A Crisis in the Delivery of Care to Patients With Brain Injuries in South Texas

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**Background:** To determine the opinions of neurosurgeons regarding the care of the injured and to assess the impact of these attitudes on the care of the patients with brain injuries.

**Methods:** A survey was sent to the 2,465 active members of the American Association of Neurologic Surgeons. A manpower assessment of neurosurgical coverage of South Texas was also performed.

**Results:** In total, 872 surveys were returned (35%). Seventy-one percent of the respondents were over the age of 44. Eighty-seven percent of neurosurgeons stated that they currently provide trauma care: 74% at Level I or II trauma centers. The majority of neurosurgeons treated <5 trauma patients per week, 80% placed 2 or fewer intracranial pressure (ICP) monitors per month. Fifty-nine percent of the respondents preferred not to treat trauma patients because of (1) perceived increased medicolegal risk (80%), (2) conflict with elective practice (75%), (3) time required (70%), and (4) inadequate compensation (65%). Fifty-six percent received no compensation for trauma call. The majority of neurosurgeons indicated that no personnel other than neurosurgeons should be allowed to perform trauma craniotomies (90%) or insert ICP monitors (76%). However, 61% thought that non-neurosurgeons should be able to perform neuro-critical care. A maldistribution of neurosurgeons was identified in South Texas, with much of the population uncovered for trauma care. Significant delays in definitive neurosurgical care were identified as a result of this maldistribution.

**Conclusions:** One-half of neurosurgeons prefer not to care for trauma patients because of perceived added time commitment, conflicts with elective practice, lack of compensation, and perceived medicolegal risk. But, they thought that only neurosurgeons should provide emergency neurosurgical procedures. These attitudes appear to impinge on the care of the patients with brain injuries in South Texas.

**Key Words:** Neurosurgeon, Head injury, Management, Survey.


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**Clinical Scenario**

*Referring emergency medicine physician:* “We have a six-year-old girl who fell off her bike around noon today and lost consciousness. At admission she was hemodynamically stable but had a Glasgow Coma Scale (GCS) score of 12. We just obtained a head computed axial tomography (CT), which shows a large epidural hematoma. Her neurologic status has deteriorated during the last 30 minutes.

“We have no neurosurgeon on call this week, but I spoke to one of our neurosurgeons in town. He refused to see the patient stating that we have inadequate neuro-critical care support.”

*Tertiary care center trauma surgeon:* “Can he perform the craniotomy and then transfer the patient to us? She may herniate in the time it takes to send a helicopter there. Moreover, the transport time will be more than 4 hours.”

*Referring Emergency Medicine physician:* “I suggested that to the neurosurgeon but he is not on call and refused to see the patient.”

Patient arrives at Level I trauma center many hours later with fixed dilated pupils and dies later in the hospitalization. (Adapted from two similar cases that the author [S.M.C.] encountered during a single trauma call.)

It is estimated that 1.5 million Americans sustain a brain injury each year and 28% develop acute subdural or epidural hematomas. More than 10% of these patients with severe traumatic brain injury require craniotomy.1 Prolonged delays in the definitive care of these expanding intracranial hematomas in neurologically deteriorating patients with brain injuries increases mortality.2 Therefore, expeditious craniotomy for traumatic intracranial bleeds has become routine.3 Unfortunately, many trauma victims with brain injury are a considerable distance from Level I or II trauma centers and therefore neurosurgeons may not be readily available.4 Trauma surgeons may be placed in situations where neurosurgical coverage is not available (vide supra).5 Patients can then experience long transport times and life-threatening delays in definitive care. We thought that this situation has resulted in a crisis in the care of patients with severe brain injuries in our region.

We hypothesized that many individuals in the neurosurgical community prefer not to perform trauma care. We further postulated that neurosurgeons might find it acceptable for others to intervene in emergency situations where these procedures could be lifesaving. We surveyed members of the American Association of Neurologic Surgeons to determine the prevailing attitudes of neurosurgeons toward the care of patients with brain injuries.
injury. Further, we reviewed one local region’s neurosurgical availability and the associated transfer of patients with brain injury, hypothesizing that attitudes and beliefs concerning trauma coverage turn into action, particularly in areas where neurosurgical coverage is less than ideal.

MATERIALS AND METHODS

Survey of Neurosurgeons

A survey was sent to 2,497 active members of the American Association of Neurologic Surgeons (AANS) who were board certified as of June 2005. Of the 2,465 members with valid addresses, 872 completed surveys were returned (35% response rate). To provide anonymity, no attempt was made to track responders/nonresponders. Therefore, only one mailing was sent. The survey content and purpose was reviewed and approved by AANS Member Services before distribution. A psychologist, expert in survey methodology, evaluated our survey instrument before completion in an effort to minimize question bias.

The survey was adapted from two previously published instruments. The first was a survey “to quantify how the trauma community views the responsiveness and the degree of involvement of neurosurgeons in the area of trauma care.” The second instrument was a questionnaire developed by Esposito et al. to document the opinions of surgeons on trauma care issues. The current survey asked respondents to provide demographic information about themselves and their hospitals (including specialty, hospital trauma certification level, location, and type of practice). Respondents were also asked about their preferences regarding providing trauma care, taking trauma call, and their perceptions of how trauma care impacts private practice. Additionally, respondents were asked about the percentage of trauma patients for which they receive compensation as well as compensation for performing trauma call. The questionnaire also asked whether disciplines other than Neurosurgery should provide neuro-critical care, or perform emergency neurosurgical procedures, and if so, under what circumstances. Finally, respondents were asked about the reasons they prefer not to provide trauma care and their level of agreement or disagreement with statements on the time commitment, reimbursement rates, and increased medicolegal risks of trauma cases. Preference for providing care for the trauma patients was measured with a single item on which respondents indicated whether they “strongly prefer to treat,” “somewhat prefer to treat,” “no preference,” “somewhat prefer not to treat,” or “strongly prefer not to treat”. For analysis, responses were collapsed into “prefer to treat” and “prefer not to treat” with those expressing “no preference” being combined with “prefer to treat”. Chi square, Fisher’s exact test, and p values were calculated where appropriate. The survey was approved by the University of Texas Health Science Center Institutional Review Board (Protocol # E-045-126). The survey items are included as an Appendix.

