The effect of dead-on-arrival and emergency department death classification on risk-adjusted performance in the American College of Surgeons Trauma Quality Improvement Program

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BACKGROUND: The American College of Surgeons' Trauma Quality Improvement Program is focused on identifying variations in outcomes across trauma centers for the purposes of performance improvement. In previous analyses, patients who died in the emergency department were excluded. We investigated the effect of inclusion and exclusion of emergency department (ED) deaths (dead on arrival [DOA] and died in ED [DIE]) on analyses of overall risk-adjusted trauma center performance.

METHODS: Data for patients admitted to 65 Trauma Quality Improvement Program hospitals during the 2009 calendar year was used. A logistic regression model was developed to estimate risk-adjusted mortality. Trauma centers were then ranked based on their observed-to-expected (O/E) mortality ratio with 90% confidence intervals (CIs) and classified by outlier status: low outliers/high performers had a 90% CI for O/E mortality ratio of less than 1, and high outliers/low performers had a 90% CI for O/E mortality ratio of greater than 1. Changes in outlier status, rank, and quartile were examined with and without DOA and DIE patients included in the analyses to discern the impact of such exclusions on overall risk-adjusted center-specific performance.

RESULTS: Thirty-one trauma centers (48%) reported no DOA patients in 2009, while 6 centers (9%) reported more than 10. Of 224 patients, 14 (6.2%) had a documented time of death of more than 30 minutes after ED arrival despite being recorded as DOA. Forty-one trauma centers (63%) changed rank by three positions or less. Ten trauma centers changed their quartile ranking by a single quartile, but no centers were found to change quartile rank more than one quartile. Changes in outlier status occurred for 6 trauma centers (9%).

CONCLUSION: The relative frequency of patients classified as DOA varies greatly between trauma centers. Misclassification of patients as DOA occurs. Inclusion of ED deaths in risk-adjusted analysis of mortality results in a small but insignificant change in predicting the outcome results of a trauma center. This change is less than the rate of finding a center to be a high or low outlier by chance alone using the 90% CI. Inclusion of DOA and DIE patients in risk-adjusted analysis of mortality is appropriate and eliminates the bias introduced by exclusion of ED deaths owing to misuse of the DOA classification. (*J Trauma Acute Care Surg*. 2012;73: 1086–1092. Copyright © 2012 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Prognostic/epidemiologic study, level III.

KEY WORDS: TQIP; risk adjusted; dead on arrival; mortality; performance improvement.

The American College of Surgeons' Committee on Trauma (ACSCOT) is committed to improving all phases of care involved in management of the injured patient. As part of a national effort to monitor and improve risk-adjusted trauma center performance, the ACSCOT has created the Trauma Quality Improvement Program (TQIP).[1,2] TQIP uses the infrastructure of the trauma registry system for data collection and the National Trauma Data Bank for data submission and collation.[3] In addition, TQIP relies on the National Trauma Data Standard (NTDS) for consistency of data elements, definitions, and an outline of a data source hierarchy to guide data abstraction.[4] Risk-adjusted benchmarking reports describing trauma center performance are created annually for TQIP participants.

To maximize equivalence in the data set used for analysis of trauma center performance, a set of inclusion and exclusion criteria are used to define who is and who is not a "TQIP" patient.[1] The inclusion and exclusion criteria were designed to allow creation of a similar group of patients for analysis and eliminate bias caused by variance among trauma centers in patients who are and who are not included within each sites trauma registry. Exclusion of minimally injured patients from the analysis is accomplished by requiring an Injury Severity Score (ISS) of 9 or greater. In reports issued before 2010, TQIP also sought to eliminate the influence of the potentially unsalvageable patient from the analysis by excluding those patients who died in the emergency department (ED). Some of these patients are classified as dead on arrival (DOA) in the trauma registry.

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Within the NTDS data dictionary, the data element ED death has three possible answers: (1) DOA, the patient is declared dead on arrival with minimal or no resuscitation attempt (no invasive procedures attempted); (2) death after failed resuscitation attempt (failure to respond within 15 minutes); and (3) died in ED (other than failed resuscitation attempt).[4] Patients who meet Criteria 2 or 3 are considered to have died in the ED and are classified as died in ED (DIE) in TQIP analyses. Based on these definitions, a patient classified as DOA should have no invasive procedures performed and be declared dead within the first 15 minutes of arrival. A review of TQIP patient data in preparation for the 2010 Classification of Early Death in TQIP Centers Report demonstrated a number of patients who were classified as DOA who did undergo invasive procedures and/or who were declared dead after being present in the ED longer than 15 minutes.[5] The question of whether exclusion of DOA and/or DIE patients from TQIP reporting is appropriate was raised given that some providers are actively attempting salvage therapy on a portion of these patients that they later classified as DOA.

