Measuring the Impact of Whole-Body Computed Tomography on Hospital Length of Stay in Blunt Trauma

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Rationale and Objectives: Whole-body computed tomography (WBCT) imaging has become commonplace in some emergency departments (EDs) for trauma where management is dependent on rapid diagnosis achieved through comprehensive imaging. The purpose of this study was to assess the value that computed tomography (CT) imaging contributes to trauma patients by retrospectively comparing hospital length of stay (LOS) between WBCT and selective CT imaging, while controlling for hemodynamic stability and socioeconomic considerations.

Materials and Methods: This study was institutional review board approved. The institutional trauma registry database was cross-referenced with our radiology information system database to identify adult patients who sustained blunt trauma between July 2011 and June 2013 and received CT imaging. Propensity score weighting was utilized to achieve balance in baseline covariates, including demographics, hemodynamic stability, Glasgow Coma Scale, and socioeconomic factors. A generalized linear model was used to compare LOS between imaging types, and a multinomial logistic regression was utilized to analyze differences in discharge disposition.

Results: A total of 2291 patients were identified of which 14.5% underwent WBCT imaging. WBCT patients had an insignificantly longer inpatient hospital LOS of 0.31 days ($P = 0.54$), and insignificantly higher odds of being discharged to a nursing home facility (versus home, odds ratio = 1.29 [$P = 0.34$]) when compared to those who received selective CT.

Conclusion: WBCT imaging did not have a statistically significant effect on inpatient hospital LOS or discharge disposition.

Key Words: Blunt trauma; whole-body CT imaging; hospital length of stay.

INTRODUCTION

In the emergency department (ED), computed tomography (CT) utilization has increased threefold between 1996 and 2007, with a quarter of all CTs performed in the United States occurring in the ED (1,2). Determining the optimal use and justification for emergent testing is essential to containing the costs of medical care. A critical area of focus for imaging utilization in the ED is in the trauma setting. The early diagnostic evaluation of patients with severe trauma has become increasingly dependent on rapid and comprehensive imaging, with an emphasis on CT over the past two decades (3). CT distinguishes patients with injuries requiring intervention from patients without critical injuries, so that the trauma team can safely focus on the acute care issues (4). With rapid data acquisition and improved image quality, whole-body computed tomography imaging (WBCT) (defined as head, C-spine, chest, abdomen, and pelvis) is being used with increasing frequency in the trauma setting (3). However, the use of WBCT imaging in patients with blunt trauma in the ED remains controversial due to (1) the proliferation of potentially unnecessary imaging, (2) the associated risk of radiation exposure, (3) the added cost of the additional imaging, (4) the added time in the scanner, and (5) the expense of further workup of incidental findings (5–7).

The literature describing WBCT imaging is mostly from Europe and has found reduced mortality in severe blunt trauma patients who underwent WBCT imaging (3,4,7–9,14,15). However, the generalizability of these results to the United States remains to be determined due to the differences in our health-care systems. The purpose of our study was to examine the impact of trauma imaging strategies on patient outcomes in a US level 1 trauma center. Primary end points included hospital length of stay (LOS) and discharge disposition, while secondary endpoints included intensive care unit (ICU) LOS and mortality rate.

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METHODS AND MATERIALS

This retrospective chart review cohort study was performed to evaluate the impact of WBCT imaging utilized in the first 24 hours after a blunt trauma presentation on inpatient hospital LOS and discharge disposition primarily, and intensive care unit (ICU) LOS and mortality rate secondarily. We are an academic Level I trauma center with 33,000 patients annually with patients from a mixture of urban and rural settings (including multiple surrounding states) with highly variable access to health-care resources. The Institutional Trauma Registry Database was accessed to identify patients ≥18 years old who sustained blunt trauma between July 2011 and June 2013. Thils institutional registry is designed to provide data to the American College of Surgeons National Trauma Data Bank (https://www.facs.org/quality%20programs/trauma/ntdb). Patients who experienced penetrating trauma, were pregnant, underwent a surgical intervention before imaging, and died before the implementation of an advanced life-sustaining treatment were excluded. Demographics, injury severity score (ISS), abbreviated injury scale (AIS), inpatient hospital LOS, ICU LOS, Emergency department (ED) LOS, mortality data, disposition location, and whether the patient was transferred from an outside institution were collected from the Institutional Trauma Registry Database (12).