Neurosurgeon Manpower in Texas

Data displayed on the map of South Texas (Fig. 1) were obtained from several sources. Population densities for Texas counties in 2004 are based upon intercensal year estimates from the US Bureau of Census. The information for active direct care Texas physicians who listed neurologic surgery as their primary specialty in 2004 was originally from the Texas State Board of Medical Examiners. This physician license information was geo-referenced into points of latitude and longitude based on a ‘practice’ address by the Texas Department of State Health Services. The trauma center information was obtained from the web site of the Texas Department of State Health Services. These hospitals were then geo-referenced into the latitude and longitude points situated at the center of their zip codes. These trauma center points were mapped by level along with the quartiles of the distribution of the Texas county population density plus the hospital practice locations of the neurosurgeons. Helicopter range and time estimates were adapted from a recent analysis of access to trauma centers and assumes 21.6 minutes spent on scene, and typical flying times at typical cruise speeds. These helicopter ranges depict distances traveled in 1 hour. The geo-coding of the trauma centers and final map preparation was completed by the Regional Center for Health Workforce Studies at the Center for Health Economics and Policy at the University of Texas Health Science Center, San Antonio.

Assessing Clinical Impact of Delayed Neurosurgical Intervention

A retrospective study of trauma cases evaluated at our Level I trauma center in 2000 to 2004 was conducted to assess the impact of delayed neuro-critical care on patient outcomes. A survey of trauma program managers and hospitals concerning neurosurgical call coverage was performed for South Texas in March 2006 by one of the authors (M.J.M.). The study was approved by the University of Texas Health Science Center Institutional Review Board (Protocol #E-045-126).

RESULTS

Sample Demographics

The survey was mailed to 2,465 active members of the American Association of Neurologic Surgeons who were board certified as of June 2005 and 847 or 35% responded (Table 1). The age ranges of the respondents were as follows: 29% were 36 to 44 years, 46% were 45 to 55 years, and 25% were >55 years of age. Seventy-four percent were involved in private practice, 28% were affiliated with academic institutions, and 6% were in other practice settings (respondents were allowed to select more than one practice category). Only 18 neurosurgeons (2%) named trauma as their area of specialty. One-half of all neurosurgeons responding stated that spine was their primary specialty area. Eighty-eight percent categorized their community as large urban (>50,000 popu-
lation) with 12% as large rural (>10,000 to <50,000). The majority (74%) practiced at Level I or Level II trauma centers. About one-quarter had a neurosurgery residency program at their hospital and almost one-third reported they had performed neurotrauma research.

**Why Many Neurosurgeons Prefer Not to Care for the Injured**

Eighty-seven percent of the respondents indicated that they provide trauma care. However, 441 neurosurgeons (52%) preferred not to provide trauma care and 450 (59%) preferred not to perform trauma call (Table 2 and Fig. 2). There was no significant difference in preferences to provide trauma care related to the size of the community (rural vs. urban). Those who preferred not to care for trauma patients were less likely to work in Level I or II trauma centers (67% vs. 80%, p < 0.001) or to have a neurosurgical residency program (18% vs. 36%, p < 0.001), but were more likely to be in private practice (85% vs. 61%, p < 0.001) when compared with those willing to care for the injured.

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**Fig. 1.** Trauma coverage in south Texas. Texas trauma service areas are shown in the geographic service area map of Texas (left). Trauma service areas P, S, T, U, and V are shown in the larger map of south Texas (above) with locations of trauma centers, neurosurgeons, 1-hour helicopter coverage circles, and population density shading.
majority (56%) of neurosurgeons caring for trauma patients stated that they usually did not receive compensation for trauma call, 19% received less than $1,000, 24% received $1,000 to $3,000, and 1% received more than $3,000 per 24-hour call. This response was essentially the same whether or not the surgeons preferred to take trauma call.

The neurosurgeons were asked why they preferred not to take trauma call. Seventy-five percent thought that trauma call conflicted with their elective practice, 70% stated that it was related to the time required, and 65% reported a lack of adequate compensation for effort (Table 2). Few respondents declared that they had no interest in brain trauma (17%) or that the field was without challenge (5%).

When asked how strongly they agreed or disagreed with the statement that trauma cases require greater time commitments than do elective cases, 78% agreed or strongly agreed. When asked to agree or disagree with the statement that the rate of reimbursement is similar for trauma patients and elective patients, 82% disagreed or strongly disagreed. Eighty percent of respondents agreed or strongly agreed with the statement that trauma patients pose an increased medical legal risk. Eighty-one percent thought that providing trauma

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**Table 1 Neurosurgeon Survey Sample Demographics (Stratified by Trauma Call Preference)**

