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Abstract

Objective: This study sought to address the disagreement in literature regarding the "golden hour" in trauma by using the Relative Mortality Analysis to overcome previous studies' limitations in accounting for acuity when evaluating the impact of prehospital time on mortality. **Methods:** The previous studies that failed to support the "golden hour" suffered from limitations in their efforts to account for the confounding effects of patient acuity on the relationship between prehospital time and mortality in their trauma populations. The Relative Mortality Analysis was designed to directly address these limitations using a novel acuity stratification approach, based on patients' probability of survival (PoS), a comprehensive triage metric calculated using Trauma and Injury Severity Score methodology. For this analysis, the population selection and analysis methods of these previous studies were compared to the Relative Mortality Analysis on how they capture the relationship between prehospital time and mortality in the University of Virginia (UVA) Trauma Center population. **Results:** The methods of the previous studies that failed to support the "golden hour" also failed to do so when applied to the UVA Trauma Center population. However, when applied to the same population, the Relative Mortality Analysis identified a subgroup, 9.9% (with a PoS 23%–91%), of the 5,063 patient population with significantly lower mortality when transported to the hospital within 1 hour, supporting the "golden hour." **Conclusion:** These results suggest that previous studies failed to support the "golden hour" not due to a lack of patients significantly impacted by prehospital time within their trauma populations, but instead due to limitations in their efforts to account for patient acuity. As a result, these studies inappropriately rejected the "golden hour," leading to the current disagreement in literature regarding the relationship between prehospital time and trauma patient mortality. The Relative Mortality Analysis was shown to overcome the limitations of these studies and demonstrated that the "golden hour" was significant for patients who were not low acuity (PoS >91%) or severely high acuity (PoS <23%). **Key words:** emergency medical services; golden hour; prehospital time; transportation; trauma

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Introduction

Background

The "golden hour" of trauma refers to the principle that the sooner a patient receives definitive hospital care following an injury, the greater is the patient's chance of survival. However, extensive literature reviews have found conflicting evidence regarding the validity of this premise (1, 2). Of studies that found a positive correlation between prehospital time and mortality (3–12), most evaluated either a small sample of patients suffering specific injuries (3–8) or a mixed sample that included nontraumatic cardiac arrest (9, 10). Of studies that evaluated an inclusive sample of solely trauma patients (11–19), seven directly evaluated the relationship between prehospital time and outcome (11, 12, 15–19). Of these, two provided support for the "golden hour" (11, 12), while five failed to identify any patients who benefited from reduced prehospital time (15–19).

Importance

Disagreement in literature regarding the "golden hour" may stem from limitations in previous studies' attempts to account for the confounding effects of patient acuity on the relationship between prehospital time and mortality. The five previous studies that failed to support the "golden hour" (15–19) suffered from two major limitations in their efforts to account for acuity within their populations. First, they quantified acuity using univariate metrics, such as Injury Severity Score (ISS) or Glasgow Coma Scale (GCS), which restrict their ability to fully capture the multisystem nature of trauma injuries (20–22). Second, the studies only evaluated a subgroup of their patient populations that satisfied a predetermined acuity threshold. In doing so, patients most impacted by the "golden hour" may have been excluded from the study populations. These limitations may have led to inappropriate rejection of the "golden hour" by these studies. This analysis addresses these two limitations of previous studies by employing a novel acuity stratification approach that evaluates the impact of prehospital time across an entire patient population, across all acuity levels, using a comprehensive triage metric. Ultimately, insights from this analysis can address the current disagreement in "golden hour" literature and better inform emergency medical services (EMS), which currently commit significant resources (e.g., emergency vehicles, staffing, training) and undertake dangerous risks (e.g., aeromedical evacuation, driving at high speeds, and hasty extrication, assessment, treatment, and transport) to reduce prehospital time for trauma patients (23–29).

Study Objective

This study sought to address the disagreement in literature regarding the "golden hour" by using a more comprehensive approach of accounting for patient acuity than that used in previous studies. To do so, this study evaluated the "golden hour" using the Relative Mortality Analysis, which stratifies patients based on acuity using the Trauma and Injury Severity Score (TRISS) calculated Probability of Survival (PoS). TRISS methodology integrates both physiological measures with Revised Trauma Score, and anatomical measures with ISS, to provide for a comprehensive calculation of patient acuity, represented as PoS (21).

