Mode of transport and prehospital interventions in urban penetrating trauma: A systematic review and practice management guideline from the Eastern Association for the Surgery of Trauma

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BACKGROUND: Prehospital procedures in urban penetrating trauma (UPT) are controversial. In certain locales, modes of immediate transport, such as police and private vehicle transport, are used with varying frequencies. We performed a systematic review and meta-analysis and developed evidence-based recommendations on whether UPT patients should receive police or private vehicle transport over waiting for emergency medical services (EMS) transport.

METHODS: Published literature was searched through MEDLINE (via PubMed), Embase (via Elsevier), Web of Science (via Clarivate), and CINAHL Complete (via EBSCO) databases by a professional librarian. The date ranges for our literature search were January 1900 to July 2023. A systematic review and meta-analysis of currently available evidence were performed using the Grading of Recommendations Assessment, Development and Evaluation methodology.

RESULTS: A total of six relevant studies were analyzed for police transport, with all being retrospective or prospective, observational studies. The pooled data found that EMS transport did not improve survival to admission (odds ratio [OR], 1.06; 95% confidence interval [CI], 0.83–1.35) or discharge (OR, 1.06; 95% CI, 0.84–1.35) over police transport. A total of two relevant studies were analyzed for private vehicle transport, with both being retrospective studies. The pooled data found that private vehicle transport improved survival (OR, 0.31; 95% CI, 0.11–0.85) to admission over waiting for EMS transport.

CONCLUSION: In UPT patients, we conditionally recommend police or private vehicle transport over waiting for EMS transport as adjuncts to traditional prehospital care.

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KEY WORDS: Prehospital procedures; urban penetrating trauma; scoop and run; police transport; private vehicle transport.

Since the implementation of Advanced Life Support (ALS) by emergency medical services (EMS) in 1992, there have been increasing numbers of prehospital procedures carried out in the field.[1] Advanced procedures such as intubation, as well as basic ones including intravenous (IV) fluids and cervical spine collar placement, are undoubtedly beneficial in certain patient populations such as nontraumatic cardiac arrest and traumatic brain injury. In addition, prehospital procedures may be helpful when transport to definitive care is prolonged.[2–4] However, several studies have reported that, for a very select patient population with penetrating trauma in urban locations, prehospital procedures may come without benefit and may be detrimental.[5–12] Furthermore, evidence has mounted that modes of transport, such as police and private vehicle transport, that bypass conventional prehospital care and embody the true principles of "scoop and run" provide equivalent to better outcomes for urban penetrating trauma (UPT) over waiting for EMS. For the purpose of this practice management guideline, "waiting for EMS" is defined as when EMS is not on scene when police or bystanders are able to initiate transport, and that EMS transportation would result in longer scene time for the patient. Scoop and run refers to a prehospital strategy where the primary focus is on rapidly transporting the injured patient to a trauma center, without any prehospital procedures. Police and private vehicle transport occur when EMS personnel are not the first to arrive on scene when a patient is injured.

In 2010, the American Heart Association adopted a "circulation first" approach into the 2010 American Heart Association guidelines, introducing the circulation-airway-breathing

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sequence.[13] This has also been reinforced by the US Department of Defense's Tactical Combat Casualty Care and the Civilian Tactical Emergency Casualty Care guidelines, emphasizing the importance of early and immediate hemorrhage control in traumatically injured patients.[14] Recently, the benefits of a circulation-first approach to hemorrhaging trauma patients have gained increasing attention in mainstream prehospital care, suggesting that decreasing time to definitive care should take precedence over prehospital procedures, such as intubation and IV fluid administration.[15–17] For hypotensive patients with penetrating injury, any delay to definitive care has been associated with mortality.[18] Translational studies have shown that time to definitive care may not be the only consideration for immediate transport in UPT. Animal studies have shown that prehospital procedures in severe hemorrhagic shock worsen physiology.[7,19–21] Intravenous fluid in hemorrhage can lead to dilution of coagulation factors and exacerbate uncontrolled bleeding.[19] Positive pressure ventilation through endotracheal intubation or bag-valve mask ventilation can decrease venous return and worsen vital organ perfusion.[7,20,21]

In Philadelphia, the majority of UPT is transported to trauma centers in police vehicles.[10,11] Studies of police transport in UPT show that it can be carried out with similar outcomes, if not better, than EMS transport, with many concluding a lack of prehospital procedures being the main reason for this finding.[6,8,22–24] Other studies have compared private vehicle transport to EMS transport, with similar findings.[9,25]

Cumulatively, these data have led to developing practice management guidelines centering around specific prehospital procedures. In 2018, an Eastern Association for the Surgery of Trauma (EAST) practice management guideline recommended against the routine placement of cervical spine collars for patients with penetrating neck trauma.[26] In addition, in 2009, an EAST practice management guideline made several recommendations regarding prehospital fluid resuscitation, stating that IV access should be placed during transport, not on scene, and that prehospital fluids should be withheld in patients with penetrating trauma to the torso.

While our working group initially set out to compare prehospital procedures with immediate transportation in UPT, it was determined that there was too much heterogeneity in studies to do this comparison. As a result, we developed an evidence-based recommendation on whether patients with UPT should receive immediate transport, or scoop and run, through the utilization of police or private vehicle transport.

