SCIENCE AND EVIDENCE-BASED CONSIDERATIONS FOR FULFILLING THE SALT TRIAGE FRAMEWORK

To the Editor:

Like most of the emergency medical services community, we authors of the Sacco Triage Method (STM) were abuzz in September 2008 when *Mass Casualty Triage: An Evaluation of the Data and Development of a Proposed National Guideline*[1] (also called SALT [Sort, Assess, Life Saving Interventions, Treatment and/or Transport] triage) was published, and we noted the industry's confusion as to what exactly SALT claimed to be. Was SALT a triage system, or was it a framework for developing triage standards? On further review, we learned that SALT should be considered as "model uniform core criteria," that is, suggested triage "criteria" against which triage systems should be evaluated. Because research indicates that non–evidence-based, color-coded systems do not and cannot satisfy the SALT committee's criteria and further that the STM was inaccurately represented within the report and does satisfy the criteria, an examination of the SALT framework is warranted.

Science, medical evidence, and specificity seemed lacking in the SALT framework. This is prominently illustrated in the first sentence of the "Limitations and Future Directions" section of the article: "There is no existing measure against which to judge the accuracy or appropriateness of mass casualty triage decisions." We agree with this statement but think that measurable outcomes in triage should be a cornerstone of the triage framework and not just a "limitation" cited in a triage study. If the industry does not adopt an objective measure of triage performance, attempts to improve the process will not be data driven and seem destined to be based on opinions and conjecture. This sentiment is consistent with the National Incident Management System,[2] which calls for measurable goals and objectives and is somewhat consistent with the invited commentary[3] that accompanied the SALT article, in which the authors suggested 5 key performance characteristics: simplicity, time efficiency, predictive validity, reliability, and accuracy. The commentary's authors also stated that the percentage of deaths among salvageable critically injured people is the outcome that best reflects the medical care system, but they did not state how the current systems would define "salvageable critically injured." The SALT treatise mentioned various desirable features (eg, must consider resources, patient differentiation, dynamic expectant category, deterioration, age categories, and all hazards) but did not identify specific criteria by which to evaluate triage performance.

Can the industry agree that the goal of triage should be to maximize the number of lives saved? It is the goal recommended by the Agency for Healthcare Research and Quality,[4] and it is a measurable goal, whereas "doing the greatest good for the greatest number" is not. If we can agree this is the goal of triage, we invite and encourage the authors of SALT to evaluate the STM and the other triage systems against this goal. We believe the STM would perform well in this analysis, especially because it is the only method formulated with this as an explicit and measured goal. Once this goal is defined mathematically, the formulation of the problem identifies exactly what is needed to solve it, for as Albert Einstein said: "You must first define the problem before you can solve it." To maximize expected survivors, you need estimates of each patient's initial and time-dependent (ie, deteriorating) survival probabilities.

The STM prescribes computing a simple physiological score for each patient—a score that correlates with survival probability—and making triage decisions so as to maximize the number of expected survivals based on those scores and in consideration of the timing and availability of transport and treatment resources. Research shows that this score, based on respiratory rate, pulse rate, and best motor response, is more accurate at predicting survival probability than the Revised Trauma Score and the Injury Severity Scale for blunt trauma[5] and penetrating trauma[6] and across 2 pediatric, 2 geriatric, and 1 general adult age classifications (W. J. Sacco, PhD, L. Romig, MD, A. Cooper, MD, et al, unpublished data, 2009). The score has been shown in an exercise[7] to be simple to learn and more accurately computed (92%) than the Simple Triage and Rapid Treatment (START) assessments (71%). Furthermore, the STM prescribes using the score daily on every trauma patient, enabling continuous model improvements, routine EMS outcome and performance tracking, and evidence-based medevac dispatching, thus creating seamless triage. Emergency responders would assess patients in the same manner during a mass-casualty incident as they do every day, eliminating the need for "tag Tuesdays," reducing training requirements, and satisfying one of SALT's recommendations to "address the infrequent use of triage protocols." The score is easy to compute by field providers and is not computed by a "proprietary computer-based algorithm" or "based on resources" as stated in the SALT article.

