The Effect of a Hospital Bed Turn Assist Feature on Biomechanical Responses When Turning Patients

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1. Introduction
Turning patients in bed is one of the most common patient handling activities performed by healthcare workers and is associated with risk of injury (Waters, 2007). Several studies have performed biomechanical analyses of turning patients (e.g., Gagnon, 1988; Skotte, 2002; Schibye, 2003; Skotte, 2008) but this body of literature has two important limitations. First, previous studies of patient turning have only considered the actual rotation of the patient and not the lateral repositioning that is commonly performed immediately beforehand. This lateral repositioning typically involves pulling the patient using a draw sheet in the direction opposite the turn so that the patient is not rolled into the side rail of the bed. Second, no studies have evaluated the physical demands on caregivers when turning patients using patient handling aids. These gaps in knowledge present challenges when designing care practices that allow caregivers to safely turn patients.

2. Methods
Nine female nurses turned two healthy subjects acting as dependent patients on an ICU bed while motion capture, ground reaction forces, and hand force data were recorded. The patients weighed 63-kg and 123-kg. Nurses were free to adjust the height of the bed and the limbs of the patient before each trial. Patients lied on a draw sheet and were turned toward the nurse with and without “turn assist,” a common feature in which air bladders in a mattress inflate to rotate the patient laterally in bed. The lateral repositioning activity that often precedes turning was performed only for the smaller patient and was analyzed separately from the lateral rotation. This lateral repositioning was also tested with turn assist to determine whether the feature reduced pull forces. Joint locations were estimated from motion capture data and imported into a static strength biomechanical modeling program (3DSSPP, University of Michigan) to estimate compression forces on the spine. Repeated measures ANOVA and pairwise comparisons were performed to compare the effects of patient size and turn assist on spinal compression forces and hand forces.

3. Results
Both the turn assist feature and patient weight significantly affected spinal compression forces. For the heavier patient, peak spinal compression forces averaged 2474 N (SD 247 N) for the manual turn and 1956 N (239 N) with turn assist. For the lighter patient, compression forces were 2164 N (254 N) for the manual turn and 1740 N (300 N) with turn assist. When laterally positioning the 63-kg patient before the turn, spinal compression forces at the L4/L5 were small because of the horizontal direction of hand force. However, pull forces at the hands were very large, averaging 340 N (40 N) when performed manually and 253 N (25 N) with turn assist.

4. Discussion
Turn assist reduced peak compression forces when turning both the lighter and heavier patient and reduced pull forces for lateral repositioning. Rotating the patient did not exceed the NIOSH recommended action limits of 3400 N of spinal compression for the conditions tested in this experiment. These results are consistent with previous studies that also found spinal compression forces below the action limits. Although peak spinal compression forces above 3400 N were observed in this study, greater forces may be experienced when turning heavier patients or for heavier nurses with a greater torso weight to support. Even with peak spinal compression forces below 3400 N, turning patients is a very common activity and that will contribute to cumulative spine loading which has been associated with risk of back injury.
(Waters, 2006). Because of these risks, healthcare workers may still benefit from enlisting the help of a second caregiver or from using aids like turn assist.

Although compression on the spine when turning a patient was modest, the pull forces required to laterally reposition the smaller 63-kg patient far exceeded recommended guidelines. For example, the 340 N mean pull force measured in this study far exceeds the psychosocial limits determined by Snook (1991) that recommend 226 N to accommodate 90 percent of the female population in similar pulling circumstances. These large pulling forces on a relatively light patient highlight an activity with high risk of injury that may have been overlooked in past studies on patient turning. Turn assist may present a new opportunity to reduce forces from lateral positioning.

References


