# Letters

RESEARCH LETTER

PACIFIC COAST SURGICAL ASSOCIATION

## Guidelines for the Treatment of Severe Traumatic Brain Injury: Are They Used?

Persons with severe traumatic brain injury (STBI) are frequently admitted to the neurologic intensive care unit. Each year, an estimated 1.4 million people in the United States have a TBI, resulting in 235 000 hospitalizations, 50 000 deaths, and $56.3 million in direct/indirect costs. Evidence-based guidelines for the management of patients with STBI have been available from the Brain Trauma Foundation (BTF) since 1995.[1] Current recommendations, particularly those related to intracranial pressure (ICP),[1] remain controversial owing to the questions raised by single-center studies and international trials about the benefit[2-4] and feasibility[5] of implementation. Based on a national assessment of US trauma medical directors (TMDs), the objective of our study was to determine the extent to which BTF guidelines are used.

**Methods** | Our study was conducted as part of a larger project assessing the military-to-civilian translation of battlefield innovations in surgical trauma care, the methods of which have been previously described.[6] The TMDs provided written informed consent and completed an anonymous, uncompensated electronic survey designed to collected data on trauma center demographics and on use of BTF guidelines. The survey was designed using a modified Delphi technique involving multiple consultations with an expert physician/surgeon panel. Pilot testing was conducted among a group of 12 trauma-section chiefs. Descriptive statistics compared differences in trauma center level (levels I-III). The institutional review board of the Johns Hopkins University School of Medicine approved our study.

Table. Subset of Questions Regarding the Use of BTF Recommendations by Trauma Center Level in the United States

| Question | Trauma Center | | | | *P* Value[a] |
|---|---|---|---|---|---|
| | Level I | Level II | Level III | Total, No. | |
| No. (%) | 108 (44.08) | 72 (29.39) | 65 (26.53) | 245 | |
| Does your institution have policies in place consistent with use of BTF guidelines to manage patients with STBI? If so, approximately what percentage of patients with STBI receive therapy pursuant to at least part of these guidelines? | | | | | |
| 0% (no use) | 3 (2.78) | 5 (6.94) | 6 (9.23) | 14 (5.71) | <.001 |
| <25% | 7 (6.48) | 6 (8.33) | 2 (3.08) | 15 (6.12) | |
| 25%-49% | 24 (22.22) | 14 (19.44) | 12 (18.46) | 50 (20.41) | |
| 50%-75% | 73 (67.59) | 39 (54.17) | 13 (20.00) | 125 (51.02) | |
| >75% | 1 (0.93) | 8 (11.11) | 32 (49.23) | 41 (16.73) | |
| If policies for ICP are in place, in approximately what percentage of STBI cases (GCS < 8) are ICP monitors placed? | | | | | |
| <20% | 4 (3.77) | 13 (18.06) | 45 (69.23) | 62 (25.51) | <.001 |
| 21%-40% | 9 (8.49) | 15 (20.83) | 3 (4.62) | 27 (11.11) | |
| 41%-60% | 24 (22.64) | 11 (15.28) | 5 (7.69) | 40 (16.46) | |
| 61%-80% | 25 (23.58) | 12 (16.67) | 4 (6.15) | 41 (16.87) | |
| >81% | 44 (41.51) | 21 (29.17) | 8 (12.31) | 73 (30.04) | |
| If policies for hypotonic saline are in place, in approximately what percentage of STBI cases (GCS < 8) is hypertonic saline (at any percentage) used? | | | | | |
| <20% | 11 (10.38) | 29 (40.28) | 51 (78.46) | 91 (37.45) | <.001 |
| 21%-40% | 11 (10.38) | 16 (22.22) | 3 (4.62) | 30 (12.35) | |
| 41%-60% | 14 (13.21) | 8 (11.11) | 5 (7.69) | 27 (11.11) | |
| 61%-80% | 27 (25.47) | 8 (11.11) | 5 (7.69) | 40 (16.46) | |
| >81% | 43 (40.57) | 11 (15.28) | 1 (1.54) | 55 (22.63) | |
| Over the last 10 years (2001-2011), has there been a resurgence (increase) at a policy level in the application of decompressive craniectomy in patients with medically refractory intracranial hypertension at your Institution? | | | | | |
| Yes | 80 (74.07) | 49 (68.06) | 23 (35.38) | 152 (62.04) | <.001 |
| No | 28 (25.93) | 23 (31.94) | 42 (64.62) | 93 (37.96) | |
| Over the last 10 years (2001-2011), has there been a resurgence (increase) at a policy level in the application of decompressive craniectomy in patients with acute TBI (excluding those with epidural hematoma) at your institution? | | | | | |
| Yes | 72 (66.67) | 49 (68.06) | 19 (29.23) | 140 (57.14) | <.001 |
| No | 36 (33.33) | 23 (31.94) | 46 (70.77) | 105 (42.86) | |

