High-risk medications in older patients with trauma: a cross-sectional study of risk mitigation

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Background: The Beers Criteria for Potentially Inappropriate Medication Use in Older Adults is a framework that can assess the nature of high-risk medication use. The objective of this study was to use the Beers Criteria to assess the prevalence and nature of polypharmacy, the magnitude of medication changes during the hospital stay and the impact of Beers Criteria medications on outcomes in older patients with trauma.

Methods: We used the Alberta Trauma Registry to conduct a retrospective review of patients aged 65 years or older with major trauma (Injury Severity Score ≥ 12) who were admitted to a level 1 trauma centre between January 2013 and December 2014. We analyzed changes in medication prescriptions during the hospital stay using descriptive statistics and assessed the association between Beers Criteria medications and relevant outcomes using multivariable regression analysis.

Results: There was no significant change in the number of Beers Criteria medications prescribed before and after admission. The adjusted odds ratio for 30-day mortality for each additional Beers Criteria medication prescribed was 2.02 (95% confidence interval [CI] 1.16–3.51) versus 1.24 (95% CI 1.04–1.59) for each additional medication of any type. The corresponding adjusted incidence rate ratios for length of stay were 1.15 (95% CI 1.03–1.30) versus 1.05 (95% CI 1.01–1.10).

Conclusion: Beers Criteria medications were not discontinued during trauma admissions. Using the Beers Criteria as a process indicator for quality improvement in trauma care may provide interdisciplinary trauma teams an opportunity to audit patient medications and stop potentially harmful medications in a vulnerable population.

Contexte : Les critères de Beers sur les médicaments potentiellement inappropriés chez les adultes âgés constituent un cadre qui permet d'évaluer la nature d'une pharmacothérapie à risque élevé. L'objectif de cette étude était d'utiliser les critères de Beers pour évaluer la prévalence et la nature de la polypharmacologie, l'ampleur des changements de prescriptions en cours d'hospitalisation et l'impact des médicaments potentiellement inappropriés sur l'évolution de l'état de personnes âgées victimes de traumatismes.

Méthodes : Nous avons utilisé le Registre albertain des traumatismes pour procéder à une revue rétrospective des patients de 65 ans et plus victimes d'un traumatisme grave (indice de gravité des blessures ≥ 12) admis dans un centre de traumatologie entre janvier 2013 et décembre 2014. Nous avons analysé les changements de médicaments prescrits durant le séjour hospitalier au moyen de statistiques descriptives et nous avons évalué le lien entre les médicaments potentiellement inappropriés et les variables pertinentes au moyen d'une analyse de régression multivariée.

Résultats : On n'a noté aucun changement significatif entre les médicaments potentiellement inappropriés prescrits avant et après l'admission. Le rapport des cotes ajusté pour la mortalité à 30 jours pour chaque médicament potentiellement inapproprié prescrit a été de 2,02 (intervalle de confiance [IC] à 95 % 1,16–3,51) contre 1,24 (IC à 95 % 1,04–1,59) pour chaque médicament additionnel, de tout type. Les rapports des taux d'incidence ajustés correspondants pour la durée de l'hospitalisation ont été de 1,15 (IC à 95 % 1,03–1,30) contre 1,05 (IC à 95 % 1,01–1,10).

Conclusion : Les médicaments potentiellement inappropriés (selon les critères de Beers) n'ont pas été cessés durant les admissions pour traumatisme. L'utilisation des critères de Beers comme indicateur de processus pour l'amélioration de la qualité des soins en traumatologie pourrait fournir aux équipes interdisciplinaires une occasion de vérifier les médicaments prescrits et de cesser ceux qui sont nuisibles à une population vulnérable.

