, 58] and six used reports from both settings [53, 56, 59, 61, 62, 64]. Details of quality criteria met by individual studies are presented in Appendix 1 (see supplementary data on the Journal’s website http://www.ageing.oxfordjournals.org).

Prospective before-and-after studies of bedrail reduction (Table 1)

Five such studies were identified; [7, 45–48] all succeeded in reducing bedrail use. Two studies met eight of a possible total of ten quality criteria [46, 48] two met seven quality criteria [7, 47] and one met five quality criteria [45]. One study described a non-significant decrease in falls [7], two described a significant increase in falls [45, 47], one described a significant increase in multiple fallers [48] and one described a significant decrease in falls rates in the patients who had bilateral bedrails removed, although falls remained significantly less likely to occur in the patients who continued to use bilateral bedrails [46]. Subsets of visually impaired patients [45] and patients with a history of stroke [48] experienced significantly increased rates of falls. One study described an apparently significant reduction in serious injuries [47] but only if minor or suspected head injuries, where nurses checked neurological observations, were defined as serious injuries. None of the studies found any significant changes to overall injuries, fractures or subdural haematoma.

Aims

We aimed to systematically identify and evaluate the empirical evidence for the use or removal of bedrails, and their effect on physical injury or falls, or any other effect, including appraising the capacity of the evidence to support the strong opinions frequently expressed in the literature. We intended the review to provide a resource to inform clinical practice and to identify gaps for future research.

Methods

Overall methodological approach and justification

The methods employed conformed to the principles set out in Quality of Reporting of Meta-analyses guidance [39]. The criteria for inclusion were deliberately broad, including studies of various design type (not restricted to randomised controlled trials) so that studies often cited in the debate over bedrail use could be set out and appraised. Meta-analysis was not attempted, as a recent meta-analysis on falls prevention in institutions identified very few papers where standardised outcome data could be extracted [15].

Search strategy and selection criteria

A search was made for articles published between 1 January 1980 and 30 June 2007 using the MeSH terms: restraint, restraint-physical, bedrail, side rail, cot-side, safety rail and protective device. An additional search was made on the websites of patient safety agencies. Full search strategies, including the databases, websites and the full list of studies rejected (with rationale) are available in Appendix 1 (see supplementary data on the Journal’s website http://www.ageing.oxfordjournals.org).

This review aimed to locate in adult healthcare settings studies of the following:

(i) The effect of bedrails on falls and injury, including studies of bedrail reduction
(ii) Direct injury apparently from bedrails
(iii) Any other effect of bedrail use

is thus uninformed by a comprehensive and current critique of the empirical evidence on bedrails, but is strongly influenced by a body of published literature with an overwhelmingly negative emphasis. The three main arguments used against bedrails are that their use is morally impermissible; that they are ineffective in preventing falls; or that they are inherently dangerous (either through direct injury, or through increasing the risk of falls and injury). Statements to the effect that bedrails are ‘dangerous and possibly unethical’, [34] cause ‘humiliation’ [35] and constitute ‘a type of physical abuse’ [36] are commonplace. This complicates the existing clinical challenge staff face in balancing patient safety with the promotion of independence and rehabilitation [5, 13, 29, 37, 38]. Whilst such emotive presentation renders objective analysis of the evidence difficult, it is precisely this challenge that this paper seeks to address.
Case–control and cohort studies of the relationship between falls and bedrail use
The single case–control study [49] (five quality criteria met) found that having one or more bedrails raised was associated with a significantly reduced risk of falling (Table 2). One retrospective cohort study [13] (five quality criteria met) found that, once adjustments were made for differences in dependency and cognitive impairment, there was no significant difference in falls or injury. A further unadjusted prospective cohort study [50] (four quality criteria met) also found no significant differences.

Retrospective surveys, case series and case reports
Sixteen such studies [14, 51–65] were included. Five described injury rates in falls from bed with and without bedrails [14, 52, 54, 63, 65] but only the multi-hospital study [14] found significant differences, with falls from bed with bedrails raised significantly less likely to result in injuries, particularly head injuries (see Appendix 3 in the supplementary data on the journal’s website http://www.ageing.oxfordjournals.org). One retrospective survey of legal claims after falls from bed [60] found that bedrails were raised in only 2.6% of cases. Twelve studies described direct injury from bedrails or injury in falls after bedrail failure, ranging from fatal entrapment to minor injuries [14, 51–53, 55–59, 61, 62, 64]. Four of these [53, 56, 59, 64] drew from the same dataset (Figure 2) and found that ‘half-rails’ (an outmoded inverted triangle design) were significantly more likely to be associated with death, full rails with non-fatal injury, and split rails with near misses (where a patient was entrapped but released without injury) [56].