The Relative Mortality Analysis addresses the two major limitations of the five previous studies that failed to support the "golden hour" (15–19) by 1) using a comprehensive triage metric, as opposed to ISS or GCS, to quantify acuity and 2) evaluating the impact of prehospital time on mortality across the full spectrum of patient acuity, as opposed to only a predetermined subgroup of the patient population. By using the Relative Mortality Analysis to evaluate the "golden hour," this study sought to demonstrate how these previous studies' limitations in accounting for acuity may have led to the inappropriate rejection of the "golden hour" and, ultimately, contributed to the current disagreement in literature regarding the relationship between prehospital time and trauma patient mortality.

METHODS

Study Setting

This retrospective analysis was conducted with the approval of the University of Virginia (UVA) Institutional Review Board for Health Sciences Research. All statistical analysis was performed using Matlab, 2016 (Mathworks, Natick, MA). The collected data were provided by the trauma registry of the UVA Health System, an American College of Surgeons Verified Level I trauma center. The registry has been under the direction of a single trauma registrar and medical director throughout its duration.

Relative Mortality Analysis

Selection of Study Population. Consistent with previous studies, the analysis included only patients transported to the trauma center by a prehospital care team from the incident scene within 120 minutes of the injury time. Of these, only patients with a recorded Glasgow Coma Scale (GCS), respiratory rate (RR), systolic blood pressure (SBP), and injury type (blunt or penetrating) were included. Patients with complete data were compared to patients with incomplete data using a two-sample *t*-test for continuous variables and a chi-squared test of independence for categorical variables.

Relative Mortality Metric. The Relative Mortality Analysis employed two tools, the Relative Mortality Metric (RMM) and the Relative Mortality Performance Trend (RMPT), to evaluate the impact of prehospital time (PHT) on mortality across the full spectrum of patient acuity within the UVA Trauma Center population. As stated above, patient acuity was quantified using Trauma and Injury Severity Score (TRISS) calculated probability of survival (PoS) (21).

The patient population was divided into bins based on PoS intervals. Patients in each bin were then divided into two cohorts based on their PHT, calculated as the difference between injury time and emergency department (ED) arrival time. Guided by the "golden hour" principle of trauma, the short PHT cohort represented patients with a PHT within 0 to 60 minutes ($0 \leq PHT \leq 60$) and the long PHT cohort represented patients with a PHT between 60 and 120 minutes ($60 < PHT \leq 120$). The observed mortality (O_b) for the long PHT and short PHT cohorts of each bin represented the proportion of patients who died (D_b) among the total number (N_b) of patients within the given cohort,

$$O_b = \frac{Db}{Nb}.$$

Using normal approximation of the binomial distribution, the error (E_b) for the O_b value was calculated by

$$E_b = Z\sqrt{\frac{Ab(1-Ab)}{Nb}},$$

where A_b (calculated as $A_b = 1 - PoS$) represented the anticipated mortality for each cohort and $Z = 1.96$ to ensure 95% confidence. From this, the minimum number of patients required to achieve a specific E_b was calculated as

$$N_b = \frac{Z^2(Ab(1-Ab))}{Eb^2}.$$

The PoS ranges for the bins are nonlinear and can be dynamically adjusted to achieve the optimal balance of resolution and statistical power (i.e., smaller PoS ranges, comprised of fewer patients, provide greater resolution among the patient acuity levels, while larger PoS ranges, comprised of more patients, provide greater statistical significance in the calculations of observed mortality). To achieve the greatest degree of resolution among the higher acuity population, the PoS ranges for bins representing high-acuity patients were sized to ensure the smallest cohort, either the long PHT or short PHT cohort, within the bin included only the minimum number of patients (N_b) needed to maintain an error of less than 0.08 ($E_b < 0.08$) for the calculation of the cohort's O_b. The specific value of this error rate was selected randomly, as it was designed simply to serve as a constant reference point throughout the sizing of each bin.

