Review
Pro/con debate: Is the scoop and run approach the best approach to trauma services organization?

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Abstract

You are asked to be involved in organizing a trauma service for a major urban center. You are asked to make a decision on whether the services general approach to trauma in the city (which does have a well-established trauma center) will be scoop and run (minimal resuscitation at the scene with a goal to getting the patient to a trauma center as quickly as possible) or on-the-scene resuscitation with transfer following some degree of stabilization.

Introduction

Since the development of organized trauma systems, the importance of simultaneous rapid evaluation and management of immediately life-threatening injuries has been widely promulgated [1]. One-half of injury deaths occur at the scene. In these patients, only prevention efforts might alter the outcome. Another 25% of deaths occur within the first 24 hours of hospitalization, principally as a result of massive hemorrhage or of traumatic brain injury [2,3]. It is this potentially salvageable group that might receive the greatest benefit from expeditious evaluation and timely management. The logical extension of this emphasis on early control of life-threatening injuries would be initiating potentially life-saving maneuvers in the prehospital setting, with the expectation that providing such basic interventions at the earliest time possible would be beneficial.

This belief has led to the development of prehospital programs that provide an array of advanced life support (ALS) interventions to the injured patient in the field, and that have largely replaced programs offering basic life support (BLS) alone. A recent large prospective cohort study examined prehospital trauma care in 15 urban and suburban regions across the United States [4]. In that report, ALS was provided to 79% of severely injured patients. While BLS programs provide such noninvasive maneuvers as maintenance of spinal precautions, fracture splinting and assisted ventilation with the aid of a bag–valve–mask system, ALS programs have the capacity to provide definitive airway control with endotracheal intubation and venous access in the prehospital setting. Selected programs might also perform more invasive procedures such as tube thoracostomy or cricothyroidotomy [5].

ALS-care providers are capable of performing a variety of procedures in the field. The specific interventions provided through ALS programs encompass a wide spectrum and depend not only on the practice environment (rural or urban) and type of personnel, but also on vagaries pertaining to local Emergency Medical Services policies and procedures. In general, ALS paramedics have only endotracheal intubation, intravenous access and the administration of various pharmacologic agents within their scope of care. ALS programs with a physician providing care might have a much larger scope of resuscitative interventions within their armamentarium. Nevertheless, all ALS providers – whether paramedics or physicians – are limited in the type of interventions they can perform prior to arrival to hospital, since the sophisticated radiographic investigations and operative interventions frequently required for definitive management of life-threatening injuries are not available in the prehospital setting.

While prehospital ALS has theoretical advantages, the evidence supporting its effectiveness and justification for widespread implementation for trauma is limited. Furthermore, there is accruing evidence to suggest that prehospital interventions might cause harm and prolong the time to definitive care [6-8]. While several studies have attempted to address the advantages of ALS (stay and play) compared with BLS (scoop and run) for prehospital trauma care, there are conflicting answers as to what might be best. The interpretation of these answers is hampered by several methodological limitations. We have attempted to summarize

ALS = advanced life support; BLS = basic life support.

many of the limitations of the studies discussed below in Table 1.

The case for stay and play
Advanced life support systems

The early control of life-threatening injuries is considered of critical importance in the management of the injured patient, and initiating therapy for such injuries in the prehospital environment may improve patient survival. A number of studies have demonstrated an association between improved outcomes and either ALS prehospital systems or interventions unique to ALS care.

Selected earlier analyses focused on feasibility or inter-mediate outcomes. For example, Honigman and colleagues demonstrated that paramedics can intubate and establish intravenous access while spending no additional time at the scene compared with BLS crews [9]. These data suggest that well-trained prehospital personnel can provide high-level care without unnecessary delays to definitive care. There is an additional suggestion that ALS care might improve inter-mediate outcomes (for example, selected physiologic para-meters), and this in turn is associated with improved survival [10]. Other small, uncontrolled studies showed improved survival with ALS compared with BLS in selected patient populations [11,12].