Proper classification of all trauma deaths in the ED may be relevant to benchmark outcome reporting as patients who die in the ED account for 20% of all trauma-related deaths.[5,6] In addition, problems have been identified with trauma registry case ascertainment, and in some trauma centers, a large proportion of all deaths may be missing.[7] Urban trauma centers are confronted with the problem that a substantial number of their trauma patients arrive as DOA or do not survive to hospital admission.[8] Trauma center performance improvement programs often focus on areas in which care could be improved for future patients even when the patient being reviewed is classified as a nonpreventable death. Concern exists, however, as to whether risk adjustment methods for trauma can adequately reflect the unsalvageable state of the DOA and/or DIE patient. To evaluate the possible impact of this difference in TQIP cohort selection and mortality reporting, we investigated whether exclusion of DOA and DIE patients alters trauma center performance.

PATIENTS AND METHODS

TQIP data from trauma patients admitted during the 2009 calendar year was used in this study. These data were collected using the existing trauma registry mechanism in each of 65 participating trauma centers. These data were then submitted to the National Trauma Data Bank during the regular 2010 call for data. Inclusion and exclusion criteria for patients incorporated into the TQIP analyses have been outlined previously.[2] TQIP reports risk-adjusted mortality for aggregated data and also for three distinct cohorts as follows: (1) blunt multisystem injury (blunt mechanism with Abbreviated Injury Scale [AIS] score of ≥3 in at least two of the following AIS body regions: head, face, neck, thorax, abdomen, spine, and upper or lower extremities); (2) penetrating truncal injury (penetrating injuries with AIS score of ≥3 in at least one of the following AIS body regions: neck, thorax, or abdomen); (3) blunt single-system injury (blunt injuries with AIS score of ≥3 limited to only one AIS body region with all other body regions having a maximum AIS score ≤2). Patients who are classified as DOA or DIE have typically been excluded from these TQIP mortality analyses.

The primary outcome of interest was death during hospitalization, defined as ED discharge disposition of "death" or hospital discharge disposition of "expired." To account for differences in baseline characteristics and injury severity of patients admitted to each trauma center, we used multivariate logistic regression modeling to allow for risk adjustment. Candidate predictors of mortality were entered into the model, and a logit equation was derived based on the significant covariates. From the derived logit equation for predicted mortality, an expected mortality risk between 0 and 1 was calculated for each patient. Summing these expected mortalities for all patients at a given trauma center allowed an estimate of the expected total number of deaths for each hospital based on the covariate characteristics. For each trauma center, the observed mortality rate (number of patients who died) was then divided by the calculated expected mortality rate to obtain an observed-to-expected (O/E) mortality ratio. These mortality ratios along with the 90% confidence intervals (CIs) allowed determination of trauma center performance and identification of statistically significant high- or low-performance outliers. In some instances, specific cases had missing values for potentially important covariates (Glasgow Coma Scale [GCS] motor score, systolic blood pressure, and pulse rate). Because missing data are frequently not missing at random, we imputed these values using multiple-imputation techniques.[9–11] The final model and analyses included all cases that met TQIP criteria.

To examine variance in DOA and DIE reporting, time to death and frequency of DOA/DIE patients were calculated using the 2009 data. In this set of data, we applied the same TQIP inclusion and exclusion criteria used previously with the exception of not excluding patients who died in the ED (DOA or DIE). This resulted in an aggregate group of 54,024 patients. TQIP mortality analyses, with DOA and DIE patients now included, were reperformed as described previously for each of the four patient cohorts as follows: (1) all patients, (2) blunt multisystem injury, (3) penetrating injury, (4) blunt single-system injury. For the all patients cohort, we analyzed the change in trauma

TABLE 1. Facility Characteristics

Variable	No. Hospitals (%)
Trauma center level	
I	48 (74)
II	17 (26)
Bed size	
≤200	1 (2)
201–400	15 (23)
401–600	19 (29)
> 600	30 (46)
Teaching type	
Community teaching	27 (41)
Community nonteaching	3 (5)
University	35 (54)
US census region	
Northeast	10 (15)
Midwest	20 (31)
South	21 (32)
West	14 (22)

center rank when ED deaths were included in the analysis. We also categorized each center into quartiles based on their ranking when DOA and DIE patients were excluded and monitored for changes in quartile when DOA and DIE patients were included in the analysis. Each trauma center was assigned an "Outlier Status" based on whether the 90% CI was completely above, completely below, or crossed the line of unity (O/E Ratio for Mortality = 1). If the CI was completely below 1, the center was designated as "Low-Outlier". If the 90% CI spanned 1, the center was designated as an "Average Performer". If the CI was completely above 1, the center was designated as "High-Outlier". We evaluated for any changes in performance status when DOA and DIE patients were included in the analysis.