Abbreviations: BTF, Brain Trauma Foundation; GCS, Glasgow Coma Scale; ICP, intracranial pressure; STBI, severe traumatic brain injury.

[a] Two-sided *P* values taken from Pearson $\chi^2$ tests (and Fisher exact tests in cell counts <5).

**Results** | A total of 245 TMDs—representing nearly 40% of trauma centers (ie, 245 of 630 centers) in the United States—completed the survey (**Table**). Fourteen TMDs (5.7%) indicated that they do not have policies in place reflecting BTF guidelines; an additional 204 TMDs (83.3%) indicated that, although policies reflecting BTF guidelines are in place, these guidelines are completely followed in less than 75% of STBI cases. Use of the BTF guidelines varied by trauma center level. For example, while only 3 of 108 level I centers (2.8%) indicated a lack of institutional policies reflecting guideline use, 6 of 65 level III centers (9.2%) indicated the same ($P < .001$). Compliance with recommendation-specific guidelines[1] was moderately high (>50%) with 2 exceptions: ICP and hypotonic saline. The majority of level I centers (ie, 69 of 108 [63.9%]) reported ICP use in more than 60% of STBI cases, while 45 of 65 of level III centers (69.2%) acknowledged use in less than 20% of cases ($P < .001$). Comparable results were observed for hypotonic saline, with 66.0% of level I centers using hypotonic saline in more than 60% of STBI cases and 78.5% of level III centers using it in less than 20% of cases.

Following published reports of battlefield efficacy during the Iraq and Afghanistan wars and publication of the most recent BTF guidelines in 2007,[1] 93 of 245 TMDs (38.0%) indicated resurgences in the use of decompressive craniectomy for patients with medically refractory intracranial hypertension between 2001 and 2011. An additional 105 TMDs (42.9%) indicated increases in the procedure for patients with acute STBI (excluding epidural hematomas). Reported increases were most common in level III centers ($P < .001$) (Table).

**Discussion** | Mixed evidence surrounding the use of BTF guidelines created controversy about the appropriateness of and need for implementation in a civilian population[1-5]; single-center studies point to both positive[2] and neutral[5] effects. The more widely recognized studies include a 2008-2011 trial of ICP conducted among 324 patients in Bolivia and Ecuador by Chesnut et al,[3] who found no difference in a composite measure of functional/cognitive status comparing patients with TBI managed using ICP with those managed using imaging/clinical-examination modalities.[3] How generalizable the findings are to other contexts, such as the United States, and how the results may have changed in more recent years since publication of the most recent BTF guidelines remain topics of debate.[3,4]

Our findings assessing the extent of policies reflecting the use of BTF guidelines among US trauma centers point to a similar trend. While the majority of TMDs reported institutional policies and perceived use consistent with overall use of BTF guidelines, use of more specific contentious recommendations, such as ICP monitoring, varied. Of 245 TMDs, 150 (61.2%) stated that ICP policies were implemented in less than 60% of STBI cases. Study limitations, including the potentially subjective nature of the TMDs' reports, need to be taken into account.[6]