Such smaller studies, while suggesting that ALS could improve patient outcomes, were limited by their sample size and by their failure to control for differences in injury severity and processes of care. Population-based analyses offer additional insights into the potential benefits of ALS care. Taking this approach, Messick and colleagues demonstrated that counties with ALS prehospital care had lower risk of injury-related mortality than counties without [13]. While there were attempts made to adjust for differences in population density and other county characteristics, it is likely there was significant residual confounding as none of the urban counties utilized BLS, rendering it difficult to conclude that ALS *per se* was responsible for the lower mortality.

Another population-based study compared five countries using paramedic-provider ALS systems with four countries using physician-provider ALS systems. This comparison demonstrated a significantly lower likelihood of early inhospital fatality when ALS was provided by physicians [14]. This observation was confounded, however, by the finding that ALS care was not uniform across environments. For example, while on the surface ALS-paramedic (or physician) systems can be considered one intervention, when mortality across countries with similar systems was compared there was a fourfold variation in the odds of death. These data highlight some of the difficulties in interpreting the term ALS, since it might mean different care provided by different types of providers. It is precisely this heterogeneity in defining ALS that makes interpreting currently available data challenging.

Advanced life support interventions
Endotracheal intubation

In an effort to address the heterogeneity in defining ALS, many studies have focused on specific ALS interventions rather than on systems of care. In this regard, there has been considerable emphasis on the establishment of a definitive airway in the field, given the potential contribution of a compromised airway to death.

Several groups have demonstrated the feasibility of definitive prehospital airway management with endotracheal intubation, and have also demonstrated that this ALS maneuver – when performed in the field – is associated with lower rates of death. Bushby and colleagues utilized the Trauma Related Injury Severity Score methodology to identify a group of unexpected survivors among patients with severe thoracic trauma, and demonstrated an association with prehospital intubation [15]. Other groups have directly compared a group of patients intubated in the field with a control group of patients who did not undergo this intervention. For example, Klemen and Grmec demonstrated decreased early mortality in patients with traumatic brain injury intubated in the field compared with those patients without definitive airway control [16]. The findings of that study, however, were confounded by the differences in training between the field physician providers, who cared for virtually all of the intubated subjects in the study, and the paramedic providers, who cared for all of the nonintubated subjects.

In studies limited to paramedic providers, lower mortality has been demonstrated among patients intubated in the field both in unselected trauma patients [17] and in those patients with severe head injuries [18]. The latter study, however, failed to fully consider factors such as injury severity and shock in its analyses. Moreover, there is considerable diffi-culty in interpreting the published data regarding prehospital intubation, since the relevant studies frequently have very dissimilar populations that also receive dissimilar care.

Premedication for intubation

In addition to variable patient populations and provider types, published studies have demonstrated considerable variability in success rates of field intubation across providers. Success rates range from a low of 33% to 100% [4]. As a result, many investigators have focused on improving outcomes in ALS programs by increasing the use of sedation and neuro-muscular blockade in the prehospital setting, with the goal of increasing the likelihood of successful prehospital intubation. While prehospital programs that do not permit the use of these agents are in the majority [18-21], several studies have demonstrated that paramedics can safely use neuromuscular blocking agents for rapid sequence intubation with improved intubation success rates [22,23]. Rapid sequence intubation in the prehospital setting has been associated with lower mortality and improved functional outcomes compared with intubation without neuromuscular blocking agents [24],