RESULTS

The majority of the 65 trauma centers enrolled in TQIP are Level I and University based facilities (Table 1). Of the 54,024 patients, 94% had blunt injuries while the remaining 6% suffered injuries as a result of a penetrating mechanism (Table 2). The mean age of all TQIP patients was 49 years. Penetrating injuries were more common in younger age groups, while single system injuries predominated in the elderly. The average ISS for the entire TQIP population was 18. The mean ISS was 29 for the blunt multisystem subset, 18 for the penetrating trauma cohort, and 14 for the blunt single-system group. Nearly 50% of TQIP patients had an ISS in the range of 9 to 15.

A total of 650 patients were listed as DIE, and 224 were classified as DOA in the 2009 trauma registry data submitted by TQIP centers. In the 2009 TQIP data, there were 3,859 deaths in total, 5.8% of which were recorded as DOA. The proportion of trauma deaths that occurred while in the ED was 23%, and the remaining 77% of deaths happened in the hospital. Thirty-one centers (48%) did not report any DOAs, while 6 centers (9%) reported more than 10 (Fig. 1). Evaluation of DOAs as a proportion of all deaths showed that 14 centers had more than 0% to 5% of their total deaths recorded as DOA, 9 centers had more than 5% to 10%, 5 centers had more than 10% to 20%, and 6 centers had more than 20% (Fig. 2*A*). The proportion of deaths recorded as DIE relative to the total deaths is shown in Figure 2*B*.

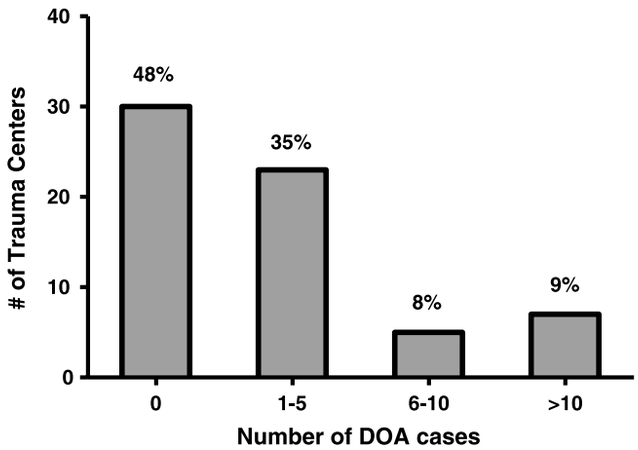

Figure 1 . Number of DOA cases reported per trauma center in 2009. Most centers (83%) reported between zero and five DOA cases in 2009. However, 9% of centers reported greater than 10 DOA cases.

Figure 3 evaluates the timing of declaration of death among DOA and DIE patients in relation to their time of presentation to the ED and demonstrates considerable overlap in time to death among patients classified as DOA versus those classified as DIE. The median time to death for all DOA patients was 4 minutes. However, 14 (6.2%) of 224 patients had a documented time of death of more than 30 minutes after ED arrival despite being recorded as DOA. Five trauma centers had data demonstrating that 50% or greater of their reported DOA patients had a recorded time of death more than 30 minutes after presenting to the ED. The median time to death among patients recorded as DOA was more than 15 minutes for 6 of the 65 total TQIP trauma centers. Nine patients categorized as DIE were missing data for time to death. Of 650 DIE patients, 240 (37%) had a documented time of death of more than 30 minutes after ED arrival. The median time to death for all DIE patients was 19 minutes.

Before determination of the risk adjustment model, missing values for ED GCS motor score, systolic blood pressure, and heart rate were calculated using multiple imputations. The rates of missing values imputed were 2,528 patients (5%) for GCS motor, 1,135 patients (2%) for systolic blood pressure, and 1,106 patients (2%) for heart rate. Calculation of risk-adjusted O/E mortality ratios for each TQIP trauma center allowed determination of trauma center performance status for the aggregate cohort. Changes in outlier status occurred for 6 trauma centers (Fig. 4). Movement was discovered in four possible exchange directions. However, the most common switch was

