# An Evidence-Based Guideline

# For the Transportation of Prehospital Trauma Patients

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### *Potential Conflicts of Interest*

The authors do not have any conflicting financial or professional interests, with the exception of the following: Stephen H. Thomas declares that he is the chair of the University of Oklahoma Department of Emergency Medicine, which provides medical control for AirMethods and AirEvac Lifeteam Helicopters in Oklahoma.

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# Abstract:


## *Background*

Decisions about the transportation of trauma patients by helicopter have been driven by political, regulatory and financial pressures and are often not well-informed by research assessing the risks, benefits and costs of such transport.

## *Objective*

The objective of this evidence-based guideline (EBG) is to recommend a strategy for the selection of prehospital trauma patients who would benefit most from aeromedical transportation.

## *Methods*

A multidisciplinary panel was recruited consisting of experts in trauma, EBG development, and EMS outcomes research. Representatives of the Federal Interagency Committee on Emergency Medical Services (FICEMS), the National Highway Traffic Safety Administration (NHTSA) (funding agency) and the Children's National Medical Center (investigative team) also contributed to the process. The panel used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology to guide question formulation, evidence retrieval, appraisal/synthesis and formulate recommendations. The process followed the National Evidence-Based Guideline Model Process, which has been approved by the Federal Interagency Committee on EMS and the National EMS Advisory Council. Panel members received GRADE training and conducted comprehensive literature reviews supported by health information specialists. Evidence profiles were developed around specific clinical questions and recommendations were drafted. All

graded recommendations (strong or weak), with descriptors of evidence quality (high, moderate, low, very low), were incorporated into an algorithm. A meeting was convened to review/endorse all materials and achieve consensus on recommendations. Literature searches were revised and appropriate changes made prior to manuscript preparation.

## *Results*

Two strong and three weak recommendations emerged from the process, all supported only by low or very low quality evidence. Guidance was developed for mode of transport as a function of time-savings between Helicopter Emergency Medical Services (HEMS) and Ground Emergency Medical Services (GEMS), use of online medical control, and considerations for local adaptation. The 2011 CDC Guideline for the Field Triage of Injured patients was incorporated into the protocol.

## *Conclusions*

We successfully created a guideline and protocol for assigning mode of transport for trauma victims, developed through a validated EBG development process. Future research should define optimal approaches for implementation of the guideline as well as the impact of the protocol on safety, outcomes and cost.

# Introduction

## *Background*

The considerable health burden of trauma and the longstanding controversies surrounding the use of Helicopter EMS (HEMS) for trauma transport lend imperative to the development of an Evidence-Based Guideline (EBG) for the transportation of prehospital trauma patients.

Trauma is the leading cause of death for young adults in the United States and accounts for more than a third of all emergency department visits, while the aeromedicine industry now supplies approximately 3% of all ambulance transports.[1-3] While the growth of the aeromedicine is based largely on an assumed superiority of care, in reality the concrete advantages of HEMS as borne out in the literature remain the subject of debate. While the existing evidence supports a morbidity and mortality benefit, its interpretation is complicated by the heterogeneity of HEMS patients and incidents.[4] The true utility of HEMS most likely hinges upon the appropriate selection of injured patients for aeromedical transport, since undertriage has implications for patient outcomes, while overtriage significantly affects system resources and patient and provider safety.

In general, evidence-based guidelines focused on prehospital care are lacking. In 2006, the Institute of Medicine (IOM) released a report on the Future of Emergency Care in the United States, and recommended the development of, "…evidence-based guidelines for the treatment, triage, and transport of patients…".[5] It was with this recommendation in mind that the National Highway Traffic Safety Administration funded the creation of a National EBG Model Process for the development, implementation, and evaluation of prehospital EBGs, and set out to test the process using trauma triage and transportation as a subject matter.[6]

## *Objectives*

The objective of this guideline is to recommend an evidence-based strategy for the triage and transportation of all prehospital trauma patients who use 911 services. The following clinical questions regarding this patient population were used to structure the research and discussion:

i) Which field triage criteria should be used to risk-stratify injury severity and guide decisions as to destination and ground versus air transport modality?
ii) When should on-line medical direction be obtained for assignment to ground versus air transport to improve patient outcomes?
iii) What are the criteria that would necessitate assignment to air transport to improve patient outcomes?

