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Outcome From Serious Injury in Older Adults

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Abstract

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Organizing Construct: 27 primary research studies published in the last 10 years describe in-hospital and long-term outcomes of serious injury among older adults. Research specific to isolated hip injury, traumatic brain injury and burn trauma was excluded.

Methods: An integrative review of research published between January 1996 and January 2005 was carried out to examine the relationship between older age and outcome from severe injury. MEDLINE, BIOSIS previews, CINAHL and PsycINFO databases were searched using the MeSH terms: injury, serious injury, trauma and multiple trauma, and crossed with type, severity, medical/surgical management, complication, outcome, mortality, morbidity, survival, disability, quality of life, functional status, functional recovery, function, and placement.

Findings: Older adults experience higher short and long-term mortality when compared to younger adults. The relationship between older age and poorer outcome persists when adjusting for injury severity, number of injuries, comorbidities, and complications. At the same time, injury severity, number of injuries, complications, and gender each independently correlate to increased mortality among older adults. The body of research is limited by over-reliance on retrospective data and heterogeneity in definitional criteria for the older adult population.

Conclusions: Additional research is needed to clarify the contributory effect of variables such as psychosocial sequelae and physiologic resilience on injury outcome. The field of geriatric trauma would benefit from further population-based prospective investigation of the determinants of injury outcome in older adults in order to guide interventions and acute care treatment.

Keywords

injury, trauma, outcome, older adult, geriatric

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Outcome from Serious Injury in Older Adults

At the last census date in 2000, 12% (35 million) of the United States' population was aged 65 years and older (Bureau of the Census, 2001). This segment of the population is projected to double in size by the year 2020. Older adults who sustain a serious injury consume a disproportionate amount of health care resources (McMahon, Shapiro, & Kauder, 2000) and experience higher in-hospital mortality rates when compared to younger cohorts with the same severity of injury (Hannan & Hoyt, 2004; Bergeron et al., 2003; Richmond, Kauder, Strumpf, & Merdith, 2002; O'Brien et al, 2002; Taylor, Tracy, Meyer, Pasquale, & Napolitano, 2002; Albaugh, Kann, Puc, Vemulapali, Marra, & Ross, 2000; Perdue, Watts, Kaufmann & Trask, 1998). Injured older adults typically need lengthier hospitalizations and longer monitoring in intensive care units when compared to younger injured adults (Bulger, Arneson, Mock & Jurkovich, 2000 and Nagy et al., 2000). Consequently, while people over 65 years of age make up only 10% of the trauma patient population, they accrue an estimated 25% of hospital costs for trauma care. (Mackenzie, Morris & Smith, 1990). Older adults have comparatively higher post-hospitalization mortality and a greater relative decline in functional status (Gallagher et al., 2003; McGwin, Melton, May & Rue, 2000; Battistella, Din, & Perez, 1998; Gubler, Davis, Koepsell, Soderberg, Maier, & Rivara, 1997; Van der Sluis, Timmer, Eisma, & ten Duis, 1997; Van der Sluis, Klausen, Eisma, & ten Duis, 1996). It is hypothesized that these poorer outcomes result from lesser physiological reserve, higher burden of comorbidities and more frequent incidence of post-injury complications (McMahon, Schwab, & Kauder, 1996).

Only two studies published in the past decade have investigated the efficacy of specific hospital-based interventions to improve trauma outcomes in older adults (Demetriades et al., 2002 and Taheri et al., 1997). One trial demonstrated improved survival with the use of aggressive resuscitative procedures and early intensive monitoring (Demetriades et al., 2002), suggesting older adults respond well to an intensive course of treatment. A second trial demonstrated that earlier involvement of physical and rehabilitative services within the trauma team significantly reduced the length of hospitalization among injured older adults (Taheri et al., 1997).

Given an aging society, the incidence of injury in older adults, and the resources consumed, health care providers need to be prepared for an influx of older adults after serious and multisystem injury. While it is important to develop public health measures to prevent injuries in older adults, it is also important to develop further evidence-based interventions to improve outcomes once injury has occurred. Therefore, the purpose of this paper is to review the research published in peer-reviewed journals from 1996-2005 that examines the physical outcomes of traumatic injury among older adults. The review will cover both in-hospital and long-term outcomes, with a specific focus on variables that contribute to increased relative mortality in this patient population.