PATIENTS AND METHODS

A working group was formed under the EAST Guidelines Committee to formulate an evidence-based guideline on the mode of transport in UPT. Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology was used.[27]

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Checklist was used for this meta-analysis (Supplemental Digital Content, Supplementary Data 1, http://links.lww.com/TA/E858). The working group consisted of relevant stakeholders including trauma surgeons, emergency medicine physicians, experts on prehospital medicine, and emergency medical services (EMS). Population, intervention, and comparator questions were generated a priori to the systematic literature review. Pertinent outcomes were identified by the working group, and each member independently voted on outcomes using a scale of 1 to 9. Outcomes that received a rounded average score of 7 to 9 were deemed critical outcomes, those receiving 4 to 6 were considered important but not critical, and those receiving a score of 1 to 3 were considered of limited importance. Only critically important outcomes were considered in decision making for final recommendations.

Our two population, intervention, comparator, and outcome (PICO) questions were defined as follows.

PICO 1: The population of interest is any adult trauma patient with a penetrating injury, in an urban location, where transport to definitive care is likely very short. The intervention is police transport. The comparator group is EMS transport. Our outcomes of interest are mortality prior to admission, mortality at 24 hours, mortality prior to discharge, disposition status, blood transfusion at 6 and 24 hours, and development of registry captured complications including pneumonia, acute respiratory distress syndrome (ARDS), acute renal failure, and venous thromboembolism.

PICO 2: The population of interest is any trauma patient with a penetrating injury, in an urban location, where transport to definitive care is likely very short. The intervention is private vehicle transport. The comparator group is EMS transport. Our outcomes of interest are mortality prior to admission, mortality at 24 hours, mortality prior to discharge, disposition status, blood transfusion at 6 and 24 hours, and development of registry captured complications including pneumonia, ARDS, acute renal failure, and venous thromboembolism.

Identification of References

Our project was registered with the PROSPERO registry of systematic reviews and meta-analysis (CRD42022308288). Published literature was searched by a professional librarian on July 31, 2023. For PICO 1, the search used a combination of database-specific subject headings and keywords for the following concepts: penetrating trauma, police transport, emergency medical services, and urban settings in various iterations and combinations. Results were limited to the English language. For PICO 2, the search used a combination of database-specific subject headings and keywords for the following concepts: penetrating trauma, private vehicle transport, emergency medical services, and urban settings in various iterations and combinations. Results were limited to the English language. The full search strategy is available online for PICO 1 (Supplemental Digital Content, Supplementary Data 2, http://links.lww.com/TA/E859) and 2 (Supplemental Digital Content, Supplementary Data 3, http://links.lww.com/TA/E860).

Studies that included adult (older than 16 years) trauma patients with penetrating trauma in urban locations were eligible for inclusion. Case-control studies, retrospective cohort studies, and prospective trials that included penetrating trauma patients in urban locations and prehospital procedures were eligible for inclusion. Studies lacking prehospital procedures were also considered eligible. Publications that consisted of animal studies, case reports, editorials, commentaries, abstracts, review articles, and editorials were excluded. For studies to be included in PICO 1, a clear comparison between patients receiving police transport and

EMS transport had to have been present with one of the critical outcomes examined. For a study to be included in PICO 2, a clear comparison between patients receiving private vehicle transport and EMS transport had to have been present with one of the critical outcomes examined. Studies that reported penetrating and blunt trauma patients combined were excluded, unless subset analysis was performed of only penetrating injuries.

Data Extraction and Methodology

Two team members independently screened titles and abstracts for inclusion. Conflicts were blindly adjudicated by a third team member. Full-text review was then performed by two independent team members. Conflicts were again resolved by a third blinded member. The reference list of included articles was reviewed by two team members for identification of potential additional articles not included in the literature search. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram for the systemic review for PICO 1 (Fig. 1) and PICO 2 (Fig. 2) are shown. For PICO 2, one accepted but unpublished manuscript was added to full-text review because of the working group's knowledge of its acceptance to a peer reviewed journal.

Data extraction was performed in duplicate using a standardized data sheet. Data extracted from each study included authors, journal, publication year, study design, urban versus rural locations, the number of patients in the intervention and comparator group, and the critical outcomes. The complications examined were defined by trauma registry definition.

Review Manager (RevMan Online; The Cochrane Collaboration, 2021, Copenhagen, Denmark) was used to perform the meta-analysis with random-effects modeling to generate forest plots. Treatment effects were calculated with each study weight being proportional to the number of subjects it contributed to each outcome. For binary outcomes, odds ratios (ORs) were calculated for the intervention group against the comparator group.[28] Heterogeneity was calculated and quantified with I^2. High heterogeneity was defined by an I^2 values of >75%, moderate for I^2 values of 50% to 74%, and low I^2 for <50%. Pooled analysis was done for survival to admission and survival to discharge, as all other outcomes were not present in multiple studies without overlapping patient populations.