Color codes do not accurately reflect survival probability and do not provide "predictive validity." A patient with even minor respiratory distress is tagged as *immediate*, as is a patient with serious respiratory distress, an accelerated pulse, and a posturing motor response. Clearly these patients are not the same priority. Likewise, if the SALT recommendation is considered for an "all hazards approach," a patient with respiratory distress from blunt trauma is not the same as a patient with respiratory distress from exposure to a nerve agent yet they would get the same color-coded category and receive the same priority under SALT. Data confirm problems with the inaccuracy of color codes at predicting patient acuity. Patients with penetrating trauma classified in the START approach as *immediate*, by definition, can have survival probabilities that range as high as 95%.[6] This wide range within the immediate category has led some responders to explain that "some patients are red, and some are *really* red!"[8] Data also show that patients classified in the START approach as *delayed* can have survival probabilities as low as 32%.[6] When considering patient age, the survival probability overlap between immediate and delayed can range from 8% for a "delayed" geriatric patient with a penetrating injury to 98% for

https://doi.org/10.1017/S1935789300002329 Published online by Cambridge University Press

an "immediate" pediatric patient. Clearly, color codes do not and cannot appropriately differentiate patients by acuity. The implications of this on triage decision making are significant. The wide range in each category leads to subjective and poor prioritization within the categories, a problem exacerbated by overtriage.

Estimating a patient's deterioration in condition is more difficult because we lack complete data. Our approach was to measure the change in survival probability of trauma patients between the scene and the emergency department for each physiological score and to supplement that in predicting deterioration during extended periods with consensus estimates from a Delphi panel of experts.[5,6] These data are not perfect, but were and are the best available and will improve once the emergency medical services community begins collecting and tracking mass-casualty incident data. It should be noted in comparison that because START and SALT do not directly consider deterioration, it is a tacit assumption that there is no deterioration. This is obviously a false and impactful assumption. (Note a correction to the SALT treatise on the role of our Delphi panel: "Although these results are promising, it must be noted that the same committee was used to develop the rule as validate the rule . . .." This was stated in discounting simulation results that show considerable lifesaving potential of the STM, but the Delphi experts had nothing to do with the triage rules or the simulations.)

With estimates of survival probability and deterioration and the timing of transport and the availability and location of treatment capacity, the expected number of survivors can be explicitly determined. In addition, the number of preventable deaths can be retrospectively computed. In a recent article "Does START Triage Work? An Outcomes Assessment After a Disaster,"[9] the authors retrospectively evaluated START, concluding that it demonstrated poor agreement between triage levels assigned by START and a priori outcomes criteria for each level; incorporated a substantial amount of overtriage; but ensured acceptable levels of undertriage, because the 22 red-tagged patients included the 2 patients who were "truly red" based on modified Baxt criteria. The authors reported that these 2 patients, both of whom ultimately died, were tagged as immediate, but did not indicate the priority of these patients within the queue of patients classified as immediate. Did these patients receive the needed priority, or was their treatment delayed because they were lost in a sea of 20 overtriaged patients classified as immediate?

In a 99-patient disaster exercise,[7] only 2 of the 13 most seriously injured patients were moved from the scene in the first 13 ambulances under START, and the 3 most seriously injured patients actually left the scene by bus nearly an hour later. The performance of START in this exercise was poor, yet before retrospectively examining patient acuity, the participating agency thought the exercise was a resounding, successful implementation of START. A large Pennsylvania study[8] illustrated extreme inconsistency in tagging and triage priorities when using START for a 45-patient exercise. The number of patients tagged as immediate across 70 teams ranged from 4 to 44, the number tagged as delayed ranged from 1 to 20, and the number tagged as expectant ranged from 0 to 17. Each of the 45 patients appeared at least once as a top 10 priority, and 40 of 45 patients were selected at least once as a bottom 3 priority patient. In the Madrid bombing, of 312 patients classified as immediate, only 91 were hospitalized and 62 of the 91 patients were not critically injured.[10]