Background

Injury occurs when a physical force exceeds the ability of the body to withstand it, resulting in critical damage to tissues and organs. Injuries are most often the consequences of motor vehicle crashes, falls, gunshot wounds, and other physical assaults. Motor vehicle crashes are the most common causes of injury for Americans younger than 75. However, after the age of 75, falls are the most frequent mechanism (McMahon et al., 2000). The third most prevalent cause of injury is the pedestrian-vehicle crash, from which older adults have the highest fatality rate and poorest functional recovery compared to any other age group (McMahon et al., 2000; Hui, Itzach, Soukiasian, Margulies, & Shabot, 2002; Ferrera, Bartfield, & D'Andrea, 2000)

The physiologic effects of aging contribute to disparities in outcomes between younger and older injured adults. Increased age is associated with a progressive loss in an individual's physiologic resilience, decreasing the efficacy of compensatory mechanisms that protect the body after traumatic injury (Pudelek, 2002). Injured older adults have up to ten times the prevalence of preexisting conditions when compared to younger injured adults (Hannan et al., 2004). These comorbities contribute to the risk of post-injury mortality during hospitalization (Gubler et al, 1997 and Taylor et al., 2002) and after hospital discharge (Battistella et al., 1998). In addition, the effects of numerous medications frequently prescribed to older adults may mask symptoms, interfere with physiologic compensatory mechanisms and contribute to poorer outcomes.

Several aspects of aging make older adults more vulnerable to the impact of injury. However, there is no distinct age by which to quantify this risk. ‘Older’ adult is typically defined as 65 years, the eligibility age for Medicare and Social Security. This definition is not standard among injury scientists with age criteria ranging from 45 to 70 or 80 years of age. Therefore, the term ‘older adult’ must be understood in the context of widely varying age criteria.

Measurement of injury severity is difficult to universally characterize. Instruments used most frequently in this review include the: Glasgow Coma Scale (GCS), Glasgow Outcome Scale (GOS), Injury Severity Scale (ISS), Abbreviated Injury Scale (AIS), and the Revised Trauma Scale (RTS). Each instrument has relative strengths and weaknesses as measures and risk indicators for traumatic injury outcome. The appendix provides a description of common instruments used by the researchers in this review and explanation of what each tool quantifies.

Methods

An integrative literature review was conducted in which MEDLINE, BIOSIS previews, CINAHL and PsycINFO were searched in January 2005 using the MeSH terms: injury, serious injury, trauma and multiple trauma, each crossed with type, severity, medical/surgical management, complication, outcome, mortality, morbidity, survival, disability, quality of life, functional status, functional recovery, function, and placement. From the English-language, human research articles secured through this query, the search was focused to identify primary research that emphasized the older adult, elderly, aged and/or the geriatric population. As there is no single accepted criteria to define an “older adult” population, the literature that was included was not bound to any specific numerical age strata.

Once the relevant literature was identified the research pertaining to three types of injury was excluded. Isolated hip injury was excluded as it is a single system injury with a substantial body of literature addressing outcomes. Traumatic brain injury was excluded due to the unique and well documented psycho-cognitive sequela that is not comparable to other types of serious injury. Burn trauma was also excluded because of the unique medical needs, complications and outcomes specific to this patient population.

The remaining literature was organized on the basis of: study design, study population, significant findings and key implications. This body of literature was then analyzed to identify similarities and differences within each category of the organizational framework. Based on the analysis, the review process culminated in an evaluation of major gaps in the published research and the development of implications for future research and health care practices.

Findings

A review of literature published between 1996-2005 yielded 27 works of primary research from 25 different research teams. Twenty-three studies were conducted in the U.S., with others conducted in Ireland (Cunningham, Howard, Walsh, Coakley, & O'Neill 2001), Canada (Inaba, Goecke, Sharkey, & Brenneman 2003), and the Netherlands (Van der Sluis et al. 1997 & 1996).

None of the studies collected baseline data prior to injury. Because injury is an unpredictable event compared to other morbidities of older age, it is time and resource-intensive to study it using a prospective, population-based research design. Twenty-three of the 27 studies were retrospective. Typically, researchers acquired existing data from trauma registries and trauma center records. Four research teams used contact information available through registry and hospital records to contact subjects for long term follow-up (Gallagher et al, 2003; Inaba et al., 2003; Battistella et al., 1998; Van der Sluis et al., 1997; Van der Sluis et al., 1996). Four smaller studies used prospective designs. Of these, two investigations used a prospective cohort with a historical control to examine the efficacy of specific hospital-based interventions (Demetraides et al., 2002, Taheri et al., 1997). In two studies, patients were recruited during hospitalization and followed longitudinally (Ferrera et al., 1998 & 2000).

Short-term mortality

Injury survival is the key criterion by which researchers quantify a ‘good’ outcome. In-hospital mortality rates are reported as low as 4.1% (Gubler et al., 1997) and as high as 38.8% (Van der Sluis et al., 1996) for injured adults. This range may be due to different inclusion criteria, the varied types/patterns of injury and the heterogeneity of older adult cohorts in terms of: baseline health status, co-morbidities, complications and injury severity. Studies using large data sets, more likely to be representative of the older adult population, report in-hospital mortality rates among seriously injured older adults as near to 10% (Richmond et al., 2002; Hui et al., 2002; Meldon, Reilly, Drew, Mancusi, & Fallon, 2002).