Please refer to Appendix A for further detail on the PICO (Patient, Intervention, Comparison, Outcome) formatted research questions.

## *Scope*

This guideline applies to trauma patients in the prehospital setting who require transportation to a hospital for the evaluation and treatment of their injuries. The evidence analyzed included patients of all ages, but excluded secondary transfers, drownings, and burn patients.

The guideline is most applicable to EMS systems where paramedics and other non-physician EMS providers make care decisions that are partially or completely independent of physician control. It is meant to be used by EMS systems administrators, medical directors, and policy makers.

### *Interpretation*

This guideline was developed using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) methodology and contains both strong and weak recommendations. According to the GRADE paradigm, the implication of a strong recommendation is that it should be adopted as policy in most settings covered by the scope of the guideline. Weak recommendations are more conditional and should only be adopted as after extensive dialogue regarding stakeholder values and preferences.[7]

## Methods

### Gathering External Inputs

A core guideline development working group consisting of the lead investigators and a GRADE methodologist recruited a panel with expertise in prehospital medicine, EMS systems administration, and evidence-based medicine. A wide range of disciplines were represented, including EMS directors, academic and community emergency physicians, ground and air EMS providers, GRADE methodologists, and health information specialists. Leaders from the Maryland Institute for Emergency Medical Services System (MIEMSS) were included from the outset because of the intent to eventually implement the protocol within their system.

To ensure uniform adherence to evidence-based guideline techniques, panellists completed training in GRADE methodology. GRADE is a standardized and transparent system for evaluating evidence and issuing recommendations that places high priority on the values and preferences of the patient in the creation of recommendations. Inherent to the GRADE process is

the formulation of clinical questions according to a standard architecture (otherwise known as PICO format) which identifies the Patient population, the Intervention under analysis, relevant Comparators, and Outcomes of interest. As part of the training, the core working group distributed literature outlining the GRADE process and held a teleconference to review core GRADE methodology and PICO question formulation.

## Guideline Initiation and Preliminary Evidence Review

Once panelists were primed on GRADE methodology, they met again by conference call to generate proposals for guideline topics. Trauma triage and transportation (ground versus air) was put forth as a candidate topic for further examination, given its variability within EMS systems and its significant impact on patient outcomes.[8,9] Contributors were asked to disclose financial conflicts and competing interests.

The core working group undertook a preliminary survey of the literature to assess whether the evidence base was robust enough to warrant EBG development. Although this overview did not identify any relevant high quality systematic reviews or randomized controlled trials, it was nevertheless agreed that a guideline based on the available evidence would have significant impact on prehospital care. In preparation for a more intensive literature review, panelists formulated clinical PICO questions related to specific areas of controversy or practice discordance in trauma triage.

## Evidence Evaluation

The next step was an intensive review of the evidence related to trauma triage in the prehospital setting. Panellists selected areas of responsibility within the guideline project and engaged the expertise of health information specialists to identify literature relevant to their PICO

question. The search strategies are catalogued in Appendix A. Panellists searched Medline, OVID, the Cochrane Clinical Trials Registry, national guideline organizations, and the grey literature. Methodologists from the core working group assisted the panellists in verifying search strategies and selecting relevant literature for deeper appraisal.

