Emergency department management of patients with rib fracture based on a clinical practice guideline

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ABSTRACT

Background Clinical practice guidelines (CPGs) have the ability to increase efficiency and standardize care. A CPG based on forced vital capacity (FVC) for rib fractures was developed as a tool for triage of these patients. The objectives of this study were to assess the efficacy and compliance of physicians with this rib fracture CPG.

Methods Patients >18 that were discharged from an urban level 2 trauma center emergency department (ED) between the dates of January 1, 2014, to December 31, 2016, were eligible for the study. Demographics, mechanism, outcomes and FVC were abstracted by review of the electronic medical record. Compliance with the CPG was examined, and comparisons were made between patients successfully discharged and patients who returned.

Results 455 patients met were identified during the study period. 233 were eligible after exclusions. 64% of the cohort was male with median age of 53 years. Falls were the most common mechanism (59.6%). The median number of rib fractures was 2 and median FVC 2500 mL. 28 (12.0%) of the 233 returned to the ED after discharge. The groups were well matched with no significant differences. The most common reason for return was pain (95%). Adjusted analysis showed that increasing age (adjusted OR (AOR) 0.968) and FVC (AOR 0.999) were independent predictors. Adherence with FVC >1500 mL is a safe criterion for discharging patients with non-life-threatening blunt chest trauma. That model can then be used to place patients into risk categories of a prespecified outcome. Current CPGs and prognostic models that exist into risk categories of a prespecified outcome.7

Conclusions This study confirms that the rib fracture CPG based on FVC for rib fractures was developed as a tool for triage of these patients. The CPG being tested was created and implemented in September 2013. The algorithm is based on three components: early bedside FVC, early analgesia and early identification of respiratory compromise. The components are centered around the goal of early identification of rib fractures and use of FVC as a guide to determine appropriate triage. The inpatient arm of this CPG was validated and was shown to decreased hospital length of stay by 2 days in patients admitted to the intensive care unit.11 An arm of this CPG was developed for discharge from the ED in patients with FVC >1500 mL, two or fewer unilateral fractures in the absence of hemothorax or pneumothorax, and after ensuring adequate pain control is eligible for discharge (figure 1). The objectives of this study were to assess the safety, efficacy and adherence of providers with this rib fracture CPG. We hypothesize that trauma patients who meet the criteria for discharge.
discharge using the rib fracture CPG could be safely discharged from the ED.

METHODS
A retrospective review of patients 18 years and older who presented to the ED from January 1, 2014 to December 31, 2016, with traumatic rib fractures were screened for study eligibility. Patients included in the study cohort needed a measured FVC followed by discharge from the ED using the institutional CPG. Patients transferred from outside hospitals, fractures identified as non-traumatic rib fractures, absence of a documented FVC and patients who returned to the ED >14 days from initial visit were excluded from the study population. The study was conducted at Memorial Hospital, a Level II Trauma Center in Colorado Springs, Colorado.

Demographic information was collected from the hospital’s trauma registry (TraumaOne, Lancet Technology, Boston, MA) and electronic health record (EPIC, Verona, WI). Variables included mechanism, number of fractures, laterality of fractures, presence of hemothorax or pneumothorax, FVC, ED length of stay (LOS) and discharge disposition. Patients successfully discharged from the ED were compared with those who returned after discharge.

Categorical variables were compared with χ² and Fisher’s exact test where appropriate and continuous variables were compared with Student’s t-test and the Wilcoxon rank-sum test based on distribution. After excluding collinear variables using correlation analysis, a multivariable logistic regression model was then constructed to adjust for confounders. Variables with a P<0.2 on bivariate analysis were selected for entry into the multivariable model. Stepwise backward regression was used to construct the final model. The Hosmer-Lemeshow goodness-of-fit test was then used to determine independent predictors. After excluding assault from the model, both FVC and age were independent predictors for return to ED (table 3).

Although the initial adherence with the CPG that required measured FVC (51%) was poor, most that had a measured FVC were >1500 mL (92%). Adherence with the other components of the CPG was good for pneumothorax, hemothorax and bilateral fractures at 96% (223/233). When looking at the number of fractures, adherence was lower at 74% (173/233).

DISCUSSION
CPGs are designed to reduce inappropriate practice and improve efficiency of care. Physician surveys have shown high satisfaction with CPGs and a belief that they improve quality of care. CPGs are often attributed to the increase in efficiency in streamlining decision-making processes. There is minimal evidence concerning the impact of rib fracture CPGs, especially for all adult trauma patients irrespective of age. There are clinical pathways for subsets of patients with rib fracture that have shown impact in reducing hospital and intensive care unit LOS.

This study has verified the safety of a CPG for predicting discharge criteria based on FVC.

