Withdrawal of Life-Sustaining Therapy in Injured Patients: Variations Between Trauma Centers and Nontrauma Centers

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Withdrawal of life sustaining therapy in injured patients: Variations between trauma centers and non-trauma centers

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Abstract

Background—We sought to identify patient and institutional variables predictive of a withdrawal of care order (WOCO) in trauma patients. We hypothesized that the frequency of WOCO would be higher at trauma centers.

Methods—Data from the National Study on the Costs and Outcomes of Trauma (NSCOT) was used to determine associations between WOCO status and patient characteristics, institutional characteristics, and hospital course. Chi-square, t-tests and multivariate analysis was used to identify variables predictive of WOCO.

Results—Of 14,190 patients, 618 (4.4%) had WOCO, which accounted for 60.9% of patients who died in hospital. Age (p=<0.001), race (p=<0.001), co-morbidity (p=<0.001) and injury mechanism were associated with WOCO (p=0.03). WOCO patients had higher NISS (p=<0.001), lower GCS motor scores (p=<0.001) and higher incidence of midline shift on head CT (p=0.01). Trauma center status (OR 1.56 (95% CI 1.06,2.30)) and closed ICU (OR 1.53 (95% CI 1.03,2.25)) were also predictive of WOCO. There was sizeable variation (0 to 16%) in the percentage of patients with WOCO across centers.

Conclusion—Most trauma patients who die in hospital do so after a WOCO. Although trauma center status and closed ICU are predictive of WOCO, variation in the percentage of patients with WOCO across all centers speaks to the complexity of these decisions. Further investigation is needed to understand how WOCO is applied to trauma patients.

Keywords

Withdrawal of care; trauma centers; end-of-life care; elderly trauma

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Introduction

There is considerable evidence to support specialized care for severely injured patients during the pre-hospital and hospital phases of care (1, 2). This has resulted in regionalization of trauma care, such that the most severely injured patients are concentrated in specialized centers best equipped to care for them. This regionalization should allow for the most efficient distribution of human and technological resources. (3)

Recent efforts to compare patient outcomes as benchmarks of quality are intended to improve care by identifying discrepant performance among institutions, standardize healthcare delivery, and allow consumers to make better-informed choices. Such comparative efforts are a particular challenge for trauma centers where patients are intentionally selected for their high-risk injuries, and survival is uncertain.

In addition, while injuries causing physical and mental incapacity may be survivable, the resultant functional outcome may be unacceptable for patients, families and surrogates. Intensive care, which prolongs death, rather than saving functionally normal lives, is generally considered inappropriate, and the goals of care may best be redirected from cure to comfort. Clearly prognosis from physicians, nurses, and other caregivers has a profound influence on these decisions. (4–6). However, prognosis is often imprecise (7) and physicians rarely offer explicit chances for long-term survival or speak in absolute terms. (8) Projections concerning functional recovery and quality of life are even more poorly defined and inaccurate. (8) In centers less experienced with major trauma, some severely injured patients may be considered unsalvageable and clinicians may offer a less optimistic prognosis. Variability in management at the end-of-life (9) (10) may cause different outcomes across centers.

It is known that the majority of patients who die in intensive care units do so after life-sustaining therapy has been withdrawn or withheld and that there is wide variation in how end-of-life care is practiced. (11) There is little data about withdrawal of life sustaining therapy in the overall trauma population. One series has shown that over 80% of elderly trauma patients who died in a four-year period had life-sustaining therapy withdrawn or withheld. (12) The prevalence of orders to withdraw life sustaining therapy in trauma patients requires close inspection as it may be a common prelude to death in severely injured patients, with likely significant age variance. If survival or length of stay is used as a performance measure,(1) differences in the utilization of withdrawal of care orders (WOCO) between centers may contribute to variation in mortality rates.

We previously examined how differences in the ICU environment affected rates of “do not resuscitate” (DNR) orders, and found significant variability in their use across centers. (13). The goal of this study was broader, and sought to examine the use of orders to withdraw life-sustaining therapy in trauma and non-trauma centers and to determine those institutional and patient characteristics associated with having withdrawal of care ordered. We hypothesized that when controlling for age, patient mix and injury severity, orders for withdrawal of care would be more prevalent in trauma centers than in non-trauma centers. For purposes of data abstraction, we used the term withdrawal of care order (WOCO) because we sought to identify cases where life-sustaining therapy was removed. Although the terms withdrawal of life-sustaining therapy, redirection of care, or transition to comfort measures only are increasingly acceptable alternatives to WOCO, we will use WOCO here for consistency.

Methods

This is a prospective cohort study of the utilization of WOCO in trauma centers and non-trauma center hospitals. This data was obtained from the National Study on the Costs and Outcomes of Trauma (NSCOT) that compared the long-term outcome and cost effectiveness of patients treated in designated trauma and non-trauma center hospitals (2, 14) The sites included 18 level 1 and 51 non-trauma centers in 15 Metropolitan Statistical regions (MSA) in 12 states. Trauma centers were designated as Level I centers by regional authorities or verified by the American College of Surgeons. The non-trauma centers treated a minimum of 25 major trauma patients annually. Institutional Review Board approval was obtained from each participating hospital.