Discussion
What this review adds
This article describes the most comprehensive systematic review and synthesis of published evidence of the effect of bedrails on falls and injury to date and examines the quality and limitations of existing research. By extending its focus beyond RCTs and the few studies where standardised outcomes can be calculated to include observational or quasi-experimental studies, it provides an inclusive analysis which allows users to see the range and the limitations of evidence often used by those advocating strongly against bedrail use. It also offers direction for future research.

Methodological limitations and interpretation of findings
We did not identify any RCT, so the level of evidence is far less robust than in a Cochrane review or meta-analysis [40]. Even the eight better-designed studies [7, 13, 45–50] met only between four and eight quality criteria out of a maximum of ten. The very nature of bedrail use as a ‘low-tech’ intervention already routinely embedded in practice, the high prevalence

Figure 1. QuoRoM Flow diagram for selection and inclusion of studies.
### Table 1. Prospective before-and-after studies of bedrail reduction

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study type</th>
<th>Number of quality criteria met [44]</th>
<th>Study population</th>
<th>Intervention</th>
<th>Falls (rate per 1,000 bed days)</th>
<th>Falls rates (statistical significance)</th>
<th>Injured patients (numbers)</th>
<th>Injury (statistical significance)</th>
<th>Other outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown, 1997 [45]</td>
<td>Prospective before-and-after study of bedrail reduction</td>
<td>5/10</td>
<td>93 US nursing home residents individually tracked 6 months before/6 months after. Mean age 85.6 years; 80.6% female, 66% highly dependent</td>
<td>Education of staff and bedrail reduction programme. Bedrail reduction achieved but specific level not stated</td>
<td>‘Falls in bedrooms at night’ pre 16, post 35</td>
<td>Pre 0.94, post 2.07 (^{1})</td>
<td>Total injured not stated</td>
<td>States not tested due to small numbers</td>
<td></td>
</tr>
<tr>
<td>Capezuti, 2007 [46]</td>
<td>Prospective before-and-after study of bedrail reduction</td>
<td>8/10</td>
<td>251 US nursing home residents individually tracked up to one year before/one year after. Mean age 83.6, 77.7% female</td>
<td>Education of staff, selection (non-randomised)(^{2}) by advanced practice nurse of patients to continue or discontinue bedrails, bedalarms, floor mats, low beds. Bedrail reduction achieved: 100% raised bilateral reduced to 48. 0% raised bilateral</td>
<td>‘Falls in bedrooms’ between 2,100 and 06,000 pre 44, post 251</td>
<td>Continue group pre 1.19, post 0.69. Discontinue group pre 3.78, post 2.04 (^{4})</td>
<td>Discontinue group significantly more likely to fall than continue group, both pre- and post-intervention ((P &lt; 0.001))</td>
<td>States not tested due to small numbers</td>
<td></td>
</tr>
</tbody>
</table>

\(^{1}\) Increase in falls significant: \(x^2P = 0.008\).

\(^{2}\) Increase in falls amongst subset of visually impaired significant: (Zelen Exact \(P = 0.01\)).

\(^{3}\) Total injured not stated ‘serious injuries’.

\(^{4}\) States not tested due to small numbers.
### Table 1. (Continued)

