# Non-Trauma Service Admissions: Should We Care?

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**The American College of Surgeons Committee on Trauma requires that trauma centers with greater than 10 per cent injured patients admitted to non-trauma services (NTSs) have processes to review these for appropriateness of care. We previously described an algorithm to determine the appropriateness of NTS admissions. Our objective was to determine if the outcome and process of care was similar between TS- and NTS-admitted patients. We conducted a retrospective analysis of our trauma registry. NTS-appropriate patients by algorithm were included. Differences between patients admitted to a TS and an NTS were compared. Nine hundred forty-one patients met the algorithm criteria as appropriate for the NTS; 694 were admitted to TS and 247 to NTS. Contact with TS was the most common association with admission to TS. NTS patients were older and had similar Injury Severity Scores, and a similar proportion had three or greater pre-existing comorbidities. NTS-admitted patients had similar risk for mortality and complications, but longer length of stay, and were less likely to have a desirable discharge disposition. Minimally injured elderly patients constitute most of NTS and a large proportion of TS admissions. NTS admission seems appropriate with respect to mortality and complications. Differences in the care process may have accounted for longer length of stay and differences in disposition destination.**

IN ITS "RESOURCES for the Optimal Care of the Injured Patient, 2014" the *American College of Surgeons Committee on Trauma* (ACS-COT) requires that trauma centers admitting greater than 10 per cent of injured patients to non-trauma services (NTSs) should have a process to review these admissions for appropriateness of care.[1] This is not discriminatory, and all injured patients, including those with minor injuries and low energy mechanisms, are included. Several studies have shown outcome advantage to dedicated trauma services (TSs) and systems.[2–7] These, however, concentrate on the more severely injured patients and do not provide insight into the value of TS *versus* NTS admissions for patients who have less severe injuries.

Additional data suggest that the demographic of trauma is changing. The trauma patient population under consideration is older and less severely injured.[8] Thus, a number of patients presenting to trauma centers have medical comorbidities and problems that are at least as significant as their injuries. It may be reasonable to question if the new demographic of trauma patients is well served, given the ACS-COT standards with respect to NTS admissions.

To review appropriateness of these NTS admissions in our institution, an algorithm was developed by the trauma program medical director.[9] Elements of the algorithm included identification of TS contact either by "trauma alert" or consult, patient age, Injury Severity Score (ISS), comorbidity burden, mechanism of injury, need for operative intervention, and severity of injury. We understood that the algorithm would necessarily be applied retrospectively because "appropriateness" would be determined using the criteria established by the ACS-COT, which cannot be obtained prospectively (ISS, surgical service consultation, and trauma consultation). We also understood that there would be extensive overlap among patients admitted to a TS *versus* an NTS with respect to the criteria we had selected. As such, we felt that the study of patients meeting these algorithmic criteria would potentially offer an opportunity to address the question of whether admission to TS benefits minimally injured

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patients. We hypothesized that outcome and process measures for patients meeting the algorithm criteria admitted to a TS *versus* an NTS would be similar.

## Methods

Data were collected from the trauma registry of our ACS-COT verified Level II trauma center from years 2014 through 2016. Patients admitted and meeting the National Trauma Data Bank submission criteria were analyzed. Patients with isolated hip fractures from same level falls were excluded. These patients are not mandatory National Trauma Data Bank submissions and are not counted among qualifying volume for ACS-COT verification. In our center, these patients have traditionally been admitted to the hospitalist service with orthopedic consultation. All other mechanisms of injury resulting in isolated hip fracture and all fractures of the femur including isolated proximal fractures were included. Records where data pertaining to the algorithm, admission service, or outcomes of interest were missing were excluded from analysis.

We selected the criteria in our algorithm (Fig. 1) based on the optimal resource document,[1] and additional criteria that we chose were based on certain assumptions: The decision to include the presence or absence of ICU admission and need for surgery was based on our intent to be conservative in our approach to the judgement of "appropriateness." We believed that these variables might be associated with greater injury magnitude even for single system injuries and/or a greater degree of physiologic derangement. We felt these patients would be best managed on a TS. Our algorithm was applied to this population, and those patients deemed appropriate for NTS admission (score of 4 or greater) were further examined for admission service, NTS, or TS. TS was defined as acute care surgery (ACS), orthopedic surgery, or neurosurgery service.