Included were patients aged 16 to 84 with at least one moderate to severe injury (AIS ≥3). Those patients who died within 30 minutes of arrival or who had delay in treatment greater than 24 hours were excluded, as were patients who had major burns, or were 65 years or older with a primary diagnosis of hip fracture. Patients who were non-English or non-Spanish speaking, homeless or incarcerated at the time of injury, were also excluded.

To avoid disproportionate enrollment from the highest-volume trauma centers, a sampling strategy was utilized with a goal of enrolling 3000 patients between 18 and 64 years of age, and 1200 patients between 65 and 84 years of age, evenly distributed between centers and within groups defined by injury severity and area of injury. Of 15,400 eligible subjects, 951 were cared for in a non-NSCOT hospital for more than 24 hours prior to transfer to a participating center. These patients were excluded from this study as our primary objective was to determine the impact of trauma care at a Trauma Center vs. Non Trauma Center on outcome, and we felt that patients spending more than 24 hours at another hospital before transfer would not accurately reflect the outcomes of care at the ultimate receiving hospital. This yielded a total of 14,476 enrolled subjects as the result of the sampling strategy which is described in detail elsewhere (2) This analysis included 4824 patients representing a weighted reference sample of 14,190 subjects. We excluded 286 patients who only had a DNR order. We sought to identify institutional and patient characteristics that would be predictors of a WOCO.

As described previously, research nurses trained for the NSCOT study abstracted data. (2) Briefly, socio-demographic information including age, gender, and insurance status were abstracted from the medical record. Pre-existing diseases were obtained from the medical record and weighted to derive the Charlson co-morbidity score.(15) The Injury Severity Score and New Injury Severity Score were used as summary measures to classify injury severity. These were calculated based on mechanism, and anatomic and physiologic derangements abstracted from the medical record. Data about each patient’s hospital course, intensive care unit stay and post discharge recovery were also abstracted from the medical record. Intensive care units were considered closed if critically ill trauma patients were routinely treated on a service led by an intensivist or were co-managed by an intensivist. (16)

Patients were considered to have a WOCO if the medical record clearly stated that life-sustaining measures were removed. Timing of the order, documentation by the attending physician regarding futility, and documentation of family discussions regarding redirection of care were not abstracted from the medical record, and so this data was unavailable for analysis.

Data Analysis

Missing co-variate data were imputed, and the analysis used data weighted to the universe of eligible patients. We predicted that variable patient mix across centers could account for apparent differences in the utilization of withdrawal of care orders. To address this, we used multivariate hierarchical modeling to develop the final weighted analysis. We sought to identify patient and institutional variables, which were predictors of a WOCO. We considered that the presence of such an order would be predicated on initial injury type and severity, pre-existing co-morbidity, complications during hospitalization, and that it would be associated with certain institutional characteristics such as trauma center designation and intensive care unit staffing. We used chi square and t tests to determine associations between WOCO status and the variables described above. We then did a multivariate analysis adjusting for age, injury severity and head injury severity to find the associations of institutional characteristics with WOCO. The ratio of generalized chi-square statistic and the degrees of freedom for each variable was between 2.44 and 2.60, which demonstrates considerable residual variability in the marginal distribution of data in the multivariate model. However, as our objective was to show the relationship of these chosen variables to presence of a WOCO, we did not include extraneous variables which may have improved the fit of the model but would have been irrelevant to our analysis. Data are presented as absolute figures and percentages within groups. All of the analyses were done using SAS 9.1 and STATA 10.

Results

Of 14,190 patients, the in-hospital death rate was 6.7% (n=954). Six hundred and eighteen patients (4.4%) had WOCO, and 581 of these died. Of patients who died in hospital, 60.9% had WOCO. The in-hospital mortality rate for patients with WOCO was 94.0% compared to 2.6% for those without such orders. The three and 12 month mortality for the WOCO group was 95.9% and 96.2%, respectively.

Patient Characteristics

Age, co morbidity and race/ethnicity were associated with the presence of a WOCO (Table 1). Patients with WOCO were older than other patients; over half were >55 years old. Patients aged 75–84 were only 9% of the total study population but comprised 25% of those with WOCO. The majority of patients in both groups had Charlson score of zero; however, higher Charlson scores were associated with WOCO. Among those in the WOCO group, 17.2% had a Charlson score ≥ 3, compared to only 6.9% of those without WOCO. Patients with WOCO were less likely to be Hispanic or Non-White, Non-Hispanic. There was no difference in gender or type of insurance between groups.

Injury Characteristics

There were significant differences in mechanism of injury between the two groups. (Table 2) WOCO patients were significantly more likely to be injured from falls or firearms than non-WOCO patients. WOCO patients were significantly more likely to be transferred from an outside hospital but, time to transfer was not significant. The majority of patients were not transferred. As expected, patients in the WOCO group had higher indicators of global injury severity with significantly higher NISS and AIS scores. The WOCO group was more likely to present with hypotension. Neurological deficit in the emergency department and head injury were significant predictors of WOCO. Sixty-eight percent of patients without WOCO had a Head AIS score ≥ 2, whereas 72.1% of patients with WOCO had Maximum Head AIS scores ≥ 4. Midline shift was noted on the initial head CT scan in 40.1% of patients in the WOCO group. One half of patients with WOCO had abnormal pupillary responses in the ED (50.2% vs. 5.4%), and 34.6% percent had an initial GCS motor score ≥ 2 (without chemical paralysis) in the ED. Over one-quarter of patients in the WOCO group were chemically paralyzed on arrival to the emergency department, which was considerably higher than in the other group (25.8% vs. 8.3%). Paralysis related to spinal cord injury was not significantly associated with WOCO. There was an association between lower extremity injury score and WOCO, however, there was no association with severity of abdominal or truncal injury.

