Background: There are very few data on characteristics or policies that improve patient outcomes in academic medical institutions. We were interested in 2 such policies or characteristics that are commonly implemented in academic centers: an in-house on-call attending physician policy and the existence of postgraduate medical education.

Hypothesis: An in-house attending surgeon on-call policy and the presence of trauma and critical care fellowship programs improve outcomes of critically injured patients.

Design: Multicenter cohort study. Two cohorts were analyzed: blunt trauma (n=601; mortality, 16.0%) and penetrating abdominal trauma (n=503; mortality, 7.5%).

Setting: Thirty-one academic level I trauma centers, 10 (32.3%) with in-house on-call policy and 11 (35.5%) with fellowship programs.

Main Outcome Measures: Mortality, hospital length of stay, and intensive care unit length of stay.

Results: In-house on-call surgeon policy had no impact on mortality or length of hospital or intensive care unit stay for either the blunt or penetrating trauma cohort. However, the presence of fellowship programs was associated with a significant decrease in blunt trauma mortality (odds ratio, 0.4; 95% confidence interval [CI], 0.1-0.8) and a decrease in length of intensive care unit stay (mean difference, 4.7 days; 95% CI, 0.6-8.8 days) and hospital stay (mean difference, 3.2 days; 95% CI, 0.6-5.9 days). There were no significant effects of fellowship programs on penetrating trauma outcomes.

Conclusions: An in-house on-call attending surgeon policy is not associated with improved outcomes. In contrast, presence of a trauma and surgical critical care fellowship program, a potential surrogate marker for an institution that is committed to this specialty interest, is associated with improved outcomes for critically injured patients. An investment in advanced postgraduate medical education has potential benefits in patient care and outcomes.

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One of the goals of academic medical centers is to deliver high-quality patient care in a teaching environment. Academic medical centers often implement different policies to provide varying degrees of attending physician supervision or different levels of medical education. However, it is not clear how these policies or characteristics affect the quality of patient care. We were interested in 2 groups of academic medical centers: the centers that use in-house on-call attending physicians to provide medical supervision and the centers that support postgraduate medical education, specifically fellowship programs.

First, there are different policies regarding attending physician supervision in academic centers. In many centers, during nonweekday hours the attending physician may direct the required care by telephone consultation from outside the hospital with presence at the bedside as needed. While house staff may be involved in medical care decisions, the attending physician remains responsible for and directs the care. In contrast, some teaching hospitals have implemented an “in-house policy” (IH policy) that requires the attending physicians to remain in the hospital and be present at the initial examination of patients. This model is relatively common for general surgeons at level I trauma centers. The American College of Surgeons Committee on Trauma requires availability of a trauma surgeon 24 hours per day for level I cen-
An in-house senior surgical resident or fellow may fulfill this requirement as long as the attending physician participates in all major decisions and returns to the hospital for critically injured patients. An IH policy is based on the premise that the more experienced attending physician can improve the initial patient treatment, optimize decision making, and minimize delays to medical intervention, thereby improving patient outcomes. However, evidence-based data supporting an IH policy and improvement in outcomes are limited, inconclusive, and inconsistent. 

Inclusion criteria for the penetrating injury cohort were pregnancy, burn injury, spinal cord injury with paralysis, an Abbreviated Injury Score of 2 or more, and fracture of at least 1 lower extremity. Inclusion criteria for the blunt trauma cohort included consecutive patients meeting inclusion criteria who were discharged from participating institutions during a 7-month period between June 1, 1998, and December 31, 1998. The penetrating trauma cohort included consecutive patients who were discharged during a 9-month period between November 1, 1997, and July 31, 1998. Data were collected by medical record abstraction at each hospital and then collated by UHC.

In addition, academic centers may provide different levels of graduate medical education. Some centers have postgraduate fellowship programs in trauma and critical care. We hypothesized that the presence of these fellowship programs may improve trauma outcomes. These institutions have invested considerable financial and educational resources to attract physicians interested in trauma and critical care and have made a commitment to be instrumental in developing their careers. The postgraduate training program in trauma and critical care may be a surrogate marker for an institution that is committed to this specialty interest, has the required resources, and therefore may have improved patient outcomes.

Using a national multicenter database, we investigated the effect of these 2 policies or characteristics on patient outcomes in major academic trauma centers. First, we examined whether the IH policy was associated with improved outcomes. Second, we examined whether academic institutions with postgraduate fellowship programs in trauma and surgical critical care had improved trauma outcomes.

The primary outcomes were hospital length of stay (LOS), intensive care unit (ICU) LOS, and risk of fatal outcome. Two separate sets of analyses were performed. In the first set, the outcomes of centers with an IH policy were compared with those of centers without an IH policy, and in the second set, the outcomes of centers with trauma and surgical critical care fellowship programs were compared with those of centers without fellowship programs.