<table>
<thead>
<tr>
<th></th>
<th>Prefer (N = 404) (%)</th>
<th>Not prefer (N = 445) (%)</th>
<th>Total (N = 849) (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36–44</td>
<td>27</td>
<td>30</td>
<td>29</td>
<td>0.39†</td>
</tr>
<tr>
<td>45–55</td>
<td>45</td>
<td>47</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>56 or greater</td>
<td>28</td>
<td>23</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Trauma center level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>46</td>
<td>29</td>
<td>37</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>II</td>
<td>34</td>
<td>39</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>8</td>
<td>12</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Not designated</td>
<td>11</td>
<td>16</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Neurosurgery residency within hospital</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>36</td>
<td>18</td>
<td>27</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>No</td>
<td>64</td>
<td>27</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>What type of practices are you currently involved in? (check all that apply)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic (yes)</td>
<td>39</td>
<td>19</td>
<td>28</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Private practice (yes)</td>
<td>61</td>
<td>85</td>
<td>74</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Other (yes)</td>
<td>9</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Primary specialty area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spine</td>
<td>37</td>
<td>62</td>
<td>50</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Trauma</td>
<td>4</td>
<td>0.5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Hospital location</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolated rural (2,500–10,000 population)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.22†</td>
</tr>
<tr>
<td>Large rural (&gt;10,000–50,000)</td>
<td>14</td>
<td>10</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Large urban (&gt;50,000)</td>
<td>85</td>
<td>89</td>
<td>174</td>
<td></td>
</tr>
</tbody>
</table>

* Pearson’s $\chi^2$ test.
† Fisher’s exact test.

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**Table 2 Reasons Neurosurgeons Prefer Not to Take Trauma Call (Stratified by Trauma Care Preference)**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Prefer (%)</th>
<th>Don’t Prefer (%)</th>
<th>Total (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time required</td>
<td>57</td>
<td>82</td>
<td>70</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Conflict with elective practice</td>
<td>60</td>
<td>88</td>
<td>75</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Lack of adequate compensation for effort</td>
<td>52</td>
<td>78</td>
<td>65</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>No interest</td>
<td>6</td>
<td>26</td>
<td>17</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>No challenge</td>
<td>3</td>
<td>7</td>
<td>5</td>
<td>0.009‡</td>
</tr>
<tr>
<td>Increased medicolegal risk</td>
<td>35</td>
<td>64</td>
<td>99</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>35</td>
<td>64</td>
<td>99</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Agree</td>
<td>36</td>
<td>25</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>

* Pearson’s $\chi^2$ test.
† Fisher’s exact test.
care somewhat negatively or very negatively impacts private practice. Those respondents who preferred not to care for the injured were significantly more likely to think that time commitment \((p = 0.02)\) and medicolegal risk \((p = 0.001)\) were greater, and that reimbursement was worse for trauma care \((p = 0.001)\), than did those neurosurgeons who preferred to provide trauma care.

Neurosurgeons typically cared for a few patients with trauma on a weekly basis, and 61% treated less than 5 patients per week. Fifty-seven percent reported that they placed zero or one intracranial pressure monitors per month. Although about one-half of neurosurgeons did perform two or more craniotomies per month, we failed to ask respondents to specify whether these were performed in patients with trauma during our survey. Neurosurgeons who preferred to care for the injured treated more trauma patients, and performed a statistically significantly larger number of intracranial pressure (ICP) monitor insertions and craniotomies each month than those who preferred not to care for the injured \((p < 0.001)\).

### Should Non-Neurosurgeons Care for the Patients with Brain Injuries?

The survey inquired about the role of non-neurosurgeons in neurotrauma care. Twenty-nine percent of neurosurgeons thought that non-neurosurgeons should be permitted to do neurotrauma procedures, including placing ICP monitors, drilling burr holes, or performing a craniotomy if a neurosurgeon was not available and herniation was considered imminent (Table 3).

<table>
<thead>
<tr>
<th>Should surgeons perform basic neurosurgery trauma procedures (including ICP monitor burr holes, craniotomy) if a neurosurgeon is not available and herniation is impending?</th>
<th>Prefer (N = 404)</th>
<th>Don’t Prefer (N = 440)</th>
<th>Total (N = 844)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (%)</td>
<td>29</td>
<td>30</td>
<td>29</td>
<td>0.68*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Should non-neurosurgeon place ICP monitors?</th>
<th>Prefer (N = 404)</th>
<th>Don’t Prefer (N = 440)</th>
<th>Total (N = 844)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (%)</td>
<td>19</td>
<td>28</td>
<td>24</td>
<td>0.005*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Under which circumstances should these services be allowed to place monitors? (N = 312)</th>
<th>Prefer (N = 404)</th>
<th>Don’t Prefer (N = 440)</th>
<th>Total (N = 844)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergencies only (e.g. patient’s condition deteriorating and neurosurgeon not available) (%)</td>
<td>30</td>
<td>29</td>
<td>29</td>
<td>0.68*</td>
</tr>
<tr>
<td>After prior consultation with neurosurgeon (%)</td>
<td>11</td>
<td>8</td>
<td>9</td>
<td>0.68*</td>
</tr>
<tr>
<td>Both of the above (%)</td>
<td>53</td>
<td>54</td>
<td>53</td>
<td>0.68*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Should services other than neurosurgery be allowed to perform trauma craniotomies?</th>
<th>Prefer (N = 404)</th>
<th>Don’t Prefer (N = 440)</th>
<th>Total (N = 844)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (%)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0.68*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>If yes, for which type of lesions? (%)</th>
<th>Prefer (N = 404)</th>
<th>Don’t Prefer (N = 440)</th>
<th>Total (N = 844)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidural hematoma and/or subdural hematoma (%)</td>
<td>92</td>
<td>95</td>
<td>93</td>
<td>0.68*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Should nonneurosurgeons provide neuro-critical care?</th>
<th>Prefer (N = 404)</th>
<th>Don’t Prefer (N = 440)</th>
<th>Total (N = 844)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (%)</td>
<td>57</td>
<td>66</td>
<td>61</td>
<td>0.008*</td>
</tr>
</tbody>
</table>

* Pearson’s \(\chi^2\) test.
† Fisher’s exact test.

