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Post-operative Inpatient Falls Among Major Lower Limb Amputees

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Abstract

Purpose of Review Amputees are at the highest risk of any subgroup to experience a fall during their inpatient stay. This review seeks to enhance the understanding of amputee falls risk and explore ways to prevent or mitigate damage due to inpatient falls.

Recent Findings Falls among lower limb amputees occur at a rate of 16.5% immediately after surgery while in the acute care hospital and 20.5 to 35% during inpatient rehabilitation. Three percent of patients experience a fall significant enough to require revision surgery and almost half of those are revised to a higher level. Unilateral transtibial amputation and diabetes mellitus as an indication for amputation are independently associated risks of an inpatient fall. In addition to assorted benefits, removable rigid dressings have been demonstrated to protect the residual limb from damage due to inpatient falls.

Summary Devices designed to protect the residual limb from possible damage due to an inpatient fall should be routinely considered in order to mitigate a possible return to the operating room for revision surgery and allow the rehabilitation process to continue uninterrupted.

Keywords Amputee and falls · BKA and revision surgery · Amputee inpatient falls

Introduction

Lower limb amputation is defined as the removal of part or parts of the lower limb. Although there is some discrepancy in the published medical literature, there is general agreement that major limb amputations include those at or proximal to the ankle. Approximately 2 million people in the USA are living with limb loss and an estimated 185,000 major limb amputations occur annually [1, 2]. Approximately 150,000 individuals in the USA are admitted to acute care hospitals to undergo an amputation secondary to peripheral vascular disease or diabetes [3]. By 2050, the number of US citizens living with limb loss is expected to grow to 3.6 million, primarily as a function of the rising rate of diabetes [4].

Hospital-acquired falls remain a recalcitrant public health problem in the USA. The World Health Organization (WHO) defines a fall as an unexpected event in which the participants come to rest on the ground, floor, or lower level [5]. Thirty to fifty percent of hospital falls result in a range of injuries, varying from severe bruises, lacerations, broken bones, and reopened surgical wounds [6]. Falls occur frequently in the USA with rates ranging for 3 to 5 falls per 1000 acute care bed days each year [6]. It is estimated that between 1 and 3% of hospital falls result in a fracture, but even minor injuries can result in anxiety and delay rehabilitation.

Consequences of Amputee Inpatient Falls

Hospital-acquired falls are a common occurrence, especially so for lower limb amputees [7, 8]. Researchers found that the highest risk of a fall in the amputee population are unilateral transtibial amputees and those with diabetic etiology [9]. Postural stability is impaired in diabetics because of the peripheral nerve damage leading to impaired lower limb proprioception, tactile sensitivity, sense of vibration, and kinesthesia [10]. In fact, patients suffering a lower limb amputation due to diabetes have greater postural instability than those with lower limb amputation due to trauma [11]. The

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reported incidence of falls is 16.5% for amputees in the acute care setting post-operatively [12]. Within inpatient rehabilitation facilities, the reported amputee fall incidence ranges from 20.5 to 35% [13–15]. The consequences of amputee inpatient falls can include fear of falling, reduced prosthetic acceptance, and social withdrawal [16–18]. Trauma to the residual limb can also cause hematomas, wound dehiscence, and increase the risk of wound infection. Perhaps more serious and certainly more immediate consequences of an amputee inpatient fall are limb fracture and damage to the surgical wound [19–21]. Evidence demonstrates that post-operative wound complications from falls in this already debilitated population lead to in a return to the operating room for an AKA conversion, resulting in worse functional outcomes [22].

Vlahov et al. discovered that lower limb amputation patients undergoing inpatient rehabilitation have the highest incidence of falls (28%), even more than stroke patients (24%) [23]. When age and gender are adjusted, the falls incidence difference between amputation and stroke decreased (19% vs. 17%); however, amputation remained the highest risk for an inpatient fall. Pauley et al. showed that 20.5% of amputees experienced a fall during their inpatient rehabilitation stay with 17.5% sustaining an injury and 4.5% requiring revision surgery [14]. Aligne et al. found that 7.1% of below-knee amputees who fell required a trip to the operating room for revision surgery [24]. Researchers found that 9% of amputees who fell experienced a "major injury," such as contusion, laceration, bone fracture, or ruptured suture line, and 3% experienced a fall hard enough to require revision surgery in two cycles of chart audits. In the third audit, however, when a removable rigid dressing was added fall rates were not reduced and no injuries were sustained that required revision surgery [13]. Yu et al. showed that 3.3% of amputees that experienced a fall in the acute care setting required a return trip to the operating room for revision surgery.

