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Low Energy Trauma in Older Persons: Where to Next?

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Abstract: The global population is increasing rapidly with older persons accounting for the greatest proportion. Associated with this rise is an increased rate of injury, including polytrauma, for which low energy falls has become the main cause. The resultant growing impact on trauma resources represents a major burden to the health system. Frailty, with its related issues of cognitive dysfunction and sarcopenia, is emerging as the unifying concept that relates both to the initial event and subsequent outcomes. Strategies to better assess and manage frailty are key to both preventing injury and improving trauma outcomes in the older population and research that links measures of frailty to trauma outcomes will be critical to informing future directions and health policy. The introduction of "Geriatric Emergency Departments" and the development of "Fracture Units" for frail older people will facilitate increased involvement of Geriatricians in trauma care and aid in the education of other health disciplines in the core principles of geriatric assessment and management. Collectively these should lead to improved care and outcomes for both survivors and those requiring end of life decisions and palliation.

Keywords: Education, falls, fracture, frailty, geriatric, low energy trauma, older persons, polytrauma.

INTRODUCTION

The aim of this article is to review the literature on polytrauma in older persons in the context of changing population demographics; the impact of low energy injuries; emerging concepts and directions relating to age, ageing and frailty; and the role of orthopaedic surgeons in the management of these patients. Whilst most of the referenced papers use the terms "elderly" or "geriatric", this paper will refer to "older persons" consistent with contemporary literature.

Whilst there are varying estimates of both the rate and magnitude of global ageing depending on regions and expected longevity [1], population ageing is accelerating rapidly worldwide from 461 million people older than 65 years in 2004 to an estimated 2 billion people by 2050 [2]. It is a global issue that will have a major impact on health policies and programmes, which has prompted the development of international collaborative studies of ageing and adult health [3-6].

With this population change, the rate of injury in older persons will continue to increase [7], in part due to efforts to remain active as a result of "healthy-ageing" strategies as well as from impaired motor and cognitive functions. The severity [8] of injuries will also increase and be disproportionately high relative to the energy of mechanism [9]. This is in part due to increased osteoporosis and bony fragility, sarcopenia, and broader issues such as frailty.

FRAILTY

The reported international prevalence of frailty in the community rises disproportionately from 4% in those aged 65-69 years to 7%, 9%, 16% and 26% in those aged 70-74 years, 75-79 years, 80-84, and over 85 years respectively [10]. Given that the fastest growing age demographic is the 80 years and older age demographic, it is then apparent that the impact of frailty in the management of older trauma patients will be significant.

Because of the variability of comorbidities in older persons, the concept of frailty has emerged as one of the key areas of debate and study amongst those involved with the care and research of this population. There has been a significant move towards the use of frailty measures rather than age *per se* in outcomes research and to direct management. Given the complexity of the concept, it is understandable that as yet there is no universally accepted definition or measure of frailty.

Clegg *et al*. described frailty as "a state of increased vulnerability to poor resolution of homoeostasis after a

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stressor event, which increases the risk of adverse outcomes, including falls, delirium, and disability" [10], characteristics which are consistent with the many existing definitions of frailty [11]. There are two main operational models in use to define the problem of frailty, the *frail phenotype model* (proposed and validated by Fried and colleagues in the Cardiovascular Health Study) [12] and the *frailty index model*, which is based on a *deficit accumulation* (proposed and validated by Rockwood and colleagues in the Canadian Study of Health and Aging) [13].

The phenotypic model consists of five variables including:

1. "shrinking" / unintentional weight loss: > 10lbs in last year – associated with chronic under-nutrition and sarcopenia;
2. self-reported exhaustion: based on questions related to effort and motivation;
3. low energy expenditure: based on gender specific calculations of kilocalories that are < 20th percentile for reported physical activities using an abbreviated leisure time questionnaire;
4. slow walking speed: based on the average of 3 timed walks at normal pace over 15 feet and adjusted for gender and height (≥ 7 seconds in males ≤ 173cm and females ≤ 159cm or ≥ 6 seconds in taller patients);
5. weakness: based on the average of 3 measured maximum grip strengths of the dominant hand using a handheld dynamometer that are < 20th percentile based on tables adjusted for gender and body mass index (BMI).

