**MEDICAL UNIVERSITY OF SOUTH CAROLINA**  
**VALUE INSTITUTE**  
Evidence-Based Practice Brief  
**Effectiveness of Low Beds for Decreasing Restraints & Falls**

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**ASK THE QUESTION**

**Question:** In hospitalized adult patients, does use of a low bed decrease use of restraints or falls with injury compared with a standard hospital bed?

**SEARCH FOR EVIDENCE**

**Databases:** PubMed, Scopus, CINAHL

**PubMed search strategy:** (“bed height” OR “low bed” OR “low beds”) AND (falls OR injur* OR restraint* OR safety)

**Filters:** Humans, English, Published last 10 years

**CRITICALLY ANALYZE THE EVIDENCE**

There were five studies found directly (Haines et al., 2010; Barker et al. 2013) or indirectly (Merryweather et al., 2015; Morse et al., 2015; Tzeng et al., 2012) addressing the use of low beds to decrease falls in hospitalized adult patients. One study (Morse et al., 2015) indirectly addressed the use of low beds without side rails, which are a form of restraint.

An RCT by Haines et al. (2010) evaluated the efficacy of a policy for low-low beds [lowered bed height of 28.5cm from ground, highest bed height of 64cm] for the prevention of falls and injuries on 18 hospital wards in Australia. Nine hospital wards had low-low beds on their unit, with priority use for patients with neurological impairment and impulsive behaviors. They found no significant differences between units with and without low-low beds for falls in bedroom and falls with injury per 1000 occupied bed days (all p > 0.05). They did, however, note a significant pre/post intervention difference in falls with injury for units with low-low beds (-0.39; 95% CI -0.75 to -0.04; p=0.03). A retrospective cohort study by Barker et al. (2013) looked for associations between the occurrence of serious fall-related injuries and implementation of low-low beds as part of the 6-PACK program. These low-low beds could be lowered to floor level, raised to a maximum bed height of 70 cm, and remained lowered to floor level at all times when high-risk patients were in bed unsupervised. They found a statistically significant reduction in serious fall-related injuries only occurred when the ratio was 1 low-low bed: 3 standard beds (IRR 0.34, 95%CI 0.16–0.70; p =0.004).
The remaining studies were all descriptive, exploratory studies. Two explored the mechanics of bed entry and egress (Merryweather et al., 2015; Morse et al. 2015), while the third (Tzeng et al., 2012) used a high-bed alert sensor network to measure how often patient beds were kept in high position [26in or higher]. Merryweather et al. (2015) found that **as bed height decreases the required torques at the hip joint significantly increases for both bed entry (mean torque 58.3+14.7Nm for low vs 43.8+13.2Nm for high, p=0.017) and bed egress (mean torque 48.2+19.0Nm for low vs 27.5+8.1Nm for high, p=0.03)**. Results of video analysis by Morse et al. (2015) led the authors to recommend that: 1) ideally the bed height should be adjustable to the patients’ needs, so that the bed “fits” the patient, 2) that entering low beds is dangerous for patients with limited hip flexion, 3) that increased effort is needed to rise out of a low bed (additional assistance was needed from staff) and 4) that differences in mechanics for entering and exiting the bed suggests the need for two heights. They also noted that side rails were used by participants to aid entry, in-bed movement and bed exiting. So, when low beds without rails were used participants had to use the mattress or head of bed to assist with turning over to sit during egress. Finally, Tzeng et al. (2012) found that occupied beds were in a high position for 5.6% (range: 0–67.18%) of the time. This wide range suggested that compliance with the high-bed alerts varied widely across the hospital.