Relative Mortality Performance Trend. Each bin's O_b was plotted, with each bin represented by the median PoS value of the bin's PoS range. A population's RMPT refers to the trend that results when plotting each cohort's O_b with respect to each bin's median PoS value. The anticipated mortality was plotted along with the RMPT. The RMM was a value representing the area between the anticipated mortality line and the RMPT for the populations. The RMM for each cohort was calculated by

$$RMM = 1 - \frac{\sum_{b=1}^{j} Rb\ Ob}{\sum_{b=1}^{j} Rb\ Ab},$$

where R_b represented the PoS range for each bin. The lower limit (RMM_{LL}) and upper limit (RMM_{UL}) of the RMM were calculated by

$$RMM_{LL} = 1 - \frac{\sum_{b=1}^{j} Rb\ (Ob + Eb)}{\sum_{b=1}^{j} Rb\ Ab}$$

$$RMM_{UL} = 1 - \frac{\sum_{b=1}^{j} Rb\ (Ob - Eb)}{\sum_{b=1}^{j} Rb\ Ab}.$$

The RMM ranges from −1 to +1, where a positive value is indicative of an RMPT below the anticipated mortality line (i.e., observed mortality below anticipated mortality) and vice versa. Together, the RMPT and RMM provided both a graphical and numerical illustration of mortality across the full spectrum of patient acuity in both the short PHT and long PHT cohorts.

Methods of Previous Studies

To assess the impact of the limitations of the five previous studies that failed to support the "golden hour," the population selection and analysis methods of these studies were applied to the UVA Trauma Center population and were compared to the Relative Mortality Analysis on how they captured the relationship between PHT and mortality. These five studies included those of Lerner et al. (15), Kleber et al. (16), Petri et al. (17), Di Bartolomeo et al. (18), and Newgard et al. (19).

Population Selection Methods of Previous Studies. First, the population selection methods of these five studies were applied to the UVA Trauma Center population to establish a total of five different study populations. Kleber et al., Petri et al., Di Bartolomeo et al., and Newgard et al. each used an acuity threshold for their study population (16–19). Each of these four studies' acuity thresholds were applied to the UVA Trauma Center population to produce four different study populations. Lerner et al. did not use an acuity threshold (15). Thus, the study population representing Lerner et al. in this analysis was the same as that used with the Relative Mortality Analysis (i.e., all UVA Trauma Center patients with a prehospital time within 120 minutes).

Analysis Methods of Previous Studies. Each of the five study populations were then assessed to determine the extent to which patient mortality was impacted by PHT. To maintain consistency and allow for direct comparison between the five previous studies and this study, the assessment of each study population was conducted using the analysis methods of the five previous studies: multivariable

TABLE 1. Acuity threshold for the previous studies, with the number of patients who met the threshold for the original study and for this study

Study author	Population acuity threshold	Number of patients who met threshold	
		Original study	This study
Lerner et al.	None	1,877	5,063
Kleber et al.	All patients with ISS ≥9	20,078	2,985
Petri et al.	All patients with ISS ≥10	5,215	2,066
Di Bartolomeo et al.	All patients with ISS >15	753	1,332
Newgard et al.	Adults (age >15 years) with ≥1 of the following: SBP ≤90 mmHg GCS ≤12 RR <10 or >29 breaths/min Advanced airway intervention	3,656	884

Note. GCS, Glasgow Coma Scale; RR, respiratory rate; ISS, Injury Severity Score; SBP, systolic blood pressure.

logistic regression (15, 16, 18, 19), comparison of mean PHT between survivors and nonsurvivors (15, 17), and plotting survival across increasing intervals of PHT (16, 18).

Along with the other analyses, the multivariable logistic regression, including the variables and PHT time intervals, was designed to be as similar as possible to the logistic regression performed by the previous studies (15, 16, 18, 19). The logistic regression included six variables: PHT, PoS, age, gender (male or female), injury type (blunt or penetrating), and transport mode (air or ground). In order to include all PHT intervals used in previous studies, the odds ratio (OR) for mortality was calculated for 1-minute, 10-minute, and 30-minute time intervals for each study population.

To apply the methods of Lerner et al. and Petri et al., the mean PHT between all survivors and all nonsurvivors were compared for each study population using a two-sample *t*-test (15, 17). Further, in accordance with the methods of Petri et al., this comparison was also performed within five approximately equal-sized patient groups stratified on the basis of ISS (17).

Finally, to apply the methods of Kleber et al. and Di Bartolomeo et al., the survival of each population was plotted across increasing intervals of PHT (16, 18). In accordance with the methods of Kleber et al., survival was plotted across four increasing intervals of PHT (minutes): <30, 30–60, 61–90, >90 (16). The 30-minute time intervals used by Kleber et al. were used instead of those used by Di Bartolomeo et al. in order to achieve greater significance in survival calculations than that achieved by Di Bartolomeo et al., which used 11-minute time intervals with each including only a small sample of patients (18).