Consistently, older injured adults have poorer outcomes than younger adults with comparable severity of injury. Eight of 12 studies concluded that age is an independent predictor of increased in-hospital mortality with older adults having two (Bulger et al., 2000) to five times (Bergeron et al., 2003) the risk of death in comparison to younger adults. The relationship between age and mortality persisted after adjusting for other co-morbidities and injury severity. Perdue et al. (1998), reported that after controlling for ISS, RTS, and preexisting conditions, trauma patients 65 years and older were 4.6 times (95% CI: 2.53 – 8.59) more likely to die in the hospital when compared to patients younger than 65 years. Similarly, Taylor et al. (2002) found that older adult patients had significantly higher mortality rates in every severity stratum (minor, moderate, severe).

Age is predictive of post-injury mortality, with a linear relationship between age progression and injury mortality risk. Relative to a 13-39 year old reference group, odds of mortality increase to 2.67, 8.41, 17.40, and 34.98 for age groups 40-64, 65-74, 75-84, and 85 years and older, respectively ($p<.0001$; Hannan et al., 2004). Patients over 55 years of age with flail chest injuries also demonstrated this pattern, with the likelihood of death increasing by 132% for every 10-year increase in age (Albaugh et al. 2000). Similarly, in a 10 year, state-wide trauma registry review, Richmond et al. (2002) reported the risk of mortality increased by 5% for each additional year of age for those over 65 years of age.

Three studies reported conflicting age-mortality relationships with no significant differences among in-hospital death rates between older and younger injured cohorts. Roth et al. (2001) found no significant difference in mortality between patients with penetrating trauma older than 55 years when compared to younger patients. Gallagher et al. (2003) compared patients older and younger than 60 years and found a higher incidence of cardiac morbidity in older injured patients, but no differences in short-term mortality between the older and younger cohort. Nagy et al.(2000) reported that the mortality rate among injured patients ≥56 years was nearly 2.5 times higher than a younger cohort matched for gender, mechanism of injury, and injury severity. However, this difference was not statistically significant.

Long-term mortality

Five studies investigated long-term survival, three of which focused on outcome in the years immediately following hospital discharge. Inaba et al. (2003) and Gallagher et al. (2003) both reported a mortality rate of near 40% from 2 – 2.8-years (range 1.8 – 4.5 years) post-injury in older adults. Battistella et al. (1998) found that 47% of older adults available for follow-up (81% of original cohort) had died 2 to 3 years post-injury. Gallagher et al. (2003) compared long term mortality rates of older and younger adults, finding that short-term survival after severe injury was not associated with age, but at 2 years post-injury the older adults suffered nearly four times the mortality than that of the younger adults.

Longer term mortality was examined by Gubler et al. (1997); the odds of mortality among older adults 5 years post-injury was 1.7 (95% CI; 1.7- 1.8) when compared to uninjured older adults adjusted for sex, race and comorbid conditions. At a 7-8 year follow-up Van der Sluis et al. (1997) reported a mortality rate of 29% among an older severely injured cohort, with the most reliable predictors of long-term survival being age and pre-injury health status (Van der Sluis et al., 1997).

Outcomes among survivors

Although research on older injured adults emphasizes mortality risk, other important post-injury variables include: functional status, quality of life, and/or changes in living arrangements and independence. For older adults, functional status has been defined by the ability to perform Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs) in combination with self-reported health status. Full functional recovery from injury was reported among 53% (Van der Sluis et al., 1997), 57% (Battistella et al., 1998), and 88% (Ferrera et al., 1998) of older adult cohorts. Ferrera et al. (2000) found that among survivors, the most severely injured older adults were able to achieve functional recovery at the same rate as did less severely injured older adults. Though these studies demonstrate the relationship between age and functional recovery, it is difficult to draw casual associations from these outcomes without data regarding pre-injury functional status.

Even without information about pre-injury functional status, McGwin et al. (2000) provide some evidence that injury has a negative effect on long-term functional status. Comparing an older injured cohort to an older uninjured cohort equivalent at baseline, the injured population was more likely to report fair/poor health and experience more limitations in performance of ADLs at 2 years post-injury. Without adjusting for pre-injury it is difficult to be confident in these findings.

Injury can be a precursor to a change in an older adult's living environment. There is evidence suggesting a relationship between older age and increased incidence of post-hospital institutionalization. Richmond et al. (2002) demonstrated this relationship in their study of nearly 40,000 seriously injured older adults, where the odds of discharge to a skilled nursing facility increased by 11% for each additional year of age. All studies comparing discharge status of older adults to younger adults, reported that older adults are less likely to return home and more likely to require further care at an institution. However, these studies reported widely divergent rates of discharge to skilled nursing and rehabilitation facilities. Gallagher et al. (2003) found that 91% of a cohort of severely injured older adults (ISS ≥15) aged 60 years and older were discharged to long-term care or rehabilitation programs. On the other hand, among the cohort described by Nagy et al. (2000) 91% of the older adults returned home. Part of the disparity found might be explained by the differing inclusion criteria and the variation in the availability of supportive care in the home. In comparison to the cohort studied by Gallagher et al., Nagy et al.'s study population was on average younger and less severely injured. Studies by Ferrera (2000) and Van der Sluis (1997) reported institutional discharge rates, somewhere in the middle, at 65% and 76%, respectively.