Those with three or more features are considered frail and those with one or two features classified as pre-frail [12]. It can be seen from these questions that under-nutrition (variable 1) and sarcopenia (variable 4 and 5) are important contributors to the development of frailty.

In a study using a slight modification of this scale (scoring 4 to 5 features as "frail", 2 to 3 as "intermediately frail" and 0 to 1 as "non-frail"), a phenotypic frailty measure was shown to correlate with elective surgical outcomes in older patients [14]. Whilst feasible in elective patients, obtaining these measurements from trauma patients acutely is clearly not possible.

The deficit accumulation approach, on the other hand, views frailty as arising from cumulative decline across multiple physiological systems, but sees frailty not as a *syndrome*, but as a multidimensional risk *state* that can be measured by the quantity rather than by the nature of health problems. The model can be indexed with information from any existing biomedical database and can include deficits such as symptoms, signs, diseases, disabilities, or laboratory abnormalities. These deficits should at least total 20 and be age-related, associated with adverse outcomes, and when combined should cover several organ systems [13]. For example, if 85 deficits are used to make up the frailty index (FI), and an individual exhibits 25 deficits, then an index score of 0.29 (25/85) is obtained. The FI works best as a continuous variable, allowing grades of frailty to be discerned; if a dichotomous definition is required for comparison purposes (e.g. present or absent; frail or not frail) this is best done empirically. Threshold or cut-off values will typically be different in men and women and usually lie between 0.21-0.25 [15]. The use of a computerised method to calculate the FI may support its use in clinical practice.

These two models are very different and rather than being viewed as alternatives they should be considered as complementary. It has been argued that the frail phenotype model may be better suited in a screening scenario and prior to the development of disabilities. The FI on the other hand can only be determined after comprehensive clinical evaluation, may contribute to future care planning and has greater applicability to the individual irrespective of age or disability [16].

Many other different screening scales of frailty have been developed including the FRAIL scale, The Tilburg Frailty Indicator [17], The Clinical Frailty Scale [18] and The Edmonton Frail Scale [19]. Some have been assessed with specific population groups and applications in mind [20-26]. For such a complex issue a "one size fits all" solution is neither possible nor appropriate but there is clearly a need to rationalise and unify this area as much as possible to optimise the research and clinical applications of frailty concepts. There are many recent reports of efforts to achieve this [27-32].

TRAUMA STUDIES AND FALLS

There have been a large number of published studies and reviews of trauma in older people [8, 33-37] but a lack of either consistency or utility with the measures used. Many of these studies have focussed on polytrauma [38-44]. Outcomes are usually reported in terms of mortality, in-hospital complications and length of stay (LOS). These outcomes are usually correlated with age, the Injury Severity Score (ISS), the Glasgow Coma Scale (GCS) and the mechanism of injury. The New Injury Severity Score (NISS) is less commonly reported although it is easier to calculate and has been shown in some studies to be superior to the ISS in predicting LOS and ICU admission [45] and functional recovery after musculoskeletal injury [46]. Whilst studies have demonstrated age, GCS score on presentation, and ISS to predict worst outcomes after traumatic injury in adults, increasing age as an independent variable is not always predictive of poorer outcomes in the elderly subgroups [47].

A 20 year review of an Australian trauma registry showed that between 1991 and 2010 proportion of major trauma volume (ISS >15) due to older patients increased by 4.9% per year to account for a third of major trauma volume with the relative contribution to major trauma due to falls increasing by 48% (2.1% per year) in that period (46% to 69%) [48].