Egger's test was used to evaluate for risk of publication bias. The GRADE framework was applied to all quantified outcomes to assess bias, publication bias, inconsistency, imprecision, and indirectness. Evidence profiles were created for each PICO using GRADEpro Guideline Development Tool Software (McMaster University and Evidence Prime, 2021, Hamilton, Ontario, Canada).[28]

All committee members voted independently, taking into consideration the quality of evidence, the relationship between benefits and harms, perceived patient values and preferences, and resource utilization. Our PICO questions and analysis results (forest plots, GradePRO table, risk of bias assessment, and summary of study types) were submitted to two external GRADE experts for blind review. Institutional review board review was not necessary as individual patient data was not examined.

RESULTS

All studies were based in the United States and were either retrospective or prospective, observational studies. For PICO 1,

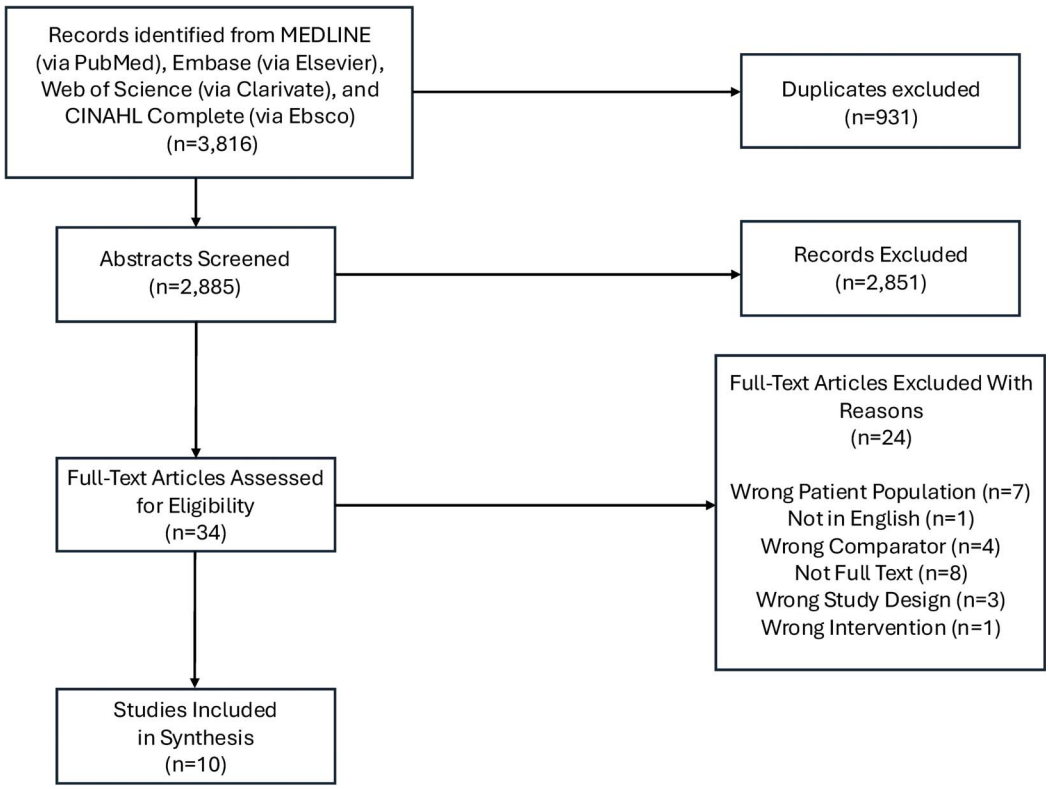

Figure 1. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram for the systemic review for PICO 1 is shown.