<table>
<thead>
<tr>
<th>Should non-neurosurgeons care for the patients with brain injuries?</th>
<th>Yes (%)</th>
<th>No (%)</th>
<th>Total (%)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurosurgeons who preferred to care for the injured</td>
<td>61%</td>
<td>39%</td>
<td>100%</td>
<td>0.008*</td>
</tr>
<tr>
<td>Neurosurgeons who preferred not to care for the injured</td>
<td>57%</td>
<td>43%</td>
<td>100%</td>
<td>0.008*</td>
</tr>
</tbody>
</table>

The situation in which non-neurosurgeons should be allowed to place monitors was judged...
by the respondents to be emergency situations only, 29%; after prior consultation with a neurosurgeon, 9%; and after both of the above, 53%. Only 10% of neurosurgeons thought that other services should be permitted to perform trauma craniotomies. In this subgroup of neurosurgeons, 93% thought that craniotomy by other than neurosurgeons would be appropriate in the setting of acute epidural and subdural hematomas.

**Neurosurgical Manpower Analysis of South Texas**

Analysis of the population densities, trauma center location, and the number of neurosurgeons revealed that neurosurgeons were concentrated in higher population areas of south Texas (Fig. 1 and Table 4). This region has a population of approximately 4 million inhabitants, primarily located in San Antonio, the Rio Grande Valley, Corpus Christi, and Victoria, TX. In this region of 52,000 square miles (about the size of Florida or Illinois), there are 3 Level I trauma centers (all located in San Antonio), and 12 Level III trauma centers (2 in San Antonio, 5 in the Rio Grande Valley, 2 in Victoria, 1 in Corpus Christi, and 2 in Laredo).

Forty neurosurgeons serve the population, twenty-two are in San Antonio where there is 24-hour coverage of neurotrauma in the three Level I centers. Ten reside in the Rio Grande Valley, where trauma neurosurgery coverage is sporadic. At the time of the survey, one Level III hospital in the Rio Grande Valley had only one day of neurotrauma call coverage per week. Although two other Level III hospitals in the Rio Grande Valley have 24/7 neurotrauma coverage, transferring patients from other hospitals in the local area to these facilities is often difficult or impossible; leading to long patient transports to San Antonio (255–288 miles). Although the Rio Grande Valley has a population of approximately 1 million residents, there is a lack of Level I and II trauma centers in the region (where continuous neurosurgical availability is an essential criterion). These factors set the stage for long delays in the care of the patients with brain injury.

**Impact of Delays in Transport on Neurologic Outcome**

The impact of delays in transport of patients with epidural (EDH) or subdural (SDH) hematomas was analyzed from the trauma registry of one of the Level I trauma centers in the region which represents about 50% of trauma patients transported to San Antonio (Fig. 3). The figure suggests that patients with brain injuries (specifically SDH or EDH) arriving with low GCS scores have a high mortality. Forty-four percent of our subdural or epidural hematoma patients arrived with a GCS score <9, (mean GCS score = 4.03 ± 1.65). We did not assess neurologic sequelae, but their mortality was 39%. In contrast, those patients arriving with a GCS score ≥9, most with a near normal GCS, had a very low death rate, 2%. In a subset of these patients with complete transport time information (n = 17), the mean decrease in GCS score during transport exceeded 6, and the mean time of transfer was 5 hours and 5 minutes. Our data are consistent with the low functional outcomes found 25 years ago by Seelig et al. associated with delays in evacuation of subdural hematomas (Fig. 4).

**Table 4 Neurosurgeon Trauma Coverage in South Texas**

<table>
<thead>
<tr>
<th>City</th>
<th>Hospitals With Neurosurgeons</th>
<th>Level</th>
<th>Neurosurgeons</th>
<th>Uncovered Trauma Call Days/Year (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metropolitan area 1</td>
<td>Trauma centers A, B, C</td>
<td>I</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>Metropolitan area 2</td>
<td>Trauma center 1</td>
<td>III</td>
<td>10</td>
<td>313 (85)</td>
</tr>
<tr>
<td></td>
<td>Trauma center 2</td>
<td>III</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Trauma center 3</td>
<td>III</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Metropolitan area 3</td>
<td>Trauma center 1</td>
<td>III</td>
<td>3</td>
<td>283 (78)</td>
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<tr>
<td></td>
<td>Trauma center 2</td>
<td>III</td>
<td></td>
<td>173 (47)</td>
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<td>Metropolitan area 4</td>
<td>Trauma center 1</td>
<td>III</td>
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<tr>
<td>Metropolitan area 5</td>
<td>Trauma center 1</td>
<td>III</td>
<td>1</td>
<td>Not available</td>
</tr>
</tbody>
</table>

**Fig. 3.** Outcome of trauma patients transported to a Level I trauma center (2001–2004). TBI, Traumatic brain injury; SCI, spinal cord injury; SDH, subdural hematoma; EDH, epidural hematoma; GCS, Glasgow Coma Score; M, mean; SD, standard deviation.
The principle findings of this study were (1) one-half of neurosurgeons surveyed prefer not to care for patients with trauma because of perceived added time commitment, conflicts with elective practice, lack of compensation, and associated medicolegal risks; (2) the surveyed neurosurgeons typically thought that only neurosurgeons should provide emergency neurosurgical procedures; (3) there is a maldistribution of neurosurgeons in south Texas leaving large populated areas potentially without access to timely neurosurgical trauma interventions; and (4) the lack of availability of neurosurgeons is associated with significant delays in care, creating the potential for preventable mortality.