**Statistical Methods**

Data were evaluated by means of multivariate logistic and linear regression. The dependent variable for the logistic regression was risk of fatal outcome, and that for linear regression was hospital or ICU LOS. First, we identified clinical variables associated ($P<.2$) with either of these outcomes by means of univariate analyses. Then, IH policy or fellowship program along with these potential confounders was entered in multivariate stepwise (backward elimination) regression models with mortality, hospital LOS, or ICU LOS as the dependent variable. Forcing IH policy or fellowship, variables were removed and reentered into the model with the use of significance levels for removal and reentry of .2 and .1, respectively. First-order interaction terms were investigated in the final model. Injury Severity Score (ISS) (0-9, 10-15, 16-25, and $\geq 26$), systolic blood pressure in the emergency department (0-59, 60-89, and $\geq 90$ mm Hg), Glasgow Coma Scale (GCS) score ($<6$, 6-8, 9-12, and 13-15), and age ($<36$, 36-55, and $\geq 56$ years) were used as categorical variables. Since trauma center volume has been associated with improved outcomes, we decided to adjust for this variable. Trauma center volume was derived from a related UHC operational database containing information on the organizational structure of each institution and represented the total number of all major trauma admissions with an ISS greater than 15 during 1998. The institutional volume ranged from 168 to 1050 patients, with a mean of 470. We used volume as a dichotomized categorical variable and assigned the institution to be relatively high volume if the trauma center volume was above the mean (<470 or $\geq 470$). The maximum Abbreviated Injury Score for abdomen and chest, transportation modality, weapon type (for penetrating injury greater than 12 years and penetrating abdominal injury, excluding patients with any other body injury with Abbreviated Injury Score greater than 2, and pregnant or burned patients.

**Study Design**

We limited our analyses to participating level I trauma hospitals, 31 in the blunt trauma and 24 in the penetrating trauma cohorts. The blunt trauma cohort included consecutive patients meeting inclusion criteria who were discharged from participating institutions during a 7-month period between June 1, 1998, and December 31, 1998. The penetrating trauma cohort included consecutive patients who were discharged during a 9-month period between November 1, 1997, and July 31, 1998. Data were collected by medical record abstraction at each hospital and then collated by UHC.

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**Institutions and Patients**

The institutions on which this analysis is based are trauma centers that participated in the University HealthSystem Consortium (UHC) Trauma Benchmarking Study. The UHC consists of 84 academic medical centers and associated institutions located throughout the United States. The UHC Trauma Benchmarking Study was designed to compare outcomes and resource utilization among centers in 2 separate and homogeneous cohorts of patients: patients with blunt trauma, characterized by head injury with long-bone fracture, and patients with penetrating abdominal trauma. Inclusion criteria for the blunt injury cohort were age of at least 18 years, head Abbreviated Injury Score of 2 or more, and fracture of at least 1 lower extremity long bone (tibia and/or femur). Exclusion criteria were pregnancy, burn injury, spinal cord injury with paralysis, and transfer from another institution more than 24 hours after injury. Inclusion criteria for the penetrating injury cohort were age greater than 12 years and penetrating abdominal injury,

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Information regarding trauma center policy mandating an in-house attending on-call surgeon and presence or absence of a trauma and surgical critical care fellowship program was obtained by direct contact with trauma coordinators at the respective institutions. The hospitals with an IH policy required an attending general surgeon to remain in the hospital 24 hours per day. The hospitals without an IH policy required the attending trauma surgeon to direct the care of all trauma patients and be present in the hospital within 15 minutes for critically injured patients.

The primary outcomes were hospital length of stay (LOS), intensive care unit (ICU) LOS, and risk of fatal outcome. Two separate sets of analyses were performed. In the first set, the outcomes of centers with an IH policy were compared with those of centers without an IH policy, and in the second set, the outcomes of centers with trauma and surgical critical care fellowship programs were compared with those of centers without fellowship programs.

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trauma), respiratory rate, and need for operation within the first 24 hours were not independently associated with the outcomes (P>.2). We used Stata Statistics/Data Analysis 6.0 software (Stata Corp, College Station, Tex).

RESULTS

Thirty-one institutions contributed patients to the blunt trauma cohort and 24 institutions contributed patients to the penetrating trauma cohort. The distribution of hospitals with an IH policy and fellowship programs is given in Table 1. There were a total of 1104 patients, 601 in the blunt trauma and 503 in the penetrating cohort. Hospitals with an IH policy treated 32.3% of patients in the blunt trauma and 38.2% in the penetrating cohort. Hospitals with trauma critical care programs treated 31.1% of the patients in the blunt trauma and 44.9% of the patients in the penetrating trauma cohort.