Table 1

Studies of advanced life support systems and interventions

Study	Study design, environment, provider and population	Intervention	Major findings	Major limitations
In support of ALS systems				
Roudsari and colleagues [14]	Multicenter, multinational, ecological study Physician and paramedic providers Adult, major trauma	Countries with physician-provided ALS compared with countries with paramedic-provided ALS	Lower early (24 hour) mortality with physician-provided ALS Lower mortality to hospital discharge among those with ISS >25	Heterogeneity in the types of prehospital and inhospital care across countries with apparent similar prehospital models of care precludes attributing improved outcomes to physician-provided ALS alone
Klemen and Grmec [16]	Single-center, retrospective cohort study Urban/physician and paramedic providers Adult, moderate to severe head injury with ISS >15	ALS with ETI by physicians compared with BLS by paramedics	No difference in overall survival Improved early (1 hour, 24 hour) survival and functional outcomes with physician providers Lower mortality among patients with GCS of 6 to 8 with physician providers	Possible measurement bias in recording GCS Crossover between groups
Messick and colleagues [13]	Multicenter, ecological study Urban and rural/paramedic providers Adult and pediatric, major trauma	Counties with ALS programs compared with counties with BLS programs	ALS program availability an independent predictor of lower per-capita county trauma death rates	Significant residual confounding as BLS counties were significantly more rural
Honigman and colleagues [9]	Single center, case series Urban/paramedic providers Adult, penetrating cardiac injuries	ALS (ETI, intravenous, PASG)	Scene time did not adversely affect outcome Scene time independent of field procedures performed and mortality	No direct comparison of BLS with ALS Not generalizable to greater spectrum of trauma patients
Jacobs and colleagues [10]	Single-center, prospective cohort study Urban/paramedic providers Adult and pediatric, major trauma	ALS-trained paramedics (ETI, intravenous, PASG) compared with BLS-trained paramedics	Improvement in trauma score in prehospital setting with ALS ALS not an independent predictor of survival	ALS care assignment nonrandom
Aprahamian and colleagues [11]	Single center, before/after design Urban/paramedic providers Adult, penetrating injuries	New ALS program (ETI, intravenous, thoracentesis, pericardiocentesis) compared with police-provided ambulance service	Lower mortality among patients with prehospital systolic blood pressure <60 mmHg	Historical controls fail to take into consideration other changes in care

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Table 1 (continued)

Studies of advanced life support systems and interventions

Study	Study design, environment, provider and population	Intervention	Major findings	Major limitations
In support of ALS systems				
Fortner and colleagues [12]	Two centers, before/after design Urban/paramedic providers Adult, falls from significant height	ALS program (ETI, intravenous) compared with BLS program	Greater proportion of patients surviving to reach hospital and surviving to hospital discharge	Historical controls Specific interventions were not documented
In support of ALS interventions				
Bulger and colleagues [24]	Single-center, retrospective cohort study Urban/paramedic and nurse providers Adult, moderate to severe head injury	Prehospital ETI with RSI compared with prehospital ETI without RSI	Lower mortality with prehospital RSI Lower mortality with prehospital RSI among patients with GCS <9 Improved functional outcomes with prehospital RSI among patients with GCS <9	Nonrandom selection Possible confounding by indication; patients not receiving RSI probably agonal
Bushby and colleagues [15]	Single-center, retrospective, TRISS analysis Urban and rural/paramedic providers Adult, blunt injuries causing moderate to severe thoracic injuries	Intubation, needle chest decompression	Prehospital intubation, chest decompression associated with better than expected outcomes	Historic controls (TRISS methodology) Long prehospital times among large proportion of patients limit generalizability
Arbabi and colleagues [17]	Two centers, retrospective cohort study Urban/paramedic providers Adult, major trauma	Prehospital ETI compared with emergency department ETI and nonintubated patients	Higher mortality with emergency department ETI compared with prehospital ETI No difference in survival with prehospital ETI compared with no intubation	Nonrandom selection and potential for residual confounding
Winchell and Hoyt [18]	Multicenter, retrospective cohort study Urban and rural/paramedics Adult, blunt injuries, GCS <9	Prehospital ETI compared with nonintubated patients	Lower mortality among intubated patients Lower mortality among intubated patients with severe head injuries	Nonrandom selection Residual confounding (no adjustment for age, ISS, shock)
In support of BLS systems				
Stiell and colleagues [32]	Multicenter, before/after design Urban/paramedic providers Adult, major trauma	New ALS program (ETI, intravenous, administration of medication) compared with BLS program	No difference in survival Higher mortality among patients with GCS <9 after implementation of ALS program	Study conducted early after implementation of ALS – may not reflect mature prehospital system Relatively few patients received ALS interventions after implementation of ALS program

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Table 1 (continued)