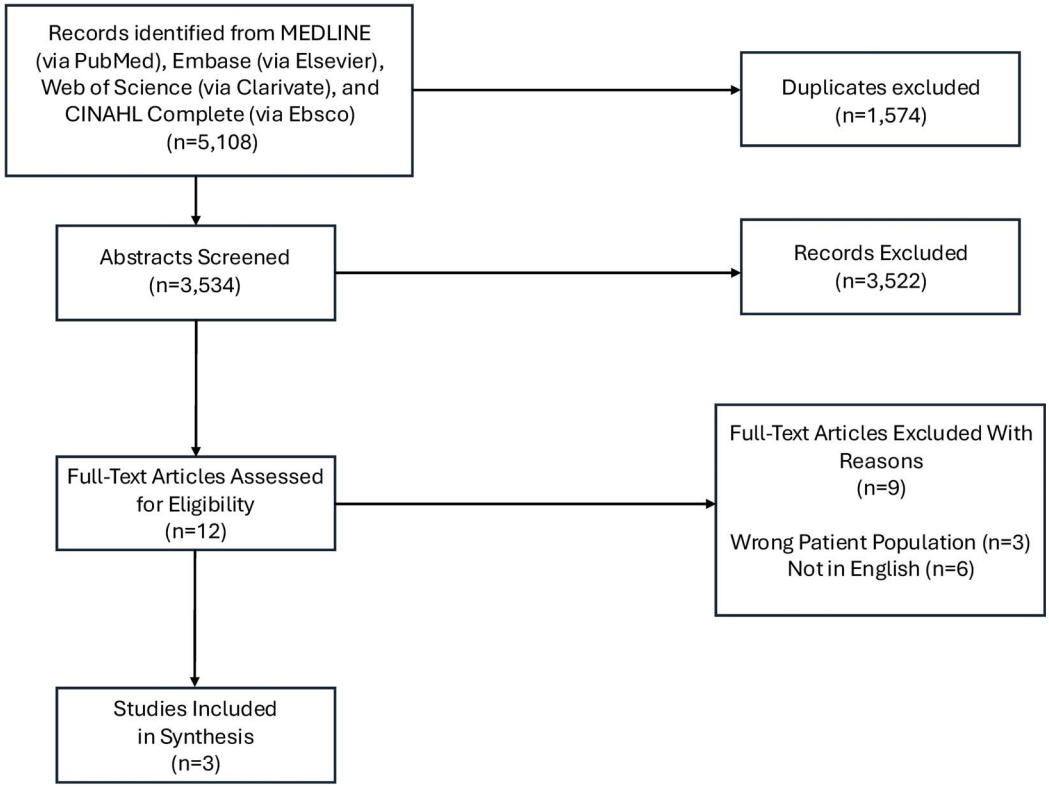

Figure 2. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram for the systemic review for PICO 2 is shown.

several studies had overlapping patient populations, including those using the Pennsylvania Trauma Systems Outcomes (PTOS) Database and three from single trauma centers that report data to PTOS (Table 1).[10,11,22,29,30,32,33] For PICO 2, three papers were included, two of which had overlapping patient populations using the National Trauma Data Bank (NTDB) (Table 2).[9,35]

Population, Intervention, Comparator, and Outcome 1

Should adult patients with penetrating injuries in urban locations with short distance to definitive care (P) receive police transport (I) versus waiting for EMS transport (C) to reduce prehospital mortality, 24-hour mortality, hospital mortality, disposition status, blood transfusions, and complications (O)?

Qualitative Synthesis

Six studies were included in the meta-analysis after removing overlapping patients; preference was given to more recent and larger studies. Studies are summarized in Table 1.[6,8,10,11,22,29–33]

Branas et al.[30] used the PTOS database to perform an analysis of survival to discharge. Patients with penetrating injury who underwent police transport had shorter out-of-hospital time, defined as the estimated time of injury to the time of arrival at the trauma center (54.6 vs. 77.5 minutes, $p < 0.001$). The authors found that patients with penetrating injuries brought in by police transport had higher unadjusted survival to discharge when compared with those with EMS transport (86.7 vs. 82.2%, $p < 0.001$).[30]

Band et al.[22] used the PTOS database spanning 2003 to 2007. Patients transported by police were more severely injured by Injury Severity Score (ISS; 21.0 vs. 19.4, 95% confidence interval [CI], −2.94 to −0.16), and on unadjusted analysis, police transport patients had lower survival (73.5% vs. 70.2%; 95% CI, 1.00–1.39). For patients with severe injury (ISS >15), adjusted analysis showed that police transport came with a survival benefit (OR, 0.73; 95% CI, 0.59–0.90). The authors concluded that police transport for UPT should be an adjunct to traditional prehospital care.

Winter et al.[10] study examined PTOS from 2014 to 2018. This study performed a one-to-one propensity match with 870 patients in each of the police and EMS transport groups. Survival at 6 hours was used as a proxy for survival to admission. The matched cohorts did not have significant survival differences. For severely injured patients (ISS, 26–75), there was a survival benefit at arrival for police transport (OR, 0.48; 95% CI, 0.24–0.94).[8]

Rappold et al.[32] was a single-center, retrospective analysis from 2008 to 2013. This study compared penetrating trauma patients in Philadelphia who received ALS, BLS, or police transport. On adjusted analysis, when correcting for ISS, police transport (OR, 2.57; 95% CI, 1.61–4.11) and ALS transport (OR, 1.86; 95% CI, 1.12–3.01) were associated with mortality compared with BLS transport. For more severely injured patients (ISS >30), neither police (OR, 1.00; 95% CI, 0.35–2.85) nor ALS transport (OR, 0.85; 95% CI, 0.27–2.71) provided a survival advantage over BLS transport.[32] The authors questioned the role of prehospital procedures in UPT and emphasized that scoop and run may save lives.[32,36]

Wandling et al.[8] retrospectively examined the NTDB and performed the largest study on police transport in UPT. After

TABLE 1. Studies Reporting Outcomes of Police Transport in Comparison With EMS Transport in UPT

Author (ID)	Year	Country	Study Year	Study Design	Data Source	Study Size	Type of EMS Transport	Outcomes Measured
Band et al.[29]	2011	USA	2003–2007	Retrospective cohort	Single center	2,127	Both basic and ALS (amount not quantified)	Survival to discharge, discharge to home
Band et al.[22]	2014	USA	2003–2007	Retrospective cohort	Pennsylvania Trauma Outcomes Study	4,122	Both basic and ALS (amount not quantified)	Survival to discharge
Branas et al.[30]	1995	USA	1986–1992	Retrospective cohort	Pennsylvania Trauma Outcomes Study	4,767	Both basic and ALS (amount not quantified)	Survival to discharge
Jacoby et al.[31]	2020	USA	2006–2015	Retrospective cohort	Pennsylvania Trauma Outcomes Study	9,438	Both basic and ALS (amount not quantified)	Survival to discharge, discharge to home, transfusion at 6 h
Maher et al.[11]	2021	USA	2012–2018	Retrospective cohort	Single center	2,007	Both basic and ALS (amount not quantified)	Survival to discharge, discharge to home, transfusion at 6 and 24 h
Rappold et al.[32]	2015	USA	2008–2013	Retrospective cohort	Single center	1,490	Both basic (n = 232; 25.8%) and ALS (n = 668; 74.2%)	Survival to discharge
Taghavi et al.[6]	2022	USA	2019–2020	Prospective, observational	EAST multicenter trial	588	ALS only	Survival to admission, survival to discharge, transfusion at 24 h, development of pneumonia, ARDS, acute kidney injury, venous thromboembolism
Wandling et al.[8]	2016	USA	2010–2012	Retrospective cohort	NTDB	88,564	Both basic and ALS (amount not quantified)	Survival to discharge
Winter et al.[10]	2021	USA	2014–2018	Retrospective cohort	Pennsylvania Trauma Outcomes Study	1,740	Both basic and ALS (amount not quantified)	Survival to admission, survival at 24 h, survival to discharge
Winter et al.[33]	2022	USA	2015–2018	Retrospective cohort	Pennsylvania Trauma Outcomes Study	1,297	Both basic and ALS (amount not quantified)	Survival to admission, survival at 24 h, survival to discharge