For patients judged appropriate for NTS admission based on our algorithm, we compared baseline characteristics of age, ISS, gender, and the presence or absence of three or greater comorbidities [as defined by the Trauma Quality Improvement Program (TQIP)] between patients admitted to TS *versus* NTS. We also examined the distribution of types of comorbidities and Abbreviated Injury Scale (AIS) body regions injured (AIS > 0) between the two groups. The outcome measures of mortality, presence or absence of a major complication as defined by TQIP, length of stay (LOS), and desirable discharge disposition (discharge to home or acute rehabilitation setting) were also compared. We performed similar comparisons between patients who were not deemed appropriate for NTS admission and were admitted to a TS *versus* an NTS.

| Criteria | Points |
|---|---|
| Age > 65 | 1 |
| 3 or more Comorbidities | 1 |
| ISS < 10 | 1 |
| Mechanism = Same Level Fall | 1 |
| No ICU admission | 1 |
| No Need for Surgical Intervention | 1 |

FIG. 1. Algorithm for appropriateness of NTS admission. A score of 4 or greater is appropriate for admission to an NTS.

Finally, recognizing the actual overlap in admitting service associated with a mandated, predetermined threshold of 10 per cent maximal rate of NTS admissions, we analyzed the data to determine which of the algorithmic variables was most closely associated with admission to the TS *versus* NTS.

Statistical analysis was conducted using SAS statistical software v9.4 (SAS Institute Inc., Cary, NC). Comparisons were made with $\chi^2$, Fisher's exact test, or the Wilcoxon test. Multiple logistic regression was carried out to determine factors associated with TS *versus* NTS admission. Significance was defined as $P < 0.05$.

## Results

Three thousand two hundred ninety-two patients were reviewed from the registry. Of these, 417 were isolated hip fractures and were excluded. Fourteen more records were excluded for missing data on admission service, leaving 2861 records for analysis. Of 2861 patients admitted for a traumatic diagnosis, 2531 were admitted to TS (88%) and 330 were admitted to NTS, an unadjusted NTS admission rate of 12 per cent. Based on our algorithm, 941 (33%) patients would be deemed appropriate for NTS admission and 1920 (67%) would be considered as inappropriate for NTS admission.

The NTS-appropriate patients were older (mean age, 74 years *vs* 44 years, $P < 0.001$), more likely to be women [562 (60%) *vs* 612 (32%), $P < 0.001$)], less severely injured (mean ISS 6 *vs* 9, $P < 0.001$), and more likely to have three or greater chronic comorbidities [482 (51%) *vs* 134 (7%), $P < 0.001$] than their NTS-inappropriate counterparts.

Of the 941 patients deemed appropriate for NTS admission in our retrospective analysis, the majority, 694 (74%) were actually admitted to a TS and 247 (26%) were actually admitted to an NTS (Fig. 2). Of 1,920 patients who were deemed not appropriate for admission to an NTS, 83 (4%) were actually admitted to an NTS and 1837 (96%) were admitted to a TS. These 83 patients were considered inappropriate NTS admissions and comprised our adjusted NTS admission rate for the purpose of ACS-COT verification.

TABLE 1. *Patient Characteristics*

| | NTSA | | | NTSI | | |
|---|---|---|---|---|---|---|
| | TS (n = 694) | NTS (n = 247) | *P* Value | TS (n = 1,837) | NTS (n = 83) | *P* Value |
| Mean age (years) | 72 | 78 | <0.001 | 44 | 52 | <0.001 |
| Female, n (%) | 398 (57) | 164 (66) | 0.01 | 570 (31) | 42 (50) | <0.001 |
| Mean ISS | 6 | 5 | 0.06 | 9 | 7 | 0.01 |
| 3+ comorbidities, n (%) | 352 (51) | 130 (53) | 0.61 | 127 (7) | 7 (8) | 0.59 |

NTSA, NTS appropriate by algorithm; NTSI, NTS inappropriate by algorithm; TS, TS admission; NTS, NTS admission.

Patient characteristics are displayed in Table 1. For NTS-appropriate patients, those admitted to an NTS compared with a TS were slightly older, were more likely to be female, had similar ISS score, and were of a similar likelihood to have three or greater pre-injury comorbidities. For patients considered inappropriate for NTS admission, patients admitted to an NTS compared with a TS were older, were more likely to be female, were less injured, but had similar likelihood of having three or greater pre-injury comorbidities.

