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Nonoperative management of splenic injuries: significance of age

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ABSTRACT

Background: In the nonoperative management (NOM) of blunt splenic injuries (BSI), the clinical relevance of age as a risk factor has not been well studied.

Methods: Using the 2011 National Trauma Data Bank data set, age was analyzed both as a continuous variable and a categorical variable (group 1 [13–54 y], group 2 [55–74 y], and group 3 [≥75 y]). BSI severity was stratified by abbreviated injury scale (AIS): group 1 (AIS ≤2), group 2 (AIS 3), and group 3 (AIS ≥4). A semiparametric proportional odds model was used to model NOM outcomes and effects due to age and BSI severity.

Results: Of 15,113 subjects, 15.3% failed NOM. The odds of failure increased by a factor of 1.014 for each year of age, or factor of 1.5 for groups 2 and 3 each. BSI severity groups 2 and 3 had increases in the odds of failure by factors of 3.9 and 13, respectively, compared with those of group 1. Most failures occurred by 48 h irrespective of age. The effect of age was most pronounced in age groups 2 and 3 with the most severe BSI, where a NOM failure rate of >50% was seen. Both age and failure of NOM were independent predictors of mortality.

Conclusions: Age is associated with failure of NOM but its effect seems more clinically relevant only in high-grade BSI. Factors that could influence NOM success in elderly patients with high-grade injuries deserve further study.

1. Background

Nonoperative management (NOM) of blunt splenic injuries (BSI) is a well-established management strategy. However, there is conflicting data about whether NOM carries a greater risk of failure in elderly patients [1–8]. This has important implications as the elderly are more likely to have acquired bleeding disorders, and also are perceived to be less tolerant of acute blood loss because of diminished physiologic reserve. Although the severity of the splenic injury is recognized as an important risk factor for NOM failure, few large studies exist specifically examining NOM failure in patients of different ages stratified by splenic injury severity. The aims of this study were to (1) examine trends in NOM of BSI in elderly patients in trauma centers in the United States and (2) evaluate the importance of age as a prognostic factor. Our hypothesis was that the elderly had an increased risk of NOM failure compared with younger patients with similar splenic injury severities.

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2. Methods

Using the 2011 National Trauma Data Bank research data set, we extracted all subjects aged >13 y from levels I and II American College of Surgeons and State verified adult trauma centers. Subjects were divided into three age groups—group 1 (13–54 y), group 2 (55–74 y), and group 3 (≥75 y). The abbreviated injury scale (AIS) predot codes (544099–544240) in conjunction with the International Classification of Diseases Ninth Revision codes E codes in the data set were used to identify subjects with BSI. Subjects who underwent any excision or repair of splenic tissue, or splenectomy excluding biopsy or diagnostic splenic procedures ([SP] International Classification of Diseases Ninth Revision codes 41.2, 41.4, 41.5, 41.95, and 41.99) were considered to have received a SP. BSI severity was stratified into three groups: severity group 1 (AIS 1 and 2), severity group 2 (AIS 3), and severity group 3 (AIS 4 and 5).

Because we were only interested in subjects where NOM was attempted, we excluded subjects who received an SP within 1 h of arrival because these subjects required an SP emergently and, therefore, were not likely to be subjected to NOM. Other exclusion criteria included discharge or death <1 h of arrival, unknown time to SP, and transfer to another hospital. The remainder of the subjects formed the basis for further analysis, with subjects who received an SP considered to have failed NOM. Although subjects who underwent abdominal angiography were ascertainable, details regarding the use of angiography of the spleen were not available in the data set.

Besides age and BSI severity, the following plausible covariates were selected for analysis: congenital or acquired bleeding disorder (the use of anticoagulants or clopidogrel, not aspirin), gender, and other intra-abdominal injuries with AIS ≥3, pelvic fractures, intracranial hemorrhage, systolic blood pressure ([SBP], dichotomized into <90 and ≥90), and trauma center designation. The AIS codes were similarly used to identify patients with the aforementioned diagnoses.

Kaplan–Meier survival curves were constructed for all age and BSI severity groups, with failure of NOM as the event of interest. We used a semiparametric proportional odds frailty model to estimate the effects of age and severity while controlling for other covariates (BSI injury severity, associated intra-abdominal injuries with AIS ≥3, intracranial hemorrhage, admission SBP, bleeding disorder, pelvic fracture, gender, and trauma center designation) and the random effect of facility. We first considered the more frequently implemented Cox-proportional hazards model but found it was not applicable because of the large proportion of right-censored data with long follow-up times [9]. This was not surprising in this context where after a certain point a patient may be considered "cured" because the event of an SP would never occur regardless of follow-up time. However, this meant the proportional hazards assumption was not met. The proportional odds assumption, however, would still be valid in this setting and would result in a similarly interpretable model. Goodness-of-fit (GOF) diagnostics were used to check appropriateness of proportional odds models. Several models were constructed to estimate the effects of age (in both the categorical and continuous parameterizations) and BSI severity, while controlling for other variables including a random effect for facility. The block bootstrap procedure was used to calculate standard errors for our parameters estimates of interest [10]. To explore the robustness of our model using the 1-h time cutoff to indicate failure of NOM, sensitivity analysis was also done for 2- and 4-h time cutoffs for age both as a categorical variable and a continuous variable, and for BSI severity. Furthermore, to assess if there were differences in time to failure of NOM among the different age groups, the empirical probabilities of successful NOM at two arbitrarily chosen time points (48 and 120 h after presentation) were calculated for each age group and stratified according to splenic injury severity. To assess if failure of NOM was independently associated with mortality, a mixed-effects logistic regression was fitted with age used as a categorical variable, facility included as a random effect, and other variables estimated as fixed covariates.

Statistical computation was done using R package version 2.37-4 (www.r-project.org). A P value of <0.05 was considered statistically significant.

3. Results

There were 16,506 subjects with BSI. The following were excluded: those who had an SP within 1 h of arrival ($n = 705$), who were discharged ($n = 11$) or who died ($n = 325$) within 1 h of arrival, who had an unspecified length of stay ($n = 6$), who were transferred to another institution ($n = 160$), or who had an unknown time to SP ($n = 183$). After exclusions, 15,113 patients remained and formed the basis for further analysis. The overall NOM failure rate and mortality rate were 15.3% ($n = 2307$) and 7.3% ($n = 1106$), respectively. Further analysis revealed that there were 239 missing observations all in the variable SBP. Because <2% of the data set contained missing variables, imputation was not done as this would not likely have changed our findings.

The majority (71%) of patients with BSI were aged ≤55 y (age group 1), with 23% in age group 2, and 6% in age group 3. Compared with younger patients, older patients were less likely to have associated significant intra-abdominal injuries or pelvic fractures, but were more likely to be managed at level II trauma centers, and to have lower grade BSI, admission hypotension, bleeding disorders, failure of NOM, and inhospital death (Table 1).

Characteristics of patients who failed NOM compared with those with successful NOM are listed in Table 2. Patients who failed NOM were likely to be older, have higher grade splenic injuries, admission hypotension, and associated significant intra-abdominal injuries.

Kaplan–Meier survival curves (Figure) illustrate NOM failure rates broken down by age and BSI severity categories. The highest NOM failure rates were seen in patients aged ≥55 y with the most severe BSI severity (>50%).

To illustrate time to failure of NOM among different age groups, empirical probabilities of successful NOM were calculated for the two chosen time points (48 and 120 h) for each age group stratified by BSI injury severity. As Table 3