In another Australian study, looking at the epidemiology of traumatic deaths [49], patients sustaining Low Energy (LE) injuries (fall from < 1 metre) were responsible for 41% of deaths, all of which occurred in hospital. This contrasts sharply with High Energy (HE) trauma in which 66% of deaths occurred prior to arrival at the hospital. Complications of head injury (76%) and skeletal injuries (24%) were the attributed causes, with 49% of deaths occurring > 7 days post admission. The mean age in this LE group was 83 ± 1 and the ISS 14 ± 1 compared with age 43 ± 2 and ISS 49 ± 2 in the HE deaths. The authors concluded that the large number of compromised older patients sustaining LE falls was having a large impact on the trauma management system and that strategies for preventing falls needed to be prioritised and consideration given to the development of specific trauma management protocols for older people [49].

In another study comparing acute hospital costs of trauma care between older (age ≥ 65 year) and younger patients the costs were 30% greater after adjusting for injury severity with falls being both the most common and expensive injury to treat. No consideration however was given to medical comorbidities such as dementia and frailty in this age division which are known to impact on recovery, rehabilitation and longer term outcomes [50].

Only one study identified in the searched English literature to date has specifically looked at the prevalence and patterns of multiple fractures in the older patients [51]. In a prospectively collected database from a single catchment population of 780 000 in the UK, 2335 patients aged ≥ 65 years where found to have injuries resulting in fractures. A simple fall was the mechanism in 2111 (90%) of these (M:F 16:84). Of these, only 119 patients (5.1%) presented with multiple fractures. Whilst HE mechanisms such as motor vehicle accidents and falls from stairs were predictably much more likely to result in polytrauma, *it was the simple falls (4.5%) which resulted in the vast majority of multiple fractures (80.7%)*. Most patients sustained two fractures with just under 8% sustaining three or more. The most common fracture types to be involved in those with multiple injuries were the distal radius (37.0%), proximal humerus (35.3%), proximal femur (32.8%) and pelvis (12.6%). Younger patients were more likely to suffer a combination of all upper limb fractures. The standardised mortality rate (SMR) increased significantly if one of the fractures included the pelvis, proximal humerus or proximal femur ($p<0.001$) with *combined fractures of the proximal humerus and femur associated with the highest one year mortality* (OR 1.8; $p = 0.05$). Medical comorbidities, cognitive or frailty measures were not collected in this study and neither age nor gender was predictive of multiple *versus* single fractures [51].

FRAILTY AND TRAUMA

With age shown to be poorly predictive of outcomes following trauma and in-hospital rehabilitation [47] it has only been in the most recent literature that the concept of "frailty" has been introduced into surgical [14] and trauma literature for consideration as an important outcomes indicator [52]. Also, for older people, preserved independence and a return to home is an important discharge goal. However, whether suffering from minor, moderate or severe trauma, studies have shown that patients 65 years and older, with pre-existing chronic medical conditions have an increased mortality risk compared with the non-chronically ill [53].

In a study looking specifically at frailty, a 50 variable FI [54], which can be developed from a comprehensive geriatric assessment of older patients, was specifically applied prospectively to 250 geriatric trauma patients and found to be an independent predictor of in-hospital complications and adverse discharge disposition (i.e. skilled nursing facility or death) [55].

From a practical perspective, this can be a very time and resource intensive exercise in a clinical acute trauma care setting. In an attempt to provide for a more rapid assessment, a later study by the same group developed a 15 variable abbreviated trauma specific frailty index (TSFI) by analysing the relative predictive values of the 50 variables used in the previous study [56]. The TSFI was used to prospectively assess 200 older trauma patients (mean age 77 +/- 12) and after adjusting for age, sex, ISS, Head Abbreviated Injury Scale, and vitals on admission, the researchers found the TSFI (odds ratio = 1.5; 95% CI, 1.1-2.5) to be the only significant predictor for unfavourable discharge disposition. Using Receiver Operating Characteristic (ROC) curve analysis, a TSFI cut-off point of 0.27 was optimal (sensitivity of 85% and specificity of 75%), for this cohort of trauma patients.