TABLE 2. Patient Characteristics

Characteristic	Aggregate	Blunt Multisystem Injury	Penetrating Truncal Injury	Blunt Single-System Injury
Patients, n (%)	54,024	11,506 (21)	3,247 (6)	39,271 (73)
Age, y				
16–25, n (%)	10,398 (19)	2,828 (25)	1,335 (41)	6,235 (16)
26–35, n (%)	7,329 (14)	1,894 (16)	898 (28)	4,537 (12)
36–45, n (%)	6,993 (13)	1,600 (14)	505 (16)	4,888 (12)
46–55, n (%)	8,400 (16)	1,908 (17)	338 (10)	6,154 (16)
56–65, n (%)	6,065 (11)	1,195 (10)	90 (3)	4,780 (12)
>65, n (%)	14,839 (27)	2,081 (18)	81 (2)	12,677 (32)
Sex, n (%)				
Female	18,636 (35)	3,620 (31)	321 (10)	14,695 (37)
Male	35,378 (65)	7,885 (69)	2,926 (90)	24,567 (63)
ISS, n (%)				
9–15	25,798 (48)	554 (5)	1,760 (54)	23,484 (60)
16–24	17,300 (32)	3,831 (33)	782 (24)	12,687 (32)
>24	10,926 (20)	7,121 (62)	705 (22)	3,100 (8)
GCS motor score, n (%)				
1–2	5,802 (11)	2,760 (24)	564 (17)	2,478 (6)
3–4	1,078 (2)	388 (3)	52 (2)	638 (2)
5–6	44,616 (83)	7,983 (69)	2,570 (79)	34,063 (87)
Missing	2,528 (5)	375 (3)	61 (2)	2,092 (5)
Transfer, n (%)	18,261 (34)	3,333 (29)	554 (17)	14,374 (37)

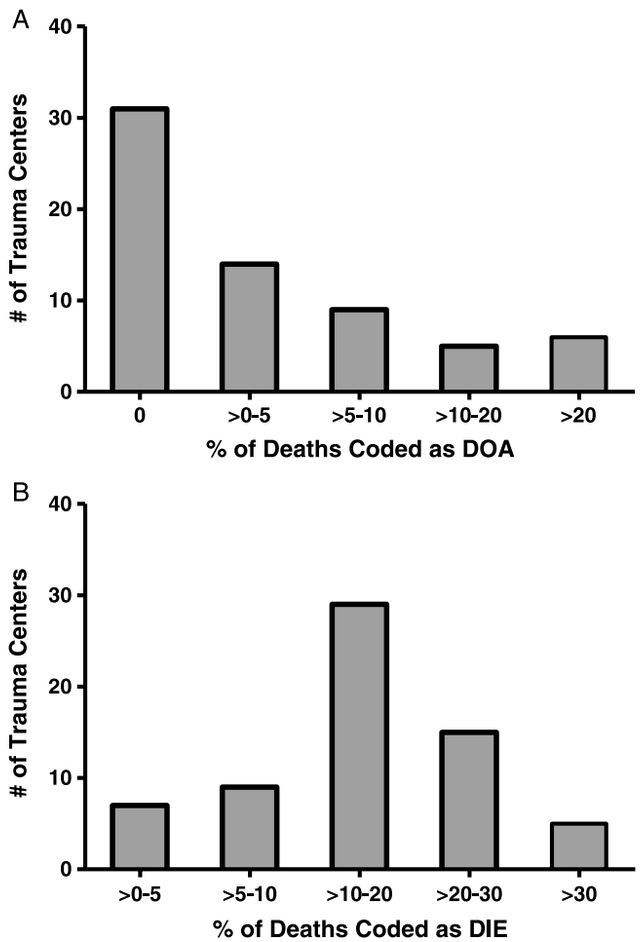

Figure 2. Proportion of DOA/DIE cases of all deaths per trauma center in 2009. *A*, There was considerable variability in the percentage of all deaths that were reported as DOA in 2009. Most centers reported a very small proportion (0–5%) of their deaths as DOA. However, some centers reported up to 20% of their center's deaths as DOA. *B*, There was also variability in the proportion of patients reported as DIE.

a change from high-outlier status to average performance by three (4.6%) trauma centers when DOA and DIE patients were included.

In the supplemental digital content (http://links.lww.com/TA/A198) provided the rank order presented on the left side of the figure represents the analysis in which patients who were DOA or DIE were excluded. Trauma centers are listed in order of lowest to highest O/E mortality ratio. Using this method, trauma centers were also divided into quartiles of rank. Centers were also assigned an outlier status based on their O/E mortality ratio and 90% CI. In the analysis that included patients who were DOA or DIE, 14 centers were considered low outliers (*green bar*, 90% CI < 1), and 11 centers were categorized as high outliers (*red bar*, 90% CI >1). The remaining 40 trauma centers demonstrated average mortality performance (*yellow bar*). The absolute change in rank and outlier status for trauma centers when DOA and DIE patients were included from the analysis is presented in the right column of the table. Forty-one centers (63%) changed rank by three positions or less. One