Ninety-two percent of patients with WOCO were admitted to the intensive care unit during their admission. This is significantly different from the non-WOCO group where less than half (46%) was admitted to the ICU at some point during their hospital stay. There were no significant differences between the two groups in the number of consultants, as a surrogate for the intensity of care received.

Irreversible complications during hospitalization can prompt the decision to redirect care. We found that patients in the WOCO group were significantly more likely to have had a stroke, cardiovascular insult, multiple organ failure, or renal failure than patients without WOCO. (See Table 3). Hospital length of stay was significantly shorter for the WOCO group.

Institutional Characteristics

There was substantial variation across all centers in the proportion of patients with WOCO, ranging from 0 to 16% (Table 4). We found considerable variation between Level I trauma centers. *(See* figure 1,2,3) In the aggregate, patients with WOCO were more likely to receive care at slightly smaller hospitals than other patients (mean number of beds 545 vs. 580), and were more likely to be treated at trauma centers. We did not find that patients with WOCO were more likely to receive care at teaching hospitals or in a closed ICU in the univariate analyses. However, after adjusting for age, ISS and maximum head AIS score, treatment in a trauma center and a closed ICU were independent predictors of WOCO. Number of admissions and hospital size were no longer predictors after this adjustment. *(See* Table 5)

Multivariate analyses

The factors found to be independently associated with WOCO are shown in Table 6. Advanced age was predictive of WOCO; the odds ratio was highest for those aged 75–84 (OR=9.96; 95% CI 5.51–18.02). Charlson score (OR 1.21; 95% CI 1.09–1.35) and high maximum AIS score (OR=1.67; 95%CI=1.23–2.26) were predictive of WOCO. Initial GCS motor score of 1 (OR 6.24; 95% CI 3.36–11.58), and midline shift on initial head CT (OR 2.07; 95% CI= 1.46–2.92) were independently associated with redirection of care. Stroke, cardiovascular complication, renal failure, and multiple organ failure were also associated with WOCO. These findings are consistent with the univariate analysis demonstrating their robustness as predictors of WOCO. LOS greater than 2 days, ICU admission, and number of consultants, were also independently associated with WOCO.

Survivors in the WOCO group

There were 37 patients who had withdrawal of care of orders written but survived their initial hospital stay (WOCO survivors). There was no significant difference in age for WOCO survivors vs. non-survivors (Table 7). There was a statistically significant difference in the Charlson scores between WOCO survivors and non-survivors although the findings are non-linear. The majority of survivors (52.2%) had a Charlson score of 1, whereas the majority of non-survivors had a Charlson score of zero (58.5%). However, more of the non-survivors than survivors had a score of 3 or more. There was a significant difference in the maximum AIS score, and initial GCS motor score between survivors and non-survivors. Over 80% of survivors had an initial GCS motor score > 4, whereas only 37% of non-survivors had an initial GCS motor score > 4. Non-survivors were also more likely to have midline shift on their initial head CT scan, abnormal pupillary response during ED evaluation, and ICU admission. This is a significant difference in how survivors and non-survivors present after their initial injury, and highlights the importance of neurological status in predicting survival. Even in patients who were sick enough to have life-sustaining therapy withdrawn, a higher GCS motor score conferred a survival advantage. Non-survivors were significantly more likely to have in- hospital complications but no survivors had multiple organ failure, cardiovascular complications or renal failure. Survivors had significantly higher length of stay, and more consultants, than non-survivors.

Discussion

This paper examines the predictors of withdrawal of care orders in trauma patients and the variation of the prevalence of these orders across centers. Others have looked at withdrawal of care in elderly trauma patients (17) but to our knowledge this is the first large prospective multicenter study to look at withdrawal of care in all major trauma patients. One study has suggested that over 80% of trauma patients who died in hospital had life sustaining therapy withdrawn or withheld.(12) In this current study 60.9% percent of patients who died in–hospital had a WOCO order. This discrepancy has serious implications for how we examine death as an outcome in this population. If survival is used as a performance measure, variation in the utilization of WOCO between centers must be considered when benchmarks are set. Unfortunately, there is a paucity of data regarding the application of withdrawal of care orders in trauma patients, particularly younger trauma patients.

When controlled for age, injury severity, and severity of head injury, we found trauma centers and closed intensive care units were independent predictors of WOCO. This supports our hypothesis that institutional characteristics influence the frequency of withdrawal of life-sustaining therapy. This study was not designed to identify the reasons for this finding. It is possible that facilities, and clinical providers, who care for critically ill trauma patients with greater frequency, have more experience in managing end-of-life care, and are more adept at providing guidance to families in making end-of-life decisions. Infrastructural support from chaplains, bereavement counselors, social work, and palliative care specialists may also be in place to facilitate end-of life decision-making with physicians and families (18). Palliation in the intensive care unit has emerged as a crucial component of patient-centered care (19); however, end-of-life care for trauma patients often differs from that for those with other conditions. Rather than a protracted course with increasing disability, previously robust patients may suddenly find themselves severely disabled. Withdrawal of life sustaining therapy is a cultural shift in the care of a trauma patient where extreme measures are routinely used to preserve life.(20) Centers with little experience caring for the most complex trauma patients may be more reluctant to move in the direction from cure to comfort.