Studies of advanced life support systems and interventions

Study	Study design, environment, provider and population	Intervention	Major findings	Major limitations
In support of BLS systems				
Liberman and colleagues [31]	Multicenter, retrospective cohort study Urban/physician and paramedic providers Adult, major trauma	ALS care (physician or paramedic provided) compared with BLS care (paramedic provided)	Higher mortality with onscene treatment by physicians Higher mortality with prehospital ALS	Nonrandom assignment of ALS care, likely confounding by indication
Di Bartolomeo and colleagues [29]	Multicenter, prospective cohort study Urban and rural/ physician and paramedic providers Adult and pediatric, severe head injury	Prehospital ALS by physician (air transport) compared with BLS by paramedics (ground transport)	No difference in mortality with prehospital ALS provided by physicians	Prolonged transport times with frequent interfacility transfers limit generalizability
Eckstein and colleagues [20]	Single-center, retrospective cohort study Urban/paramedic providers Adult and pediatric, major trauma	Prehospital ETI compared with prehospital BVM and emergency department ETI Prehospital intravenous fluids compared with no prehospital intravenous fluids	Higher mortality with prehospital ETI	Nonrandomized with possible confounding by indication
Cayten and colleagues [27]	Multicenter, retrospective, TRISS analysis Urban/paramedic providers Patients aged >12 years, major trauma	ALS units (ETI, intravenous fluids, PASG) compared with BLS units	Improved prehospital RTS with ALS No improvement in predicted mortality with ALS Higher than predicted mortality for patients with penetrating injuries receiving ALS care	Biased exclusion of patients due to missing data Variable expertise among providers Historic controls (TRISS methodology)
Sampalis and colleagues [30]	Multicenter, retrospective cohort study Urban/physician and paramedic providers Adult and pediatric, major trauma	ALS care (physician provided) compared with BLS care (physician or paramedic provided)	No difference in mortality	Nonrandom assignment of ALS care, likely confounding by indication
Potter and colleagues [25]	Multicenter, prospective cohort study Urban/paramedic providers Adult, major trauma and burns	ALS prehospital care compared with BLS prehospital care	Lower rate of early deaths (24 hours) with prehospital ALS, yet no improvement in survival to hospital discharge	Nonrandom assignment of ALS, likely confounding by indication *Ad hoc* presence of physicians with BLS crew renders attribution of outcomes to ALS versus BLS crew difficult

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Table 1 (continued)

Studies of advanced life support systems and interventions

Study	Study design, environment, provider and population	Intervention	Major findings	Major limitations
In support of BLS systems				
Ivatury and colleagues [34]	Single-center, retrospective cohort study Urban/paramedic providers Patients with penetrating thoracic injuries, in extremis, requiring emergency department thoracotomy	Field stabilization (ETI, intravenous, PASG, drug administration) compared with direct transport	Lower survival among patients with field stabilization attempts	Wide range of ALS procedures, some with low success rates Confounding by indication likely
In support of BLS interventions				
Davis and colleagues [19]	Multicenter, retrospective cohort study Urban/paramedic providers Adult, moderate to severe head injury	Prehospital ETI compared with emergency department ETI	Higher mortality with prehospital ETI Higher mortality with prehospital ETI among patients with severe head injuries	Nonrandomized with possible confounding by indication
DiRusso and colleagues [39]	Multicenter, retrospective cohort study Urban and rural/ paramedic providers Pediatric, major trauma	Prehospital ETI compared with emergency department ETI and nonintubated patients	Higher mortality with prehospital ETI Worse functional outcomes at discharge with prehospital ETI	No information about provider type Nonrandomized with possible confounding by indication
Stockinger and McSwain [21]	Single-center, retrospective cohort study Urban/paramedic providers Adult, major trauma, receiving prehospital ETI or BVM	Prehospital ETI compared with prehospital BVM	Higher mortality with ETI compared with BVM Higher than predicted mortality with ETI among patients with penetrating injuries using the TRISS methodology Mortality as predicted among patients with blunt injuries receiving ETI	Nonrandomized with possible confounding by indication
Wang and colleagues [37]	Multicenter, retrospective cohort study Urban and rural/ paramedic providers Adult, moderate to severe head injury	Prehospital ETI compared with emergency department ETI	Higher mortality with prehospital ETI	Nonrandomized with possible confounding by indication

Table 1 (continued)