Sarcopenia is an age related loss of muscle mass with a resultant decrease in strength, mobility, and function. It is integral to frailty. In addition to its association with falls risks in the causation of injury, it is also associated with outcomes from injury. It is argued that whilst osteoporosis can be measured with bone mineral density; sarcopenia should be defined through measurement of muscle mass in addition to other frailty or functional measures [57]. In a study looking at the relationship between sarcopenia and trauma discharge outcomes in the elderly, abdominal CT scans taken on admission as part of the trauma assessment were retrospectively reviewed and used to access sarcopenia [58]. The lower psoas major muscle cross sectional area (CSA) was measured at the L4-L5 intervertebral disc level and correlated with the discharge destination. Each 1 cm^2 increase in psoas muscle CSA was associated with a 20% decrease in dependent living. This study suggests that relatively available additional objective measures of sarcopenia could prove to be valuable adjuncts to frailty assessment in trauma.

Whilst promising, these studies are still in their infancy however they illustrate the importance of considering the physiological status of the older patient which is implicit in the concept of frailty.

MANAGEMENT

Although challenging to manage compared to younger patients, good outcomes can be achieved in older trauma patients [42]. Early aggressive management with invasive haemodynamic and cardiac monitoring and access to ICU are advised to optimise resuscitation and subsequent management in these patients in whom there is often a fine line between hypo and hyperperfusion. This approach has been shown to increase survival [59].

In a recent review article of polytrauma in the elderly [43] it was argued that Damage Control Orthopaedics (DCO), which is indicated in the case of unstable or extremis physiological state in adult trauma patients, may be more broadly indicated in the elderly due to their reduced physiologic reserves. The DCO approach helps to control the lethal triad of hypothermia, acidosis and coagulopathy, and also regulate the evolving systemic inflammatory response by reducing the complications of adult respiratory distress syndrome and multiple organ dysfunction. It is reasoned therefore that since these complications are less tolerated by older patients, DCO should reduce mortality and improve outcomes,

Without intervention, a downward spiral of decline is experienced among the frail, threatening the independence of the individual, resulting in costly hospitalization, increased reliance on aged care services, or premature residential care placement. Studies of osteoporotic fractures have also confirmed that frail individuals (odds ratio 2.44; 95% CI 1.95-3.04) are at greater risk of falls compared to non-frail individuals [60]. The frail individual is vulnerable to medication adverse effects and in hospital complications and therefore, to ensure best longer term outcomes, it is important to identify those who are frail so that appropriate management can be provided to better meet their needs [61, 62]. Involving geriatricians in the peri-operative care of older patients, especially those that are frail, has been advocated for both surgeons and anaesthetists [63] who should also understand geriatrics and gerontology management principles to achieve best care outcomes for older patients.

EMERGING STRATEGIES

Geriatric Emergency Departments

It is clear that older persons have special needs and that emergency management systems, which are often the first port of call for older people with LE trauma, need to better address these specific requirements. Specialised Geriatric Emergency Departments (GEDs) have started to emerge in the last decade and standardised guidelines have been more recently developed for their implementation [64]. These evidence and consensus-based guidelines were developed in collaboration between the American College of Emergency Physicians, the American Geriatrics Society, Emergency Nurses Association, and the Society for Academic Emergency Medicine. They provide detailed templates in the areas of staffing, equipment, education, policies and procedures, follow-up care, and performance improvement measures. The guidelines are designed to be implemented in existing EDs to improve the care of the geriatric patient and with the expectation that staff satisfaction will also be improved. Critical to this, is the inclusion of geriatric trained providers and education programs to ensure that the multiple health disciplines and ancillary service staff involved in management are adequately skilled. Environmental modifications to support excellence in care are also suggested through these guidelines. The GED is a significant opportunity to help ensure that LE trauma patients begin their hospital journey and ‘road to recovery’ with the best possible opportunity to not only have their trauma needs met but also with an improved chance of geriatric syndromes such as frailty, dementia, delirium and malnutrition being appropriately managed.