The five most commonly encountered comorbidities in patients meeting the algorithm criteria for NTS appropriateness were hypertension, bleeding disorder, diabetes mellitus, functional dependence, and dementia. These five were preserved as the five most frequent comorbidities in both the TS and NTS groups. Distribution of these comorbidities was similar except for the increased prevalence of dementia and functional dependence in patients admitted to an NTS (Table 2). Of the NTS-appropriate patients, those admitted to TS were more likely to have a head injury (AIS region 1) [248 of 694 (36%) *vs* 25 of 247 (10%), $P < 0.001$] and a torso injury (AIS regions 4 and 5) [177 of 694 (26%) *vs* 15 of 247 (6%), $P < 0.001$] and less likely to have an extremity injury (AIS regions 7 and 8) [289 of 694 (42%) *vs* 181 of 247 (73%), $P < 0.001$]. TS-admitted patients were also more likely to have an injury in greater than one AIS region [264 of 694 (38%) *vs* 41 of 247 (17%), $P < 0.001$].

Outcomes were similar between the two groups with regard to mortality and complication rates, but LOS was longer, and the likelihood of undesirable discharge disposition was greater for NTS patients (Table 3). Data regarding preadmission living status were somewhat limited because New York state terminology to define dependent living status changed during the period of review and data elements were missing in 19 per cent of records. Preadmission status listed as "home" was observed more frequently in patients admitted to an NTS [134 of 215 (62%) *vs* 258 of 552 (47%), $P < 0.001$]. For comparison purposes, the odds ratio for having baseline functional dependence for NTS admissions *versus* TS admissions is 1.52 (95% confidence interval: 1.07–2.15), whereas the odds ratio for undesirable discharge destination for NTS patients compared with TS patients is 3.18 (95% confidence interval: 2.34–4.31).

Understanding that our algorithm could not be applied prospectively, given the threshold established by the ACS-COT criteria, we performed a multiple logistic regression analysis of the 2861 patients to determine which factors in our algorithm were most strongly associated with NTS and TS admissions (Table 4). Age, presence of three or more comorbidities, absence of a surgical procedure, and absence of ICU admission were the variables most strongly associated with NTS admission. A nonalgorithmic factor, ACS contact, was found to have the strongest association with admission to a TS and was negatively associated with admission to an NTS (Table 4). ACS service contact was more often by consult [493 (72%) *vs* 190 (28%)] than alert. For trauma alerts, 185 (97%) *versus* 5 (3%) ($P < 0.001$) were admitted to the TS, and for trauma consults, 464 (94%) *versus* 29 (6%) ($P < 0.001$) were admitted to the TS.

## Discussion

This is a retrospective study of prospectively collected data, which attempts to examine the consequence of admission to TS *versus* NTS for minimally injured patients who were retrospectively deemed appropriate for NTS admission by a previously described algorithm. Actual prospective application, whether in the context of a clinical study or otherwise, is limited by the ACS-COT threshold of 10 per cent NTS admission rate, and as such, some elements of the algorithm can only be adjudicated retrospectively. Given the current demographic of trauma patients in our (and many) trauma centers, we knew a large number of patients meeting the criteria would actually be TS admissions to comply with the standard. We also recognize the algorithm is arbitrary and institution specific, but we could not use a stepwise logistic regression in creating the model because of the considerations noted earlier. The determination of appropriateness of admission to NTS was based on an arbitrary cutoff score of four or greater points, and it is not possible to determine with precision which of the elements contributed to the final score, although