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study type</th>
<th>Study population</th>
<th>Intervention</th>
<th>Falls (numbers)</th>
<th>Falls rates (per 1,000 bed days)</th>
<th>Falls rates (statistical significance)</th>
<th>Injured patients (numbers)</th>
<th>Injury (statistical significance)</th>
<th>Other outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanger, 1999 [47]</td>
<td>Prospective before-and-after study of bedrail reduction</td>
<td>135 beds (1968 patients) in NZ rehabilitation hospital for older people, 6 months before/6 months after</td>
<td>Policy and education to reduce bedrail use, better treatment of delirium, use of toileting programmes, and patients nursed on mattresses on floor. Bedrail reduction achieved: 29.6% bedrails attached reduced to 11.5% bedrails attached</td>
<td>‘Falls around the bed,’ pre 186, post 232</td>
<td>Pre 8.9, post 10.6&lt;sup&gt;5&lt;/sup&gt;</td>
<td>Original paper states increase not significant (unpaired Students t-test, P value not given). Original paper also applies 95% CI to the mean rate of falls around the bed pre- and post-intervention per 100 admissions (P = 0.09) and per 10,000 bed days (P = 0.12). A subsequent meta-analysis found the increase in falls significant (rate ratio 1.16, 95% CI 1.01–1.34)</td>
<td>Total injured patients: pre 76, post 78</td>
<td>Minor injuries: pre 43, post 42, ‘serious injury’&lt;sup&gt;6&lt;/sup&gt; pre 33, post 33</td>
<td>Falls from bed</td>
</tr>
<tr>
<td>Hoffman, 2003 [7]</td>
<td>Prospective before-and-after study of bedrail reduction</td>
<td>180 beds (successive residents) in three US dementia care, rehabilitation and hospice care units over one year before/one year after</td>
<td>Removal of bedrails, addition of crash mats, hip protectors, body pillows, position alarms, moving bed next to wall. Bedrail reduction achieved: 31.3% raised bilateral reduced to 18.3% raised bilateral&lt;sup&gt;10&lt;/sup&gt;</td>
<td>‘Falls from bed’ pre 142, post 126</td>
<td>Pre 2.28, post 2.13</td>
<td>Study states reduction in falls not statistically significant using χ² but P value not given. A subsequent meta-analysis confirmed decrease in falls NS (rate ratio 0.93, 95% CI 0.73–1.19)</td>
<td>Injured patients: pre 42, post 35</td>
<td>Of which hip fracture: pre 1, post 2</td>
<td>Study states reduction in patients injured NS using χ² but p value not given</td>
</tr>
</tbody>
</table>
The effect of bedrails on falls and injury

Si, 1999 [48]
Before-and-after study of bedrail reduction
8/10 25 beds (246 residents) in USA rehabilitation units within nursing homes over 1 year before/1 year after. Mean age 83.1, 87% female
Education of staff, advice from advanced practice nurse. Addition of bed alarms, non-slip floors and shoes, transfer rails, exercise. Bedrail reduction achieved: 'virtually all' raised bilateral to 19/130 (14.6%)

"Falls within ten feet of the bed" pre 19, post 31
pre 3.68, post 5.42
No statistical tests on overall falls. States patients significantly more likely to experience multiple (>2) falls post-intervention (RR = 4.95% CI not stated). States patients admitted with stroke significantly more likely to fall post-intervention (RR = 2.95% CI stated as '0.68-5.10') No significant changes in falls pre- and post-intervention in patients admitted with hip fracture

Injured patients:
pre 2, post 2 of which subdural haematoma: pre 0, post 1

Median length of stay:
42 days before, 40 days after

1 Based on assumption all 93 residents completed 6 month before/6 month after to be included in study.
2 Residents selected for discontinue group had significantly better functional status (P = 0.001) and mobility (P = 0.002) than the continue group, and were significantly more likely to be on antipsychotic drugs (P = 0.04).
3 Calculated from 9 serious injury falls representing 3.68% of pre-intervention total falls and 4 serious injury falls representing 1.99% of post-intervention total falls.
4 Converted from per resident per month.
5 Serious injury is defined as fractures, dislocated joints, subdural haematoma, lacerations requiring suturing.
6 Converted from per 10,000 bed days.
7 Minor injuries defined as anything not defined as a serious injury.
8 Serious injury is defined in Table 2 of the original paper as fractures, dislocations, skin lacerations requiring plastic surgery, suturing or grafts, and hip pain without fracture. However, if the text of the paper is read the apparent change in serious injury occurred in an extra category not included in the results tables but defined within the text as minor head injuries where neurological observations were taken. It appears minor bruises and lacerations to the head were counted as minor injuries unless neurological observations were taken, in which case they were counted as serious injuries.
9 Calculated from falls numbers and falls rates per 10,000 days within the paper.
10 The project encouraged placing beds against the wall, so some of the reduction in bilateral bedrail use occurred where one side of the bed was against the wall and one bedrail was in use on the other side of the bed. Also implies bedrail use increased in periods when the researchers were not inspecting the unit 'the use of rails was somewhat variable. Rail use tended to decrease. . . immediately after intense feedback and monitoring' Taken from Table 3 in the original paper, using Table 2 in the original paper would give different percentages.
11 Residents pre-intervention group had significantly less requirement for assistance (P = 0.012) and were significantly more likely to be female (P = 0.003) than the post-intervention group.
12 Calculated from number of falls, number of admissions, and mean length of stay.
Table 2. Case-control and cohort studies of the relationship between falls and bedrail use