**The Problem**

An estimated 1.5 million Americans sustain a brain injury each year. In a review of more than 200,000 traumatic brain injuries from the National Trauma Database, Esposito and colleagues found that 74% were closed head injuries, and 2.2% underwent placement of ICP monitors, 3.6% had craniotomies, and 12% died. Eighteen percent of the patients with brain injuries had acute subdural hematomas (13% required craniotomy) and 10% had acute epidural hematomas (17% required craniotomy). Currently, there are about 3,000 board certified neurosurgeons in the United States. Of the approximately 800 neurological residents, about 150 finish their residencies each year and about the same number of neurosurgeons retire. The average age of neurosurgeons in practice is 56 years. In 1993, 20% of neurosurgeons preferred not to take care of trauma patients. Today, as shown in our survey, over 50% express a preference for not providing trauma care. On the basis of these published data (vide supra), each of the approximately 3,000 neurosurgeons in the United States would be burdened with less than one ICP monitor placement per month and about 1.5 craniotomies for trauma per month if the injured population could be equally divided. However, the limited number of neurosurgeons making themselves available and geographic distribution has created an environment in which poor neurotrauma outcomes are more likely to occur. Esposito and colleagues expressed a concern that “. . . the abandonment of trauma care by rank and file neurosurgeons has created a crisis in access to neurotrauma care.” Although these attitudes are shared by many other surgical specialties, including general surgery, the very small number and the principally urban/suburban distribution of neurosurgeons set the stage for a crisis in neurotrauma care.

Difficulties with specialty collaboration in the management of trauma patients are not new. Valadka et al. reported on the results of a survey sent to the membership of the AAST (84% academic trauma surgeons, half with neurosurgical residencies at their institutions) regarding neurosurgical involvement in trauma. Problems were most significant in trauma centers without neurosurgical residents, where 50% of those surveyed thought that neurosurgeons did not answer pages promptly when on call (24% reported that they did not answer at all), 43% thought that they were too slow in getting patients to the operating room, and 58% perceived that neurosurgeons were reluctant to place intracranial pressure monitors. Serious erosion in the central role of neurosurgeons in the care of the trauma patient was anticipated if perceived deficiencies in care were not addressed.

One-fifth of the US population (46.7 million Americans) does not have access to Level I or II trauma centers within 1 hour. Only Level I and II trauma centers are mandated to have immediate neurosurgical availability. In Texas, 26% of the population is greater than 1 hour from a Level I or II trauma center. The Rio Grande Valley has a population exceeding 1 million inhabitants and has no Level I or II trauma centers (Fig. 1). Neurosurgical coverage in this region is erratic with the five or six neurosurgeons in the area taking trauma call only sporadically. Patients with acute neurologic trauma emergencies may therefore require long transports (>4 hours to the nearest trauma centers in San Antonio) to undergo neurosurgical interventions.

Prolonged delay in providing definitive surgical decompression in patients with severe traumatic brain injury is known to have a negative impact on outcome. Seelig et al. documented in 82 patients with acute subdural hematomas that delays of >4 hours in surgical intervention increased mortality from 30% to 90% and that delays of >2.8 hours were associated with lesser functional recovery. Others have supported the concept that delay in craniotomy of comatose or deteriorating patients with acute subdural or epidural hematomas leads to a much worse outcome.

**DISCUSSION**

**Principle Findings**

The principle findings of this study were (1) one-half of neurosurgeons surveyed prefer not to care for patients with trauma because of perceived added time commitment, conflicts with elective practice, lack of compensation, and associated medicolegal risks; (2) the surveyed neurosurgeons typically thought that only neurosurgeons should provide emergency neurosurgical procedures; (3) there is a maldistribution of neurosurgeons in south Texas leaving large populated areas potentially without access to timely neurosurgical trauma interventions; and (4) the lack of availability of neurosurgeons is associated with significant delays in care, creating the potential for preventable mortality.
hematoma was 158 minutes, this is not surprising. Similarly, Wilberger found no relationship between timing of craniotomy and outcome in these patients.\textsuperscript{14} Certainly, patients with low GCS score, or deteriorating neurologic status require rapid intervention.

**Potential Solutions: Increased Involvement of Non-Neurosurgeons in Neurotrauma Care**

Considering the current situation of limited neurosurgical coverage, alternatives should be considered to minimize patient morbidity and improve outcome in these areas with limited access to neurotrauma care. In the setting of acute neurosurgical emergencies, such as deteriorating mentation or coma after traumatic brain injury, expeditious diagnosis of an intracranial mass lesion is essential. Fortunately, the availability of CT scanners in emergency rooms is widespread. The ability of non-neurosurgeons to perform lifesaving interventions in the absence of hands-on neurological involvement has been demonstrated. Schecter et al. reported on the experience from 1974 to 1982 in American Samoa, which is 3,000 miles and 5.5 hours by commercial jet from the closest neurosurgeons in Hawaii.\textsuperscript{15} They reported on 50 patients with traumatic brain injuries (TBI) treated by non-neurosurgeons with exploratory burr holes (no CT available in that era). Eighteen of 20 comatose patients had intracranial hematomas. They concluded that general surgeons in isolated rural areas should be trained to operate on patients with evidence of acute depressed fractures or expanding intracranial mass lesions.\textsuperscript{15} Schecter in his comments to an article presented by Esposito further clarified his thoughts on the matter.\textsuperscript{1} He emphasized the importance of involving neurosurgeons in the care of the injured patient. Quoting Schecter, “I would not argue that I gave the same level of care that my neurosurgical colleagues at San Francisco General Hospital provide to our patients. My view is that we have to insist on the highest standards of care for our trauma patients—which means that, if possible and if available, neurosurgeons must see acutely injured patients as soon as possible after injury.”