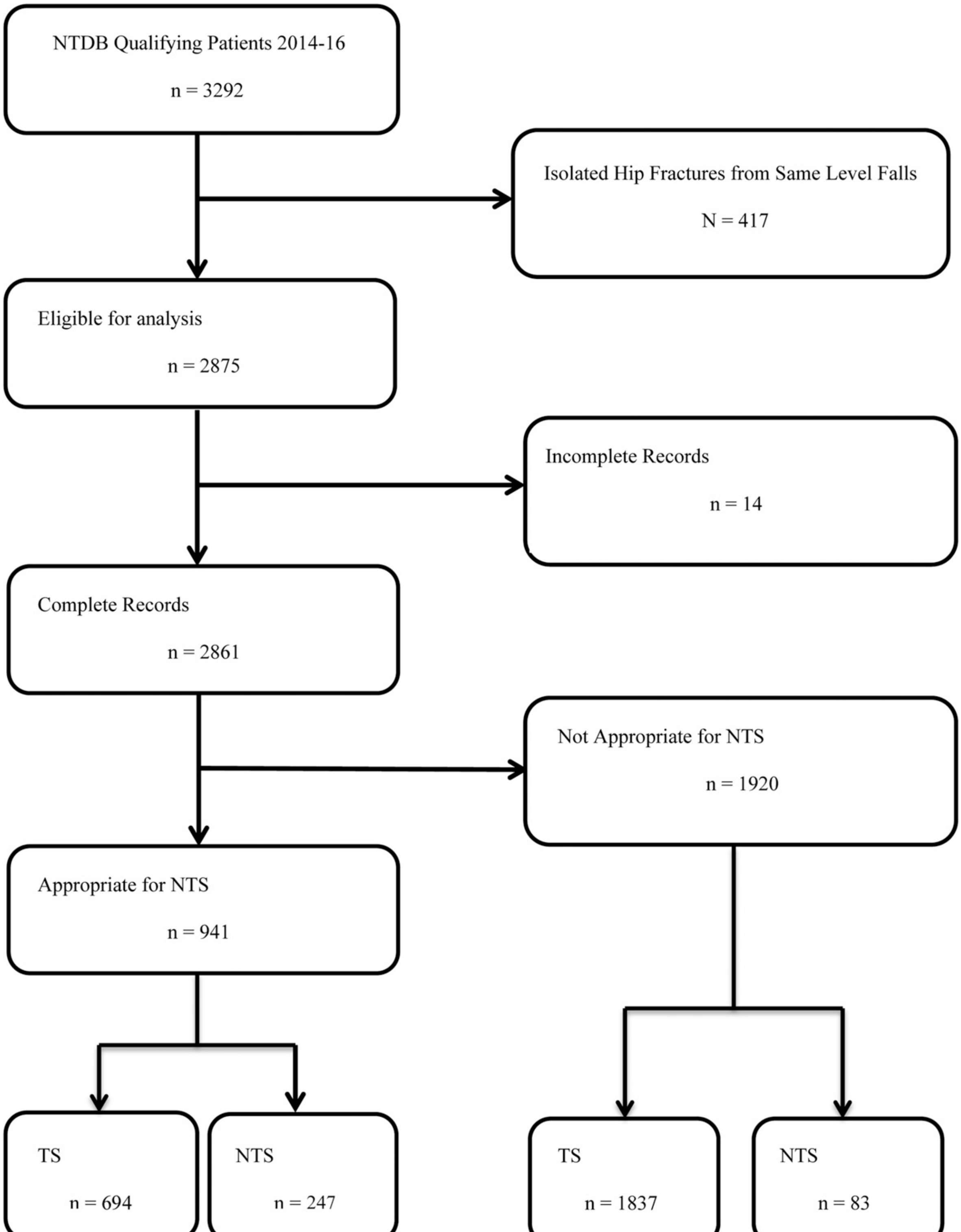


FIG. 2. Patient inclusion flow diagram.

the regression analysis (Table 4) affords some clues. Clearly, the effect of any TS contact predicted TS admission, again consistent with the need to comply with the 10 per cent ACS-COT threshold.

Despite these limitations, the data do allow us to measure comparisons between groups actually admitted to a TS *versus* an NTS and determine if outcome differences exist between them. Because the strongest

Table 2. *Distribution of Chronic Comorbidities for NTSA*

| | TS (n = 694), n (%) | NTS (n = 247), n (%) | *P* Value |
|---|---|---|---|
| Hypertension | 485 (70) | 179 (72) | 0.48 |
| Bleeding disorder | 231 (33) | 68 (28) | 0.09 |
| Diabetes mellitus | 170 (25) | 72 (29) | 0.16 |
| Functional dependence | 123 (18) | 61 (25) | 0.02 |
| Dementia | 98 (14) | 48 (19) | 0.05 |

NTSA, NTS appropriate by algorithm; TS, TS admission; NTS, NTS admission.

Table 3. *Outcomes for NTSA*

| | TS (n = 694) | NTS (n = 247) | *P* Value |
|---|---|---|---|
| Mean LOS (days) | 4.7 | 6.1 | <0.001 |
| Patients with complication, n (%) | 26 (4) | 13 (5) | 0.31 |
| Mortality, n (%) | 11 (2) | 2 (1) | 0.53 |
| Desirable discharge, n (%) | 465 (71) | 105 (44) | <0.001 |

NTSA, NTS appropriate by algorithm; TS, TS admission; NTS, NTS admission.