adjusting for multiple variables, including ISS, mortality risk was not different with police-transported patients (OR, 1.00; 95% CI, 0.69–1.45).[8]

Taghavi et al.[6] performed a post hoc analysis of a multicenter, prospective observational study of adults with UPT including 25 urban trauma centers from 2019 to 2020. A one-to-one propensity match analysis of 588 patients receiving either police or ALS transport was performed. Survival to discharge was not different when comparing the two matched cohorts (85.0% vs. 84.4%, $p = 0.82$). This study also examined complications such as ARDS, venous thromboembolism, acute kidney injury, pneumonia, and catheter-associated urinary tract infection and found no difference. The authors concluded that police transport results in similar outcomes as ALS transport and that immediate transportation should be emphasized in UPT.[6]

Quantitative Synthesis (Meta-analysis)

Survival

Three studies were included in the meta-analysis for survival to admission (Fig. 3*A*). There were 1,754 patients who received police transport and 2,064 receiving EMS transport. The pooled data showed that those receiving police transport did not have decreased survival (OR, 1.06; 95% CI, 0.83–1.35). Heterogeneity was moderate for survival to admission. Pooled analyses of studies examining survival to discharge included five studies (Fig. 3*B*). There were 5,939 patients receiving police transport and 91,914 receiving EMS transport. Patients receiving police transport were not more likely to survive until discharge (OR, 1.06; 95% CI, 0.84–1.35). Heterogeneity was high for survival to discharge. Risk of bias is shown (Fig. 3*C*).

PICO 1 Recommendation

We conditionally recommend police transport over waiting for EMS transport in adults with UPT. Ten authors voted for a conditional recommendation and two authors voted neutral.

Population, Intervention, Comparator, and Outcome 2

Should adult patients with penetrating injuries in urban locations with short distance to definitive care (P) receive private car transport (I) versus waiting for EMS transport (C) to reduce mortality prior to admission, mortality at 24 hours, mortality prior to discharge, disposition status, blood transfusion at 6 and 24 hours, and development of registry captured complications (O)?

Qualitative Synthesis

Simpson et al.[34] was another post hoc analysis of the EAST multicenter trial on prehospital procedures in UPT. This study compared private vehicle transport to both ALS and BLS transport. For the ALS analysis, one-to-one propensity matching was performed between the private vehicle transport cohort and the ALS cohort. Each cohort had 389 patients. The authors found that patients with private vehicle transport were more likely to survive to the emergency department (98.1% vs. 96.1%, $p < 0.001$) and that survival to discharge was not different (94.6% vs. 97.2%, $p = 0.52$). Propensity matching could not be performed in the private vehicle comparison with BLS transport because the cohorts were too different. On multivariate

TABLE 2. Studies Reporting Outcomes of Private Vehicle Transport in Comparison With EMS Transport in UPT

Author (ID)	Year	Country	Study Year	Study Design	Data Source	Study Size	Type of EMS Transport	Outcomes Measured
Simpson et al.[34]	2024	USA	2019–2020	Prospective, observational	EAST multicenter trial	778	ALS	Survival to discharge, transfusion at 24 h, development of pneumonia, ARDS, acute renal failure, venous thromboembolism
Wandling et al.[9]	2018	USA	2010–2012	Retrospective cohort	NTDB	103,029	Both basic and ALS (amount not quantified)	Survival to discharge
Zafar et al.[35]	2014	USA	2007–2010	Retrospective cohort	NTDB	74,187	Both basic and ALS (amount not quantified)	Survival to discharge

analysis, private vehicle transport was independently associated with survival. The authors concluded that private vehicle transport in lieu of waiting for EMS transport may be a helpful adjunct in UPT.[34]

Wandling et al.[9] examined the NTDB from 2010 to 2012 and included 103,029 patients. There were 16,932 patients receiving private vehicle transport and 86,097 receiving ground EMS transport. Private vehicle patients were less severely injured by ISS (5.5 vs. 10.1, $p < 0.001$) and had lower unadjusted survival (97.8% vs. 88.4%, $p < 0.001$). After adjusting for multiple variables, including ISS, private vehicle transport was associated with a survival advantage (OR, 0.38; 95% CI, 0.31–0.47). The authors concluded that private vehicle transport had a survival advantage over ground EMS transport in UPT.[9]

Quantitative Synthesis (Meta-analysis)

Survival

Two studies were included in the meta-analysis for survival to discharge (Fig. 4*A*). There were 17,321 patients with private vehicle transport and 86,486 with EMS transport. Pooled analysis demonstrated that private vehicle transport was associated with a survival advantage (OR, 0.31; 95% CI, 0.11–0.85). Heterogeneity was high. Risk of bias is shown in Figure 4*B*.