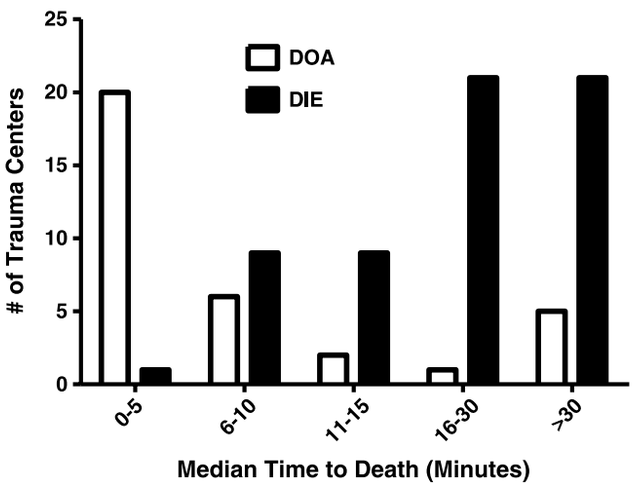

Figure 3. Median time to declaration of death for patients recorded as DOA or DIE. Most of the DOA cases were declared within 10 minutes of arrival at the trauma center. However, additional patients were recorded as DOA in the category of more than 10 minutes although this is inconsistent with the published NTDS definition. DIE cases occur later with the majority occurring greater than 15 minutes after arrival.

center improved their rank by nine positions. Ten trauma centers changed their quartile ranking by a single quartile, but no centers were found to change quartile rank more than one quartile.

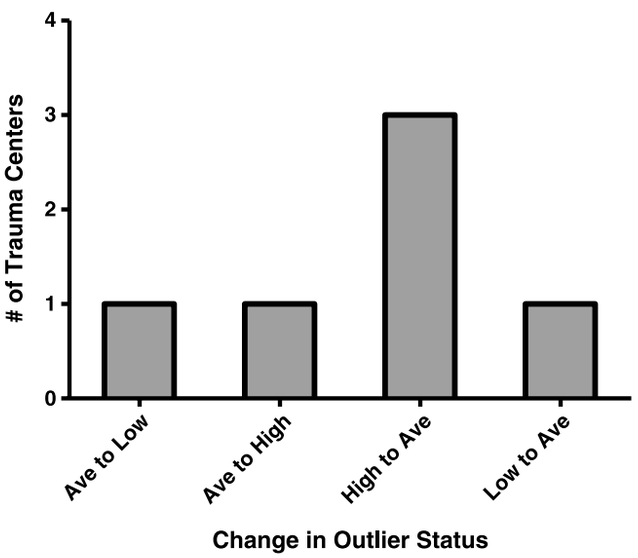

Figure 4. Change in risk-adjusted mortality outlier status with exclusion of ED deaths. Little change was noted overall in the study population after exclusion of ED deaths (DOA and DIE). However, three centers did experience a potentially beneficial change in performance status (from high outlier to average status) when ED deaths were excluded.

DISCUSSION

The credibility of benchmark performance reports to assess trauma outcomes is reliant on the selection of a relatively homogenous patient cohort and execution of appropriate risk adjustment to minimize the effect of differences between centers attributed to confounding variables. Because of differences present among trauma centers in patient transport times and type of injuries seen, there is concern that some centers may be penalized for inclusion of potentially nonsalvageable patients in mortality outcome analyses. A way of managing this problem is to exclude patients who died in the ED from the statistical analysis. This has been the method used by TQIP for compiling its risk-adjusted feedback reports in 2008 and 2009.

Concern has developed that exclusion of the DOA and DIE patients could lead to removal of a considerable portion of those patients that account for a trauma center's overall mortality. Some centers may excel at the resuscitation phase of care but do not receive credit for this effort if deaths occurring in ED are excluded from the analysis. Our results demonstrate that many patients who are classified as DOA in the trauma registry have undergone a substantial resuscitation attempt. This suggests a problem with the definition of DOA status and its correct application to the appropriate clinical situation when used for case exclusion. It is also conceivable that patients coded as DIE may have variability in their ability to be salvaged by different trauma centers. Exclusion of these patients from the mortality analysis eliminates critical assessment of a major phase of trauma system care.