## Guideline and Algorithm Development

Panellists ranked the importance of the various possible outcomes pertinent to their PICO question. Emphasis was placed on the perspective of patients and their families, although healthcare system and EMS provider viewpoints were considered as well. Contributors then created GRADE tables for their PICO question and generated draft guideline components. In July 2010, a meeting was convened to review the work generated thus far. Through a series of presentations panellists presented evidence pertinent to their PICO question to the larger group and invited feedback regarding their assessment of the quality of evidence and strength of recommendations. The core working group planned to use Delphi-based processes to resolve impasses, although this proved unnecessary owing to the high degree of consensus. The final set of recommendations was transformed into an algorithm for prehospital trauma triage to be used in the field by EMS providers.

In February 2012, panellists repeated their literature searches to identify new research which might impact the recommendations. These recent publications were appraised and incorporated into the existing evidentiary tables where applicable. The core working group was prepared to reconsider the strength of recommendations based on this new evidence, although changes were deemed unnecessary given the concordance in quality and content between the old and new data.

## Guideline Dissemination and Implementation

The final EBG and algorithm were presented to the MIEMSS Protocol Review Committee in September 2010. The EBG was compared to the existing MIEMSS trauma triage protocol and only one area of discordance was noted. Specifically, while the MIEMSS protocol required online medical control for patients meeting criteria from Steps 3 and 4 of the CDC trauma triage guidelines, the EBG makes a weak recommendation that online medical control is an option for this patient group. According to the GRADE paradigm, weak recommendations are meant to be considered within the local context and only implemented after extensive dialogue amongst policy-makers. In this instance, the MIEMSS Protocol Review Committee decided against recommending adoption of this element of the EBG into their statewide protocols.

In so doing, the MIEMSS Committee considered their local safety data and the published research and decided that the weak recommendation of the EBG was not appropriate for their system. All other elements of the EBG are currently implemented in the MIEMSS system and are being evaluated using their standard procedure for statewide protocols. The MIEMSS process involves review of the available literature, retrospective analysis of system experience using Quality Improvement (QI) data, and advisory body input.

In-depth provider education was not considered necessary at the time of implementation, as the EBG did not result in a change to existing MIEMSS practice or policy. Post-implementation education will continue during the active protocol period primarily through MIEMSS' regularly occurring regional and statewide continuing education and recertification conferences, and through local review by jurisdictional education coordinators.

In addition, the project investigators planned to distribute the guideline to national stakeholders for feedback, and to submit it for presentation at national meetings for EMS physicians, prehospital care providers, and EMS researchers.

# Recommendations

We recommend that field triage criteria for all trauma patients should include anatomic, physiologic, and situational components* in order to risk-stratify injury severity and guide decisions as to destination and transport modality.

(Strong recommendation, low quality evidence)

* As outlined by the CDC 2011 Guidelines for the Field Triage of Injured Patients (Figure A)[1]

*Remarks:* In formulating this recommendation, the panel placed more importance on avoiding undertriage and less importance on possible overtriage. The panel also considered that most patients would highly value the potential morbidity and mortality benefit of incorporating all possible triage variables.

*Recommendations:*

We recommend that EMS providers should not be required to consult with online medical direction (OLMD) before activating HEMS for trauma patients meeting appropriate physiologic and anatomic criteria for serious injury.*

(Strong recommendation, low quality evidence)

We suggest that for all other trauma patients, online medical direction may be used to determine transportation method as long as it does not result in a significant delay.

(Weak recommendation, very low quality evidence)

* Patients meeting appropriate physiologic and anatomic criteria have clinical features consistent with Steps One and Two of the CDC 2011 Guidelines for Field Triage of Injured Patients (Figure A).[1]

*Remarks:* In formulating these recommendations, the panel acknowledges that the relative lack of evidence is at odds with the fact that strong GRADE recommendations are generally meant to be adopted as policy. However, the panel considered that most patients with severe injuries would highly value the most expedient mode of transport possible and felt strongly that OLMD should therefore not be *mandatory* in order to activate HEMS for the sickest patients. Thus, the panel suggests that despite their strength of recommendation, it would be reasonable for individual EMS systems to reconsider the evidence and contextualize both recommendations for their own milieu.