As in other studies (21) (12), we found that advancing age is independently associated with withdrawal of life sustaining therapy in trauma patients. However in a retrospective review of elderly trauma patients, Trunkey et al. (17) failed to show that age, elderly, maximum AIS, comorbidities, admission Glasgow Coma Scale or vital signs were predictive of withdrawal of life sustaining therapy. This suggests that there may be different considerations for WOCO in younger compared with older trauma patients. Manara et al., have shown that pre-morbid activity, concern regarding loss of independence, and imminent death are all key considerations in end of life decision making for elderly patients (22), while quality of life considerations are the most significant factors for younger patients.

The presence of co-morbidities was independently associated with WOCO, although the majority of patients in the WOCO group had a Charlson score of zero. Without detailed records regarding the discussions preceding decisions to withdraw life-sustaining therapy it is difficult to surmise what role co-morbid conditions play in end-of life decisions. Other studies have found a “paradoxical” effect of co-morbidity adjustment, in that hospitalized patients who died were less likely to have co-morbidities recorded than patients who survived.(23). Whether this is due to under-recording of co-morbidities in the medical record of those who died, saturation of the number of fields for coding diagnoses among patients with multiple complications, or a true non-linear relationship between complications and survival is unknown. This remains an important limitation.

In this study of patients aged 18–64, injury severity, and severe head injury were independently associated with WOCO. In our analysis, half of patients with WOCO had abnormal pupillary responses when they arrived in the emergency department, and 40% had midline shift on the initial CT scan of their head. First GCS motor score of one, without chemical paralysis, was the physical finding most predictive of WOCO. This is likely to simply represent patients with devastating head injuries in whom any meaningful functional recovery is highly unlikely. This is consistent with a study by Plaiser et al. (12) where the majority of trauma patients who had care withdrawn had traumatic brain injuries. Most patients who are not suffering from severe illness say that they would not want life-sustaining therapy that would result in severe cognitive impairment or dependence on others (24) Tolerance of more aggressive interventions declines with worsening functional outcome. (25) However, paralysis from spinal cord injury was not predicative of WOCO in our study, suggesting that cognitive disability may more devastating than physical disability to many patients or their surrogate decision makers.

When adjusted for age and injury severity, organ dysfunction during hospitalization was predictive of WOCO. Although all complications, including stroke, multi organ failure and cardiovascular insult reached statistical significance in this study, renal failure was most strongly associated with WOCO.(26) Prolonged dependence on mechanical ventilation and hemodialysis are factors known to influence redirection of care.(27) Our study did not specifically query about risk for prolonged mechanical ventilation but the significant association between WOCO and organ failure, in both univariate and multivariate analysis, suggests its influence on the presence of WOCO. Some patients do not want medical intervention if they cannot return to a “meaningful” or “independent” life. In a survey of 287 elderly patients during primary care visits, Murphy found that the majority wanted short-term ventilation or tube feedings if chances for recovery were favorable.(28) Fewer than 5 percent wanted long-term support. (28)

Surrogates make most decisions about withdrawal of life sustaining therapy in the ICU (12, 29); advance directives can guide their decisions. Our study did not examine the role of advance directives in this setting, so it is unclear how this influenced our findings. Discussions about advance directives are best made in the primary care setting when patients may have an established relationship with their provider, and can make decisions without duress. (30) (31) Unfortunately this is usually not possible in the trauma ICU where surgical intensivists do not have established relationships with patients and proxies, infirmity is unexpected, prognosis is uncertain, overwhelmed surrogates may be unreliable, and few patients can participate in decisions themselves.(32, 33) In addition, even when advance directives are available, providers or proxies do not often follow them.(34) In cases where directives are ambiguous, and do not specifically address the situation at hand, providers and proxies are left to guess. It is probable that acute trauma presents an unanticipated scenario that could make advance directive less useful.

Ethnic differences have a profound effect on decision making at the end-of-life. Our analysis did show an association with ethnicity; patients in the WOCO group were more likely to be white-non-Hispanic. Whites are more knowledgeable about advanced directives than other groups (35), (20) and are more likely to have advanced directives than African Americans. (36) Negative attitudes about advanced directives among African Americans stems from general distrust of the medical system. (28, 36, 37) This study had too few African-Americans to have any meaningful analysis of this group. Ethnic differences have been shown in other settings; African-Americans are more likely than whites to refuse withdrawal of life sustaining therapy. (38) To our knowledge, ethno-cultural variation in end-of-life decision-making in trauma patients has not been examined. Given that trauma is so closely related to social disparities, such a study would be worthwhile.