Rural surgeons in Montana participated in a 1-day workshop given by a neurosurgeon and then reported success (seven of eight survivors) with emergency craniotomy for trauma patients with deteriorating neurologic status.\textsuperscript{3} Likewise a referral hospital in New Zealand without neurosurgeons, successfully cared for TBI for 10 years with comparable mortality figures to other centers with neurosurgical support.\textsuperscript{16} Similarly, house officers and midlevel practitioners have successfully placed ICP monitors in patients with brain injuries.\textsuperscript{17,18} A 5-year experience with bedside burr hole for ICP monitor placement in 120 TBI patients by Italian ICU physicians was associated with minimal morbidity.\textsuperscript{19} These studies all suggest that there is a pool of general surgeons whose neurosurgical capabilities can be upgraded with minimal additional training and experience to the point where they can provide emergency neurosurgical care when neurosurgeons are not available.

Providing neurosurgical care when neurosurgeons are not available is controversial, and others have discouraged craniotomy by non-neurosurgeons as potentially harmful. The inexperienced surgeons may have difficulties evacuating cerebral blood clots, or may struggle to control profuse hemorrhage. It was postulated that early intervention by trauma surgeons could potentially delay transfer to experienced neurosurgeons. Wester reported a significant negative impact of early drainage of acute epidural hematomas at local hospitals by general and orthopedic surgeons, as 8 of 11 decompressive surgeries (among 83 patients with epidural hematomas undergoing care) were deemed inadequate.\textsuperscript{20} He recommended transfer to a neurosurgical unit before emergency craniotomy. Recently, Esposito and colleagues suggested that immediate neurosurgical availability is not essential if a properly trained and credentialed trauma surgeon or other health care provider can properly monitor and transfer patients with traumatic head injury to a center with neurosurgical coverage.\textsuperscript{1} In response, R. Dacey, Chairman of the American Board of Neurologic Surgery, expressed concern regarding non-neurosurgeons struggling with the placement of external ventricular drains in patients with shifted or small ventricles, and warned that inexperienced surgeons could encounter lesions that could result in exsanguination. Dr. Dacey further stated that “cooperation between trauma surgeons and neurosurgeons is going to be the key in solving this problem”. We agreed and thought that further discussion should continue, with the intention of developing guidelines on how to proceed when neurosurgical care is not available in a given region or location. Unfortunately, as our data demonstrate, this problem is still unsolved, at least in one area of the country. The increased involvement of non-neurosurgeons in the care of the patients with brain injuries may not be desirable and may be impractical, so other solutions such as increasing the availability of neurosurgeons or better coordinating the involvement of neurosurgeons should be considered.

**Potential Solutions: Increased Availability of Neurosurgeons for Care of the Trauma Patient**

Solutions can be devised to increase neurosurgeon availability for care of the trauma patient. This could be accomplished by several short- and long-term strategies. In the long term, the neurosurgical community could consider increasing the number of neurosurgical graduates from residency programs. This would serve to reduce the pressure on individual neurosurgeons caring for trauma patients. In the short term, neurosurgeons could increase their call availability. Many of the reasons cited for dissatisfaction with neurosurgical call are probably more perceptual than real. The number of patients with serious brain injuries is relatively small; so the time commitment is also relatively small. Trauma surgeon/neurosurgeon or emergency medicine/neurosurgeon coordination may be able to reduce the number of calls for minor injuries, thus making neurosurgeon call more palatable. Reimbursement may be a problem in many areas of the country; but is never severe enough to justify withholding lifesaving
care. Creative and cooperative partnerships with local trauma centers may lessen the financial burden for the neurosurgeon and improve neurosurgical coverage. Malpractice risk is cited as a reason that makes trauma call less than desirable; however, surgeons generally overstate the perceived increased trauma malpractice risk. There is a malpractice and malpractice premium crisis in many areas of the country; however, in a recent review, Stewart and colleagues did not demonstrate an increased malpractice risk in seriously injured trauma patients when compared with elective surgical patients. Although we do not think that there is an increased malpractice problem unique to patients with trauma, it is probable that the medical liability incurred by responding neurosurgeons is in fact significantly higher than other physicians, as evidenced by higher malpractice insurance premiums, which probably in part explains their negative attitudes toward malpractice risk and taking neurotrauma call. Local tort reform holds the potential to address, at least in part, the malpractice premium crisis.

We think that the concerns of the survey respondents should be addressed by making trauma call more attractive for the practicing neurosurgeon.

Potential Solutions: Increased Regional Cooperation and Coordination of Neuro-Trauma Care

Another short-term strategy requiring minimal increased work and virtually no cost would be to increase the cooperation among hospitals and neurosurgeons in a given local area. The problems cited in south Texas could be greatly attenuated by increased call cooperation among neurosurgeons and hospitals with sporadic neurosurgical coverage. For example, if a given geographic area has three hospitals, each with three dedicated neurosurgeons, the hospitals and neurosurgeons could rotate call among the three hospitals. This effectively changes neurosurgical call from 1:3 to 1:9 for each given neurosurgeon, and could result in significantly improved neurosurgical call availability. Formal cooperation between surgeons and hospitals could more efficiently utilize the surgeons’ time.

Study Limitations

This study has several significant potential limitations. First, we claim that there is a crisis in the care of patients with brain injuries in our region and extrapolate that experience to the United States as a whole. Although most neurosurgeons would prefer not to provide care for trauma patients (similar to many general surgeons), the great majority currently do so. The experience ("crisis") in south Texas may not represent the experience in the remainder of North America.

Second, an important consideration in this survey is the response rate of only 35%. Although this proportion is similar to other surveys of this type and the demographics of the subset appeared similar to the AANS as a whole, there is always the potential of a response bias among those AANS members who participated, and therefore the results may not be representative of the entire neurosurgical community.

Third, analysis of the outcome of patients with brain injuries transported to our Level I trauma center includes the inaccuracies inherent in any trauma registry, along with uncertainties regarding the impact of sedation/paralysis for air transport on admission GCS score.