*Recommendations:*

We suggest that HEMS be used to transport patients meeting appropriate physiologic and anatomic criteria for serious injury to an appropriate trauma center if there will be a significant time-savings over GEMS.*

(Weak recommendation, very low quality evidence)

We suggest that GEMS be used to transport all other patients to an appropriate hospital, so long as system factors do not preclude safe and timely transportation.

(Weak recommendation, very low quality evidence)

* Patients meeting appropriate physiologic and anatomic criteria have clinical features consistent with Steps One and Two of the CDC 2011 Guidelines for the Field Triage of Injured Patients (Figure A).[1]

*Remarks:* In formulating these recommendations, the panel placed high importance on potential morbidity and mortality benefit, and lower importance on cost and resource utilization.

A suggested protocol was drafted based on these recommendations (Figure B).

# Discussion

## *How might this EBG improve HEMS triage?*

The development of Evidence-Based Guidelines for the transportation of trauma patients is intricately linked to the overall quality of the literature surrounding the benefits of HEMS. Given the inherent difficulties with assessing patient outcomes as a function of prehospital care, as well as with making ground versus air comparisons, the authors formulated the recommendations based on their assessment of the best available evidence.

In the United States, helicopters are used frequently for the transportation of trauma patients; a 2007 overview estimated that 753 helicopters (and 150 dedicated fixed-wing aircraft) are in EMS service.[3] The ideal HEMS triage tool ensures patients receive the right care from the

right institution without wasting health-care resources. Accepting that patients needing specialized services might not have severe or readily identifiable injuries at the scene, the watershed territory of trauma triage is the identification of patients who might benefit from specialized services while not having readily apparent physiologic or anatomic derangements.

Being too selective in activating HEMS might lead to unacceptably high rates of undertriage and increased morbidity and mortality in trauma.[10] The possibility of undertriage, however, must be balanced against the opposite outcome of overtriaging and sending too many patients to specialized centers. The American College of Surgeons has stated that "an undertriage rate of 5-10% is considered unavoidable and is associated with an overtriage rate of 30-50%."[11] Despite this triaging challenge, studies focusing on this subject cite overtriage rates from 50-90%.[12,13] One recent analysis determined that the costs associated with trauma care and overtriage would decrease substantially if the CDC Guidelines for the Field Triage of Injured Patients were consistently applied.[14]

## *How was patient and staff safety factored in to the guideline?*

The safety of patients and EMS providers is a key consideration when assessing whether to transport by ground or air, and a controversial topic both in the EMS community and in the popular media. It is widely thought that the benefit to patient outcomes greatly exceeds any potential risks inherent in helicopter transport, although recent adverse incidents have instigated renewed dialogue about the best way to maximize this benefit: risk ratio.[4,15] A recent NTSB report indicates that the "aviation risk" of HEMS has not been well studied or evaluated by EMS.[16] The debate is confounded by heterogeneity in HEMS equipment, crew training, and safety protocols, as well as difficulties in directly comparing safety risks between ground and air transportation. Overall,

the data indicates that the risk of aeromedical transport is very low, but the risks of ground transport are not negligible either.[17-19] Given the inconclusiveness of the data on this subject, this guideline recommends preferential use of HEMS only when there is a likely outcome benefit to the patient.

## *What are the strengths and limitations of this guideline?*

This guideline represents the first synthesis of the available evidence on prehospital trauma triage using the GRADE methodology. The GRADE process increases the transparency of guideline formulation whilst lending flexibility to the implementation of the end product by assigning strengths to the developed recommendations. Nevertheless, it was the authors' experience that the dearth of information about patient preferences, relative harms and benefits, and resource usage on the subject of HEMS made the assignment of recommendation strengths problematic and more susceptible to subjective decision-making by the expert panel. While there is some literature that addresses public perception vis-à-vis HEMS, the data is quite sparse. The available evidence suggests that at least in some countries, the public preferences with respect to HEMS use are generally in line with policy-maker expectations with regard to use of financial resources to fund HEMS.[20]

Despite the lack of published literature, the volume of annual HEMS flights, combined with the non-likelihood of significant short-term improvement in the evidence, render it reasonable to promulgate guidelines based upon the best available information. The guideline panel made every effort possible to be objective in areas where some consensus-based decision-making was necessary owing to lack of definitive evidence.