The rationale for exclusion of the DOA patient is that a properly classified DOA patient has no realistic chance of being revived and therefore the trauma center plays no role altering this patient's outcome.[6] This is likely true, but the finding in this study that 6% of patients categorized as DOA had a time to death greater than 30 minutes and 6 of 65 trauma centers reported a median time to death for DOA patients longer than 15 minutes makes use of this criteria for case exclusion questionable. Differences between trauma centers can occur for what is essentially the same patient. For example, a trauma center that receives patients from the scene after short transport times may have a substantially greater proportion of patients that arrive in extremis (rather than DOA) and receive some form of initial resuscitation. Performing an invasive procedure on such a patient changes their classification from DOA to DIE based on the NTDS ED death criteria. The same patient presenting to a different trauma center after a longer transport time may be declared DOA with no resuscitation or invasive procedures attempted based on having lost signs of life in the field/transport and having no signs of life on arrival. This patient will be coded as DOA despite being the exact same patient described in the first scenario. An alternative method of handling this situation when evaluating mortality outcomes would be to include all deaths occurring in the ED and assessing if the risk adjustment methods can adequately account for the relative unsalvageable status of the DOA patient.

Risk-adjustment allows prediction of death while accounting for patient factors that may alter outcome. By definition, all predictive models of death are incorrect because they calculate a probability of mortality between 0 and 1. Real patients, however, are either dead (1) or alive (0). It is in the aggregation of results that these models have value, and they can approach very high levels of discrimination and calibration. We investigated whether the TQIP risk adjustment models adequately managed the patient who was classified as DOA or DIE and ascertained the effect of excluding or including these patients from the analyses on individual trauma center outcomes. An important question is can the risk adjustment methodology used by TQIP account for the likely demise of the DOA or DIE patient? A 20-year-old patient who arrives with no signs of life will have a systolic blood pressure of 0, a pulse of 0, and a GCS of 3; for this patient with an ISS of 9 and no comorbidities, the predicted risk of mortality in the 2009 TQIP model for mortality is 85% for a blunt mechanism and 97% for a penetrating mechanism. The same patient with a change in the ISS to 15 results in a predicted mortality of 93% for a blunt mechanism and 99% for a penetrating mechanism. Hence, the risk adjustment method seems to work well when predicting mortality for a patient who arrives in extremis.

Complete assessment of severity of anatomic injury is limited in the most severely injured patients who die before they receive cross-sectional imaging or operative exploration. Autopsy findings have revealed that initial ISS scores are underestimated in DOA and DIE patients.[12] For this reason, it has been strongly advocated to include data from autopsy reports when assigning final injury type and AIS score to provide for more accurate recording of fatal injuries in the trauma registry.[13] Provision of more complete and accurate ISS values in fatal situations will lead to improved reliability when calculating the probability of death for a patient with an early death.

Should early deaths be included in the TQIP mortality analysis and do they affect estimates of risk-adjusted performance? The early phase of care accounts for on average one quarter of a trauma center's recorded deaths. We have found that a substantial proportion of patients who die in the ED do not meet DOA classification criteria, despite being recorded as such in the trauma registry. Risk adjustment models that use physiologic parameters on arrival to the ED, ISS, and age can provide a high degree of accuracy when predicting mortality for the "potentially unsalvageable patient." The inclusion of ED deaths did exert an effect on risk-adjusted trauma center performance in our study because some centers changed their rank, quartile status, and/or outlier status. In comparison, inclusion of DOA and DIE patients modified the outlier status of 9% of centers, which is less than the 10% rate of such an occurrence happening by chance alone when using a 90% CI. Therefore, TQIP inclusion of ED deaths in risk adjustment analyses of mortality results in a small but insignificant change in outcome results of individual trauma centers. This finding provides additional evidence to support the conclusion by Gomez et al.[7] that differences in case ascertainment of DOAs do not lead to observed differences in trauma center performance.

CONCLUSION

Inclusion of ED deaths in risk adjustment analysis of mortality results in a small but insignificant change in predicting the outcome results of a trauma center. This change is less than the rate of finding a center to be a high or low

outlier by chance alone using the 90% CI. Hence, inclusion of DOA and DIE patients in risk-adjusted analysis of mortality is appropriate and eliminates the bias introduced by exclusion of ED deaths owing to misappropriate use of the DOA classification. For now, TQIP will continue to report mortality outcomes with and without DOA/DIE patients included. TQIP is investigating the feasibility of a signs-of-life data element replacing the ED death classification system.

AUTHORSHIP

J.F.C., A.B.N., J.S.Y., M.L.N., J.A., J.J.F., and M.R.H. designed this study. J.F.C., A.B.N., M.L.N., J.A., and M.R.H. contributed to the literature search. J.F.C., A.B.N., M.L.N., J.A., and M.R.H. collected the data, which J.F.C., A.B.N., M.L.N., S.G., J.A., and M.R.H. analyzed. All authors participated in data interpretation. J.F.C., J.A., and M.R.H. wrote the manuscript and prepared figures.