One study compared pre-injury living arrangement to post-hospitalization outcome. In this study, Inaba et al. (2003) found that although 98% of the older injured cohort lived independently at home prior to hospitalization, only 36% of injury survivors were discharged to their homes. Of the 36% that returned home, nearly 40% were unable to regain full independence at follow-up (1.8 – 4.5 years post injury).

While none of the researchers used instruments that assessed quality of life, Inaba et al. (2003) used age and country-specific SF-36 norms for adults without injury to compare the results to injured adults over 65 years who survived to hospital discharge. The injured population had significantly lower scores in physical functioning, role performance, bodily pain, perception of general health, vitality, social function, emotional health, and mental health.

Correlates of outcomes

Injury severity, number of injuries, complications, and gender have been found to correlate with increased mortality among injured older adults. It is important to look at these correlates and consider the extent to which they might confound or mediate the relationship between advanced age and poorer outcomes after injury. In all of the analyses, higher ISS was associated with increased mortality. This is not a surprising finding since ISS was specifically developed as a mortality predictor. Interestingly, this relationship persists even when mortality is not particularly high. For example, Gubler et al. (1997) found a low 4.1% in-hospital mortality rate among an older injured adult cohort. Of the patients who died, 55.9% had severe injuries and an ISS greater than or equal to 26. Higher ISS was associated with higher mortality even after adjusting for other variables (Bergeron et al., 2003; Hui et al., 2002; Meldon et al., 2002; Taylor et al., 2002; Richmond et al., 2002; Ferrera et al., 2000; Tornetta, et al., 1999). In fact, Ferrera et al. (2000) when controlling for age (above and below 80 years), gender, mechanism of injury, ISS, and comorbid and preexisting conditions, found injury severity to be the only factor to be significantly associated with mortality.

There is a progressive relationship between the magnitude of injury severity and mortality risk. Adjusting for comorbidities and number of injuries, Bergeron et al. (2003) reported that patients with an ISS >30 had over five (OR 5.48, 95% CI: 1.7–18.1) times the probability of mortality when compared to those with ISS scores between 16 and 29 (OR 1.19, 95% CI: 0.4–3.4). In their large data set study, Richmond et al. (2002) adjusted for age, complications, and number of injuries, and found the severely injured (ISS≥26) were 25 (OR 25.51, 95% CI: 14.5–44.8) times more likely to die than those in the least injured group (ISS of 0–9). Conversely as ISS decreases, so does the risk of mortality. Richmond et al. (2002) reported that among injured older adults assigned ISS scores between 10 – 15 (OR 2.76, 95% CI: 1.7 – 4.4), the probability of dying is nearly half that of injured older adults assigned ISS scores between 16 – 25 (OR 4.65, 95% CI: 2.9 – 7.4). Albaugh et al. (2000) reported a similar relationship between mortality and ISS, with the risk of death increasing by 30% for each unit increase in ISS.

In older adults, the number of injuries also affects outcome. Bergon et al. (2003) adjusted for injury severity and found that older adults with three or more fractures have 3.13 times the likelihood (95% CI: 1.3-7.6) of mortality when compared to those with single injuries. Richmond et al. (2002) reported a 10% increase in risk of death for each additional injury. Bulger et al. (2000) found the risk to be a bit higher, with 19% increase in risk for each additional injury.

Post-injury complications are associated with increased mortality among older adults (Bergeron et al., 2003; Holcomb, McMullin, Kozar, Lygas & Moore, 2003; Richmond et al., 2002; Cunningham et al., 2001; Bulger et al., 2000; Perdue et al., 1998). In one study, among patients older than 65 who were hospitalized for more than 24 hours, cardiac, renal and septic complications were all independently predictive of mortality after adjusting for injury severity and preexisting disease (Perdue et al., 1998). Among the older adults included in the analysis by Richmond et al.

(2002) cardiovascular complications nearly tripled and pulmonary complications double the risk of post-injury mortality.

Pneumonia is the most prevalent and dangerous complication after rib facture in older adults and the implications are substantial. Adjusting for injury severity, number of fractures, and comorbidities, Bergeron et al. (2003) reported that older adult patients who develop pneumonia are nearly four times more likely to die than those without pneumonia (OR 3.80, 95%CI: 1.5-9.7). Bulger et al. (2000) compared cohorts younger and older than 65 years and found that older adults were more likely to develop pneumonia (31% vs. 17%) and for each additional rib fracture the chance of mortality increased by 19%, and risk of pneumonia by 27%.