Delirium and Dementia Protocols

Cognitive function is a very important variable in terms of outcomes, assessment and management decisions. Determining the presence of dysfunction in a GED is a critical initial step in the assessment of the older patient and in ensuring that delirium is prevented or where it occurs treated early. A dementia friendly environment will ensure that patients with dementia have their care needs better met and in some ways and is a marker of good care [65]. The Hospital Elder Life Program has been shown to be very effective in preventing and treating delirium [66, 67].

Fracture Units for Frail Older People

It is also timely that due consideration is given towards the development of specific fracture units for frail older people. These units could be based within the orthopaedic services and be viewed as a joint venture between orthopaedics, geriatrics and anaesthetics services. It will ensure that following initial care in the GED, frail older patients will continue to have their health care needs met in a comprehensive manner providing them with the best opportunities to be discharged home and to remain independent. The development of such units will allow for the delivery of comprehensive geriatric assessment (CGA) in parallel with best orthopaedic trauma care. CGA has been shown to result in the reduction of functional and cognitive decline and residential care placement, especially in hospitals, through inpatient services [68]. The unit will ensure that all fragility fracture patients, and not just hip fracture patients, have access to CGA. Falls assessment, falls prevention and osteoporosis management would be a standard part of management. Those that require rehabilitation post-discharge will be linked into either inpatient or community based rehabilitation programs. There is the opportunity to develop integrated services that also include community falls prevention programs and fracture follow-up programs.

End of Life Care

Whilst it is clear that excellent outcomes can be achieved by the aggressive management of injured older patients there is a subgroup for whom a palliative approach is more appropriate and end of life care warranted. Unfortunately on presentation the usual default position is to “save life at all costs”. In the absence of clear advance directives and guidelines to the contrary, many of these patients will continue to be inappropriately subjected to invasive, resource intensive and very expensive medical care.

This is clearly an area for which a multifaceted approach is required and includes better utilisation of advance care directives, a shift in health professional and community perceptions of what constitutes appropriate and humane care, and validated tools to aid the decision making progress. In this regard, discussions framed in terms of frailty can be a very useful to unify clinicians, patients and family with respect to understanding the clinical severity and desirable management goals [69].

CONCLUSION

The number and proportion of older persons in our communities is on a steep incline globally. Combined with public health initiatives to remain physically active and achieve 'Healthy Ageing', the likelihood of injury is on a corresponding rise. The assessment and treatment of older people with trauma presents greater challenges than in the young from primary and aged care through to rehabilitation or end of life care decision making. Simple falls on a background of sarcopenia, osteoporosis and frailty will result in increased polytrauma with all the associated resourcing burdens. Excellent outcomes can be achieved in this population group with aggressive management however the subgroups for whom palliative approaches would be better applied are difficult to define with current measurement tools such as the injury severity scores or age. Whilst difficult to clearly define and measure, frailty, rather than age, should be a key factor considered when developing management plans. The increasing presence of geriatricians and multidisciplinary teams with gerontology skills performing comprehensive geriatric assessments will be critical to optimising outcomes. GEDs and education programs need to expand ensuring that all associated health professionals are competent in core areas of geriatric syndromes, particularly frailty assessment and management. Further trans-disciplinary communication and research is required globally to achieve common definitions and valid measures of frailty and to include these in prospective trauma audits and registries. This will allow informed health policy development, funding allocations and direct future outcomes and translational research which would include fracture units and prevention programs. Orthopaedic surgeons need to be aware of these issues and embrace these required changes to achieve the outcomes we desire for older people, their ability to remain mobile and be independent.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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