DISCLOSURE

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DISCUSSION

Dr. Samir M. Fakhry (Charleston, South Carolina): I would like to commend Dr. Calland on an excellent presentation of a somewhat difficult subject to address.

The authors, as you heard, set out to determine whether the exclusion of patients dead on arrival (DOA) or those who died in ED (DIE) in the analysis of trauma center performance affects commonly used outcome metrics such as the observed-to-expected ratio of mortality.

This is an important question, and it is important that we address this as we refine the methodology and the model for Trauma Quality Improvement Program (TQIP) to allow us to better interpret not only our individual performance as centers but also our performance as a group.

Well, the short answer to the question of "Does it make a difference?" is yes it does but not very much. Having stated that, I would like to ask the authors a few questions and make some comments regarding the article and the data as I have read it.

The first is if I understood your methodology, Dr. Calland, you surveyed 2008 and 2009 data, and then you used the 2008 data to help you identify the problem and then derive a model to risk-stratify. Then, you used the 2009 data set to test the influence of excluding DOA or DIE patients for the analysis. If that is the case, why not simply aggregate the data from both years to improve your ability or, for that matter, extend the analysis to a larger data set?

The second question is along the same lines. You provided us the percentage of DOA in the 2008 data set but not in the 2009 data set. Was there a significant difference? Why not combine the 2 years for purposes of data analysis?

The third question is, in your article, you showed that the percentage of missing data for Glasgow Coma Scale score was approximately 5%, but you did not have rates of missing values for things like blood pressure and heart rate. Were these in the same range or were they outside the range? The reason I chose those is because of their importance in the early evaluation of patients in a trauma bay and because data are sometimes missing and need to be imputed in these evaluations.

Fourth, as you pointed out, the relative frequency of DOA patients varied greatly among centers. You only showed the percentage of DOA/DIE in the 2008 group. Do we have any idea of why it varies so much? Was it any different in 2009? Why are centers not a little bit more clustered in this particular data point?

Fifth, is excluding DIE the same as excluding DOA? Centers that elect to pursue invasive interventions on patients with essentially no survival potential strike me as being at a quality disadvantage compared with those who do not pursue these futile interventions.

Sixth, given that a small minority of centers changed quartiles in this analysis, I have to ask you whether the manipulation of these data, as you are proposing, is really worth performing for most applications.

Finally, seventh, as is the case with other quality measures that we are evaluating or that others are evaluating to use on us, how do we avoid the possibility that centers will not attempt to resuscitate patients in extremis for fear of damaging their outcome metrics and in that way attempt to influence the data?

I would like to thank Dr. Calland for providing me the article well ahead of time and commend him, again, on an excellent presentation and an important piece of work. I would also like to thank the Association for the privilege of the floor.

Dr. John R. Clarke (Philadelphia, Pennsylvania): Wonderful presentation, Forrest. For many people who come into the emergency department dead with a single bullet hole in their chest, you really do not know what their diagnosis is. Some of them got resuscitated and put in your DIE group. To what extent would it be worth identifying or having the centers identify whether they feel that they have, in fact, a complete diagnostic list for the Injury Severity Score (ISS)? I think the fact that you may have incomplete diagnoses may be confounding both groups, the DOA which you are not looking and the DIE group which you are looking at.

The second question has to do with your attempt to basically clean up the data. Have you considered using propensity score, that is to see whether you can correctly classify people as being recorded as DOA or DIE and then look at the cases that were in a classification other than what you predicted?

Dr. Ronald J. Simon (New York, New York): We are also struggling in New York State with our own trauma registry in trying to look at just and unjust mortality rates.

One of the things that we have found is that if you see a lot of head injury patients that they may go on to die or be allowed to die and they never really have the high ISS that get them into the high-risk group, then you actually have a lot of deaths with relatively low risk of deaths. I was just wondering if you saw anything similar to that in your review.

Dr. James Forrest Calland (Charlottesville, Virginia): Dr. Fakhry, thank you very much for your kind remarks. Dr. Simon and Dr. Clarke, I will try and address each of your questions.

Dr. Fakhry you first asked why we did not actually aggregate the 2008 and 2009 data. I have to admit that as I heard your question I thought to myself, what a great idea.

However, we actually identified the problem using 2008 data and then tested our hypotheses regarding the effect of DOA exclusion using 2009 data. I did not report that in the presentation, but there was no significant change in the rate of DOA between years.