## *How did we come to recommend the CDC 2011 Guidelines for the Field Triage of Injured Patients as part of this guideline?*

This guideline recommends that the 2011 CDC Guidelines for the Field Triage of Injured Patients (Figure A) be used to stratify patients into groups most likely to benefit from HEMS. The CDC guidelines utilize the best available evidence to derive the safest possible triage guidelines. Factors that inform this triage process may be categorized as anatomic (*e.g.* specific injuries noted), physiologic (*e.g.* vital signs abnormalities), or situational (*e.g.* logistics, injury mechanism).[1,21] Each of these three major categories includes at least some variables that are associated with risk of major injury and worse outcomes.[13,22-30] The decision-making surrounding transport modality is inextricably linked to the data informing trauma triage, since patients at higher risk of injury are more time-sensitive cases for which advanced intervention and transport to high-level trauma care is often achievable only via HEMS.[31]

Many laudable attempts to streamline prehospital trauma triage have attempted to identify anatomic, physiologic, or situational components that identify patients appropriate for advanced trauma care without resulting in substantial overtriage. [32-34] Reliance on physiologic criteria/vital signs alone, for instance, will likely result in unacceptable levels of undertriage, as patients with significant injuries may have normal vital signs at the scene.[35,36] The same concerns apply to triage decisions based solely on anatomic or situational factors.[34,37,38]

The strength of evidence addressing patient morbidity and mortality associated with field triage decisions was judged to be low, largely due to the lack of prospective, large-scale trials. The prospective data that do exist are derivation studies or pilot-testing of new triage parameters such as heart-rate variability.[39,40] Thus, the evidence base is insufficient to meet the GRADE criteria for

anything other than low evidentiary quality. Issuing a strong recommendation in the face of low evidence quality is potentially problematic, but is justified in the opinion of the panel reviewing the data. This justification rests on the harm/benefit balance of promulgating the 2011 CDC Guidelines. While the criteria are potentially over-inclusive, in that they incorporate all triage information categories that are currently known to be associated with time-sensitive and severe injuries, the harm of undertriage due to inappropriate reduction of triage criteria is significant.[41] The alternate harm, of overtriaging patients to high-level trauma care (and in many cases, helicopter transport), is primarily one of unnecessary resource utilization.[42] In addition, some data indicates that despite their broad inclusiveness, previous iterations of the CDC trauma triage criteria might actually reduce overtriage rates.[43] The panel considered patients' likely preferences regarding risk of death or major disability versus risk of potential resource overutilization. The weighting of significant risk of morbidity/mortality, versus potential resource overutilization, was considered by the panel to justify a strong recommendation.

The panel understands and intends that the strong recommendation sets a standard by which EMS systems should be measured. In fact, this standard is also consistent with the standard developed by other national-level bodies such as the Centers for Disease Control and Prevention's National Center for Injury Prevention and Control.

## *On what basis do we justify our recommendations regarding online medical control?*

The panel reviewed the literature to determine whether online medical direction should be required for activating helicopter transportation for trauma patients. Mortality, morbidity, and under-triage of critically ill patients were determined to be critical outcomes. Overtriage (with its

associated higher costs and assumed risks) and system related outcomes such as scene times, error rates, and unnecessary treatments were determined to be of secondary importance.