TABLE 2. Summary of bins for the Relative Mortality Analysis

Bin	R_b	N_b		$O_b \pm E_b$	
		Short PHT	Long PHT	Short PHT	Long PHT
1	.00–.23	63	105	.841 ± .079	.724 ± .061
2	.23–.91	153	347	.170 ± .078	.328 ± .052
3	.91–.95	79	122	.038 ± .056	.016 ± .045
4	.95–.97	315	437	.022 ± .022	.032 ± .018
5	.97–.98	216	318	.023 ± .021	.013 ± .017
6	.98–1.00	1269	1639	.006 ± .006	.003 ± .005

Note. E_b, error value for 95% confidence interval
N_b, number of patients in cohort
O_b, observed mortality
R_b, probability of survival range
PHT, prehospital time.

RESULTS

Characteristics of Study Populations

There were 8,097 patients within the UVA trauma registry transported by EMS within a day of their injury. Of this population, 6,642 patients had a recorded GCS, RR, SBP, injury type, injury time, and ED arrival time. Compared to those with complete data, the patient population with incomplete data included fewer males (59% < 61%; $p < 0.01$), had a greater average age (46 > 44; $p < 0.01$), and had a lower rate of penetrating injuries (92% < 94%; $p < 0.01$). The remaining variables did not differ significantly, including mortality ($p = 0.52$), PHT ($p = 0.71$), PoS ($p = 0.25$), and transport mode ($p = 0.69$).

Of these 6,642 patients, 5,063 patients had a PHT within 0 and 120 minutes. These patients comprised the study population for the Relative Mortality Analysis and were used to represent the study population of Lerner et al., which did not use an acuity threshold. Of these 5,063 patients, 2,985 patients had an ISS ≥9 and were used to represent the Kleber et al. study population, 2,066 patients

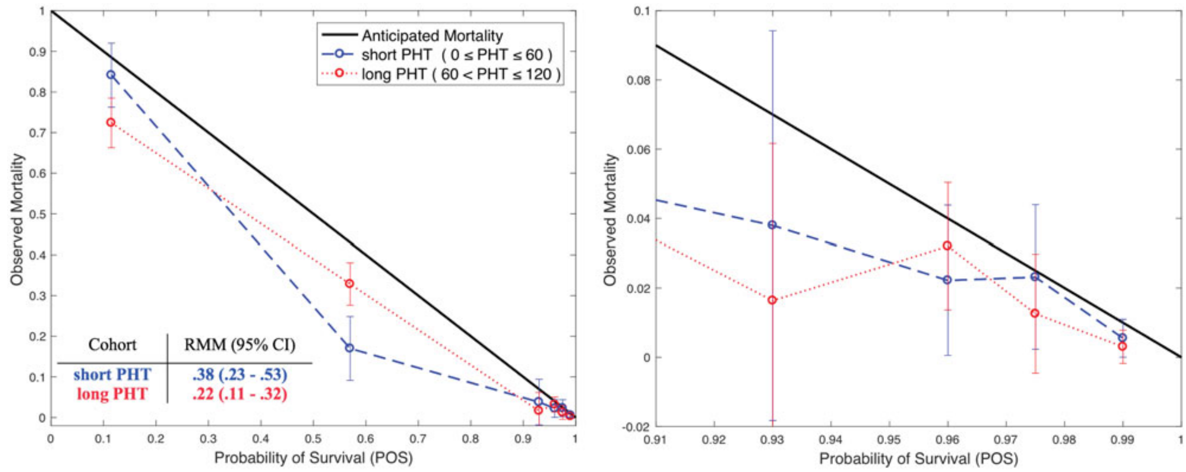

Figure 1. Relative Mortality Performance Trend (RMPT) analysis across full spectrum of patient acuity and Relative Mortality Metric (RMM) for short prehospital time (PHT) and long PHT cohorts. The 95% confidence intervals (CI) are shown by error bars for the RMPT plot and in parentheses for the RMM values. (a) Full view of the RMPT analysis. (b) Enlarged view of the RMPT analysis for PoS > .91.

had an ISS ≥10 and were used to represent the Petri et al. study population, and 1,332 patients had an ISS >15 and were used to represent the Di Bartolomeo et al. study population. Finally, 884 patients were adults (age >15 years) with an advanced airway intervention, SBP ≤90 mm Hg, GCS ≤12, or RR of <10 or >29 breaths/min, and were used to represent the Newgard et al. study population. The acuity threshold for each of the previous studies and with the number of patients who met the acuity threshold for both the original study and this study are provided in Table 1.