When making end-of-life decisions, patients and surrogates rely on physicians to provide a clear prognosis with regard to survival and functional outcome. (39) Nonetheless, prognostication is imprecise, and is inaccurate even after redirection of care,. The mortality rate in this study was 94% after WOCO. This finding is consistent with a retrospective study of 318 ICU patients by Nolin et al., which demonstrated a 92% in-hospital mortality rate after withdrawal of life-sustaining therapy. (18) Prognosis is heavily influenced by physician bias and the length of their relationship with the patient (11, 40, 41). Once a trauma patient survives the initial injury, scoring systems are a less useful tool for predicting final outcome, and complications add uncertainty to predicting the outcome. (42) Recognition of characteristics predictive of death after WOCO could inform communication with families and surrogates.

Limitations

There are a number of limitations to our study. Although data was collected prospectively, the NSCOT database was not specifically developed to look at end-of-life care in trauma patients specifically. We did not collect data as to the timing of WOCO with respect to admission or death. Others have shown that writing an order to withdraw life-sustaining therapy care is highly predictive of death in intensive care unit patients, and that most orders to withdraw life sustaining therapy precede death by less than 72 hours (18, 34, 43). The high in hospital mortality rates in our WOCO groups are consistent with these findings.

Our data did not include presence of advanced directives therefore we are unable to draw conclusions about their influence in WOCO in this group of trauma patients. Whatever their shortcomings, advanced directives serve as a starting point for end-of-life discussions and ease the burden for family members and caregivers at time when patients are unable to advocate for themselves. It is possible that advance directives are an independent predictor of WOCO, especially for older patients. Finally, our study could not adequately capture the complexity that a WOCO order entails. We did not collect data regarding meetings with family and surrogates or physician opinion regarding prognosis or futility. Nor did we capture data about the presence of nurses during such discussions. Nurses also offer prognostic information to patients and their surrogates, are often the first clinicians to approach the family about redirection of care, and are often the first to identify conflict among team members. (44) (45) Multiple conversations with physician, nurses, chaplains and family members are a prelude to an order that may be a single computer entry or a scribbled line on a chart. Trunkey et al. (17) found two factors associated with withdrawal of life sustaining therapy in elderly trauma patients: attending surgeon documentation of futility, and family participation in the decision to withdraw therapy. We were unable to capture either factor in this study.

In conclusion, the majority of in-hospital deaths in our study were preceded by a withdrawal of care order. Patient characteristics independently associated with WOCO include age, ethnicity, overall injury severity, head injury severity, and complications during hospitalization. We also demonstrated differences in frequency of WOCO among level I trauma centers and between trauma centers and non-trauma centers. Treatment in a trauma center and a closed ICU were independently associated with WOCO. These differences likely reflect institutional and physician preferences that are not measured here. More study is needed to understand what accounts for variability between centers in the prevalence of WOCO and whether such variation has an impact on patient care.

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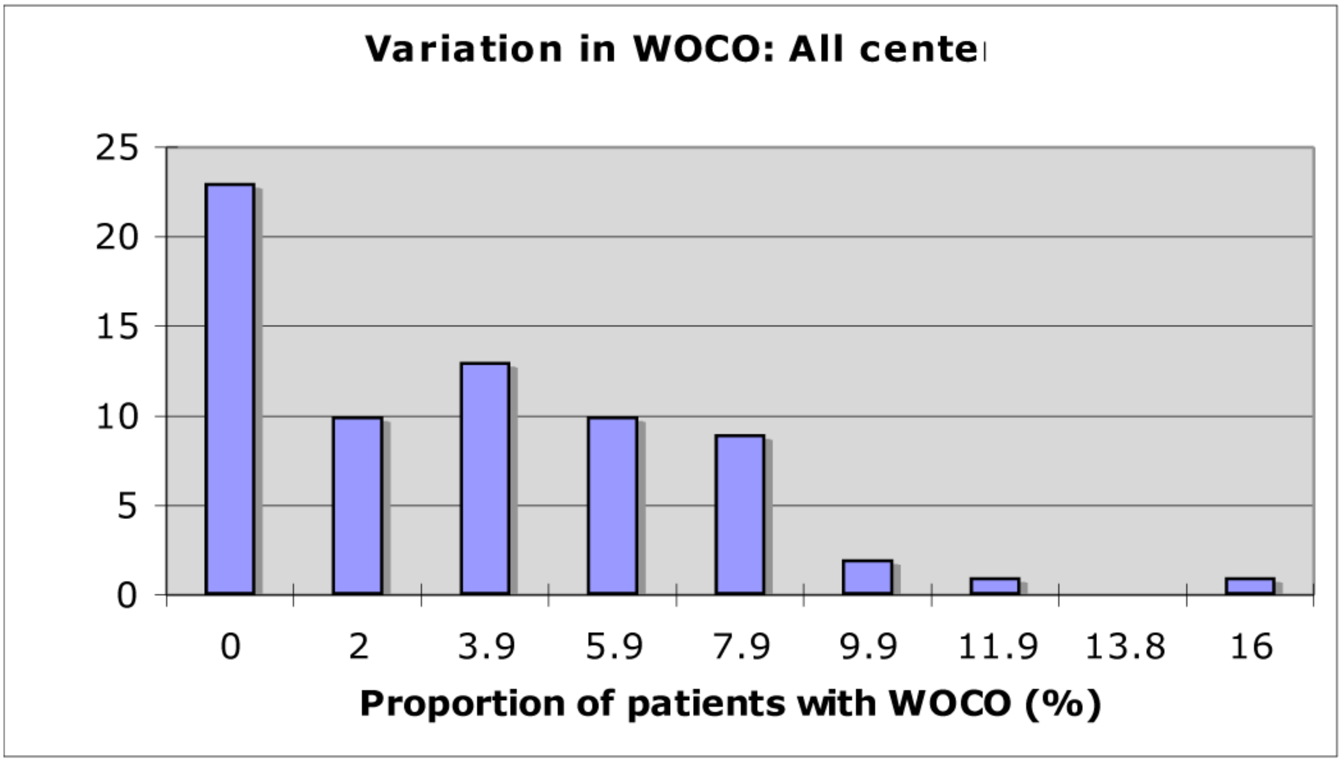