PICO 2 Recommendation

We conditionally recommend private vehicle transport over waiting for EMS transport in UPT. Ten authors voted a conditional recommendation, while two authors voted for a strong recommendation for private vehicle transport.

USING THE GUIDELINES IN CLINICAL PRACTICE

A significant body of evidence suggests that prehospital procedures in UPT are not helpful and that, at best, provide no advantage over scoop and run.[1,5,37] The benefits provided by scoop and run could be related to decreased transport time to definitive care or due to detrimental physiological effects that prehospital procedures can cause.[1,12,19,38] This practice management guideline started as a review of prehospital procedures and comparison with scoop and run for UPT patients. Currently, there are existing guidelines against using spine immobilization and IV fluids for this select patient population.[26] While there are data demonstrating that prehospital procedures in UPT are

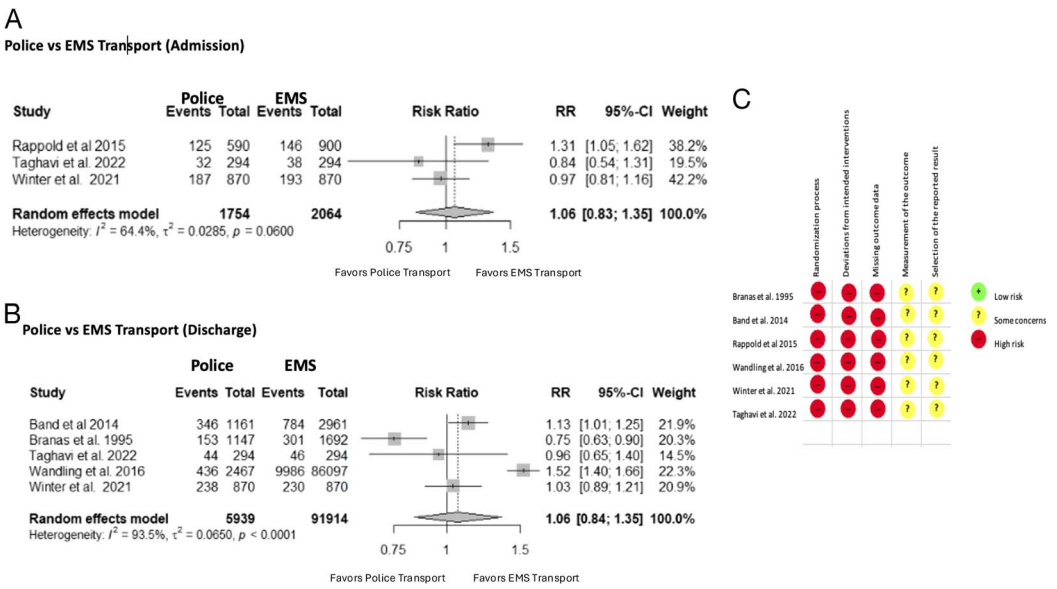

Figure 3. Pooled analyses of studies examining survival to (*A*) admission and (*B*) discharge are shown comparing police and EMS transport. (*C*) Risk of bias is shown.

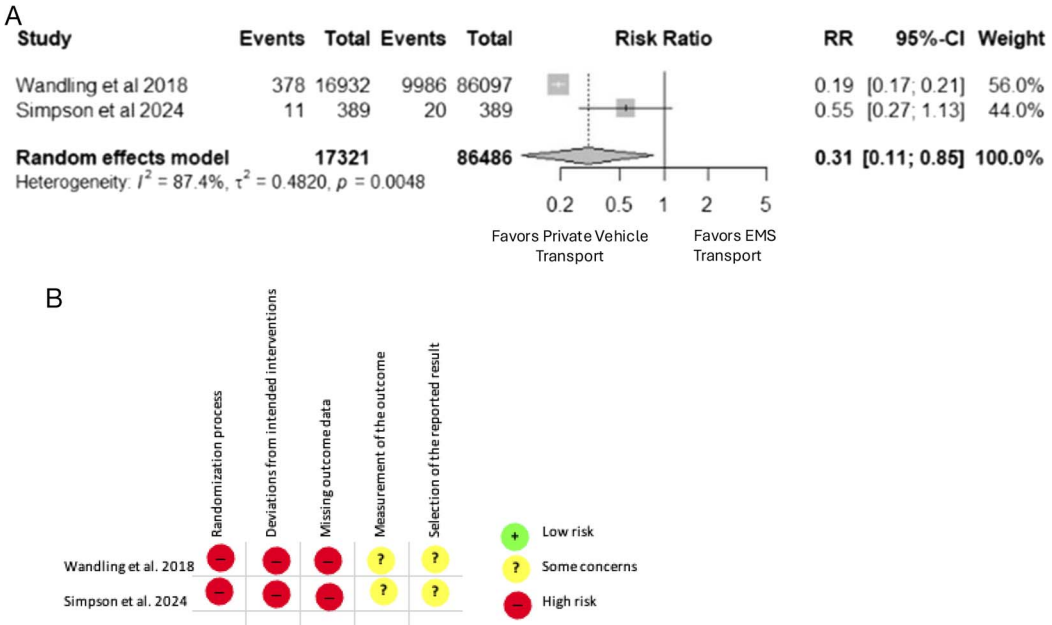

Figure 4. Pooled analyses of studies examining (*A*) survival to discharge are shown comparing private vehicle and EMS transport. (*B*) Risk of bias is shown.