Table 4. *Factors Associated with Admission to NTS from Multiple Logistic Regression*

| | Odds Ratio | 95% Confidence Limits | |
|---|---|---|---|
| Age > 65 years | 5.05 | 3.43 | 7.44 |
| 3+ comorbidities | 3.60 | 2.38 | 5.44 |
| ISS < 10 | 1.33 | 0.69 | 2.57 |
| Same-level fall | 1.34 | 0.93 | 1.91 |
| No ICU | 2.02 | 1.05 | 3.89 |
| No surgery | 3.59 | 2.33 | 5.53 |
| Contact with ACS service | 0.007 | 0.005 | 0.012 |

determinant of TS admission is TS contact, and the predominant mode of contact was consultation, the data may be reflective of factors affecting the emergency department's decision to contact the TS or not. The observation of older age, a higher dependent functional status, single body region injury, and absence of torso and head injuries among NTS admissions suggests there may be perceived differences in the populations at the point of care, and these differences may affect decisions in real time to contact the TS.

The outcome differences observed between TS and NTS admissions may reflect differences in the populations, leading to longer LOSs and a higher frequency of unfavorable discharge status, or these outcomes may be related to differences in processes of care between services. We believe the latter because the clinical significance of these differences is unclear. Data from another single-center study have shown that for elderly trauma patients aged ≥90 years, there is an association between TS admission and decreased LOS. This lends some support to our conclusion and suggests some level of generalizability to our data.[10] While strictly speculative, it might be that ACS-COT standards and performance improvement metrics create a level of structure not found on most hospitalist services. One example that might affect LOS and disposition would be consistent and timely evaluation by physical therapy and rehabilitative services.

With the low mortality observed in this population, it should also be expected that no difference in inpatient mortality would be observed. We believe an argument for using the discharge disposition outcome as a surrogate for quality of care measure can be made. The use of this measure is supported by data, showing that trauma patient discharge to an acute rehabilitation facility was not associated with increased long-term mortality compared with discharge home, whereas other discharge destinations including skilled nursing facilities were associated with increased long-term mortality.[11] In this study, we do observe a large difference in desirable discharge disposition, favoring admission to TS. Despite functional dependence being a more frequent comorbidity in the NTS population, the magnitude of difference in desirable discharge far outweighs the baseline difference. As such, we must conclude this represents a benefit to patients from TS admission.

It is possible that rehabilitation referral patterns may be influential in the discharge disposition difference noted. It is possible that the structural requirements for rehabilitation services during the acute care phase mandated by ACS-COT might lead to a dissimilar referral pattern on TS compared with NTS. There is also a recent national trend toward a decreased proportion of trauma patients being discharged to inpatient acute rehabilitation facilities because of a reduction in bed availability, and these limited beds are being occupied more frequently by poststroke patients.[12] This further strengthens the argument for considering discharge disposition as a care quality metric because the criteria for acceptance to inpatient rehabilitation are likely becoming stricter. Given the potential for confounding factors, long-term follow-up with mortality and functional status data on well-matched cohorts would be required to truly objectively describe desirable discharge disposition as a universal measure of quality.

The difference noted in LOS also is likely representative of process differences between TS and NTS rather than preadmission variables, but causation could not be determined in the present study. The burden of increased LOS in any trauma center cannot be overlooked. The impact on bed utilization over the course of the study would have resulted in 1317 bed days saved for TS *versus* NTS admissions. Given the frequency at which hospitals operate at or above capacity, this stress could have negative consequences for patient care.[13, 14] Further investigations are warranted in an effort to determine if there are process differences between a TS and an NTS as defined by utilization of rehabilitative services, frequency of consultations with medical subspecialists, and test ordering, which could be driving the differences in both LOS and discharge disposition.

The question of how to best care for minimally injured patients whose medical problems and frailty are at least as significant as their injury may not fully be answered by this study. One might conclude "trauma patients" (if, in fact, these are trauma patients) with minimal injury and significant comorbidity fare just as well on an NTS because our data suggest that mortality and aggregate complication rates would not be negatively affected by such an approach. We, however, conclude that there does appear to be a benefit to trauma patients to be admitted to a TS, given a more favorable discharge disposition, and a potential institutional benefit, given decreased LOS.

Given that this patient population is a growing cohort in many trauma centers, we feel that further investigation into differing care models is imperative to maximize quality and efficiency of care.[8]

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