Figure 1.
Variation in WOCO: All centers

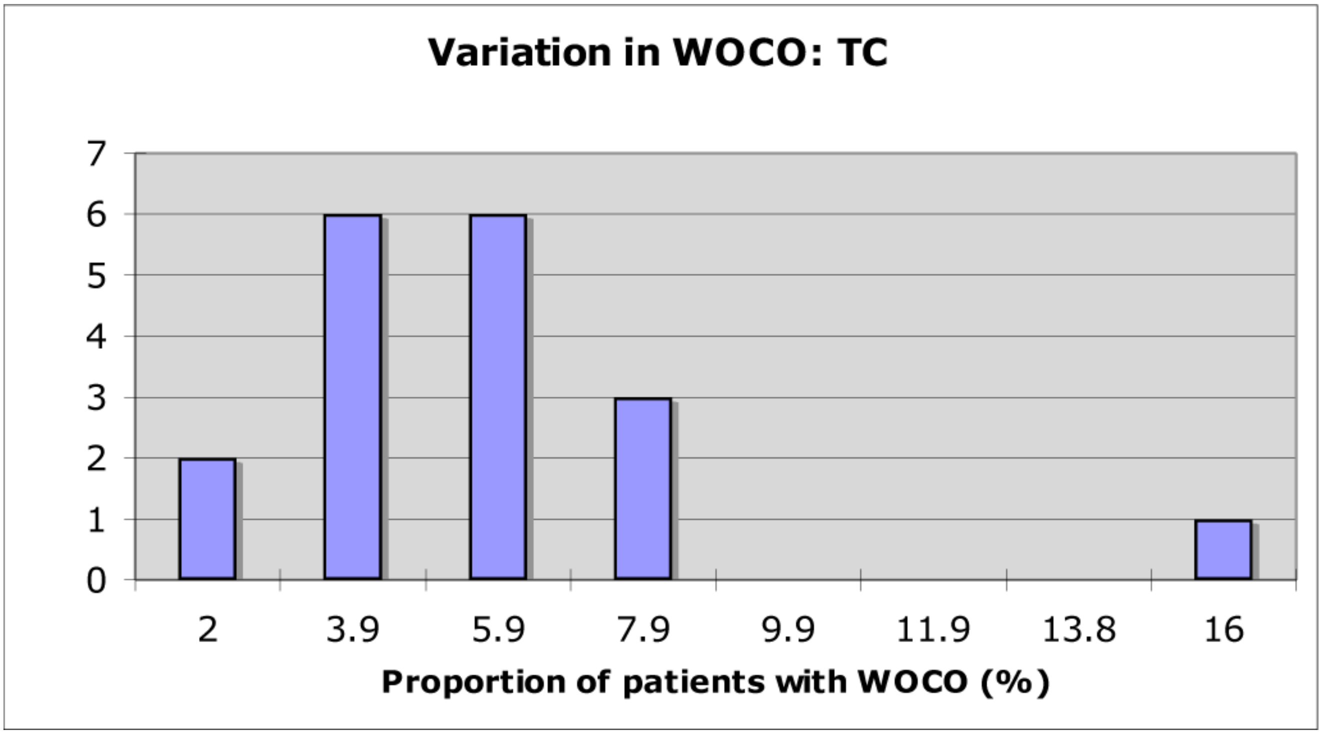

Figure 2.
Variation in WOCO: Trauma centers

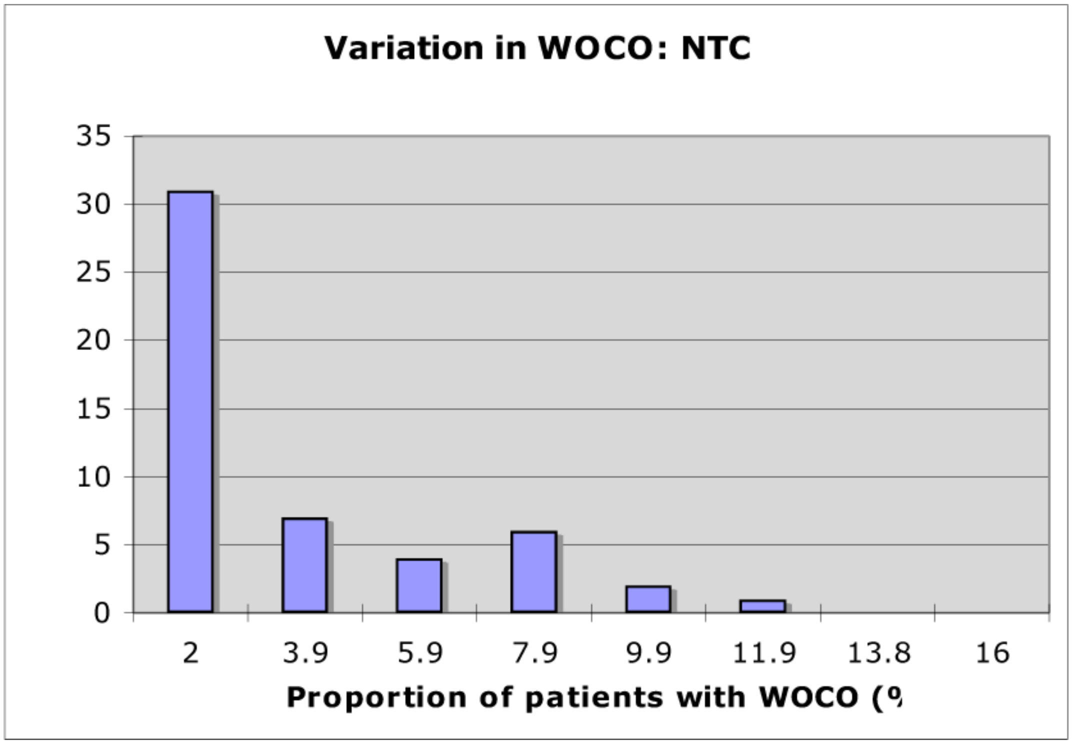

Figure 3.
Variation in WOCO: Non-trauma center

Table 1

Patient characteristics associated with the presence of a withdrawal of care order (WOCO)

Patient Characteristics	Unweighted (n)	Weighted (n)†	No WOCO %	WOCO %	p
Age					<0.001
< 55	3026	10224	73.1	48.8	
55–64	535	1607	11.2	13.5	
65–74	569	1073	7.3	12.7	
75–84	695	1286	8.3	25.1	
Male gender	3234	9783	69.0	68.4	0.72
Race/Ethnicity					<0.001
White, Non-Hispanic	3093	8502	59.5	69.1	
Non-White, Non-Hispanic	1026	3308	23.5	18.4	
Hispanic	705	2381	17.0	12.5	
Health Insurance¶					0.84
Public	2071	6333	44.7	44.1	
Private	2754	7858	55.3	55.9	
Charlson Co-morbidity Score					<0.001
0	3214	10198	72.6	56.7	
1	729	2071	14.5	16.9	
2	378	878	6.1	9.3	
3 or more	504	1044	6.9	17.2	

* Column values refer to percent of weighted patients

† Refers to number of patients after weighting back to eligible population

¶ Public: Medicare, Medicaid, or self-pay; Private – Medicare with private insurance, other private insurance