The proportion of the population over the age of 65 years is growing throughout the developed world.[1] In Canada, the proportion of the population in this age group increased from 8% to 16% between 1970 and 2015, and is expected to reach 23% by 2030.[1,2] Traumatic injuries in older people have also increased: in 2009, nonintentional injury was the fifth-leading cause of hospital admission and the sixth-leading cause of death among Canadians aged 65–74.[3–5] Older adults experience higher rates of mortality and morbidity than those of average age.[6–10] Substantial resource use is associated with trauma in older people, both directly, owing to health care expenditures, and indirectly, through increased care needs, productivity losses and premature loss of life.[11,12] The American College of Surgeons has acknowledged these issues and has developed dedicated geriatric trauma management guidelines as part of its Trauma Quality Improvement Program.[13,14]

The incidence and severity of traumatic injuries in this age group has numerous associations, including comorbidities, sensorium deterioration, substance abuse and polypharmacy.[14–18] Polypharmacy has been the focus of multiple studies that have identified associations between preinjury medications and subsequent morbidity and mortality.[14,16,19,20] The updated Beers Criteria for Potentially Inappropriate Medication Use in Older Adults lists medications for which the risks of use may outweigh the benefits in patients over the age of 65.[21,22] These guidelines were developed and updated through systematic literature reviews by an expert interdisciplinary panel appointed by the American Geriatrics Society.[22] The medications are organized into subcategories based on organ system/therapeutic category. The criteria are prognostic for increased hospital admissions and length of stay, and their use has been effective in reducing polypharmacy in older adults.[23,24] Since older patients who have experienced injury are more than 3 times more likely to be readmitted with recurrent trauma than similar older patients with no trauma history, reducing the risk of reoccurrence through reduction of high-risk medications is a logical prevention measure.[25] The American College of Surgeons has recommended the use of the Beers Criteria to make pharmacotherapy decisions during trauma admissions in this population.[14]

To our knowledge, there is no literature exploring the role of the Beers Criteria as a process measure for inpatients with trauma.[21,26] The objective of this study was to use the Beers Criteria as a framework to assess the prevalence and nature of polypharmacy, the magnitude of medication changes during the hospital stay and the impact of Beers Criteria medications on outcomes (length of hospital stay and 30-day mortality) in older patients who experienced trauma. This information will inform the suitability of the Beers Criteria as a guideline and indicator for medication review in this patient population.

Methods

This study was approved by the Health Research Ethics Board at the University of Alberta. We performed a retrospective study of patients aged 65 years or more with trauma who were admitted to a level 1 trauma centre within 24 hours of injury between January 2013 and December 2014. Patients were identified from the Alberta Trauma Registry, a prospectively maintained database of patients with major trauma (Injury Severity Score ≥ 12[27]). Out-of-province patients and patients who died during initial resuscitation were excluded. Chart review collected data on demographic characteristics, injury mechanism, hospital and intensive care unit length of stay, 30-day mortality, in-hospital complications, clinical service that discharged the patient, final disposition, and pre- and postadmission prescription medications.

Statistical analysis

We used basic descriptive statistics to delineate medication use and change in the number of Beers Criteria medications prescribed before and after the injury. It was determined that a negative binomial approach was the optimal modelling approach for predicting length of stay. We adjusted the outcome variable length of stay for preadmission medications (independent variable of interest) as well as the covariables age, sex, Injury Severity Score, number of operations during the hospital stay and admission to the intensive care unit. Table 1 outlines the models. Model 1 adjusted for all covariables. Model 2 repeated this process but instead adjusted for number of Beers Criteria medications only, rather than all medications at admission. Model 3 considered the effect of each subcategory of the Beers Criteria list, adjusting for a series of binary variables corresponding to the presence of a medication from each class, along with all other independent variables. Model 4 considered binary variables representing Beers and non-Beers medications, along with all other independent variables. To explore the impact these medications had on

Table 1. Statistical model description

Model no.	Outcome variable	Independent variable of interest
1	Length of stay	Number of preadmission medications
2	Length of stay	Number of preadmission Beers Criteria medications
3	Length of stay	Binary representation of Beers Criteria categories
4	Length of stay	Binary representations of presence of Beers and non-Beers medications
5	30-day mortality	Number of preadmission medications
6	30-day mortality	Number of preadmission Beers Criteria medications

Beers Criteria = Beers Criteria for Potentially Inappropriate Medication Use in Older Adults.[21,22]

30-day mortality, we created logistic regression models. Model 5 adjusted mortality for the total number of medications prescribed before admission and all other covariables listed above, and model 6 adjusted for the number of Beers Criteria medications prescribed before admission, along with the previously described covariables. We calculated standard errors using both asymptotic theory (oim) and bootstrapping, with minimal difference. We report oim results. We compared each model permutation using the Akaike information criterion and the Bayesian information criterion or area under the receiver operator curve and the Pearson χ^2 test, as applicable. All analyzes were conducted with Stata version 13 (StataCorp).