Complications of other organ systems also pose serious risk. Gallagher et al. (2003) found that cardiac morbidity affected 28% of older injured patients, but did not worsen short-term survival in older patients. Conversely, Hui et al. (2002) found cardiac complications to be an independent predictor of in-hospital mortality for older adult patients requiring intensive care following a motor vehicle crash. In a study of 22,571 patients from a trauma registry, 5.9% developed renal failure after injury, which was associated with a 10-fold increase in the risk of mortality (Taylor et al., 2002).

Gender affects the relationship between injury and mortality in older adults. In the five studies that looked at gender in relation to outcome, men had a consistently higher risk of mortality when compared to women. In two of the five studies, male gender was an independent risk factor for in-hospital mortality when adjusting for other variables. After adjusting for comorbidities, severity of injury, and multiple injuries, the likelihood of mortality from rib fractures was 2.35 (95% CI: 1.1-5.7) times higher in men than in women (Bergeron, et al., 2003). Two other studies found that men had a higher (up to 44%) risk of dying from injury when compared to women within the same older adult age strata (Taylor et al., 2002; Gubler et al., 1997). In looking at long-term survival after serious injury, Van der Sluis et al. (1997) reported that females have a significantly greater chance of survival at a 7-8 year post-injury follow-up when compared to men in the same cohort.

Discussion

Key Findings

The fact that older adults sustain and survive life-threatening injury comes as a surprise to some. Older adults not only survive serious injury, but have the potential to return to independent function. Yet, it is only in the past decade that a few injury researchers and even fewer nursing researchers began to focus on outcomes specific to seriously injured older adults. The relative dearth of research specific to geriatric trauma results in important gaps in knowledge. Older adults are at greater risk for mortality both during and after hospitalization and the relationship between older age and poorer outcome persists when researchers adjust for other important injury-related variables such as injury severity, number of injuries, comorbidities, and complications. Despite this, an important finding is that age is not the only explanation for disparate outcomes. Injury severity, number of injuries, complications, and gender each independently correlate to poorer injury outcome in older adults. Since none of the research to date includes pre-injury data collection, it is difficult to draw definitive causal relationships between aging, injury characteristics and injury outcome. Until there is a more sophisticated understanding of the physiologic processes that underlie the association between older adulthood and injury outcome, research efforts should be targeted towards those correlates that are associated with poor outcome and are amenable to nursing intervention. Towards this goal, the body of research upon which practice is based, needs further development.

Limitations

The reliance on retrospective data is a major limitation of the literature. Looking backward in time increases the difficulty in ascertaining the discrete impact of injury, separate from objective information about pre-injury health status and comorbidities. This is especially problematic when examining the impact of injury on functional status. Some studies attempted to follow-up with patients identified in trauma registries. However, this led to high attrition because contact information was collected from sources created years prior to follow-up, compromising external validity. Retrospective record review is limited by the extent and level of detail allowed by medical records. As a result, outcomes are restricted to common variables found in hospital records. The findings are most likely biased as they are limited to subjects for whom there are complete records.

A challenge to interpreting the literature is the heterogeneity of the older adult population. In this review, older adults are defined as young as 45 and as old as 100 years of age. Physiologic health and resilience vary greatly among a population group extending over five decades. To create a body of evidence that will support specific interventions, it will be important to establish a more uniform definition of the 'older adult' and to look at specific sub-segments of the older adult population to better understand the physiologic differences contributing to different outcomes.

Time-dependent effects also compromise the comparability of findings. With the progression of time, medical and nursing care evolves as new strategies and further evidence change the science of trauma care. It may not be appropriate to compare injured older adults admitted to hospitals in different time frames or to compare older adults admitted to trauma systems vs. non-trauma hospitals. Nagy et al. (2000) compared 85 older adults presenting to a trauma center between 1983 and 1998 to younger adults. The cohorts were matched for gender, mechanism of injury and injury severity. This study would have been strengthened by also matching or adjusting for year of admission to decrease the potential for differences in innovation and sophistication of care.

A final overarching critique is that within similar retrospective cohort study designs, there were quite a bit of analytic variations. Simple associations between injury characteristics and outcomes highlighted important areas, but without controlling for other important co-variates. More sophisticated regression models were employed to adjust for important co-variates and determine independent contributions to outcomes, but the variables considered important were not universal. Some researchers controlled for comorbidities and complications, and others looked at ICU length of stay and numbers of fractures. Even though injury severity was almost always assessed, the instruments (Appendix) that quantified injury severity were not consistent.

Filling gaps in knowledge

Little is known about the role of physiologic reserve, resilience and frailty on outcomes of older adults from injury. The research demonstrates the association between older age and poorer outcomes but not the underlying causative factors. Because of the distinguishing outcome characteristics of the older adult trauma patient there is a need for development of a distinct sub-specialty in ‘geriatric trauma.’ A deeper understanding of the interactions of severe injury and aging, clarified through a population-based prospective investigation would likely change the way that injured older adults are assessed and managed to enhance their chances of a functional recovery.