Table 2

Distribution of Injury Characteristics across WOCO status

Injury Characteristic	Unweighted (n)	Weighted (n)	No Withdrawal %	Withdrawal %	p
Mechanism					0.03
Blunt – Motor Vehicle	2124	6755	48.0	38.3	
Blunt – Fall	1606	4091	28.6	34.6	
Blunt – Other	488	1350	9.4	11.1	
Penetrating - Firearm	458	1394	9.6	13.8	
Penetrating – Other	150	600	4.3	2.2	
Transfer from outside hospital					0.001
Not transferred	3764	10985	77.7	70.4	
Transferred within 4 hrs	649	1888	13.0	20.6	
Transferred within 4–24 hrs	411	1318	9.3	9.0	
Transferred within 4 hrs					0.80
NTC to study NTC	112	203	10.8	10.2	
NTC to study TC	537	1685	89.2	89.8	
Transferred within 4–24 hrs					0.28
NTC to study NTC	88	174	13.5	7.8	
NTC to study TC	323	1144	86.5	92.2	
Global injury severity					
Shock (SBP<90 mmHg) in ED	279	544	3.5	11.1	<0.001
New Injury Severity Score (SD)	4824	14190	22.7 (23.5)	40.9 (18.1)	<0.001
Maximum AIS Score (SD)	4824	14190	3.4 (1.4)	4.4 (0.9)	<0.001
Head injury severity					
Abnormal pupillary responses in ED	603	1048	5.4	50.2	<0.001
First ED GCS Motor Score					<0.001
6	3571	11192	81.3	25.4	
4–5	348	932	6.2	14.2	
2–3	91	188	1.1	5.6	