Using bivariate analysis, Behar et al. showed a statistically significant association between trauma to the residual limb and below-knee amputation (BKA) failure [19]. Additionally, researchers found that of the BKA patients that experienced a fall significant enough to require revision surgery, 47% had a revision to an above-knee amputation (AKA) as a final outcome. BKA failure requiring revision surgery, when accompanied with common co-morbidities such as myocardial, cerebrovascular, and renal disease, is associated with significant morbidity and mortality [25–28]. Knee preservation is critical because studies consistently have demonstrated improved mobility in below-knee amputees (BKA) compared to above-knee amputees (AKA), with more than 65% of BKA patients successfully ambulating with a prosthesis compared to less than 33% of AKA patients [29–31]. Additionally, the perioperative mortality rates for BKA patients (0.9 to 14.1%) differ greatly from AKA patients (2.8 to 35%) [26]. Loss of a knee joint, in addition to higher mortality and decreased ambulation, also results in a significant decrease in independent living and prolonged rehabilitation [32, 33]. Researchers have consistently demonstrated the importance of avoiding wound infection and residual limb trauma during the postoperative period in order to reduce the likelihood of revisions to a higher level [34].

Falls Prevention

Falls are the most common reportable incident by acute care hospitals, but the falls are not evenly distributed throughout the hospital. The rate of falls varies greatly from 1.7 to 25 falls per 1000 patient days depending on the unit and patient type [35]. Estimates are that in the USA approximately 700,000 to 1,000,000 hospital falls occur annually and are associated with over $30 billion in direct medical costs; most of which is shifted to third party payers like Medicare [36, 37]. Harvard University School of Public Health researchers concluded after examining 14,732 hospital discharge records from 24 facilities, that 78% of the costs associated with hospital-acquired falls were externalized to outside payers and 70% of the costs were associated with negligent injury [38]. Hospital falls not only account for a considerable portion of injuries to hospitalized patients but can also lead to lawsuits [39, 40]. Armed with this information, in October 2008 the Centers for Medicare and Medicaid Services (CMS) discontinued reimbursement to hospitals for costs associated with inpatient falls. For an event to be included in the broad sweeping payment restructuring scheme legislation mandated the condition fulfill three criteria: (1) be associated with high cost and occurrence, (2) result in higher payment to the hospital when submitted as a secondary diagnosis, and (3) be reasonably prevented by adoption and implementation of evidence-based guidelines. The inclusion of hospital-based falls in the CMS no-pay policy was questioned because identifying falls in claims data can be challenging and the published medical evidence demonstrating preventability remains weak [41, 42]. Regardless, CMS included falls as a part of their effort to reduce what they deemed preventable and unnecessary costs incurred during an acute care stay. Central-line associated bloodstream infections and catheter associated urinary tract infection decreased following the implementation of the CMS no-pay policy, but the payment changes have not resulted in any meaningful reduction in hospital acquired falls [43, 44]. Unsurprisingly, a well-designed and executed cluster randomized controlled trial of multifactorial fall prevention interventions demonstrated no change in fall rates compared to controls [45]. Ultimately when researchers studied the impact of the CMS no-pay policy on hospital-acquired fall prevention related practice

patterns, they concluded the policy increased utilization of fall prevention strategies despite little evidence that the measures prevent falls [46]. However, researchers have found that identifying small groups of patients at dramatically increased risk of injury due to falls and applying specific interventions did in fact reduce the incidence of injury due to falls [47]. Unilateral transtibial amputees are clearly a small subset of patients that would benefit from targeted interventions designed to reduce falls or mitigate damage due to inpatient falls. There is also a compelling business case for fall prevention because falls are associated with increased length of stay, higher rates of discharge to alternate care sites, and greater overall utilization of health care services [6]. In fact, Yu et al. demonstrated a mean increase of 32.5 days in the length of stay at the acute care hospital when a fall occurred. Another study showed that operational costs for patients experiencing a fall with serious injury were $13,316 higher than those that did not fall [48].