harmful,[5] enough studies with matching patient populations and outcomes could not be found in sufficient numbers for a systematic review. Therefore, the focus was turned to modes of transportation that abide by the principles of scoop and run. Use of alternative modes of transport, including police and private vehicle transport, are the purest forms of scoop and run and have been in usage in varying degrees in certain cities for decades.[8,9] This guideline seems to indicate that a scoop and run prehospital strategy may be beneficial in UPT patients.

Through our literature review, we conditionally recommend the use of police transport over waiting for EMS in UPT. While the meta-analysis showed no significant difference between police and EMS transport, the working group thought that, without any clear benefit to EMS transport, police transportation is a viable alternative over waiting for EMS transport. Particularly with a critical analysis of the existing studies, it shows that police transport may have better outcomes in the more severely injured patients. Furthermore, police transport may be an alternative to EMS transport in cities where EMS response is understaffed, providing much needed help to 911 municipalities that struggle with timely EMS response. For example, it is important to note that most of the studies looking at police transport were limited to a small number of urban cities that have adapted processes to optimize police transport. Whether police transport is generalizable to other cities needs further investigation.

It is important to note that the working group specifies that police and private vehicle transport are alternatives to waiting for EMS, meaning if EMS personnel are not already on scene, police and private vehicle transport are viable alternatives. As stated by the official Philadelphia Police Department Directive, "Persons suffering from a serious penetrating wound (e.g., gunshot, stab wound, and similar injuries of the head, neck, chest, abdomen, and groin) shall be transported to the nearest accredited trauma center. Transportation of such cases will not be delayed to await the arrival of Fire Department paramedics."[39] This indicates that police transport should occur only if EMS is not already on scene and that any additional time on scene for EMS arrival would be considered "waiting for EMS." The reviewed studies in this meta-analysis did not look at EMS response times and how this should factor into utilization of police and private vehicle transportation. As such, the working group considers that police or private vehicle transport would occur only if EMS were not already on scene. Future studies can help clarify whether "waiting for EMS" should be more nuanced.

Implementing police transport involves creating a system to receive these patients from police expeditiously and training to optimize this process.[40] Philadelphia serves as a model, as police transport is the most common type of transport for penetrating trauma.[11] Police officers are trained to rapidly place the injured person to the rear of the police vehicle and travel with lights and sirens to the nearest trauma center.[40] While en route, police officers communicate with city police department dispatchers, who then call the emergency department to inform them that there is an incoming penetrating trauma patient. Trauma centers in Philadelphia use visual cues to designate a "Drop-Off Zone" that directs arriving officers where to stop in the emergency department driveway, including a large sign that is labeled "Police Emergency Drop-Off Here." This visual cue encourages police to park one car length from ambulance bay doors on a relatively flat surface so that there is space for patient stretchers to maneuver. The emergency department entrance is kept equipped with stretchers and personal protective equipment for staff to don before proceeding to vehicles for extrication. Generally, three nurses and/or emergency department technicians are designated for patient extrication. One is the primary leader during extrication, while the second and third are responsible for the physical extraction. Often times, during rapid

transport, the injured patient is not secured and ends up in the confined space of the vehicle's floor up against the partition dividing the front and back seats, creating a challenge for rapid extraction of the patient from the vehicle.[40] As a result, emergency department personnel practice and are prepared to use two extraction techniques for this difficult situation. The emergency department attending and residents are stationed at the ambulance bay doors to facilitate a rapid response. Weapons screening is also performed in the emergency department vestibule at the ambulance entrance area.[40] Trauma centers in Philadelphia have credited simulation and education of new personnel for their efficient and rapid extrication process.[40]

Certain metropolitan areas do not incorporate police transport for various reasons. Some of the factors cited by police departments in major metropolitan cities include need to establish scene safety and security, the belief that patients should be cared for by trained EMS, and fear for police officer safety.[41] Police forces that are short-staffed may not have the resources or bandwidth to use immediate transportation. Legal reasons may also exist, for example, in New Orleans, a consent decree limits the ability of police to transport patients to trauma centers.[42] The initiation of police transport in Philadelphia started in the 1980s, when the rate of gunshot injuries often outpaced the resources of EMS. Official policy was enacted in Philadelphia in 1996 as stated previously.[23,39] Other municipalities are carrying out police transport, with Philadelphia, Detroit, and Sacramento accounting for 87.8% of all police transports nationwide.[8] An examination of cities with the 12 highest rates of gun violence shows that 40% have written policies allowing for police transport.[43] Urban trauma centers should consider whether the engagement of police departments may be beneficial in adding police transport as an adjunct to waiting for EMS in their metropolitan area. Other factors to consider are how the implementation of police transport can affect the relationship of the police force with a community. Qualitative studies show that victims of penetrating trauma that receive police transport are often grateful but experiences can be mixed.[31,44]