Studies of advanced life support systems and interventions

Study	Study design, environment, provider and population	Intervention	Major findings	Major limitations
In support of BLS interventions				
Davis and colleagues [42]	Multicenter, retrospective matched cohort study Urban/paramedic providers Adult, moderate to severe head injury	Prehospital ETI attempted with RSI compared with matched nonintubated historical controls	Higher mortality with prehospital RSI Higher mortality related to hypocapnea on arrival	Nonrandomized with possible confounding by indication
Murray and colleagues [38]	Multicenter, retrospective cohort study Urban/paramedic providers Adult and pediatric, severe head injury	Prehospital ETI compared with attempted ETI or nonintubated patients	Higher mortality with prehospital ETI compared with nonintubated patients Higher mortality with prehospital ETI compared with attempted ETI	Nonrandomized with possible confounding by indication
Sloane and colleagues [36]	Single-center, retrospective cohort study Urban/aeromedical crews, physician, paramedic or nurse provider Adult, major trauma	Prehospital ETI compared with emergency department ETI	No difference in mortality in subgroup analysis of patients with isolated head injuries Overall mortality effect not reported	Small sample size with potential for type II error
Bickell and colleagues [33]	Single-center, prospective, unblinded quasirandomized study (alternate-day assignment) Urban/paramedic providers Adult, penetrating torso injuries causing hypotension and operative intervention	Prehospital fluid resuscitation compared with delayed fluid resuscitation (once hemorrhage controlled)	Lower mortality with delayed resuscitation Shorter length of stay with delayed resuscitation	Not generalizable to wider spectrum of trauma patients

ALS, advanced life support; BLS, basic life support; BVM, bag–valve–mask ventilation; ETI, endotracheal intubation; GCS, Glasgow Coma Scale; ISS, Injury Severity Score; PASG, pneumatic anti-shock garment; RSI, rapid sequence intubation; TRISS, Trauma Related Injury Severity Score.

although it is likely that patients who can be successfully intubated without premedication are, overall, more severely injured.

Summary of advanced life support
Taken together, the studies suggest an overall benefit for ALS with two major caveats. First, risk adjustment poses significant challenges in analyses that need to be better addressed. More importantly, ALS – and stay and play – is a very heterogeneous concept. Who is staying, how they are playing and their skills sets might have tremendous influence on outcome, but are so poorly characterized that any definitive conclusions regarding efficacy are impossible. Moreover, in some cases it is possible that patients received care from multiple providers with various capabilities in the prehospital setting. In one study, for example, almost one-quarter of

patients categorized as having received only BLS had a physician present and participating in field resuscitation [25].

The case for scoop and run

Although the theoretical advantages of prehospital ALS for injured patients appear to be in agreement with some of the fundamental principles of trauma care, increasing evidence suggests that such interventions might have unanticipated harmful effects. Specifically, while early intervention appears to be key to preventing deaths following significant trauma, many prehospital interventions do not provide definitive management of the injury, which constitutes the primary threat to survival – and unnecessary maneuvers may in fact delay definitive management.

The growing concern over prehospital ALS is evident from a recent study that sought to achieve expert consensus on the most important indicators of quality prehospital trauma care. Among trauma experts, three of the five most highly ranked filters for auditing the quality of prehospital trauma care focused on documenting the indications for prehospital procedures and on the maintenance of technical proficiency among prehospital personnel [26]. These data suggest that general concern exists over the potential harm that can be caused by unnecessary prehospital interventions.

Advanced life support systems

Several studies suggest these concerns are justified. Although a number of studies showed no increase in the prehospital time with field ALS interventions [9,10,20,25,27], others have associated ALS care with excessive prehospital times [21,28]. This inconsistency across studies is probably related to differences in expertise among prehospital providers, variations in protocols and heterogeneous patient populations. In addition, other aspects of prehospital care – such as extrication or spinal immobilization, which are universal to both ALS and BLS – might proportionally contribute more than advanced interventions to the prehospital times, thus obscuring any differences in prehospital times when comparing ALS with BLS.