Despite an extensive literature search (see Appendix A), the panel did not identify any high quality studies directly pertinent to the question at hand. Two prospective observational studies demonstrated that paramedics can apply standing orders for a variety of medical and trauma-related complaints with an acceptably low error rates and few adverse outcomes.[44,45] Mulholland et al. demonstrated that paramedics could independently and reliably identify patients with life-threatening injuries, lessening the concern for undertriage for the critically ill.[38] A retrospective review of triage appropriateness by Lubin et al. concluded that paramedics and community emergency physicians have similar proficiency at identifying cases appropriate for transfer to a Level One Trauma Center.[46] However, a prospective observational study by Champion et al. suggested paramedics might have a tendency to overtriage, and that OLMD might reduce the overtriage rates by up to 50% in low severity cases.[47]

Recognizing the time-sensitive nature of life threatening traumatic injuries, the panel also investigated whether OLMD affects scene times for trauma patients. Recent literature was not available. Four studies, all conducted more than 20 years ago, were reviewed by the panel but their applicability was limited since there have been many changes in the quality of EMS care since their publication. Erder et al. determined that OLMD was associated with slightly longer scene times and infrequent physician-directed deviation from written care protocols, but the patient sample included medical and trauma patients.[48] In a prospective before-and-after study of non-trauma patients, Rottman et al. determined that the use of protocols by paramedics (rather than online medical direction by nurses) did not affect scene times or the appropriateness of clinical decisions.[49] A 1991 retrospective study by Gratton et al. determined that standing orders for procedural interventions in unstable trauma patients resulted in similar scene times as when OLMD

was used.[50] No studies directly addressed morbidity, mortality, or cost as a function of requiring online medical direction for activating HEMS for trauma patients. However, the available evidence does indicate that paramedics are able to exercise good judgment in identifying critically ill trauma patients, with perhaps a tendency towards overtriage. While online medical direction might lessen this overtriage, it has not been proven to reduce morbidity, mortality, or scene times. Improving triage specificity could have an indirect effect on patient and crew safety by lessening the number of flights and hence the inherent risks associated with aeromedical transportation, but this assumption has not been proven with objective data.

The panel considered that patients at greatest risk of life-threatening injury, and their families, would value the most expeditious transfer possible to the trauma centre providing the highest level of care much more than the potential costs and risks associated with overtriage. As such, the panel strongly recommends HEMS can be activated without OLMD for patients falling into the CDC Guidelines Steps One and Two.

For all other trauma patients, the panel felt that a more balanced valuation of outcomes was warranted. Patients might be more concerned with the costs and risks associated with air transport if their injuries were less severe, and therefore would more likely support improved triage specificity through OLMD. As such, the panel suggests for patients who meet the criteria for Steps 3 or 4 of the CDC Guidelines, EMS providers utilize OLMD at their own discretion, provided it will not result in significant transport delays.

## *What are our reasons for recommending helicopter transportation for patients with certain anatomic and physiologic criteria?*

There is some evidence to suggest that severely injured trauma patients benefit from being transported directly from the scene to an appropriate trauma center.[51-53] Since the panel meeting for this guideline, two major studies germane to the subject have been published in the peer-reviewed literature. One study by the ROC consortium identified a positive, but not statistically significant, point estimate for the association between HEMS transport and scene trauma mortality. Another, far more methodologically rigorous, study focused only on those patients with severe injuries as defined by ISS; a statistically significant association between air transport and mortality was identified.[54,55]

Attempts to isolate a workable subset of HEMS activation criteria have been stymied by both the variability in EMS systems and the challenges of prehospital research. For instance, a systematic review by Ringburg et al. examined a wide variety of physiologic, anatomic, and mechanistic dispatch criteria. No single component demonstrated sufficient accuracy in narrowing the number of considered dispatch variables and the authors concluded that a more rigorous analysis was needed.[34] A retrospective registry review by Braithwaite et al. found that patients with an Injury Severity Score (ISS) of 16 to 60 might have improved outcomes with HEMS.[56] A review panel led by Black selected decreased LOC, airway obstruction, respiratory distress, shock, and significant head injury as the clinical features that should prompt activation of HEMS.[32] Through a database review, Giannakopoulos et al. isolated anatomic, physiologic, and mechanistic criteria which warranted the most timely transportation possible to a trauma center.[41] Moront et al. determined that in pediatric trauma, the combination of GCS<12 and HR>160 yielded a 99% sensitivity and 90% specificity for major trauma, although there were limitations in the study.[42]