As compared with penetrating trauma, the blunt trauma cohort had higher mortality rate (16.0% in blunt and 7.5% in penetrating; P<.001), longer hospital stay (mean, 14.7 days for blunt and 6.3 days for penetrating; P<.001), longer ICU stay (mean, 9.2 days for blunt and 3.5 days for penetrating; P<.001), older patients (mean, 40 years for blunt and 31 years for penetrating; P<.001), higher ISS (mean, 24 for blunt and 11 for penetrating; P<.001), and lower GCS score (mean, 11 for blunt and 14 for penetrating; P<.001). The characteristics of patients for each cohort are presented in Table 2. There were no significant differences in age, sex, ISS, GCS score, and systolic blood pressure between patients treated in hospitals with an IH policy vs those without an IH policy or between patients treated in hospitals with fellowship programs vs those without fellowship programs.

RISK OF FATAL OUTCOME

There were 96 deaths in the blunt trauma cohort and 38 deaths in the penetrating trauma cohort, for a total of 134 deaths (12.1%) in 1104 patients. The presence of an IH policy (vs no IH policy) had no effect on risk of fatal outcome in either cohort (Table 3). However, presence of a trauma and critical care fellowship significantly decreased the risk of fatal outcome in the blunt trauma cohort (adjusted odds ratio, 0.4; 95% confidence interval, 0.1-0.8 [P=.03], after adjusting for GCS score, ISS, systolic blood pressure, age, and institutional volume).

HOSPITAL AND ICU LOS

The mean hospital LOS for patients who survived was 14.7 days for the blunt trauma cohort and 6.3 days for the penetrating trauma cohort. The mean ICU LOS for the patients who survived was 9.1 days for the blunt trauma and 3.5 days for the penetrating trauma cohort.

In-house policy had no effect on LOS in either the blunt or the penetrating trauma cohort. However, comparing hospitals with trauma and critical care fellowship programs with those without fellowship programs, multivariate linear regression demonstrated a decrease in hospital LOS, −3.2 days (95% confidence interval, −3.9 to −0.6), and ICU LOS, −4.7 days (95% confidence interval, −8.8 to −0.6), in the blunt trauma cohort (Table 4). The difference in LOS was adjusted for GCS score, ISS, systolic blood pressure, age, and institutional volume, and there were no effect modifications (P>.05 for first-order interaction terms). The LOS in the penetrating trauma cohort was not significantly associated with IH policy or presence of a fellowship program.

COMMENT

Care of the injured patient in the United States is evolving from a voluntary-based service to an organized team approach with established protocols and statewide trauma systems. The development of organized trauma systems has been associated with improved outcomes. In academic institutions, the trauma care is changing from an orphan service with no attending physician input to a specific division of general surgery with surgical attending physicians directing the patient care. Although higher patient volumes have been associated with improved outcomes, it is not clear how educational programs and other institutional policies affect patient outcome. It is presumed that an in-house on-call policy for the attending surgeon improves outcomes by increasing the attending physician presence on the initial arrival of the patient. Studies on the impact of an in-house on-call policy on trauma outcomes have conflicting conclusions and have been severely limited, with the best studies comparing the outcomes of only 2 hospitals.

This is, to our knowledge, the first multicenter cohort study investigating the impact of an in-house on-call policy on patient outcomes. There was no difference between the outcome of patients treated in hospitals with and without an IH policy. The presence of an IH policy did not modify outcomes in any of the studied cohorts of blunt trauma, penetrating trauma, fellowship centers, or nonfellowship centers. It is important to emphasize that the goal of this study was to evaluate the effect of a policy regarding in-house stay on trauma outcomes. This study, however, did not investigate whether the direct involvement of an experienced trauma surgeon improved outcomes. The number of surgeons dedicated to trauma care is limited, and the attending sur-
geon on call may or may not be an experienced trauma surgeon. Moreover, although an IH policy increases attending physician presence in the hospital, it does not necessarily result in an increase in attending physician presence at the bedside. Since we did not have the attending physician response time, we could not evaluate the premise that an IH policy translates to faster and more frequent attending surgeon presence at the bedside. Therefore, we could not evaluate the extent of involvement of the attending surgeon in each cohort. Our goal was to evaluate the effectiveness of the IH policy in improving outcomes. This study found no evidence that having a mandatory in-house attending physician on-call policy at academic teaching hospitals improved patient outcomes.