There is a lack of research that focuses on the role of psychosocial response after serious injury in older adults. A clearer understanding of age-related psychological vulnerability and psychosocial outcome after injury can shape potential interventions to enhance recovery. An emerging body of research suggests that depressive symptoms are associated with poor post-injury outcomes (Scaf-Klomp, Sanderman, Ormel, & Kempen, 2003; Mast, MacNeill, & Lichtenberg, 1999; Piccinelli, Patterson, Braithwaite, Boot, & Wildinson, 1999). Psychosocial variables are typically not examined in retrospective cohort studies because psychiatric and social assessments are not standard components of hospital-based trauma records or included in registries. Because physical and psychosocial health both contribute to functional status, understanding the relationship is especially important in improving long-term post-injury wellbeing.

Once the relative contributions of physiologic, injury and psychological factors that influence injury outcome in older adults are clarified, interventions can be designed and tested. Demetriades et al. (2002) showed that early intensive monitoring and the presence of a trauma surgeon in emergency departments resulted in improved outcomes for severely injured older adults. Although their use of historical controls for comparison with the results of their intervention has weaknesses, it is clear that interventions can improve outcomes in this vulnerable population.

Further trials, comparing concurrent intervention and control groups are needed to ensure that older adults respond favorably to intensive courses of treatment and rehabilitation and to define the circumstances where such interventions are worth the effort in terms of cost and quality of life.

One of the most striking findings is the lack of nursing perspectives and nursing research in this area. From the emergency room, to the ICU, to step-down units to rehabilitation facilities, nurses provide the majority of care and monitoring of injured older adults. Yet in the last ten years, the only published intervention, carried out by trauma surgeons, suggested that what was needed to change injury outcomes was more trauma surgeons. The needs of seriously injured older adults require evidence based nursing to reduce complications, enhance survival, and improve functional outcomes. In particular, nurses need to design and test interventions to meet age-specific needs of older injured patients. Generally, research has demonstrated that older injured adults require longer hospitalization after injury. Nurses are integral in developing interventions that optimize the recovery process. Early mobilization mediated by the nursing staff can prevent development of respiratory complication, deep vein thrombosis and pressure ulcers (Pudelek, 2002). While it is known that maintenance of good nutrition, appropriate pain control and emotional support (Pudelek, 2002) are essential nursing tasks in the care of the older injured adult, further evidence-based practices need to be developed to make a tangible difference in hospital-based outcomes.

Conclusion

The published research regarding seriously injured older adults is lacking, but it provides a starting point from which to think about future scientific inquiry. From this review, two recommendations emerge. First, there is a compelling need to develop a sub-specialty of geriatric trauma and to more thoroughly explore the relationship between older age and vulnerability to the effects of serious injury. Second, the factors that enhance positive outcomes in severely injured older adults need to be explored in more depth. Development of this science should include not only clinically-based studies but also those that examine the ethical and cost-benefit issues relative to outcomes and quality of life. With stronger evidence, nurses will be better prepared to develop and test relevant interventions that enhance the survival and recovery of older adults who experience severe injury.

References

Albaugh, G., Kann, B., Puc, M., Vemulapalli, P., Marra, S. & Ross, S. (2000). Age adjusted outcomes in traumatic flail chest injuries in the elderly. *The American Surgeon, 66*(10), 978 -981.

Baker, S.P., O'Neill, B., Haddon, W., & Long, W.B. (1974) The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *Journal of Trauma-Injury Infection & Critical Care*, *14*(3), 187-96.

Battistella, F D., Din, A M., & Perez, L. (1998) Trauma patients 75 years and older: long term follow-up results justify aggressive management. *Journal of Trauma-Injury, Infection & Critical Care, 44*(4), 618-23.

Bergeron, E., Lavoie, A., Clas, D., Moore, L., Ratte, S., Tereault, S., Lemaire, J., & Martin, M. (2003). Elderly trauma patients with rib fractures are at greater risk of death and pneumonia. *The Journal of Trauma, Injury, Infection, and Critical Care, 54*(3), 478- 484.

Bulger, E.M., Arneson, M.A., Mock, C., & Jurkovich, G. (2000). Rib Fractures in the elderly. *The Journal of Trauma, Injury, Infection, and Critical Care, 48*(6), 1040- 1047.

Bureau of the Census. (2001). Age 2000: Census 2000 Brief. Retrieved July 1, 2005 from http://www.census.gov/prod/2001pubs/c2kbr01-12.pdf.

Champion, H.R., Sacco, W.J., Copes, W.S., Gann, D.S., Gennarelli, T.A. & Flanagan, M.E. A revision of the trauma score. *Journal of Trauma-Injury Infection & Critical Care*, *29*(5), 623-9.

Copes, W.S., Sacco, W.J., Champion, H.R., & Bain, L.W. (1990) Progress in characterizing anatomic injury. *Proceedings of the 33rd Annual Meeting of the Association for the Advancement of Automotive Medicine*, *Baltimore, MA, USA,* 205-218.