Stewart et al. determined that the mortality benefit of HEMS was minimal in patients with normal vital signs or in whom the Revised Trauma Score was less than three.[52]

The issue of HEMS activation is perhaps even more complex in pediatric trauma, where the potential for saving life-years might prompt overtriage. Eckstein et al. retrospectively examined pediatric trauma transportation and concluded that many pediatric patients in their system who were transported by helicopter had minor injuries. A third of the children in their study were discharged directly from the Emergency Department.[57] Concerns regarding pediatric overtriage were also expressed by Moront et al, who derived a pediatric overtriage rate of 85% from their retrospective study.[42]

Further confounding the analysis of this subject is the disputable time savings of HEMS. Some studies found no difference in transport times for HEMS vs. GEMS, even when controlling for distance travelled.[58] From a methodological perspective, it is exceedingly difficult to retrospectively determine which transport modality is superior unless variables such as local weather, traffic congestion, and EMS crew capabilities are specifically noted as part of the patient record.

Overall, the quality of research examining this issue is low or very low, with most studies being retrospective and heavily reliant on large data registries. None of the HEMS activation variables derived in these studies have been prospectively validated in multi-center trials. In formulating the recommendations, the panel considered that the most seriously injured patients and their families would likely place high value on the most expedient transport possible to hospital. And while the time and cost effectiveness of HEMS remains disputable, the authors posit that most seriously injured patients would choose HEMS over GEMS unless its perceived mortality and time

benefits were conclusively disproven with high quality evidence. Reinforcing this patient perception of HEMS is some debatable evidence of mortality benefit for the sickest patients.

Given the poor quality of the evidence supporting mortality benefit and their estimation of patient preference, the authors have issued a weak recommendation to transport patients meeting anatomic and physiologic criteria as per the CDC Guidelines by HEMS to a trauma center, provided it will be more expedient. The authors suggest transporting all other patients by GEMS unless system variables such as patient condition, local weather, road conditions, and EMS crew training and availability make HEMS the preferable modality.

By assigning a weak strength to these recommendations, the authors intend that EMS policy-makers and administrators will contextualize guidelines based on the dynamics of their particular system. It also suggests that further research on the benefits of HEMS is urgently required. Consultation with key stakeholders, including patients and EMS providers, should be a pivotal part of this process, particularly given the lack of published data regarding patient preferences for HEMS.

## *What are the plans to contextualize, implement, and evaluate the guideline?*

Weak GRADE recommendations provide latitude for policy-makers to revise and contextualize the guideline without altering its fundamental intent.[59] This is the case with the MIEMSS contextualization of this guideline. Specifically, the MIEMSS Committee decided that online medical control should remain mandatory for patients meeting criteria for Steps 3 or 4 of the CDC Guidelines, whereas the EBG issues a weak recommendation that OLMD should be optional for patients in this category.

This flexibility of the GRADE process and the National EBG Model process will assist in overcoming an important barrier to implementation by allowing policy-makers to shape the guideline to their needs. Ideally, before-and-after research could be used to demonstrate that guideline implementation results in improved outcomes. Sometimes provider beliefs and opinions can challenge implementation of a new guideline, particularly if it is very different from what currently exists in their system. To overcome provider reluctance, the authors suggest that the guideline be incorporated into local annual protocol revision processes and yearly provider educational conferences.

### *How will the guideline be revised in the future?*

The guideline will be presented to relevant professional societies and government agencies, such as the NAEMSP Standards and Practice Committee and FICEMS, for feedback and potential endorsement. A regular cycle of review and updates is suggested for regularly planned future meetings of these organizations.