Several studies directly comparing outcomes among patients receiving ALS or BLS prehospital care have demonstrated the absence of benefit, or even the presence of harm, with ALS care. Two cohort studies reported outcomes among a heterogeneous group of patients receiving either BLS or ALS in an urban environment served by multiple hospitals. Both studies failed to demonstrate lower mortality in the ALS group [25,27]. Worse yet, patients with penetrating injuries who had received ALS had higher than expected mortality [27]. Another study comparing ALS provided by physicians using helicopter transport with BLS provided by paramedics using ground transportation demonstrated no mortality benefit with ALS care [29]. Similarly, a multicenter study that compared survival among patients managed by physicians providing field ALS care with those patients receiving BLS

care administered by emergency technicians failed to demonstrate a benefit with the higher level of care [30]. Liberman and colleagues reported on the results of a large retrospective multicenter study involving three urban regions in Canada, and demonstrated a higher risk of death in patients who received prehospital ALS [31]. Outcomes were worst among patients receiving ALS care provided by a physician. Finally, a large multicenter study that examined the effect of system-wide implementation of ALS in multiple jurisdictions showed no improvement in survival among injured patients, and demonstrated higher mortality among patients with Glasgow Coma Scale score <9 after the introduction of prehospital ALS [32].

These data lend further evidence that, at the population level, ALS may not be of benefit to the majority of patients. It is important, however, to note that the majority of studies examining care in the prehospital environment are based on data from established regional systems, in which the decision for a field ALS or BLS response is protocolized. As a result, more critically injured patients receive ALS – which makes it difficult to assess whether the higher rates of adverse outcomes are due to ALS or occur in spite of ALS care.

Advanced life support interventions

Further arguments for scoop and run come from an examination of specific field interventions. For example, intravenous fluid resuscitation and attempts at field stabilization have been linked to negative outcomes in patients with penetrating trauma [33,34]. It is generally believed that the administration of fluids without hemorrhage control only leads to more bleeding. In a study by Bickell and colleagues, holding fluid resuscitation until definitive hemorrhage control could be achieved reduced the rates of coagulopathy, transfusion and mortality [33]. Further, establishment of an intravenous line might significantly impact on prehospital times. The time required for intravenous placement was found to be equivalent to the transport time in one study [35].

Endotracheal intubation
While the simple act of placing an intravenous line and infusing crystalloids is believed by some to contribute to adverse outcomes, the concerns over prehospital intubation are far greater. Field intubation is complicated by challenges not experienced by hospital personnel – challenges that could potentially cause harm. Several studies comparing bag-valve-mask ventilation with more advanced airway management found no benefit associated with prehospital intubation [20,21,36]. In fact, a number of studies have demonstrated higher rates of mortality, with the group most likely to be affected being those patients with traumatic brain injury. These data are particularly concerning, given the theoretical benefit of airway control in this population.

In a retrospective review of patients with head injuries requiring intubation either in the emergency department or in

the prehospital setting, a Pennsylvania study demonstrated a fourfold greater odds of death for patients who underwent intubation in the field [37]. These investigators also demonstrated significantly improved functional outcomes in those patients that underwent intubation only after arrival in the emergency department. While the investigators used propensity analysis to adjust for differences in injury severity, it is still plausible that residual confounding played some role in the observed associations. Using a matched cohort analysis to try to address some of this potential confounding, Murray and colleagues [38] reported a higher risk of death among head-injured patients undergoing attempts at field intubation – a finding observed in a similar study [19]. Prehospital intubation has also been associated with poor outcomes in the pediatric head-injury population [39].

Although the previously cited studies appear to support scoop and run, a number of methodological issues should be highlighted. More severely injured patients are more likely to undergo intubation attempts, and the potential for confounding by indication (that is, more severely injured patients receive the intervention being studied) poses significant challenges. The question is further complicated by the heterogeneity of patients and providers included in available studies. For example, many studies of prehospital intubation include patients with both blunt and penetrating injuries [17,21], while others have focused on patients with head injuries [16,19,37]. Providers include physicians and paramedics with variable training, and the frequency of intubation attempts and successful intubations clearly depends on each individual prehospital system. This variability in the factors that influence prehospital intubation complicates any effort to examine prehospital intubation as a single entity in a meaningful way.

How can advanced life support be harmful?

Is it possible for higher levels of care to be harmful? An understanding of this potential is critical to advancing care. Clearly, increased time to definitive care might be problematic. In many animal studies, intravenous fluid resuscitation in the absence of hemorrhage control leads to additional bleeding [40,41]. The relationship between intubation and harm, however, is only now being explored.