Cunningham, C., Howard, D., Walsh, J., Coakley, D., & O'Neill, D. (2001). The effects of age on accident severity and outcome in Irish road traffic accident patients. *Irish Medical Journal, 94* (6), 168-171.

Demetriades, D., Karaiskasis, G., Velmahos, G, Alo, K, Newton, E, Asensio, M.J. et al. (2002).

Effect on outcome of early intensive management of geriatric trauma patients. *British Journal of Surgery, 89*, 1319-1322.

Ferrera, P., Bartfield, J.M., & D'Andrea, C. (2000) Outcomes of admitted geriatric trauma victims. A*merican Journal of Emergency Medicine, 18*(5), 575-580.

Ferrera, P., Bartfield, J.M., & D'Andrea, C. (1998) Geriatric Trauma: Outcomes of elderly patients discharge from ED. *American Journal of Emergency Medicine,17*(7), 629-632.

Gallagher, S., Williams, B., Gomez, C., DesJardins, C., Swan, S., Durham RM., & Flint, LM. (2003). The role of cardiac morbidity in short and long-term mortality in injured older patients who survive initial resuscitation. *American Journal of Surgery, 185*, 131-134.

Gubler, K.D., Davis, R.. Koepsell, T., Soderberg, R., Maier, R.V., & Rivara, F.P. (1997). Long-term survival of elderly trauma patients. *Archives of Surgery, 132*(9), 1010-4.

Hannan E.L., Waller C.H., Farrell L.S., & Rosati, C. (2004) Elderly trauma inpatients in Ne*w York State: 1994-1998. Journal of Trauma-Injury Infection & Critical Care, 56*(6), 1297-304.

Holbrook, TL & Hoyt, DB. (2004). The impact of major trauma: Quality of Life Outcomes are worse in women than in men, independent of mechanism and injury severity. *The Journal of Trauma, Injury Infection, and Critical Care,56*, 284-290.

Holcomb, J., McMullin, N., Kozar, R., Lygas, M., & Moore, F. (2003). Morbidity from rib fractures increases after age 45. *Journal of the American College of Surgeons, 146*(4), 549 – 555.

Hui, T., Itzhak, A., Soukiasian, H., Margulies, D. R., & Shabot, M. (2002). Intensive care unit outcome of vehicle-related injury in elderly trauma patients. *The American Surgeon, 68*(12), 1111-1114.

Inaba, K., Goecke, M., Sharkey, P, & Brenneman, F. (2003). Long-term outcomes after injury in the elderly. *The Journal of Trauma, Injury, Infection, and Critical Care, 54*(3), 486-491.

Jennett, B., Snoek, J.. Bond, M.R., Brooks, N. (1981) Disability after severe head injury: observations on the use of the Glasgow Outcome Scale. *Journal of Neurology, Neurosurgery & Psychiatry, 44*(4):285-93.

Kempen. (2003). The role of depressive symptoms in recovery from injuries to the extremities in older persons. A prospective study. *International Journal of Geriatric Psychiatry, 15*, 14-22.

MacKenzie, E.J., Morris, & J.A., Smith, G.S. (1990) Acute hospital costs of trauma in the United States: Implications for regionalized systems of care. *Journal of Trauma, 30*, 1096-1101.

Mast B.T., MacNeill S.E., & Lichtenberg P.A. (1999) Geropsychological problems in medical rehabilitation: dementia and depression among stroke and lower extremity fracture patients. *Journals of Gerontology Series A-Biological Sciences & Medical Sciences. 54*(12), M607 -12.

Meldon, S.W., Reilly, M., Drew, B.L., Mancusi, C. & Fallon, W. (2002) Trauma in the very elderly: a community-based study of outcomes at trauma and nontrauma centers. *The Journal of Trauma, Injury, Infection, and Critical Care, 52*(1), 79 –84.

McGwin, G., Melton, S, May, A., & Rue, L. (2000). Long-term survival in the elderly after trauma. *The Journal of Trauma, Injury, Infection, and Critical Care,* 49(3), 470-476.

McMahon, D.J., Shapiro, M.B., & Kauder, D.R. (2000) The injured elderly in the trauma intensive care unit. *Surgical Clinics of North America, 80*(3), 1005-1019.

McMahon, D.J., Schwab, C.W., & Kauder, D. (1996) Comorbidity and the elderly trauma patient. *World Journal of Surgery, 20*, 113-1120.

Nagy, K., Smith, R., Roberts, R., Joseph, K., An, G., Bokhari, F., & Barrett, J. (2000). Prognosis of penetrating trauma in elderly patients: a comparison with younger patients. *The Journal of Trauma, Injury, Infection, and Critical Care, 49*(2), 190-194.