Fourth, we make the following assumptions that may not be accurate: (1) delays of 4 to 6 hours in definitive neurotrauma care are not optimum, (2) delays in neuro-trauma care result in poor outcomes (death and disability), (3) neurosurgeons practicing in south Texas have similar attitudes to the responding neurosurgeons in the national survey, and (4) some of the patients with epidural or subdural hematomas deteriorated directly as a result of a delay in definitive care. If these assumptions are inaccurate, our conclusions may also be inaccurate.

Fifth, the transfers to a single Level I trauma center may not be representative of the entire region.

Finally, our assertion that general surgeons could deliver care in situations where neurosurgeons are not available may be erroneous and impractical, although to be clear, we have suggested this only when a neurosurgeon is not available for lifesaving care. We have not proposed replacing neurosurgical management of severe traumatic brain injury when a neurosurgical specialist is available and can intervene. However, based on the literature cited, we think that management of acute epidural and subdural hematomas, in neurologically deteriorating patients, would lead to a better outcome if a “damage control” type procedure was provided by an available surgeon under the direct guidance of a neurosurgeon at a remote location. Such an intervention would be reserved for care in population areas without adequate neurosurgical coverage, where transfer times are quite long. Certainly, this temporizing effort would be followed by immediate transfer to a tertiary care center for definitive management.

CONCLUSIONS

Our survey revealed that neurosurgeons who responded to the national survey are typically middle-aged private-practice clinicians living in urban areas, and that most care for trauma patients. About one-half of neurosurgeons prefer not to care for trauma patients because of perceived added time commitment, conflicts with elective practice (half are “spine surgeons”), lack of compensation, and associated medicolegal risk. But, they thought that only neurosurgeons should provide emergency neurosurgical procedures.

Our review in south Texas supports our supposition that there is a crisis in the care of patients with brain injury, and that attitudes translate into actions, at least in regions where neurosurgical coverage is less than ideal. Patients are frequently transported long distances from hospitals that have neurosurgeons on staff, but that do not have a neurosurgeon available for call. To solve this problem, we echo the comments of Dr. Dacey, the past Chair of the American Board of...
Neurologic Surgery, “cooperation between trauma surgeons and neurosurgeons is going to be the key in solving this problem”.

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REFERENCES


Appendix

**Neuro-Critical Care Practice in the Trauma Setting:**

An Assessment of Neurosurgery Manpower Dedicated to Trauma Care*

1. Do you provide treatment for trauma patients?
   — Yes —— No
   
   [If NO, please skip to item 5.]

2. What level is the trauma center where you practice?
   — Level I —— Level II —— Level III —— Level IV —— Non-designated

3. On average, how many neuro-trauma patients do you treat per week?
   — (Please fill in the number of patients.)

4. For what percentage of trauma patients do you receive compensation (approximately)?
   — <25% —— 26% to 50% —— 51% to 75% —— 76% to 100%

5. What is your personal preference in terms of the treatment of trauma patients?
   — Strongly prefer to treat
   — Somewhat prefer to treat
   — No preference
   — Somewhat prefer NOT to treat
   — Strongly prefer NOT to treat

6. How do you think trauma care impacts private practice?
   — Very positively
   — Somewhat positively
   — Neither positively nor negatively
   — Somewhat negatively
   — Very negatively

7. How many intracranial pressure monitors do you place per year?
   — None —— 1–12 —— 12–24 —— ≥ 25
8. How many craniotomies do you perform per year?

- None
- 1–12
- 12–24
- ≥ 25

9. Have you conducted neuro-trauma research?

- Yes
- No

[If NO, please go to item 11.]

10. How many papers on this subject have you published during your career?

- (Please fill in the number of publications.)

11. Do you perform neuro-trauma call?

- Yes
- No

[If NO, please go to item 15.]

12. What is the average compensation you receive from your hospital for performing 24 hours of neuro-trauma call?

- None
- <$1,000
- $1,000–$3,000
- >$3,000

13. What is your personal preference in terms of continuing to perform trauma call?

- Strongly prefer to perform trauma call
- Somewhat prefer to perform trauma call
- No preference
- Somewhat prefer NOT to perform trauma call
- Strongly prefer NOT to perform trauma call

14. Indicate the reasons you prefer not to take trauma call. (Choose all that apply.)

- Time required
- Conflict with elective practice
- No interest
- No challenge
- Lack of adequate compensation for effort
- Other (specify):

15. In your opinion, should non-neurosurgeons perform basic neurosurgery trauma procedures (including ICP monitor burr holes, craniotomy) if a neurosurgeon is not available and herniation is impending?

- Yes
- No

16. In your opinion, should non-neurosurgeons provide neuro-critical care?

- Yes
- No

17. In your opinion, should services other than neurosurgery be allowed to place ICP monitors?

- Yes
- No

[If NO, please go to item 20.]

18. Indicate which services should be allowed to place ICP monitors? (Check all that apply)

- General, trauma, cardiothoracic, vascular surgeons
- Other surgical specialists (e.g., genitourinary, orthopedic, otolaryngology)
- Anesthesiologists
- Adult medical specialists (e.g., critical care, pulmonary, cardiology)
- Pediatricians (including subspecialties)
- Other (specify):

19. In your opinion, under which circumstances should services other than neurosurgery be allowed to place ICP monitors?

- Emergencies only (e.g., patient’s condition deteriorating and neurosurgeon not available)
- After prior consultation with neurosurgeon (e.g., by telephone)
- Both of the above
- Whenever indicated (neurosurgery consultation not needed)

20. In your opinion, should services other than neurosurgery be allowed to perform trauma craniotomies?

- Yes
- No

[If NO, please go to item 23.]

21. For which types of lesions?

- Epidural hematoma and/or subdural hematoma
- Intraparenchymal hematoma
- Other (specify):

22. In your opinion, under which circumstances should services other than neurosurgery be allowed to perform trauma craniotomies?