Relative Mortality Analysis

The population of 5,063 patients was divided into six bins, summarized in Table 2. The short PHT cohort had fewer patients than the long PHT cohort for each bin. Thus, the short PHT cohort included only the minimum number of patients needed to ensure $E_b < .08$ for bin 1 and bin 2, to achieve the greatest resolution among the higher acuity patients (PoS <91%), resulting in the PoS ranges (R_b) shown in Table 2.

As shown in Figure 1, the RMM values for the short PHT cohort and long PHT cohort did not significantly differ, with overlapping confidence intervals (CI). However, for bin 2, which contained patients with 23% ≤ PoS <91%, the observed mortality for the long PHT cohort ($O_b = .328 \pm .052$) was significantly greater than that of the short PHT cohort ($O_b = .170 \pm .078$), as shown in Figure 1 and Table 2. Bin 2 comprised 9.9% of the UVA Trauma Center population and was the only bin with patients who benefited from reduced PHT. The results did not differ when the analysis was repeated for a variety of error rates, E_b, ranging from .06 to .12.

Methods of Previous Analyses

As shown in Tables 3–5 and Figure 2, the analysis methods from Lerner et al., Kleber et al., Petri et al., Di Bartolomeo et al., and Newgard et al. yielded significant results only when applied to the bin 2 population, the population identified by the Relative Mortality Analysis to benefit from reduced PHT. None of the methods identified any significant relationship between PHT and mortality when applied to the study populations formed by the population selection methods of the five previous studies that failed to support the "golden hour."

For the multivariable logistic regression (Table 3), PoS was the only continuous variable not normally distributed and was dichotomized at the median PoS value for each study population. The OR values were only significant for bin 2 (p value <0.01).

When comparing the mean PHT for survivors and nonsurvivors (Table 4) among the different populations, there was only a significant difference for the bin 2 population, in which survivors had a lower mean PHT than nonsurvivors. As shown in Table 5, when the population created by the Petri et al. acuity threshold was stratified into ISS groups of approximately equal size, the resulting ISS intervals were 10–12, 13–15, 16–19, 20–26, and >27. There was no significant difference in mean PHT between survivors and nonsurvivors for any of the ISS intervals.

Finally, when plotting survival across increasing intervals of PHT (Figure 2), the only population with a notable trend was that of bin 2, in which survival was negatively correlated with PHT (Figure 2b). The number of patients in each PHT interval is provided in parentheses within each plot.

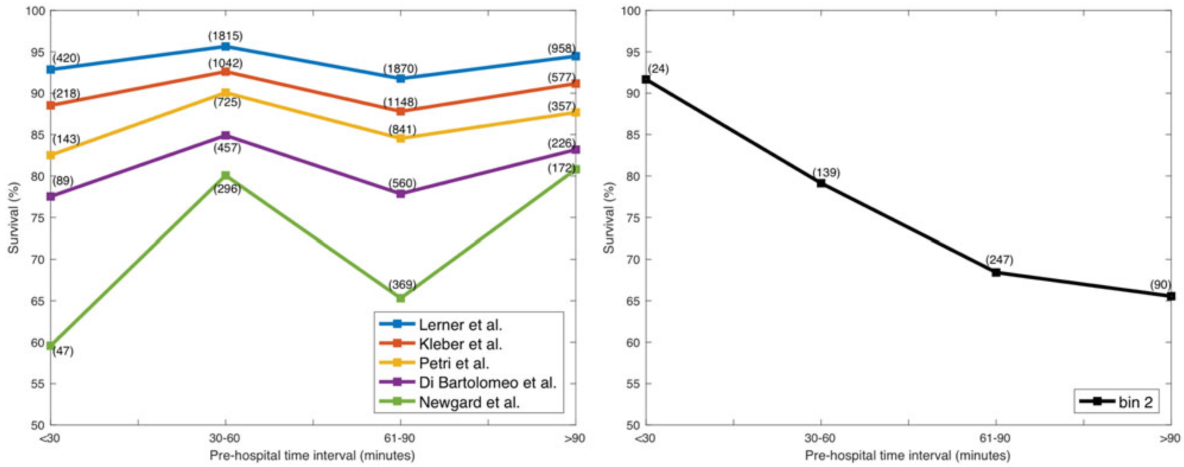

FIGURE 2. Plot of patient survival across increasing intervals of prehospital time, with the number of patients in each time interval provided in parentheses. (a) Plot of the 5 study populations created from the previous studies' population selection methods. (b) Plot of the bin 2 population from the Relative Mortality Analysis.