O'Brien, D., Luchette, F., Periera, S., Lim, E., Seeskin, C, James L., et al. (2002). Pelvic fracture in the elderly is associated with increased mortality. *Surgery*, *132*(4), 710-715.

Pickering, S., Esberger, D. & Moran, C.G. (1999). The outcome following major trauma in the elderly: Predictors of survival. *Injury, 30*, 703-706.

Perdue, P.W., Watts, D.D., Kaufmann, C.R., & Trask, A. (1998). Differences in mortality between elderly and younger adult trauma patients: Geriatric status increases risk of delayed death. *The Journal of Trauma, Injury, Infection, and Critical Care, 45*(4), 805-810.

Piccinelli M., Patterson M., Braithwaite I., Boot D., & Wilkinson G. (1999) Anxiety and depression disorders 5 years after severe injuries: a prospective follow-up study. *Journal of Psychosomatic Research*, *46*(5),455-64.

Ponzetto, M., Zanocchi, M., Maero, B., Giona, E., Fransciestti, F., Nicola, E, & Fabris, F. (2003). Post- hospitalization mortality in the elderly. *Archives of Gerontology and Geriatrics, 36*, 83 – 91.

Pudelek, B. (2002) Geriatric trauma: special needs for a special population. *AACN Clinical Issues: Advanced Practice in Acute and Critical Care, 13*(1), 61-72.

Richmond, T.S., Kauder, D., Strumpf, N & Meredith, T. (2002) Characteristics and outcomes of serious traumatic injury in older adults. *Journal of the American Geriatrics Society, 50*(2), 215-22.

Roth, B., Velmahos, G., Danila, O., Vassiliu, P., Tatevossian, R., Demetriades, D., et al. (2001). penetrating trauma in patients older than 55 years: a case-control study. *Injury, 32*, 551-554.

Scaf-Klomp, W. Sanderman, R., Ormel, J. & Kempen, G. (2003). Depression in older people after fall-related injuries: a prospective study. *Age and Ageing, 32*, 88-94.

Taherii, P.A., Iteld, L.H., Michaels, A.J., Edelstein, S.. Di Ponio, L., & Rodriguez, J.L. (1997). Physician resource utilization after geriatric trauma. *The Journal ofTrauma: Injury, Infection and Critical Care, 43*(4), 565-569.

Taylor, M., Tracy, K., Meyer, W., Pasquale, M., & Napolitano, L. (2002). Trauma in the elderly: intensive care unit resource use and outcome. *The Journal of Trauma, Injury, Infection and Critical Care, 53*(3), 407-414.

Teasdale, G., & Jennett, B. (1974) Assessment of coma and impaired consciousness: A practical scale. *Lancet. 2*(7872), 81-4.

Tornetta, P., Mostafavi, H., Riina, J., Turen, C., Reimer, B., Levine, R., et al. (1999). Morbidity and Mortality in Elderly Trauma Patients. *The Journal of Trauma, Injury, Infection, and Critical Care, 46*(4), 702-706.

Van der sluis, C.K., Timmer, H.W., Eisma, W.H. & ten Duis, H.J. (1997). Outcome in elderly injured patients: injury severity versus host factors. *Injury, 28*(9), 588-592.

Van der Sluis, C.K., Klasen, H.J., Eisma, W.H. & ten Duis, H.J. (1996). Major trauma in young and old: What is the difference? *The Journal of Trauma, Injury, Infection, and Critical Care,40*(1), 78-82.

Appendix

Instrument	Definition	Scale	Quantifies
Abbreviated Injury Scale (AIS) (Copes, Sacco, Champion, & Bain, 1989)	Anatomical ranking of injury severity in specific body regions: head, face, chest, abdomen, extremities, and external	1 (minor) to 6 (unsurvivable)	Mortality risk from injury that does not reflect combined effect of multiple injuries
Injury Severity Score (ISS) (Baker, O'Neill, Haddon, & Long, 1974)	Anatomical scoring system for patients with multiple injuries based on cumulative AIS scores for body regions	0 (no injury) to 75 (unsurvivable)	Mortality risk from multiple injuries without quantification of effect of multiple injuries in each body region
Glascow Coma Scale (GCS) (Teasdale & Jennett, 1974)	Physiologic scoring system that looks at level of consciousness through ability to open eyes, provide verbal response and perform motor movement	3 (completely unresponsive) to 15 (normal level of response)	Level of consciousness/coma
Glascow Outcome Scale (GOS) (Jennett Snoek, Bond, & Brooks., 1981)	Combined physiologic and functional recovery tool that assesses the outcome of serious craniocerebral injuries through GCS and interview items	1 (dead) to 5 (good/full recovery)	Functional Outcome/Disability after severe head injury
Revised Trauma Scale (RTS) (Champion et al., 1989)	Physiologic scoring system made up of Glascow Coma Scale, systolic blood pressure, and respiratory rate	0 (no threat) to 12 (most severe risk)	Mortality risk from injury and/or illness