Figure 1  Clinical practice guideline for rib fracture algorithm—emergency department management.
This CPG is composed of three components: early measurement of FVC, early identification of respiratory compromise from rib fractures and adequacy of analgesia. The CPG uses an algorithm to stratify patients with rib fractures based on FVC measurements, number of fractures and age. The current study had 92% of patients with an FVC of at least 1500 mL with the majority safely discharged without returning to the ED (88%). Fewer patients had hemothorax, pneumothorax or bilateral fractures (4%), and usually these patients are admitted for aggressive pulmonary hygiene and pain control. Occasionally, these patients may be discharged, but that should be done on a case-by-case basis after consultation with trauma services. A CPG is only useful, however, if it is clinically applicable and easy for clinicians to use. The first obstacle to applying this CPG is actually obtaining the measured FVC. A robust educational effort is under way for the ED providers about the CPG. Additionally, the hospital has increased the dedicated respiratory therapists present in the ED to assist with this algorithm. The component of the algorithm that providers followed the least was the absolute number of fractures ≤2. Interestingly, an increase in the number of rib fractures did not result in a higher return rate to the ED. This will be excluded from future versions of this CPG.

This study found that the most common reason for return was inadequate pain control. Due to the current opioid epidemic, there is likely hesitancy among providers to prescribe large amounts of opioid medications for pain control in any patient populations including patients with rib fracture. Including a pain control protocol in our CPG may increase provider comfort and volume goals may not have been optimal. Studies have shown that FVC is significantly related to age and it may be beneficial to adjust for age when obtaining the measured FVC. A better way to quantitate respiratory effort and function impairment compared with an elderly individual with a similar FVC. A better way to quantitate respiratory effort and function may be to calculate the percent predicted of the FVC based on

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Demographics and comparisons of successful discharge and return to the emergency department (ED)</th>
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<tbody>
<tr>
<td></td>
<td>Total study (n=233)</td>
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<tr>
<td>Male</td>
<td>64%</td>
</tr>
<tr>
<td>Age</td>
<td>53 (43–62)</td>
</tr>
<tr>
<td>FVC (mL)</td>
<td>2500 (1900–3200)</td>
</tr>
<tr>
<td>ED LOS (minutes)</td>
<td>232 (180–301)</td>
</tr>
<tr>
<td>Rib fractures</td>
<td>2 (1–3)</td>
</tr>
<tr>
<td>Pulmonary contusion</td>
<td>1.7%</td>
</tr>
<tr>
<td>MVC</td>
<td>11.2%</td>
</tr>
<tr>
<td>MCC</td>
<td>3.9%</td>
</tr>
<tr>
<td>Fall</td>
<td>60.9%</td>
</tr>
<tr>
<td>Assault</td>
<td>11.6%</td>
</tr>
</tbody>
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Categorical variables are presented as percentages. Continuous variables are presented as median (IQR).

FVC, forced vital capacity; LOS, length of stay; MCC, motorcycle collision; MVC, motor vehicle collision.

Table 2 Regression analysis predicting return to the emergency department

<table>
<thead>
<tr>
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<th>AOR</th>
<th>CI</th>
<th>P</th>
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<tbody>
<tr>
<td>Age</td>
<td>0.973</td>
<td>0.944 to 1.002</td>
<td>0.065</td>
</tr>
<tr>
<td>FVC</td>
<td>0.999</td>
<td>0.999 to 1.000</td>
<td>0.027</td>
</tr>
<tr>
<td>Assault</td>
<td>1.640</td>
<td>0.549 to 4.989</td>
<td>0.375</td>
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AOR, adjusted OR; FVC, forced vital capacity.

Table 3 Independent predictors of return to the emergency department

<table>
<thead>
<tr>
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<th>AOR</th>
<th>CI</th>
<th>P</th>
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<tbody>
<tr>
<td>Age</td>
<td>0.968</td>
<td>0.942 to 0.996</td>
<td>0.025</td>
</tr>
<tr>
<td>FVC</td>
<td>0.999</td>
<td>0.999 to 1.000</td>
<td>0.018</td>
</tr>
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</table>

AOR, adjusted OR; FVC, forced vital capacity.
individual patient characteristics to more accurately assess true impairment or adequate function.

Further research is needed to determine what can be considered as appropriate pain control for patients with rib fractures. Additionally, future research should be performed to determine whether these guidelines are maintained as part of routine clinical care with similar incidence of return to the ED after rib fractures.

Conclusion
This study confirms that the ED discharge pathway of the rib fracture CPG is safe and an FVC of 1500 mL is a safe minimum criterion for discharge in the absence of hemothorax, pneumothorax or bilateral fractures. Adherence with the number of fractures lagged, but number of fractures did not predict return to the ED and will be excluded from the CPG. Interestingly, it appears that older age is protective. Finally, more work needs to be done on effective pain control to decrease return to the ED using this CPG.

Contributors
CH, LB, AT and TS conceived the study and designed the investigation. CH, LB, AT, AO, AB and DC conducted data collection. LB and AT oversaw quality control of the data collection. CH drafted the article and all authors contributed to its revision. CH takes responsibility for the article as a whole.

Competing interests
None declared.

Ethics approval
The Institutional Review Board of University of Colorado Health approved the study.

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REFERENCES