Injury Characteristic	Unweighted (n)	Weighted (n)	No Withdrawal %	Withdrawal %	p
1 (Not Chemically Paralyzed)	354	599	3.1	29.0	
Chemically Paralyzed	461	1280	8.3	25.8	
Midline shift on initial CT scan of the head	447	754	3.7	40.1	<0.001
Truncal/Extremity injury severity					
Maximum thorax AIS					0.21
≤2	3206	9438	66.4	68.7	
3	1079	3254	23.1	18.9	
4–6	539	1498	10.5	12.5	
Maximum Abdominal AIS					0.73
≤2	4241	12608	88.8	89.9	
3	298	847	6.0	5.5	
4–6	285	735	5.2	4.5	
Maximum extremity AIS					<0.001
≤1	2307	6085	41.8	66.3	
2	868	2509	17.8	15.9	
3–5	1650	5596	40.4	17.8	
Maximum Head AIS					<0.001
≤2	2918	9395	68.3	20.3	
3	510	1493	10.7	7.7	
4–6	1396	3302	21.1	72.1	
Paralysis	181	516	3.5	6.5	0.10
Number of consultants					0.67
0	2118	6043	42.4	46.0	
1	1454	4273	30.4	24.5	
2	669	1925	13.5	14.0	
>=3	584	1950	13.7	15.5	
Admitted in ICU	2678	6931	46.9	92.1	<0.001

Table 3

Distribution of complications across WOCO status

Complication	Unweighted (n)	Weighted (n)	No Withdrawal %	Withdrawal %	p
Multiple organ failure	37	47	0.2	3.8	<0.001
Cardiovascular	293	576	3.6	13.6	<0.001
Stroke	49	91	0.5	4.6	<0.001
Renal failure	101	146	0.7	8.4	<0.001
Length of stay (median/interquartile range)	4824	14190	6 (9)	3 (9)	<0.001

Table 4

Institutional characteristics associated with the presence of WOCO

	No Withdrawal N=13573	Withdrawal N=618	p
Hospital characteristics			
Mean number of beds (SD)	580 (574)	545 (273)	<0.001
Mean admissions per year (SD)	20770 (10618)	20193 (5634)	0.001
Trauma center (%)	72.1	79.5	0.02
Member of Council of Teaching hospitals, AAMC (%)	81.5	85.5	0.19
Closed ICU	74.7	78.8	0.18

SD – standard deviation

Table 5

Institutional predictors of WOCO

Multivariate Analysis controlling for Age, ISS and MAX Head AIS

Institutional characteristics	**OR(95% CI)**
Trauma Center	1.56(1.06,2.30)
Closed ICU	1.53(1.03,2.25)
Member of council of teaching hospitals	1.32(0.89,1.97)
Admission per year (each 100 increase)	0.999(0.995,1.003)
Number of beds (each 100 increase)	0.987(0.930,1.047)

Table 6

Predictors of WOCO

Patient Characteristics	OR	95% CI	P value
Age			
18–54	ref	ref	
55–64	3.90	1.72–8.87	0.001
65–74	3.48	1.64–7.39	0.001
75–84	9.96	5.51–18.02	0.000
Abnormal pupils in ED	3.02	1.88–4.85	0.000
GCS Motor Score ED			
6	ref	ref	
4–5	3.4	2.09–5.89	0.000
2–3	4.36	2.33–8.14	0.000
1 not paralyzed	6.24	3.36–11.58	0.000
1 paralyzed	3.7	2.31–32.51	0.000
Midline shift initial head CT	2.07	1.47–2.92	0.000
MAX AIS	1.67	1.23–2.26	0.001
Charlson Score	1.21	1.09–1.35	0.001
LOS >2 days	0.242	0.17–0.338	0.000
ICU admission	7.40	4.18–13.11	0.000
Number of consultations	0.84	0.72–0.99	0.034
Hospital complications			
Renal failure	9.74	2.92–32.52	0.000
Stroke	5.81	2.22–15.21	0.000
Cardiovascular	1.65	1.03–2.66	0.039
Multi organ failure	5.69	1.90–17.00	0.002

Table 7

A comparison of WOCO survivors and non-survivors

Patient Characteristics	Unweighted (n)	Weighted (n)†	Survival 15(37)	Dead 569(581)	p
Age					0.09
< 55	287	301	37.9	49.4	
55–64	71	83	31.7	12.3	
65–74	76	78	5.9	13.1	
75–84	149	155	24.4	25.1	
Charlson Co-morbidity Score					<0.001
0	336	350	28.1	58.5	
1	89	104	52.2	14.6	
2	55	57	8.4	9.3	
3 or more	103	106	11.3	17.6	
Maximum AIS Score (SD)	583	618	4.2 (1.7)	4.4 (0.8)	0.01
Abnormal pupillary responses in ED	301	310	15.0	52.5	0.01
First ED GCS Motor Score					<0.001
6	135	157	71.0	22.5	
4–5	85	88	10.9	14.4	
2–3	34	35	0	6.0	
1 (Not Chemically Paralyzed)	175	179	11.9	30.1	
Chemically Paralyzed	154	159	6.2	27.1	
Midline shift on initial CT scan of the head	242	248	10.6	42.0	0.01
Number of consultants					0.04
0	277	284	17.8	47.8	
1	134	151	40.9	23.4	
2	80	87	25.3	13.3	
>=3	92	96	16.0	15.4	
Admitted in ICU	537	568	88.4	92.3	0.02

Patient Characteristics	Unweighted (n)	Weighted (n)†	Survival 15(37)	Dead 569(581)	p
Multiple organ failure	23	24	0	4.1	<0.001
Cardiovascular	83	84	0	14.5	<0.001
Stroke	28	29	2.7	4.7	0.55
Renal failure	52	52	0	9.0	<0.001
Length of stay mean(SD)	583	618	17.4 (17.7)	7.8 (13.3)	0.01