TABLE 3. Multivariable logistic regression analysis of impact of prehospital time on mortality in each study population*

Population	1-minute increments, OR (95% CI)	10-minute increments, OR (95% CI)	30-minute increments, OR (95% CI)
Lerner et al.	1.00 (0.99–1.00)	0.97 (0.93–1.02)	0.98 (0.85–1.13)
Kleber et al.	1.00 (0.99–1.01)	1.00 (0.95–1.05)	1.05 (0.89–1.24)
Petri et al.	1.00 (0.99–1.01)	0.99 (0.93–1.05)	1.01 (0.85–1.20)
Di Bartolomeo et al.	1.00 (0.99–1.01)	1.00 (0.95–1.05)	1.07 (0.88–1.30)
Newgard et al.	1.00 (0.99–1.01)	1.04 (0.96–1.13)	1.17 (0.93–1.48)
Bin 2	1.02 (1.01–1.03)	1.25 (1.13–1.37)	1.95 (1.47–2.60)

Note. CI, confidence interval
OR, odds ratio.
*Multivariable logistic regression models included the following covariates: prehospital time, probability of survival, age, gender, injury type, and transport mode.

TABLE 4. Comparison of mean prehospital time (PHT) between survivors and nonsurvivors in each study population

	Mean PHT (minutes)		
Population	Survivors	Nonsurvivors	p Value
Lerner et al.	66.69	67.49	0.59
Kleber et al.	67.83	68.08	0.87
Petri et al.	67.24	67.51	0.87
Di Bartolomeo et al.	67.51	67.69	0.91
Newgard et al.	69.56	67.69	0.31
Bin 2	68.04	76.88	<0.01

TABLE 5. Comparison of mean prehospital time (PHT) between survivors and nonsurvivors across Injury Severity Score (ISS) subgroups

		Mean PHT (minutes)		
ISS	Number of patients	Survivors	Nonsurvivors	p Value
10–12	312	66.54	54.10	0.38
13–15	422	67.05	76.30	0.41
16–19	458	68.54	65.24	0.65
20–26	432	67.01	67.96	0.76
>27	442	66.58	67.89	0.54

LIMITATIONS

Eighteen percent of the patient population did not have complete data. When comparing patients with complete data to those with incomplete data, there were no significant differences in mortality, patient acuity (PoS), prehospital time, or transport mode, but there were differences in gender ratios, age, and injury type. It is possible that exclusion of these patients introduced bias. Furthermore, the reduced number of patients limited the resolution with which the high acuity patients could be evaluated in the Relative Mortality Analysis. The smaller the study population, the larger the PoS range must be for each bin to include enough patients to maintain statistical power in the observed mortality calculation. Due to this limitation, the PoS range of bin 2 spanned from 23% to 91%. A more narrow PoS range would have allowed for greater precision in identifying which patients were most impacted by prehospital time. The limited number of patients also reduced the amount of patients who satisfied the acuity threshold of the previous studies. Three of the five representative study populations in this study contained fewer patients than the original study. This limitation, in addition to the absence of recorded response, on-scene, and transport times in the UVA trauma registry, restricted the extent to which the methods of Kleber et al., Petri et al., and Newgard et al. could be fully evaluated. Finally, the methods of the two previous studies that supported the "golden hour," both conducted by Sampalis et al. (11, 12), could not be fully evaluated in this study as the UVA trauma registry does not consistently collect patients' Prehospital Index, which was used to establish the inclusion criteria for these studies.

Discussion

This study demonstrated that the population selection and analysis methods of the five previous studies that failed to support the "golden hour" also failed to do so when applied to the UVA Trauma Center population. However, the Relative Mortality Analysis, which was designed to directly address the limitations of these studies, did support the "golden hour," identifying a patient subgroup within the UVA Trauma Center population with significantly lower mortality when transported to the hospital within 1 hour. In all, these results suggest that the failures of previous studies to identify patients who benefited from reduced prehospital time likely resulted from limitations in their attempts to account for confounding effects of patient acuity within their populations, as opposed to the true absence of such patients.