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study type</th>
<th>Number of quality criteria met</th>
<th>Study population</th>
<th>Differences between bedrails/no bedrails patients</th>
<th>Statistical significance (falls)</th>
<th>Findings on injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capezuti, 2002 [13]</td>
<td>Retrospective cohort study comparing reported falls for 131 patients with bilateral bedrails with 188 patients with partial or no bedrails, utilising patient characteristic data collected in an earlier body restraint reduction study</td>
<td>5/10</td>
<td>Three nursing homes in the USA over one year in 1990/1991. Mean age 82.8 years, 87% female</td>
<td>Patients given bilateral bedrails significantly less independent and more cognitively impaired ($P = 0.0001$).</td>
<td>When adjustments were made for the differences between groups, no statistically significant difference in the likelihood of falling (AOR = 1.13 95% CI 0.45–2.03) or recurrent falls (AOR = 1.25 95% CI 0.33–4.67)</td>
<td>Overall injury not stated Bilateral bedrails ($n = 130$) 2 hip fractures, 1 subdural haematoma. Partial bedrails ($n = 188$) 2 hip fractures. States serious injuries too few for statistical analysis</td>
</tr>
<tr>
<td>Krauss [49]</td>
<td>Case-control study comparing 98 hospital patients who fell with 318 non-fallers matched for length of stay</td>
<td>5/10</td>
<td>Large urban academic hospital in the USA, including general and psychiatric patients (no other overall demographics given)</td>
<td>Not stated</td>
<td>Having one or more bedrails raised was associated with a significantly reduced risk of falling (AOR 0.006 95% CI 0.001 to 0.024).</td>
<td>Not stated</td>
</tr>
<tr>
<td>Kron, 2003 [50]</td>
<td>Prospective cohort study of 472 patients' characteristics (including bedrail use) analysed in conjunction with retrospective recording of falls over following 12 months</td>
<td>4/10</td>
<td>Three nursing homes in Germany in 1998/99. Mean age 84 years, 77% female</td>
<td>Not stated</td>
<td>OR of falling with bedrails 0.7 (95% CI 0.5–1.1) OR of multiple falls with bedrails 0.9 (95% CI 0.6–1.5)</td>
<td>Not stated</td>
</tr>
</tbody>
</table>
of frailty and cognitive impairment in potential study populations, and the fact that both bedrail use or removal can be seen as interventions, may make the lack of high-quality evidence inevitable [41, 43, 66]. Additionally, most studies were based on reports from frontline staff, a method limited by incomplete data and under-reporting [14, 19–21]. However, it can be argued that the role of systematic reviews ‘is not to let the desire for “best” evidence stand in the way of using the best available evidence.’ [43]

The best evidence we located were four of the five before-and-after studies of bedrail reduction which met seven to eight quality criteria [7, 46–48], whilst one before-and-after study was of lower quality [45]. However, even well designed before-and-after studies can be confounded by concurrent changes in staffing, treatment and patient case-mix [48]. Two of these studies [45, 46] tracked individual nursing home residents, whose deteriorating health and mobility over one [45] or two years [46] potentially confounded the findings. Most bedrail reduction studies concurrently introduced additional interventions, including hip protectors, [7] movement alarms, [7, 46, 48] toileting regimes [47] and crash mats [7, 46]. Although unlikely to account for the observed increases in falls from bed in three studies [45, 47, 48] their introduction may have created a ‘Hawthorne effect’ [42], increasing reporting of falls. One bedrail reduction study [46] found significant baseline differences in mobility, falls history, independence and medication between the patients selected to continue using bedrails and the patients selected for bedrail reduction likely to confound the results. None of these studies showed significant differences in overall injury or fracture rates but were likely to be underpowered to detect these, and the single significant finding that neurological observations were less likely to be recorded after bedrail reduction [47] may be a measure of nurses’ beliefs rather than of seriousness of injury. Although overall, the before-and-after studies suggest that unselective reductions in bedrail use may contribute to an increase in patient falls, particularly in patients with stroke or visual impairment, the methodological issues mean this cannot be a firm conclusion.