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*Study concept and design:* Zogg, Schneider, Orman, Rasmussen, Blackbourne, Haider.
*Acquisition, analysis, or interpretation of data:* Piper, Zogg, Haider.
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## COMMENT & RESPONSE

### Estimation of Life-Years Saved by Solid-Organ Transplant

**To the Editor** Using data collected over 25 years from the United Network for Organ Sharing database, Rana and colleagues[1] recently reported in *JAMA Surgery* that more than 2 million life-years were saved by solid-organ transplant. In their seminal article on the survival benefits of kidney transplant, Wolfe and colleagues[2] previously reported that the likelihood of survival became equal for patients treated with dialysis who remained on the waiting list and for those who underwent a transplant at day 244, with survival after day 244 favoring transplant recipients; this reflects the higher risk of death more proximate to transplant surgery. Wolfe and colleagues,[2] in their analyses, evaluated transplant status in patients on the transplant waiting list as a time-varying exposure to correctly classify exposed vs unexposed person-time when determining mortality risk. In contrast, when estimating life-years saved, Rana and colleagues[1] used the time spent on the wait listing as a common point of origin. Accordingly, we are concerned that Rana and colleagues[1] dramatically overestimate the number of life-years saved by solid-organ transplant owing to immortal person-time bias in transplant recipients.[3] Because Rana and colleagues[1] estimated the number of life-years saved as a result of transplant using the time of transplant listing, patients receiving a transplant are required to survive until they receive the transplant, making them "immortal" for the entire time they spend on the waiting list; this contrasts with waiting list-only patients, who, by definition, can die at any time following initial listing prior to transplant. Therefore, with this approach, the survival time accrued between the time of listing and the time of transplant for patients who received a transplant is misclassified as survival that is due to the transplant. As a result, the benefit of a transplant is overstated. While, given prior studies,[2,4,5] we are confident that a transplant has advantages over dialysis for most patients, the results provided by Rana and colleagues[1] are fatally biased and therefore should not be used in clinical practice to frame the potential benefits of solid-organ transplant.

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**In Reply** Foster et al make the point that our analysis "should not be used in clinical practice to frame the potential benefits of solid-organ transplant." We agree entirely. It is not an analysis that determines the survival benefit for an individual patient in the current era. Instead, it looks at what has been accomplished in the field of solid-organ transplantation. Excluding less than 1.6% of patients listed for solid-organ transplant, it is an inclusive study that simply follows up with everyone using the Social Security Death Master Files. Our analysis looks at the collective survival benefit of the entire group over 25 years. It is not a study for individual patients and not for clinical use in the current era.

Our 2 cohorts comprised listed candidates who did not undergo a transplant and those who did, with approximately 500 000 patients in each cohort. We have 2 options to compare observed survival. We can follow up with patients from a common time point, the time of listing, or we can compare waitlisted patients from the time of listing and transplant recipients from the time of transplant. The second option is deeply flawed because the clinical states of the patients are dramatically different. For example, a potential liver recipient listed at a Model for End-Stage Liver Disease score of 15 is in a dramatically different state of health compared with a liver recipient transplanted at a Model for End-Stage Liver Disease score of 35. We felt that the cleaner analysis would be to follow up with everyone from a common time point.

There are several flaws in this analysis, but it does illustrate the actual fate of everyone listed for solid-organ transplant over 25 years. First, there are the inaccuracies in the Social Security Death Master File and within the United Network for Organ Sharing database itself. Then there is the selection bias of those who actually received a transplant. There is also the immortal person-time bias as pointed out by Foster et al. On the other hand, there is the bias of candidates inappropriately listed for transplant whose condition improves and who are long-term waitlisted survivors.

Foster et al express concern that we dramatically overestimate the survival benefit of solid-organ transplant. This is very unlikely. First, we only report on the benefit observed to date; the actual benefit will only be realized once the entire cohort is exhausted. In the case of kidney transplant, we observe 4.4 years of survival benefit for each recipient—this is actually lower than estimates in the literature.[1] In fact, according to the very article cited by Foster et al, a 20-year sur-