As discussed, the acuity thresholds of previous "golden hour" studies were intended to account for patient acuity by including only patients considered high acuity and who were thus thought to benefit the most from reduced prehospital time (15–19). However, the results of the Relative Mortality Analysis demonstrate that even if the acuity thresholds were successful in isolating high-acuity patients in these previous studies, they still would have failed to account for the confounding effects of acuity on the relationship between prehospital time and mortality among their patients. That is, contrary to assumptions made by previous studies, the Relative Mortality Analysis shows that severely high-acuity patients (PoS <23%) were not significantly impacted by prehospital time. A possible explanation for this observation is that these patients, due to the severity of their injury, would not survive regardless of how quickly they were transported to the hospital. Nonetheless, the Relative Mortality Analysis demonstrates that to properly account for the confounding effects of acuity, it is not sufficient to simply isolate a high-acuity study population, as the correlation between prehospital time and mortality may still be diluted by very-high-acuity patients. In fact, as the affected subgroup identified by the Relative Mortality Analysis included patients with a PoS of up to 91%, the acuity thresholds of the previous studies may have even eliminated patients who were most impacted by prehospital time. In all, when acuity thresholds were used in attempt to isolate patients with severe injuries in previous studies, the patients for whom prehospital time was most important may have still been drowned out and/or may not have been even fully represented in the study population.

Although both Petri et al. and the Relative Mortality Analysis stratified patients on the basis of acuity, the methods of Petri et al. failed to support the "golden hour" for each patient subgroup, while the Relative Mortality Analysis identified a subgroup that significantly benefited from reduced prehospital time. The two limitations in the methods of Petri et al., and that are common to all the previous studies that failed to support the "golden hour," can be used to explain this difference in results. First, Petri et al. used a univariate metric, the Injury Severity Score, to stratify patients, which is less comprehensive than PoS, probability of survival, in capturing patient acuity (21, 22). ISS incorporates only the highest three AIS (Abbreviated Injury Scale) values in its calculation. AIS is an anatomical scoring system and simply represents the perceived threat, on a scale of 1 to 6, of a specific injury to patient survival. The sole dependence of the ISS on AIS values renders it unhelpful as a triage tool when used alone (22). As discussed, the TRISS calculated PoS incorporates both physiological and anatomical measures, including all of the triage metrics used by previous studies (age, GCS, SBP, RR, and ISS), within its calculation, providing for a more comprehensive representation of patient acuity than ISS alone (21). A second potential cause of this difference may have been that in the methods of Petri et al., only patients who satisfied the acuity threshold (ISS $\geq$10) were stratified. Thus, patients who were most impacted by prehospital time may have been excluded from the analysis.

EMS agencies and prehospital providers have always faced the challenge of regulating resource expenditure and risk exposure to optimize the good for the communities they serve. This study demonstrates that the commitment to minimizing prehospital time must remain a priority for all trauma patients, despite the conclusions of previous studies (15–19). Although only a subgroup (9.9%) of the patients within this study was identified to be significantly impacted by prehospital time, this group is still too ill-defined and the relationship between prehospital time and mortality is still too misunderstood to justify delaying transport of any given trauma patient.

Future efforts will focus on determining whether the subgroup identified by the Relative Mortality Analysis, bin 2, included all patients impacted by the "golden hour" and whether all patients within this subgroup were in fact impacted by the "golden hour." More work is also needed to better elucidate how patient mortality changes across smaller intervals of prehospital time. These efforts would be better supported with a larger study population, which would provide freedom to create a larger number of bins within the high acuity population and to test a greater variety of prehospital time intervals. In addition, it would be insightful to use the Relative Mortality Analysis to evaluate how changes in the specific types of prehospital time (i.e., response time, on-scene time, and transport time) impact patient mortality.

In all, this study provides an explanation for the current disagreement in literature regarding the "golden hour." Specifically, this study suggests that previous studies failed to support the "golden hour" not due to a lack of patients significantly impacted by prehospital time within their trauma populations, but instead due to limitations in their efforts to account for patient acuity. As a result, these studies inappropriately rejected the "golden hour," leading to disagreement in literature regarding the relationship between prehospital time and trauma patient mortality. The Relative Mortality Analysis was shown to overcome the limitations of these previous studies and, in doing so, demonstrated that the "golden hour" is significantly impactful for patients who were not low acuity (PoS $>$91%) or severely high acuity (PoS $<$23%).

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