In fact, the increased mortality seen among patients with head injuries who arrive in the emergency department already intubated may be due to unexpected and harmful side effects of prehospital intubation. These side effects include hyperventilation, derangements in venous return and a paradoxical rise in intracranial pressure due to increased intrathoracic pressure. Several analyses have demonstrated a strong association between prehospital intubation, mortality and significant hypocapnea, with its deleterious effects on cerebral blood flow [42-45]. This association suggests that while prehospital intubation might not be inherently harmful, hyperventilation might play a significant causal role in the

observed relationship between intubation and death. Further analyses have linked poor outcomes not only to hypocapnea, but also to profound desaturations during rapid sequence intubation [46].

These findings point to the unpredictable consequences associated with interventions previously believed to be beneficial, even critical, to patient survival. There is clearly a need for critical assessment of all aspects of care when transferring previously tested techniques into new environments.

Conclusion

Optimal prehospital care for the injured patient is controversial. The lack of strong evidence and the methodological limitations inherent in most analyses make any definitive recommendations open to criticism [47]. In addition, the interpretation of published evidence is complicated by the significant heterogeneity in study design, patient populations, outcomes of interest and variability in the type of interventions performed in the prehospital setting. Even the largest population-based comparison of prehospital systems demonstrated a significant variability in early mortality among patients treated under similar prehospital programs but in different countries, underscoring the high degree of variability introduced by other processes of care in any study of prehospital interventions [14]. Efforts to simply dichotomize prehospital systems into either ALS type or BLS type do not sufficiently take into account this heterogeneity.

The methodological challenges inherent in designing studies of ALS systems make it unlikely that new high-level evidence will shed light on the optimal model of care. Large randomized controlled trials are difficult to conduct in regions with set Emergency Medical Services protocols. This impediment, combined with the challenges faced with emergency waiver of consent studies, renders analyses at the system level quite problematic. As a result, it may be more informative to focus on studies of individual interventions. Even considering these analyses alone, however, the preponderance of evidence suggests no benefit with any single prehospital intervention. Furthermore, data on prehospital intubation suggest the potential for harm, particularly among patients with head injuries. Among patients without head injuries who require immediate hemorrhage control, intubation is even less likely to be of benefit. The advanced operative or interventional procedures required to affect outcome in the bleeding patient are simply delayed by interventions performed in the prehospital setting.

Although the patterns of injury observed are significantly different from those observed in a typical urban trauma system, accruing evidence from the military experience points to the importance of early, definitive operative intervention among severely injured patients with exsanguinating hemorrhage [48-50]. This evidence further supports a system-wide emphasis on rapid transport of these patients.

Given the lack of benefit, and the potential for harm, newly developed systems of trauma care should focus on efficient and rapid means of transport, rather than on field interventions. It should, however, be appreciated that these recommendations might differ significantly depending on the prehospital environment. While there is no strong evidence to support prehospital ALS, the wide range of settings and providers included in the studies examining this topic preclude any definitive conclusions from being drawn. Certainly, certain prehospital systems that function in the ALS model function extremely efficiently. The specific processes of care associated with the success of these programs have not yet been identified, however, and may therefore preclude translating such programs to other environments. Finally, in the context of very long transport times (for example, rural environments) – where the relative amount of time spent on interventions is proportionally less – interventions prior to transportation to hospital might provide some advantage.

Further study is needed to confirm whether the adverse effects of prehospital interventions are due to a delay in the provision of definitive care or are due to inherent harmful effects of a specific procedure that may or may not be modifiable. Specifically, with the growing body of literature linking prehospital intubation to inappropriate ventilation, it is plausible that education or better monitoring might play an important role at negating the harmful effects of prehospital intubation, and might even demonstrate an overall benefit to this intervention.

In summary, in an urban environment with relatively short transport times (the typical clinical setting of most published studies), there is no strong evidence supporting field ALS – and only a suggestion of harm. It is acknowledged that in very selected circumstances ALS maneuvers might be life-saving, but the rarity of such patients and the difficulty in maintaining competence if practiced only in these circumstances preclude any advantage at the population level to implementing prehospital ALS. During the design phase of a new trauma system in an urban setting, emphasis should be placed on efficient transport, on limited BLS interventions at the scene and on triage to a designated trauma center [51].

Competing interests
The authors declare that they have no competing interests.

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