<table>
<thead>
<tr>
<th>Author/Date/ Journal</th>
<th>Purpose of Study</th>
<th>Study Design</th>
<th>Sample&amp; Setting</th>
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<th>Design Limitations</th>
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<td>Haines et al., 2010, Journal of the American Geriatrics Society</td>
<td>To evaluate the efficacy of a policy to introduce low-low beds for the prevention of falls and fall injuries</td>
<td>RCT -cluster randomized</td>
<td>10,937 patients admitted on 18 public hospital wards in Australia -9 intervention units (5 stand-alone, 2 acute medicine, 1 rehab, 1 ortho) [median beds/ward = 30] -9 control units (7 stand-alone, 1 rehab, 1 general surgery) [median beds/ward = 26] Both groups provided falls incident reporting training</td>
<td>Low-low beds: lowered bed height of 28.5cm from ground, highest bed height of 64cm -priority for low-low beds in patients with neurological impairment Reported difficulties with using low-low beds: -ortho unit: inability to move bed into the Trendelenburg position -difficulty with ensuring patients at the highest risk were placed in low-low-beds at all times -difficulty with stock bed attachments -difficulty moving beds with existing equipment Falls in bedroom per 1000 occupied bed days were not significantly different between the intervention &amp; control groups, but there was a significant decrease pre/post intervention -ITT: 0.38 (95% CI -0.30 to 1.06, p=0.27) -per protocol: 0.48 (95% CI -0.26 to 1.21; p=0.21) -pre/post intervention: -0.39 (95% CI -0.75 to -0.04; p=0.03) Falls with injury per 1000 occupied bed days were not significantly different between the intervention &amp; control</td>
<td>Study Limitations = None <strong>RCT &amp; Quasi-Experimental Studies</strong> - Insufficient sample size - Lack of randomization - Lack of blinding - Stopped early for benefit - Lack of allocation concealment - Selective reporting of measures - Large losses to F/U</td>
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<tr>
<td>Study</td>
<td>Design</td>
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<td>Barker et al. 2013, Journal of Advanced Nursing</td>
<td>Retrospective cohort</td>
<td>356,158 inpatient admissions at a single hospital in Australia (1999-2009) using a standardized fall prevention program (6-PACK) -3946 falls -1005 fall-related injuries -60 serious injuries (fracture, subdural hematomas) Low-low beds: can be lowered to floor level and raised to a maximum bed height of 70 cm [lowered to floor level at all times when high-risk patient in bed unsupervised] -purchased in stages (1999 = 5 beds; 2004 = 13 beds; 2007 = 45 beds) -priority for low-low beds in patients with cognitive impairment (more likely to get out of bed unassisted); decision based on clinical judgement of nurse -if low-low bed unavailable, patient in standard bed at lowest level with no bed rails</td>
<td>The rate of falls increased over the 11 year period [Poisson regression Incidence rate ratio (IRR) 1.03; 95%CI 1.02–1.04; p &lt; 0.001] -rate of falls injuries (IRR 0.90; 95% CI 0.88–0.92; p &lt; 0.001) and serious fall-related injuries (IRR 0.88; 95% CI 0.82–0.96; p =0.003) both declined significantly -12% decrease in serious fall-related injuries each year A statistically significant reduction in serious fall-related injuries only occurred when the ratio was 1 low-low bed to 3 standard beds (2007-09; IRR 0.34, 95%CI 0.16–0.70; p =0.004)</td>
<td>Study Limitations = □ None Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, survey) □ Insufficient sample size □ Variables (confounders, exposures, predictors) were not described and accounted for □ Outcome criteria not objective or were not applied in blind fashion □ Insufficient follow-up, if applicable □ For prognostic study, sample not defined at common point in course of disease/condition □ For diagnostic study, gold standard not applied to all patients □ For diagnostic study, no independent, blind comparison between index test and gold standard</td>
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<td>Merryweather et al., 2015, Work</td>
<td>Descriptive, exploratory</td>
<td>12 adults (age &gt; 55) purposively selected to provide a range of 6/12 participants were unable to complete the bed egress movement (i.e., sit-to-stand)</td>
<td>Study Limitations = □ None Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, survey) □ Insufficient sample size □ Variables (confounders, exposures, predictors) were not described and accounted for □ Outcome criteria not objective or were not applied in blind fashion □ Insufficient follow-up, if applicable □ For prognostic study, sample not defined at common point in course of disease/condition □ For diagnostic study, gold standard not applied to all patients □ For diagnostic study, no independent, blind comparison between index test and gold standard</td>
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Publication Bias (e.g. pharmaceutical company sponsors study on effectiveness of drug)

Increase Quality Rating if:
- Large effect (When the relative risk of association between two factors is large or very large)
- Dose response (When the dose-response relationship increases the confidence than an effect is real and substantial)
- Plausible confounders (When plausible residual confounding is directly impacting the magnitude of effect)