Despite best efforts, evidence demonstrates that the programs designed to prevent inpatient falls do not dramatically reduce the incidence of falls in acute care hospitals. Ultimately, ameliorating the high incidence of institutional falls, particularly among amputees, has proven elusive.

Interventions focused on a reduction in morbidity associated with amputee inpatient falls therefore seem to be reasonable approaches to the problem.

Mitigation of Falls Damage

Despite the lower postoperative mortality rate and higher potential for rehabilitative success, BKA patients may still suffer complications after surgery. Complications can include poor wound healing, knee flexion contractures, intractable pain, edema, diminished function, and high rehabilitation costs. Complications may lead to decreased patient satisfaction and many BKA patients fail to reach ideal outcomes [49]. In 1979, the removable rigid dressing (RRD) was designed to address many of the complications associated with a below-knee amputation [50]. A review of the total body of evidence demonstrated that use of a RRD allowed faster healing times, reduced limb edema, improved residual limb contouring in preparation for prosthetic fitting, prevented knee contractures, and reduced trauma to the limb [51••]. Two additional pieces of evidence have come out supporting the use of the removable rigid dressing as a postoperative strategy for transtibial amputees. The first study was a randomized controlled trial that compared RRDs to traditional elastic bandages (EB) [52••]. The primary outcome of interest was limb maturation. The study demonstrated a median time to residual limb maturation in the RRD group of 28 days (interquartile range, 17–51 days) compared to the elastic bandage group of 54 days (interquartile range 30–77 days). Unfortunately, patient satisfaction and complications showed no statistical difference between the two groups. Researchers concluded the use of an RRD led to a significantly shorter period to limb maturation compared to the traditional elastic bandage. The most recent study was a retrospective chart audit that compared conversions from a BKA to an AKA before and after instituting the use of RRDs [53••]. The authors reported that the conversion rate from a BKA to an AKA was reduced to 7.55% from 42.86% after instituting the routine use of RRDs for transtibial amputees postoperatively. The results were credited to improved wound healing and protection of the residual limb, although the relative contribution of each was not presented in the study.

The evidence in support of RRDs currently numbers 17 articles, with 6 level I randomized controlled trials, 7 level III retrospective matched controlled trials, and 4 level V case reports. Perhaps the least studied, yet most appreciated benefit of removable rigid dressings is protection of the residual limb when an amputee experiences a fall in the inpatient setting. Notwithstanding the reported results are dramatic. Hughes at al. reported in the acute care hospital that the annual incidence of injury to the residual limb of transtibial amputees decreased from 22% to nil within 1 year of the introduction of RRDs [54]. The actual falls rate was not reported; however, it is not unreasonable to suspect the actual number of falls decreased as the RRD served as a kinesthetic reminder of amputation when the patient transfers from the hospital bed. Additional evidence supporting the role of a postoperative protective device for transtibial amputees comes from a three-phase retrospective chart audit at a rehabilitation hospital [13]. In the first two phases, approximately 3% of BKA patients that fell injured themselves so seriously that they returned to the operating room for revision surgery. The addition of RRDs as the standard of care was the only change made in the final phase of the study and no patients suffered falls requiring immediate transfer back to care of the surgeons.

Conclusion

Transtibial amputation patients have the highest fall rate of any subset of patients in both the acute care hospital (16.5%) and inpatient rehabilitation hospitals (20.5–35%). Several studies support that approximately 3% of transtibial amputees fall hard enough to require a return to the operating room for revision surgery and 47% have an above-knee amputation as a final outcome. It seems reasonable to provide a removable rigid dressing or protective device during the postoperative acute care stay to mitigate potential damage that occurs during falls. Preventing severe damage due to falls can allow for progression of rehabilitation and a return to activities of daily living.

Declarations

Conflict of Interest Reichmann declares he has no conflict of interest. Kreulen receives royalties and consulting fees from Arthrex and consulting fees from Restor3d.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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