Three further studies met at least four quality criteria. The single case–control study [49] showed a significantly lower rate of falls in patients with bedrails raised, which needs to be interpreted with caution as only length of stay was controlled for, and other uncontrolled differences between the groups might account for the reduced rate of falling. The two cohort studies [13, 50] found no significant difference in falls rates with or without bedrails, but are likely to be confounded by differences between patients who have or have not been provided with bedrails; [1, 4, 13] even when some differences are adjusted for [13] others will remain.

The design of retrospective surveys, case series, and case studies means they inherently fail to meet quality criteria, but may still provide useful circumstantial information. The five retrospective surveys of falls from bed can only provide information on the likelihood of injury once a fall has occurred, but none supported the current orthodoxy that injury is more likely in falls with bedrails because patients will climb over them and fall from a greater height. Some patients may do so [14, 65] but the largest study found injury, particularly head injury, appeared significantly less likely in falls from bed with bedrails, with most falls from beds with bedrails raised appearing to be feet-first towards the bed end rather than through climbing over bedrails [14]. The study based on legal cases [60] relied on an inherently biased sample but suggests relatives view failure to raise bedrails as negligent. The studies of injury or death from bedrail entrapment or failure describe incidents generally linked to problems with maintenance, assembly or outmoded equipment design rather than to bedrail use itself. Inevitably, these studies cannot provide information on the injuries which might have occurred if the devices had not been used, and few provide data to assess how frequently such injuries occur; one UK study [14] suggests deaths linked to bedrail entrapment in hospitals have been reported at the rate of around one per 20 million admissions, with minor direct injuries from bedrails estimated at 1,250 per 10 million admissions. The US studies [53, 56, 59, 64] suggest an annual average of around 20 deaths through bedrail failure or entrapment across hospital, nursing home and domestic settings.

Our search found no studies describing any effects of raised bedrails other than those on falls and injury described above. Of these, only two included data on any other potential effects of bedrail use and these noted only marginal increases [47] or decreases [48] in length of stay despite substantial decreases in bedrail use. Because a perceived risk of falls is the nurses’ main rationale for providing bedrails [1, 4, 5], it is unsurprising to find that patients provided with bedrails are older, less mobile, more cognitively impaired and more likely to be incontinent than patients who are not provided with bedrails [1, 2, 13, 67–69]. Where bedrails have been described as causing incontinence, confusion or reduced mobility [5, 55, 63, 70], this appears to arise from mistaking correlation for causation.

Why is there a mismatch between the evidence and orthodoxy?

Despite the weak methodological quality of many of the studies, the evidence presented in this review does not support the prevailing orthodoxy that bedrails increase the likelihood of falls and injury, or that bedrails result in an inherent risk of fatal entrapment. So why the current negative view of bedrail use? There appear to be a number of interlocking issues that influence practitioners and policy makers.

Evidence-based practice requires critical appraisal, rather than partial citation. Despite the old dictum that ‘absence of evidence is not the same as evidence of absence of effect’ [41] commentators have stated that bedrails should not be used to prevent falls from bed on the basis of no significant findings in inadequately powered arms of studies [7, 35, 36] or because no RCTs have been carried out [34, 71].
Entrapment between bedrail bars, or between bedrail bars and the bed frame

Some deaths occurred through head or chest entrapment in poorly designed bedrails, especially wide gaps between vertical bars in bedrails not permitted by current safety standards [87,89] wide gaps between the lowest horizontal bar in bedrails and the bedbase, and triangular gaps in a specific design referred to as a ‘half’ bedrail. Some deaths occurred where the gap between the top of the bedrail and the head of the bed did not conform to current standards and patient’s neck was trapped in the gap. Together these entrapments between or below bedrail bars or between the top of the bedrail and the head of the bed accounted for 36% of deaths and injuries, and an additional 13% of cases involved non-fatal injury from limb entrapment between the rails [56]. These types of fatal entrapments are unlikely to occur if inter-rail and under-rail spaces are less than 12cm whilst gaps between the top of the bedrail and the head of the bed are less than 6cm or more than 25cm [87]

Poorly attached or broken bedrails leading to falls from bed

21% of deaths and injuries occurred because bedrails fell off and the patient fell to the floor, either because the bedrail broke, or because the bedrail was not properly attached [56].