Results

During the 2-year study period, 319 patients met the inclusion criteria. Demographic and descriptive data are reported in Table 2. The median length of stay in the trauma centre was 8 days (range 1–155 d), and the mean was 16.8 days (95% confidence interval [CI] 14.37 to 19.31). The 30-day mortality rate was 1.88% (Table 2). The mean number of prescribed medications on admission was 4.36 (95% CI 3.93 to 4.78), with 204 patients (63.9%) taking at least 1 Beers Criteria medication and 100 (31.3%) taking 2 or more Beers Criteria medications. The mean change in total number of medications from admission to discharge was –0.52 (95% CI –0.81 to –0.23) (range –9 to 13). The mean change in number of Beers Criteria medications was 0.03 (95% CI –0.08 to 0.13) (range –3 to 5). Of the patients who were taking Beers Criteria medications on admission, 92 (45.1%) were discharged taking the same number as on admission. There was no association between the clinical service (e.g., general surgery, orthopedic surgery) that discharged the patient and the number of prescribed medications or the change in number of medications.

Table 2. Demographic and descriptive characteristics of older patients with major trauma

Characteristic	Mean (95% CI)* *n* = 319
Age, yr	76.0 (75.06–76.88)
Male sex, no. (%)	207 (64.9)
Injury Severity Score	22.3 (21.43–23.10)
Length of stay, d	16.8 (14.37–19.31)
30-day mortality, no. (%)	6 (1.9)
Mechanism of injury, no. (%)	
Fall from level	129 (40.4)
Fall from height	75 (23.5)
Motor vehicle related	69 (21.6)
Other	46 (14.4)
No. of visits to operating room	0.52 (0.43–0.62)
No. of admission medications	4.36 (3.93–4.78)
No. of discharge medications	4.87 (4.42–5.33)
No. of preadmission Beers Criteria medications	1.16 (1.01–1.31)
No. of discharge Beers Criteria medications	1.13 (0.99–1.28)

CI = confidence interval.
*Except where noted otherwise.

Among the subcategories of Beers Criteria medications on admission, 69 patients (33.8%) were taking central nervous system drugs, 59 (28.9%) were taking gastrointestinal medications, 55 (27.0%) were taking cardiac medications, 9 (4.4%) were taking anticoagulants, 8 (3.9%) were taking antithrombotics, 7 (3.4%) were taking pain medications, 7 (3.4%) were taking endocrine medications, and 2 (1.0%) were taking antibiotics. These proportions were unaltered on discharge. Of note, only 3 patients who were not taking prescription pain medication before the injury were discharged home on new pain medication.

In multivariable regression analysis model 1, each additional admission medication was associated with an incidence rate ratio (IRR) of 1.05 (95% CI 1.01 to 1.10). In model 2, each additional Beers Criteria medication was associated with an IRR of 1.15 (95% CI 1.03 to 1.30), representing an increased length of stay.

In model 3, only central nervous system medications had a statistically significant impact on length of stay, with an IRR of 1.58 (95% CI 1.21 to 2.00). In model 4, Beers Criteria medications had an IRR of 1.46 (95% CI 1.13 to 1.88) for length of stay. Non-Beers medications were not statistically significant predictors of length of stay.

With respect to 30-day mortality, model 5 showed that a 1-unit increase in any medication on admission had an adjusted odds ratio (OR) of 1.24 (95% CI 1.04 to 1.59). Model 6 showed that a 1-unit increase in the number of Beers Criteria medications was associated with an adjusted OR of 2.02 (95% CI 1.16 to 3.51). The area under the receiver operator curve values were 0.81 and 0.77, respectively.

Discussion

As the population ages, attention must be directed toward providing quality trauma care for older patients. Polypharmacy is a known risk factor for hospital admission and injury in older adults and is a potential target for improvement in trauma outcomes. Moreover, a previous trauma admission is a risk factor for future traumatic injury, making polypharmacy reduction during a trauma admission a prospective injury prevention mechanism.[25] The Beers Criteria can serve as both a clinical tool and a measure of quality and can be used as an admission screening tool in all older patients with trauma.