You asked, if the relative frequency of DOA patients varied among centers, why did we not show it for 2009. We could have, but frankly, I think that one of the key interpretations of our findings is that DOA and death during resuscitation classifications are, in and of themselves, flawed and perhaps not objective given the amount of variability we see between centers. We actually made a philosophical decision in the reporting of our data to start moving away from those classifications and instead start talking about some more objective things, which actually predict survival such as things we will be looking at in 2012, prehospital cardiopulmonary resuscitation by a health care provider, and whether the patient had any signs of life when they arrived at the trauma center.

You also asked is excluding DIE the same as excluding DOA. Frankly, this is a concern of mine. Are we going to take a patient who is nonsalvageable and moribund and actually convert them from somebody who would have been previously excluded from the whole TQIP risk adjustment scheme to somebody that counts against us?

You asked whether it is worth performing the analysis of excluding DOA and DIE given the small number of centers that change performance quartile. My mind was changed on this issue in the process of putting together this article together—most of the people in this room are highly achievement driven. We have all wanted to be beyond two SDs from the mean in everything we have ever tried to do. Perhaps, in this case, we need to maybe focus not so much on where our individual point estimate for mortality is but on where it is going potentially and what are we doing at our own individual centers to change the processes and structures of care to improve the health of our populations.

I think I already addressed it but you also asked, are we going to begin to be thinking about our TQIP reports and make individual decisions in the trauma bay about the survivability of our patients. The decision of going forward to simply produce twin caterpillar graphs for each category of injury, both with DOAs included and excluded, will give each center the opportunity to ask themselves the question not only how their overall performance is but also how is their performance during this initial critical phase of care.

Finally, you asked was there any difference between the rate of missing Glasgow Coma Scale (GCS) score and those of systolic blood pressure and pulse rate. The missing GCS was approximately 5%, and the rate for both pulse rate and blood pressure, as you might imagine they would be similar, run approximately 2.1%.

Dr. Clarke, you asked about these patients who arrive at our centers and are, frankly, too sick to get adequate imaging to accurately classify their injuries and wind up looking like deaths in low-risk categories because of a low ISS. I think that this is a problematic population. We are hoping that this issue about signs of life and the existence of prehospital cardiopulmonary resuscitation will positively influence the accuracy of our risk adjustment models.

I will tell you at our own individual center that we are trying to work closely with our medical examiner and pathologist to get as many autopsies as we possibly can to try and catalogue the injuries in these patients so that their injuries are appropriately risk adjusted.

You then, lastly, asked about propensity scoring. Great idea. That is one of the things that we are thinking of doing, but I cannot otherwise offer any comment on that. One of the questions is whether any methodology can adequately risk adjust for something as severe as multiple gunshot wounds.

Then the last question was by Dr. Simon, this issue about the head injuries and can you wind up with deaths in apparently low-risk categories. This is a real issue, and the challenge of this is that all of us look at our responsibility to preserve patient and family autonomy, to reserve and respect opinions near the end of life. It is tempting to try and just get these patients out of the hospital with a tracheotomy and a peg so that you do not wind up with a mark on your record of potentially a death in a low-risk category.

All of us have to work toward preserving individual patient and family autonomy and think less about our risk adjustment report when we are making those decisions.

Thank you again for the privilege of the floor.

Supplemental Figure

Figure 5. Performance with and without DOA / DIE patients excluded

Rank w/o DOA/DIE	Center ID	Outlier Status w/o DOA/DIE	Outlier Status with DOA/DIE	Change in Rank	Change in Quartile
1	50			0	0
2	18			-4	0
3	29			1	0
4	31			0	0
5	56			2	0
6	27			-5	0
7	7			2	0
8	2			-7	0
9	33			1	0
10	16			-3	0
11	63			-1	0
12	3			2	0
13	47			6	0
14	10			5	0
15	55			-1	0
16	45			-6	0
17	15			3	-1
18	39			-6	0
19	32			-7	0
20	21			1	0
21	60			4	+1
22	5			1	0
23	6			5	0
24	36			-1	0
25	57			2	0
26	30			6	0
27	22			-3	0
28	43			-5	0
29	64			0	0
30	44			-6	-1
31	12			-7	-1
32	61			5	0
33	51			-2	-1
34	26			3	+1
35	19			-4	0
36	4			8	+1
37	46			5	+1
38	17			-3	0
39	52			2	0
40	9			-3	0
41	49			7	0
42	35			-9	-1
43	20			3	0
44	14			0	0
45	59			3	0
46	42			-2	0
47	25			-2	0
48	28			3	0
49	54			2	0
50	13			4	+1
51	53			-1	0
52	58			-4	0
53	37			0	0
54	48			4	0
55	24			1	0
56	11			-1	0
57	65			-3	0
58	40			0	0
59	8			4	0
60	1			-1	0
61	23			2	0
62	38			-1	0
63	62			-2	0
64	41			0	0
65	34			3	0