Level of evidence for studies as a whole:
- High
- Moderate
- Low
- Very Low
| Angles during hospital bed entry and egress at two bed heights | Strength and mobility limitations (stature, gait)  
-2 randomly-ordered bed heights  
-low bed: 38 cm from the floor to top of mattress  
-standard bed in lowest position: 58 cm from floor to top of mattress  
-bed rails in lowered position  
Subjects (average Morse Fall Scale score 43.3±24.6):  
-3 with no observable gait impairment  
-3 with a weak or impaired gait  
-4 with Parkinson Disease  
-1 with stroke resulting in hemiplegia  
-1 surgical patient with an abdominal wound  
Subjects asked to:  
-approach to the bed from a chair positioned 10 feet from the bed  
-bed entry (stand-to-sit motion)  
-specific in-bed movements  
-finishing with bed exiting (sit-to-stand) and return to the chair  
Data collected with 3 digital video cameras and processed to establish estimates of joint torques and angles from the low bed without significant assistance from 1-2 assistants  
-4 unable to rise from the standard bed without assistants  
-for 6 able to complete the task, as bed height decreases the required torques at the hip joint increases (mean torque 48.2±19.0Nm for low vs 27.5±8.1Nm for high, p=0.03)  
For bed entry (i.e., stand-to-sit), as bed height decreases the required torques at the hip joint increases (mean torque 58.3±14.7Nm for low vs 43.8±13.2Nm for high, p=0.017)  
-there was no statistical difference in required ankle or knee torques between the low and standard bed heights (both p > 0.70)  
There was a strong, significant correlation between Morse Fall Scale score and the average torque at the knee when participants were entering the low bed (Spearman rho = 0.69, p = 0.012)  
There was a strong correlation between Morse Fall Scale score and the average torque at the hip when participants were rising from both bed heights (Spearman rho = 0.79, p = 0.059)  
Author note:  
Although the low bed may reduce the risk of injury should a patient roll out of bed, there is a high probability that 1) they may not be able to get out bed unassisted, for example, if | Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, survey)  
- Insufficient sample size  
- Sample not representative of patients in the population as a whole  
- Variables (confounders, exposures, predictors) were not described and accounted for  
- Outcome criteria not objective or were not applied in blind fashion  
- Insufficient follow-up, if applicable  
- For prognostic study, sample not defined at common point in course of disease/condition  
- For diagnostic study, gold standard not applied to all patients  
- For diagnostic study, no independent, blind comparison between index test and gold standard |
| Morse et al., 2015, Global Qualitative Nursing Research | To explore the safety of standard and low hospital beds | Descriptive, exploratory | 15 adults (mean age: 72.6 years for men, 63 years for women) purposefully selected with various disabilities to test ability to sit-to-stand and stand-to-sit in 3 different bed scenarios (random order)  
- standard bed with side rails up  
- standard bed with side rails down  
- low bed with side rails down  
Standard bed in lowest position (23 in mattress height)  
Low bed (15 in mattress height)  
Subjects:  
- 3 surgical acute care with abdominal wounds  
- 4 Parkinson disease  
- 2 hemiplegia (cane, assist belt)  
- 3 “weak and impaired” gait  
- 3 normal gait  
Subjects asked to:  
- walk to bed, sit on bed, lie down  
- move to sitting position, get out of bed, stand, walk to chair, sit down  
- use any walking aids | Side rails were used by participants to aid entry, in-bed movement and bed exiting  
- when the rails were not in position, 2 subjects pulled on the mattress or the head of the bed, and 2 subjects were unable to turn over  
- however, if the top side rail extends mid-way along the deck (or further), it will impede the bed entry and exit of the patient  
Patients are of different heights and abilities, so ideally the bed height should be adjustable to the patients’ needs, so that the bed “fits” the patient  
- entering low beds is dangerous for patients with limited hip flexion  
- increased effort is needed to rise out of a low bed (additional assistance was needed from staff)  
- differences in mechanics for entering and exiting the bed suggests the need for 2 heights | Study Limitations =  
- Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, survey)  
- Insufficient sample size  
- Sample not representative of patients in the population as a whole  
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| Tzeng et al., 2012, Contemporary Nurse | To measure the percentage of the time that patient beds were kept in high position | Descriptive, exploratory | Overall, occupied beds were in a high position for 5.6% (range: 0–67.18%) of the time - occupied beds were left in a high position for 5.40% (range: 0–63.57%) of the time in the day shift, 6.88% (range: 0–87.53%) of the time in the evening shift, and 4.38% (range: 0–50.63%) of the night shift. Average bed height for 30 cases 25.04in (range: 24-29.6) | Study Limitations = □ None Non-Experimental/Observational Studies (case-control, cohort, cross sectional, longitudinal, descriptive, epidemiologic, case study/series, survey) □ Insufficient sample size □ Sample not representative of patients in the population as a whole □ Variables (confounders, exposures, predictors) were not described and accounted for □ Outcome criteria not objective or were not applied in blind fashion □ Insufficient follow-up, if applicable □ For prognostic study, sample not defined at common point in course of disease/condition □ For diagnostic study, gold standard not applied to all patients □ For diagnostic study, no independent, blind comparison between index test and gold standard |

| | | | | |

REFERENCES


Appendix A: GRADE criteria for rating a body of evidence on an intervention
Developed by the GRADE Working Group

**Grades and interpretations:**
- **High:** Further research is very unlikely to change our confidence in the estimate of effect.
- **Moderate:** Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
- **Low:** Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
- **Very low:** Any estimate of effect is very uncertain.

**Type of evidence and starting level**
- Randomized trial—high
- Observational study—low
- Any other evidence—very low
### Criteria for increasing or decreasing level

#### Reductions
- Study quality has serious (–1) or very serious (–2) problems
- Important inconsistency in evidence (–1)
- Directness is somewhat (–1) or seriously (–2) uncertain
- Sparse or imprecise data (–1)
- Reporting bias highly probable (–1)

#### Increases
- Evidence of association† strong (+1) or very strong (+2)
- Dose-response gradient evident (+1)
- All plausible confounders would reduce the effect (+1)

†Strong association defined as significant relative risk (RR 2-5 or 0.5-0.2) based on consistent evidence from two or more studies with no plausible confounders;
Very strong association defined as significant relative risk (RR >5 or <0.2) based on direct evidence with no threats to validity