The list of patient encounters was cross-matched with the radiology information system (RIS) database, thereby identifying imaging records including CT imaging acquired both in-house and at any outside hospital before transfer. WBCT imaging was defined as CT imaging (with or without contrast) of at least the head, C-spine, chest, abdomen, and pelvis. Selective CT imaging was defined as any CT imaging that did not include all of these body areas.

A propensity score model (propensity to receive WBCT versus selective CT, given all the variables shown in Table 1) was utilized to achieve balance in baseline covariates (Tables 1 and 2) including demographics, hemodynamic stability, and ED Glasgow Coma Scale (GCS) (13). There were missing values for the following variables, due to variations in clinical practice: white blood cell (WBC) count, red blood cell (RBC) count, platelet count, international normalized ratio (INR), partial thromboplastin time (PTT), home distance from the university, glucose, potassium, anion gap, calcium, sodium, chloride, carbon dioxide, ED pulse, ED systolic blood pressure, creatinine, and blood urea nitrogen (BUN). Accordingly, a multiple imputation procedure was utilized, and transformations to normality on missing variables were necessary. Multiple imputation was carried out using PROC MI in SAS (version 9.4, SAS Institute, Cary, NC) using five imputations. All transformed variables were then back-transformed, and all variables were rounded to match original variable formats.

To create propensity scores, we performed a logistic regression analysis by each imputation, modeling the probability to receive WBCT versus selective CT and using our chosen predictors of interest (Table 1). We then generated propensity score weights based on the average treatment effect for the treated (ATT) weighting scheme (those receiving WBCT were assigned a weight of 1, and those receiving selective CT were assigned a weight of (propensity score/(1 − propensity score)). ATT estimates the average treatment effect for those who actually received the treatment, in this study the WBCT. We observed propensity score overlap between imaging groups and chose to exclude subjects with propensity scores less than 0.7, as shown in Figure 1. Using all imputed data, we generated standardized differences between imaging groups both before propensity score weighting and after propensity score weighting to assess the effectiveness of our propensity score model.

For our outcome of hospital discharge disposition, we performed a multinomial logistic regression on each imputation using the propensity score sample weights to assess the effect of imaging on discharge disposition (nursing home, home, or other). A $P < 0.05$ was used to determine statistical significance. Analyses were performed using SAS (version 9.4; SAS Institute, Cary, NC) or Stata (Stata Statistical Software, Release 13; StataCorp LP, College Station, TX).

The present study was reviewed and approved by the institutional review board.

RESULTS

Overall, 2,291 trauma registry patients met the inclusion criteria. The fully imputed dataset consisted of 11,328 observations, after removing 127 subjects with propensity scores less than 0.7. 1,958 (85.5%) subjects received selective CT imaging and 333 (14.5%) received WBCT imaging. Those patients who received WBCT were younger (44.2 versus 49.0 years old), less alert (Glasgow Coma Scale [GCS] of 12.2 versus 13.9), more likely have been involved in a motor vehicle accident (72.8% versus 49.9%), tachycardiac (pulse 94.9 bpm versus 88.7 bpm), and were more likely to need resuscitative products (5.3% versus 1.6% of patients) than selective CT imaging patients (Table 1). Variables with the greatest absolute standardized difference include “received lactate test,” motor vehicle accident, calcium level, GCS, and minutes in the ED, in descending order (Table 1).

All baseline variables had standardized differences after propensity score weighting less than 0.1 (Table 2), indicating that propensity score weighting worked properly at achieving balance between imaging groups. Figure 1 shows sufficient overlap between the distributions of propensity scores for the patients receiving selective CT imaging and for the patients receiving WBCT imaging, to suggest that we can be reasonably certain in the precision of our effect estimates.

For our primary analysis, we assessed the effect of imaging on inpatient hospital LOS while applying sample weights based on our propensity scores. Overall, the average LOS for subjects receiving whole-body imaging was 0.31 days longer when compared to subjects receiving selective imaging (95%