We found that the number of high-risk medications prescribed was not altered during trauma admission at our institution. This represents a potential area for improvement via medication review and optimization, as a lack of reduction in high-risk medication prescriptions represents a lost opportunity to prevent future trauma and other adverse

events, such as prolonged length of stay and death. It may be that, currently, effective medication reviews are simply not occurring or that there is a cultural preference to defer changes in long-term medications to primary care providers. Prescribers may also not be aware of high-risk medications on the Beers Criteria list and that suitable non-Beers medication alternatives exist. In addition, there are many medications included in the Beers Criteria list, several with stipulations such as "avoid in patients with CrCL [creatinine clearance] < 60 mL/min," perhaps making it cumbersome as a clinical tool for medication review.[22] Finally, some medications may be necessary for certain patients and cannot be substituted or stopped. A medication review conducted by a dedicated trauma team member may mitigate these issues.

The importance of this failure to reduce high-risk medications is reinforced by the results of our multivariable analysis, which showed that each additional Beers Criteria medication prescribed before admission increased length of stay by 10% more than each additional medication of any type. This increase likely represents substantial resource use. Furthermore, Beers Criteria medications were statistically significant predictors of 30-day mortality. These results support attention to medication review in this high-risk population.

We found that a third of older patients were prescribed a central nervous system medication. In addition, central nervous system medications were predictors of increased length of stay. Although this may be due to their ubiquity, other possible explanations include the underlying condition warranting these medications or their anticholinergic and sedating effects. Moreover, many of these medications are known to induce hypotension, which may predispose patients to injury.[22] On the other hand, several classes of medications were prescribed relatively infrequently in our study. The less frequent nature of medications such as antithrombotics, anticoagulants and endocrine medications may be a result of preinjury clinical indications, provider recognition of the risks of these medications or the sample size used in our study. Alternatively, these less frequently prescribed medications may increase the preadmission mortality rate, thereby excluding these patients from the hospital admission sample.

The Beers Criteria represent a guideline for medication review and a valuable process indicator for quality care in older people. Process indicators for quality care are a useful metric of health care system performance that allow for early improvement signal detection.[28] The American College of Surgeons' Trauma Quality Improvement Program informs trauma centres of their performance against national standards using quality indicators, and the use of the Beers Criteria is congruent with the college's current approach of improving both trauma management and trauma prevention.

Results from this retrospective study can be used to design a medication review process based on the Beers Criteria as a quality indicator for older patients with trauma at our institution. A dedicated trauma team member, such as a pharmacist or geriatrician, could facilitate formal medication review and communication with primary care providers to promote a reduction in polypharmacy and high-risk medication use. Moreover, bringing attention to the need to scrutinize patient medications may strengthen the collective relationship between providers of trauma care and primary care networks and thereby lead to further injury prevention measures. The Beers Criteria is an applicable framework, as it differentiates between medications to avoid completely, those to avoid in certain subpopulations and those to review and consider changing. It also provides a rationale and references for the recommendations. A future study prospectively assessing the changes in high-risk medications during the hospital stay and the effect on outcomes with implementation of the Beers Criteria could further illuminate the benefit of including medication review with the Beers Criteria as a process indicator for quality improvement.

Limitations

Several limitations of our work merit consideration. First, this study was a retrospective application of the Beers Criteria, and the pertaining issues surrounding bias and validity apply. Further limitations include the lack of a comprehensive analysis surrounding patient comorbidities, as these details were unavailable in the trauma registry. Comorbidities have been shown to be associated with worsened outcomes in geriatric trauma.[29–33] It was not possible to elucidate whether the increased length of stay and risk of mortality were due to the effect of the medications or whether Beers Criteria medications were a proxy measure for comorbid conditions that resulted in poorer outcomes. To mitigate the effect of this omitted variable, we adjusted the impact of the independent variable of interest using comparable statistical models, including the effect of total medications compared to the effect of Beers Criteria medications alone. Further omitted variable bias may have been associated with over-the-counter medications, which were not included owing to data unavailability.

Conclusion

Providing high-quality care to older patients who have experienced trauma is important, and one way to attain this is by developing relevant and practical process indicators for quality improvement. Using the Beers Criteria as a quality process indicator in older patients with trauma may provide dedicated interdisciplinary trauma teams with an opportunity to audit preinjury medications and stop potentially harmful medications in this vulnerable population.

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