In contrast, institutions with trauma and surgical critical care fellowship programs had improved patient outcomes. The majority of this effect was related to the care of blunt trauma patients in the ICU. It is unlikely that the improved outcomes are due to the direct involvement of the fellow. The fellow’s experience level exceeds that of the senior resident by at most a few years and thus may not explain such a large effect. We propose that the presence of a trauma and surgical critical care fellowship program may be a marker for a mature, dedicated trauma and critical care service. Since fellowship programs must undergo external review and resource verification, it is likely that these programs have a more organized and committed trauma and critical care system. In the timetable of major changes in the development of an institutional trauma system, establishment of a trauma director, a trauma service with appropriate nurse coordinators, and a dedicated trauma ICU precede the development of a trauma and critical care fellowship program. Similar to other studies showing improved outcomes with dedicated ICU services, we suggest that the presence of a fellowship program identifies a more highly evolved system that has the required resources and expertise for the care of the critically injured patient. We conclude that the presence of a trauma and critical care fellowship program is associated with improved patient outcomes. This study suggests that an investment in advanced postgraduate medical education improves patient care and, ultimately, outcomes.

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Table 2. Characteristics of the Blunt and Penetrating Trauma Cohorts

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<thead>
<tr>
<th>In-house Policy</th>
<th>Fellowship Program</th>
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<tbody>
<tr>
<td><strong>Blunt (n = 60)</strong></td>
<td><strong>Penetrating (n = 503)</strong></td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>39 (17)</td>
</tr>
<tr>
<td>Sex, % M</td>
<td>66</td>
</tr>
<tr>
<td>ISS, mean (SD)</td>
<td>24 (12)</td>
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<tr>
<td>SBP, mean (SD), mm Hg</td>
<td>125 (28)</td>
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<tr>
<td>GCS, mean (SD)</td>
<td>11 (5)</td>
</tr>
<tr>
<td>Mortality, %</td>
<td>16.6</td>
</tr>
<tr>
<td>Hospital LOS, mean (SD), d</td>
<td>13.3 (13.4)</td>
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<tr>
<td>ICU LOS, mean (SD), d</td>
<td>9.9 (13.5)</td>
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<thead>
<tr>
<th><strong>Blunt trauma</strong></th>
<th><strong>Penetrating trauma</strong></th>
</tr>
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<tbody>
<tr>
<td>Risk of fatal outcome</td>
<td>1.2 (0.5-3.0)</td>
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<tr>
<th>In-house Policy vs No In-house Policy</th>
<th>Fellowship Program vs No Fellowship Program</th>
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<tbody>
<tr>
<td>Risk of fatal outcome</td>
<td>0.4 (0.1-0.8)</td>
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<tr>
<th>Table 3. Adjusted Risk of Fatal Outcome by In-house Policy and Fellowship Program</th>
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<tr>
<td><strong>Odds Ratio (95% Confidence Interval)</strong></td>
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<tr>
<td><strong>In-house Policy vs No In-house Policy</strong></td>
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<tr>
<td>Risk of fatal outcome</td>
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<td>Penetrating trauma</td>
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<th>Table 4. Adjusted Difference in Hospital and ICU LOS by Hospital Policy and Fellowship Program</th>
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<tr>
<td><strong>Difference (95% Confidence Interval), d</strong></td>
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<tr>
<td><strong>In-house Policy vs No In-house Policy</strong></td>
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<tr>
<td>Hospital LOS</td>
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<tr>
<td>Penetrating trauma</td>
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<tr>
<td>ICU LOS</td>
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<tr>
<td>Penetrating trauma</td>
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</table>

Abbreviations: GCS, Glasgow Coma Scale; ICU, intensive care unit; ISS, Injury Severity Score; LOS, length of stay; SBP, initial systolic blood pressure.
REFERENCES


Invited Critique

F rom this article it would seem that in-house attending physicians have little effect on outcome, whereas a commitment to a fellowship training program does. We must be cautious in interpreting these results. The amount of data collected, though concurrent, is small for the number of centers studied. In each cohort in each trauma center, there are on average less than 20 patients. The injury matching is balanced by Injury Severity Score, but the Abbreviated Injury Score used between centers is not standardized, which introduces variability.

The authors assume that self-designation of in-house vs out-of-house leads to an actual difference in surgeon response. This was not measured or controlled for. It is possible that attending physician arrival was rapid for all severely injured patients in both groups. The composition of resuscitation teams varies in hospitals. Involvement of an experienced attending emergency department physician in an out-of-house hospital might balance the effect on care of an in-house hospital.

In high-volume hospitals with experienced residents, the involvement of the attending physician will be less important, but one cannot make that conclusion in a hospital where volume is modest and where attending physicians are not needed. The association of a teaching program with improved outcome makes sense and is in line with the authors’ recent publication regarding volume and outcome.1 Both of these measure commitment.

To resolve this debate, a well-designed, appropriately controlled study is needed. This will be difficult to perform for ethical reasons. This debate, however, needs to be resolved within the profession or we will leave a void to be filled by external regulation. Where we sleep is not the issue. Being available for a sick patient is our responsibility.

David B. Hoyt, MD
San Diego, Calif