- Emergencies only (e.g., patient’s condition deteriorating and neurosurgeon not available)
- After prior consultation with neurosurgeon (e.g., by telephone)
- Both of the above
- Whenever indicated (neurosurgery consultation not needed)

Please indicate how strongly you agree or disagree with each of the following statements.

23. “Trauma cases require a greater time commitment than do elective cases”.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

24. “In my community, the rate of reimbursement is similar for trauma patients and elective patients”.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

25. “The trauma patient poses an increased medicolegal risk”.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
EDITORIAL COMMENT

I have been asked to provide a very brief editorial comment about this article. I was given the opportunity to read the reviewers’ comments and the authors’ responses, all of which were illuminating.

The authors review some of the problems confronting the emergency care network in this country. However, as a scientific work in which data must be provided to support conclusions, this article falls short. The authors emphasize that their survey found that 52% of neurosurgeons prefer not to provide trauma care. They make the assumption “that attitudes translate into actions”. However, a recent survey by the American Association of Neurologic Surgeons (AANS) found that 93% of neurosurgeons participate in the emergency care system. This result is similar to the 87% rate of trauma participation reported in the current work. All of our jobs have some duties that do not appeal to us, but the most important concern is whether we do them anyway, not how we feel about them. Of note, another recent publication reported that 26% of general surgeons preferred not to treat trauma patients, as opposed to 20% each for orthopedic and neurologic surgeons. That same article found that 50% of general surgeons would abandon call if it were not required; corresponding percentages were 31% for neurosurgeons and 40% for orthopedic surgeons.1

A second topic of this article is a “neurosurgical manpower analysis of south Texas”. The authors list numbers of neurosurgeons and hospitals, but a detailed analysis of workload, needs, and benchmarks is not performed.

A third part of this article attempts to investigate the “impact of delays in transport on neurologic outcome”. Most of those results focus on the relationship between lower Glasgow Coma Scale (GCS) scores and worse outcomes. Of note, the authors’ data were gathered from only one of the three Level I trauma centers in San Antonio. The only endpoint that the authors report is mortality, and their mortality data actually are comparable to those of other published series. They provide complete transport time information for only 17 patients. For these 17, they report that the mean decrease in GCS score during transport exceeded 6, but it is unclear whether this change was caused by sedatives and paralytics administered before or during transport.

These are only a few examples of how the authors frequently analyze incomplete information, from which they then make leaps of faith to arrive at conclusions which are more properly described as assumptions or suppositions. One could also make other criticisms and suggest ways to improve many other details of this work (some of which are discussed in the limitations section at the end of the article), but space does not permit a more detailed discussion here.

Please tell us a little bit about yourself, your training and practice.

26. What is your age?
   — 35–44 years  — 45–55 years  — 56 years or greater

27. How many years post-training are you currently?
   — <10 years  — 10–20 years  — >20 years

28. What type of practices are you currently involved in? (Check all that apply.)
   — Academic
   — Private Practice
   — Other

29. What is your primary subspecialty area? (please choose one)
   — Cerebrovascular
   — Epilepsy
   — Endovascular
   — Pain
   — Pediatric
   — Skin Base
   — Spine
   — Stereotactic & Functional
   — Trauma
   — Tumor
   — Peripheral Nerves

30. In which region of the United States do you practice?
   — New England (CT, ME, MA, NH, RI, VT)
   — Mid-Atlantic (DE, MD, NJ, NY, PA, DC)
   — South (NC, SC, TN, VA, WV)
   — Midwest (IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, WI)
   — Southwest (AZ, NM, OK, TX)
   — West (AK, CO, CA, HI, ID, MT, NV, OR, UT, WA, WY)

31. Please indicate which best describes the area where your hospital is located:
   — Isolated rural (2,500 to 10,000 population)
   — Large rural (>10,000 to 50,000 population)
   — Large urban (>50,000 population)
   — Military

32. Is there a neurosurgery residency program at your hospital?
   — Yes  — No

The problems that the authors attempt to describe represent a failure of regional coordination in their area. To gain some perspective on the broader context of emergency care in the authors’ region, it would have been interesting to see comparable data for patients with non-neurosurgical emergencies. Of note, the Institute of Medicine’s 2006 report on emergency care cited an example of a San Antonio patient with a lower extremity vascular injury who ultimately underwent a leg amputation because the emergency care system in that area failed to meet his needs. That unfortunate patient apparently had no neurosurgical injury.

There are undoubtedly areas of this country in which systems for the delivery of emergency neurosurgical care, like those for emergency care in general, do not always function as well as we would like. In this context, many of the opinions expressed by these authors could also apply to other parts of the emergency care system, not just neurotrauma care.

Much has happened since the authors’ survey was conducted. Within their state of Texas, the passage of tort reform in September 2003 has reduced professional liability premiums and encouraged more specialists, including neurosurgeons, to move to Texas. Nationwide, greater recognition of the importance of emergency care networks and of business-based models of sustainable arrangements for providing such care has led some neurosurgeons to make emergency care a major part of their practices. Organized neurosurgery has begun to identify steps toward improving patient access to emergency care while still maintaining patient safety as the most important priority. The AANS and the Congress of Neurologic Surgeons have been working with the American College of Surgeons and the American Medical Association on these issues. The Institute of Medicine has spelled out many of the underlying problems and proposed sweeping solutions. Among these is regionalization of care.

Clearly, the problems affecting neurotrauma care in some areas are the same problems that affect all emergency care. Regionalization will be part of any improvements, as will tort reform, financial stability, and further refinements of the Emergency Medical Treatment and Labor Act. There is no quick fix. Only by working together to identify problems and implement solutions will the “house of surgery” be able to optimize the care of the emergency patient.

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