Our literature review led us to conditionally recommend private vehicle transport. This recommendation was made despite high heterogeneity in the meta-analysis and the inclusion of only two studies in the overall pool analysis. Factors that likely contributed to high heterogeneity includes variations in patient demographics, prehospital system characteristics, hospital care practices, and temporal periods. Trauma centers in Philadelphia have used similar training and preparation that have been used for receiving police transport, to train staff to rapidly and efficiently receive private vehicle drop-offs of patients with penetrating trauma.[23] The Stop the Bleed campaign encourages and trains bystanders to take an active role in helping bleeding trauma patients by applying direct pressure or tourniquets to patients with exsanguinating hemorrhage.[45] Taking this one step further and encouraging bystanders also perform transport to trauma centers is a more difficult endeavor, as there are numerous logistical and ethical questions. Private vehicle transport could put the bystanders themselves at risk while trying to expeditiously drive a trauma victim to the nearest trauma center. Furthermore, an untrained bystander could exacerbate injuries during transport, which raises the question of legal ramifications for bystanders. Furthermore, a limitation of our meta-analysis on private vehicle transport is that one study is given a high degree of weight in a review that only included two studies. In addition, bystanders may not know which hospitals are designated trauma centers and may instead drive patients to the nearest hospital, which is not equipped to receive trauma patients. Similarly, patients who are driven to nontrauma centers would not have been captured in these studies and those patients could have worse outcomes than if transported by EMS. Despite these limitations, the working group still overwhelmingly voted in favor of conditional recommendation for private vehicle transport over waiting for EMS, as the existing data demonstrate that it can be done with better or comparable outcomes to EMS transport. Like our rationale with police transport, private vehicle transport may be a viable alternative strategy for understaffed EMS systems. Private vehicle transport has the potential to decrease transport time and save resources for other patients that may benefit more from EMS transport, as compared with UPT patients. Trauma centers that see a high volume of penetrating trauma must ensure that their emergency departments are prepared and equipped to rapidly extricate patients from private vehicles when brought in by private vehicle transport.

It is important to note that the usage of blood transfusion by ground EMS in the prehospital setting is a relatively recent phenomenon and has been increasingly employed by EMS agencies, even in UPT.[46,47] Some studies have found a benefit with prehospital blood transfusion in UPT.[46,47] However, it is important to note that patients receiving prehospital blood were not compared with those receiving scoop and run, as patients in the control group were transported by EMS. Furthermore, these studies were limited by selection bias, as the vast majority of penetrating trauma patients were excluded because of missing data or cardiac arrest.[46,47] Future studies are needed to compare police or private vehicle transport to prehospital blood transfusion by EMS in UPT.

Another important point is the lack of an accepted definition for "urban location" and what defines "short transport time" for penetrating trauma patients. "Trauma deserts" have been typically described as locations over 5 miles away from the nearest trauma center.[48] However, other studies have shown that actual transport times are the more important metric, instead of geographical distance, as the closest trauma center can vary based on transport capabilities.[49] Victims of penetrating trauma that are injured in "trauma deserts" are known to have worse outcomes.[48] Unfortunately, a cutoff time of transport that defines when scoop and run may be more beneficial than "stay and play" has not been defined. Further research using geomapping techniques may help determine when police or private vehicle transport may be more beneficial than waiting for EMS.

There are several limitations to our systematic review and meta-analysis. The first is the inherent bias and confounding in the designs of included studies. All studies reviewed for both PICO questions were retrospective cohort and observational studies with some data overlaps. The largest contributors of patients were cohort studies of administrative databases that may suffer from coding errors, missing data, and selection bias. In addition, many of the studies did not discern what type of EMS transport was carried out. Transportation by ALS crews results in more prehospital procedures, whereas patients who receive BLS transport may have more prehospital procedures foregone

in lieu of immediate transportation.[32] The heterogeneity of included studies does require consideration, particularly the analysis for survival to discharge in police and private vehicle transport. For PICO 2, the analysis was limited to two studies, with one study making up the majority of the pooled analysis weight. Finally, randomized study design trials are difficult to implement to look at mode of transport.

CONCLUSION

Based on the available evidence, the authors conditionally recommend both police and private vehicle transport over waiting for EMS transport in UPT. With efficient integration into trauma systems of care, police and private vehicle transport can be effective adjuncts to EMS transport in UPT.

AUTHORSHIP

S.T. contributed in the literature search, study design, data collection, data analysis, data interpretation, writing, and critical revision. G.C., Z.M., D.T., M.J.L., A.S.R., L.T., C.L.J., S.P., M.J.S., E.R.H., and A.J.G. contributed in the literature search, data collection, data interpretation, and critical revision. J.F. contributed in the literature search, study design, data collection, data analysis, data interpretation, writing, and critical revision.

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DISCLOSURE

Conflicts of Interest: Author Disclosure forms have been supplied and are provided as Supplemental Digital Content (http://links.lww.com/TA/E857).

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