Color codes do not support the committee's recommendation that "triage decisions cannot be made in isolation and must consider resources." Color codes are static, but if we are to maximize the expected number of survivors, they must be dynamic based on the incident size and type and the extent to which resources are taxed. The motivation for SALT's recommendation for a dynamic (but optional) expectant category reflects this need, but data analysis and simulations clearly show that *every* category should be dynamic. For the STM, each patient's age-adjusted physiological score indicates a patient's expected survival probability, *but not their priority*, because priority is dependent on the size and type of incident, the number of patients and severity distribution, and the type and timing of resources. Priority is typically determined by applying simple rule-based protocols that vary to reflect resource availability. In a recent exercise,[7] providers with minimal training successfully implemented the STM, moving 12 of the 13 highest priority patients in the first 6 ambulances.

Effective triage should maximize the number of survivors and should be measured explicitly against that goal. Emergency medical services performance in every exercise and mass-casualty incident can and should be evaluated based on the number of patients who survived and the number who should have survived. The SALT project identified desirable features of triage but did not explicitly define goals, objectives, and criteria and failed to recognize the flaws inherent in color-coded systems. Data show that existing color-coded systems yield broad, overlapping, and static categories that cannot differentiate patient acuity effectively, cannot be dynamic in response to the incident type and size (even espouse worst-first triage), and result in significant overtriage and subjective prioritization within each category.

The STM is a triage system that fulfills the SALT framework. The STM uses an easy-to-compute, age-dependent physiological score—a score suggested to be used every day on every trauma patient—that accurately differentiates patient acuities and estimates survival probability and deterioration for blunt, penetrating, and blast overpressure trauma across all ages. These survival probabilities are more accurate than those from the Revised Trauma Score and the Injury Severity Scale and certainly provide a more accurate patient assessment than color codes, even though they are based on non–mass-casualty incident trauma data. The distribution of patient scores is used in consideration of the timing and availability of resources to de-

https://doi.org/10.1017/S1935789300002329 Published online by Cambridge University Press

termine a triage strategy that maximizes expected survivors. We have begun research on chemical trauma and have extended the STM application to evidence-based hospital triage in response to Israel's "scoop and go" scene triage approach and also to medevac dispatching that shows the potential to dramatically reduce flights and costs while reducing mortality. We encourage the emergency medical services community to review the STM in comparison with the other triage systems against the requirements of National Incident Management System, Agency for Healthcare Research and Quality, and SALT and welcome partners to further advance the research and implementation of evidence-based triage.

D. Michael Navin, MS
William J. Sacco, PhD

Author Affiliation: ThinkSharp, Inc, Bel Air, MD

Correspondence: D. Michael Navin, MS, ThinkSharp, Inc, 1114 Runnymede Lane, Bel Air, MD 21014 (mick@sharpthinkers.com).

Funding/Support: This work was privately funded by ThinkSharp, Inc.