Entrapment between the mattress and the bedrail

17% of deaths and injuries occurred when the patient became trapped between the side of the mattress and the bedrail [56]. This risk usually occurs when the mattress is not an appropriate size for the bed [87] or with specific types of pressure relieving mattress [59].

Entrapment through body restraints caught on bedrails

Some deaths and injuries occurred through body restraints becoming caught on bedrails, leading to suffocation [62]. These deaths would not occur where body restraints are not used.

Entrapment in the central gap between split bedrails

Rarely (4% of cases) deaths or injuries occurred when patients slid either head or feet first through the gap between split bedrails, and became stuck halfway [56].

Postural asphyxiation through collapsing with neck or chest over bedrails

Very rarely (<1% of cases) deaths occurred when the patient’s upper body was ‘draped’ across the top of the bedrail, compressing their chest or neck [64]. The patients who died in this way appear to have been extremely weak or paralysed. This risk would remain even with correctly maintained and fitted bedrails.

Figure 2. How bedrails can cause death and injury.

Implications for policy, practice, and research

Overall, whilst the evidence base is of limited quantity and quality, it does not support the prevailing orthodoxy that bedrail use should be eliminated or strictly curtailed on the basis of bedrail effect on falls, injury in falls or direct injury, and suggests wholesale bedrail reduction may increase the risk of falls. Practical and ethical considerations mean that bedrails are not usually appropriate for a patient who could be independently mobile without them, or for a patient with capacity who does not want them, nor for a patient with severe confusion who is mobile enough to climb over them. But for patients who request bedrails, or who are incapable of leaving their bed without help, bedrails are unlikely to act as restraint, or restrict independence. For patients without decision-making capacity, staff have a duty of care to act in their best interests [77, 78] underpinned by realistic assessment and regular review of the individual risks of bedrail use or non-use [79].
Bedrails should never be a substitute for adequate levels of care and observation [6, 38, 80] or used as a stand-alone method of falls prevention [14, 15, 37]. Crash mats, movement alarms, and ultra-low beds are often suggested as alternatives to bedrails, their effect on reducing injury is unknown [15, 81] whilst we know that recognising and treating delirium, [82, 83] comprehensive geriatric assessment, [84] medication review, [85, 86] or multifaceted falls prevention interventions [15] can reduce falls rates in institutional settings. Healthcare organisations need to appreciate that fatal bedrail entrapment is neither random nor inevitable but can be prevented by removing outdated equipment, ensuring that all bed, mattress and bedrail combinations are compatible, maintaining equipment, and training staff to fit and use bedrails safely and appropriately [4, 53, 79, 87–89].

Whilst an RCT of bedrail use would present design challenges [90] and for ethical reasons could randomise only individuals without absolute contraindications or indications for bedrail use, the controversy is unlikely to be fully resolved until such a trial is carried out. In addition to effects on falls and injury, any other potential harms or benefits of bedrail use merit investigation, as does the effect of different bedrail designs, partial compared to full bedrails, alternatives to bedrails, and the role of policy or decision tools to support staff in assessing the risks and benefits of bedrail use for individual patients. Given the emotive nature of the bedrail debate, qualitative exploration of the views of patients and staff may also be helpful.

Conclusion
Careful evaluation of the empirical evidence on the use and non-use of bedrails does not lend adequate support to the widely held and powerful views that bedrails are inherently harmful. This review suggests that healthcare organisations should not aim for the universal reduction of bedrail use, but focus on eliminating outdated equipment and reducing inappropriate bedrail use on a case-by-case basis.

Conflicts of interest
None

Key points
- Bedrails, used to prevent accidental falls from bed, are not defined as restraints, and most patients find their use acceptable
- No evidence was located that bedrails increase falls from bed or increase fall-related injuries
- Fatalities from bedrail entrapment are not an inherent risk of bedrail use but usually relate to outmoded design, incorrect assembly and incompatible combinations of equipment
- Healthcare organisations and practitioners should be encouraged to reduce inappropriate use of bedrails rather than uncritically push for wholesale and universal reduction in use

The effect of bedrails on falls and injury

Supplementary data
Supplementary data for this article are available online at http://ageing.oxfordjournals.org.

References
(Due to the large number of references, only 29 are listed below and are represented by bold type throughout the text. The full list can be found in the supplementary data online, on the journal website http://www.ageing.oxfordjournals.org)

F. Healey et al.


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