REFERENCES

1. Lerner EB, Schwartz RB, Coule PL , et al. Mass casualty triage: an evaluation of the data and development of a proposed national guideline. *Disaster Med Public Health Prep*. 2008;2(suppl 1):S25-S34.
2. US Department of Homeland Security. National Incident Management System. December 2008. http://www.fema.gov/pdf/emergency/nims/NIMS_core.pdf. Accessed January 21, 2010.
3. Armstrong JH, Frykberg ER, Burris DG. Toward a national standard in primary mass casualty triage [editorial]. *Disaster Med Public Health Prep*. 2008;2(suppl 1):S8-S10.
4. Health Systems Research Inc. *Altered Standards of Care in Mass Casualty Events: Bioterrorism and Other Public Health Emergencies*. Rockville, MD: Agency for Healthcare Research and Quality. 2005. AHRQ publication 05-0043.
5. Sacco WJ , Navin DM , Fiedler KE , Waddell RK II, Long WB , Buckman RF Jr. Precise formulation and evidence-based application of resource-constrained triage. *Acad Emerg Med*. 2005;12(8):759-770.
6. Sacco WJ, Navin DM, Waddell RK II, Fiedler KE, Long WB, Buckman RF Jr. A new resource-constrained triage method applied to victims of penetrating injury. *J Trauma*. 2007;63(2):316-325.
7. Navin M, Sacco W, Waddell R. Operational comparison of START and the Sacco Triage Method (STM) in mass casualty exercises. *J Trauma*. In press.
8. Navin M, Waddell R. Triage is broken. *EMS Magazine*. 2005;34(8):138-142.
9. Kahn CA, Schultz CH, Miller KT, Anderson CL. Does START triage work? an outcomes assessment after a disaster. *Ann Emerg Med*. 2009; 54(3):424-430.
10. Peral Gutierrez de Ceballos J, Turégano-Fuentes F, Perez-Diaz D, Sanz-Sanchez M, Martin-Llorente C, Guerrero-Sanz JE . 11 March 2004: the terrorist bomb explosions in Madrid, Spain: an analysis of the logistics, injuries sustained and clinical management of casualties treated at the closest hospital. *Crit Care*. 2004;9(1):104-111.

Lerner et al reply:

We thank Thinksharp, Inc, for submitting the letter to the editor. Triage strategies to improve patient care and save lives have always been the goal of our group, and we are glad that companies like Thinksharp, Inc, share that vision. As we stated in the framework article, we consider our work to be a beginning rather than an end, and our group is continuing to work toward a national guideline for mass casualty triage that will improve interoperability across the United States.

In the development process of the framework article and the corresponding position paper, our members carefully reviewed all available evidence and made what we thought were the best decisions based on that evidence. The expert panel development team considered the following to be important: (1) Initial sorting should identify the casualties in need of lifesaving interventions and provide the lifesaving interventions as soon as possible early in the triage process. (2) Deterioration in the condition of a casualty should be determined through casualty reassessment and not through an estimate of time to deteriorate based on a brief single assessment. (3) The triage guideline must be nonproprietary and inexpensive to widely disseminate.

To continue the development of this work, we have begun to develop the Model Uniform Core Criteria for Mass Casualty Triage. The Model Uniform Core Criteria will be a checklist that industry and communities will be able to use to ensure that whatever triage system they use meets the national guidelines. SALT Triage remains a free, public-domain, nonproprietary system that will be adjusted to conform to the criteria as they develop. We hope that the Model Uniform Core Criteria will be revised at regular intervals as new science becomes available, and we will evaluate any new literature that has become available since our last review. We agree that it is disappointing that a "gold standard" for evaluating triage does not yet exist and hope that as this work progresses, one can be developed. The current lack of a gold standard for the evaluation of triage decisions restricts the research that can be done and the progress that can be made in this area.

Finally, our process addressed only initial triage, and we agree there is a need to expand beyond this to include secondary triage and the provision of care at the scene and the process for moving patients from the scene to the receiving medical facility. We hope that our efforts will someday be expanded to address what comes after patients have initially been sorted.

E. Brooke Lerner, PhD
Richard B. Schwartz, MD
Phillip L. Coule, MD
Eric S. Weinstein, MD
David C. Cone, MD
Richard C. Hunt, MD, FACEP
Scott M. Sasser, MD
J. Marc Liu, MD
Nikiah G. Nudell, NREMT-P, CCEMT-P
Ian S. Wedmore, MD
Jeffrey Hammond, MD, MPH
Eileen M. Bulger, MD
Jeffrey P. Salomone, MD
Teri L. Sanddal, BS, NREMT-B
Graydon C. Lord, MS(c), NREMT-P
David Markenson, MD, FAAP, EMT-P
Robert E. O'Connor, MD, MPH

https://doi.org/10.1017/S1935789300002329 Published online by Cambridge University Press