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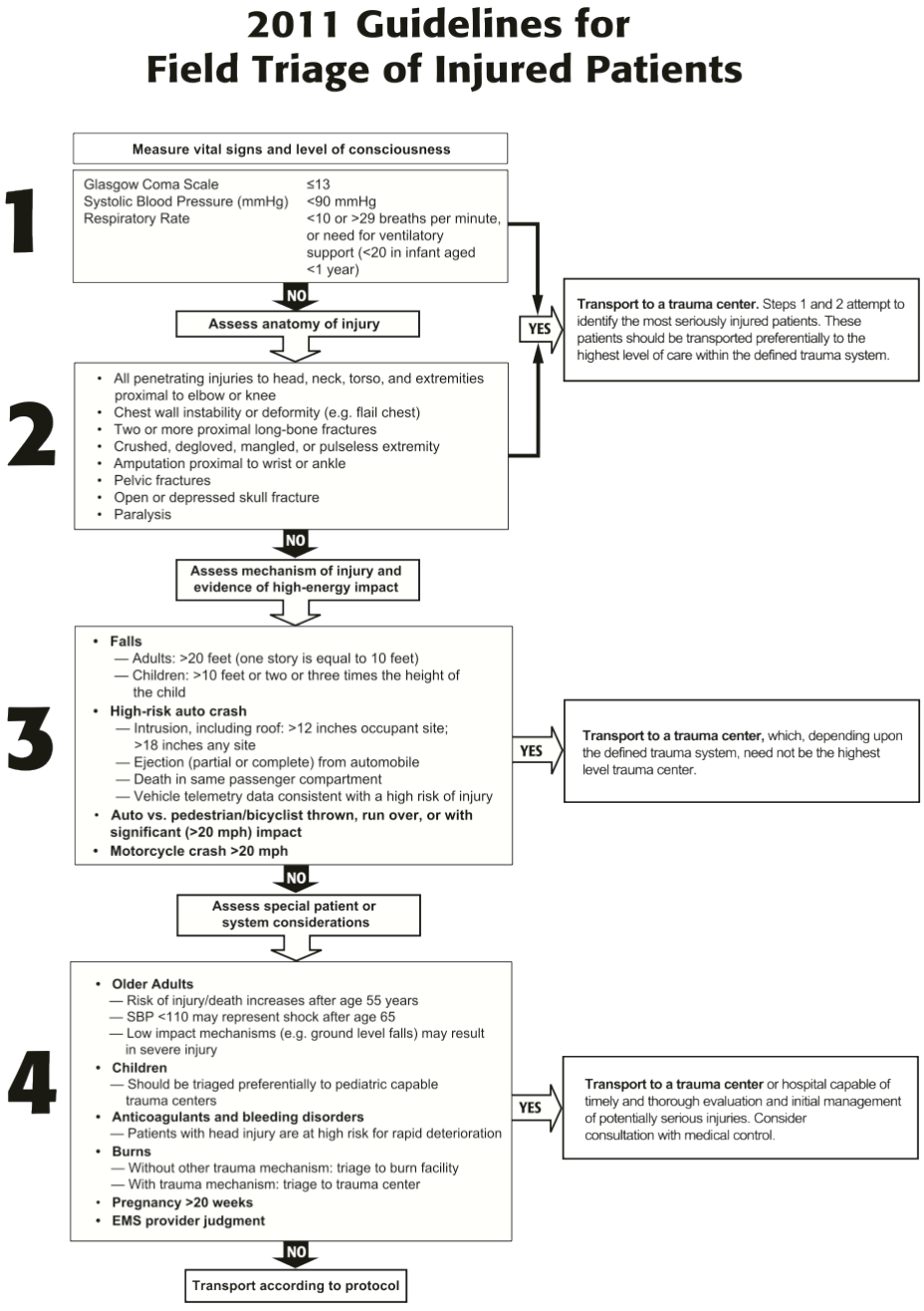
## Appendix A – Search Strategies

## Appendix B – Evidentiary Tables

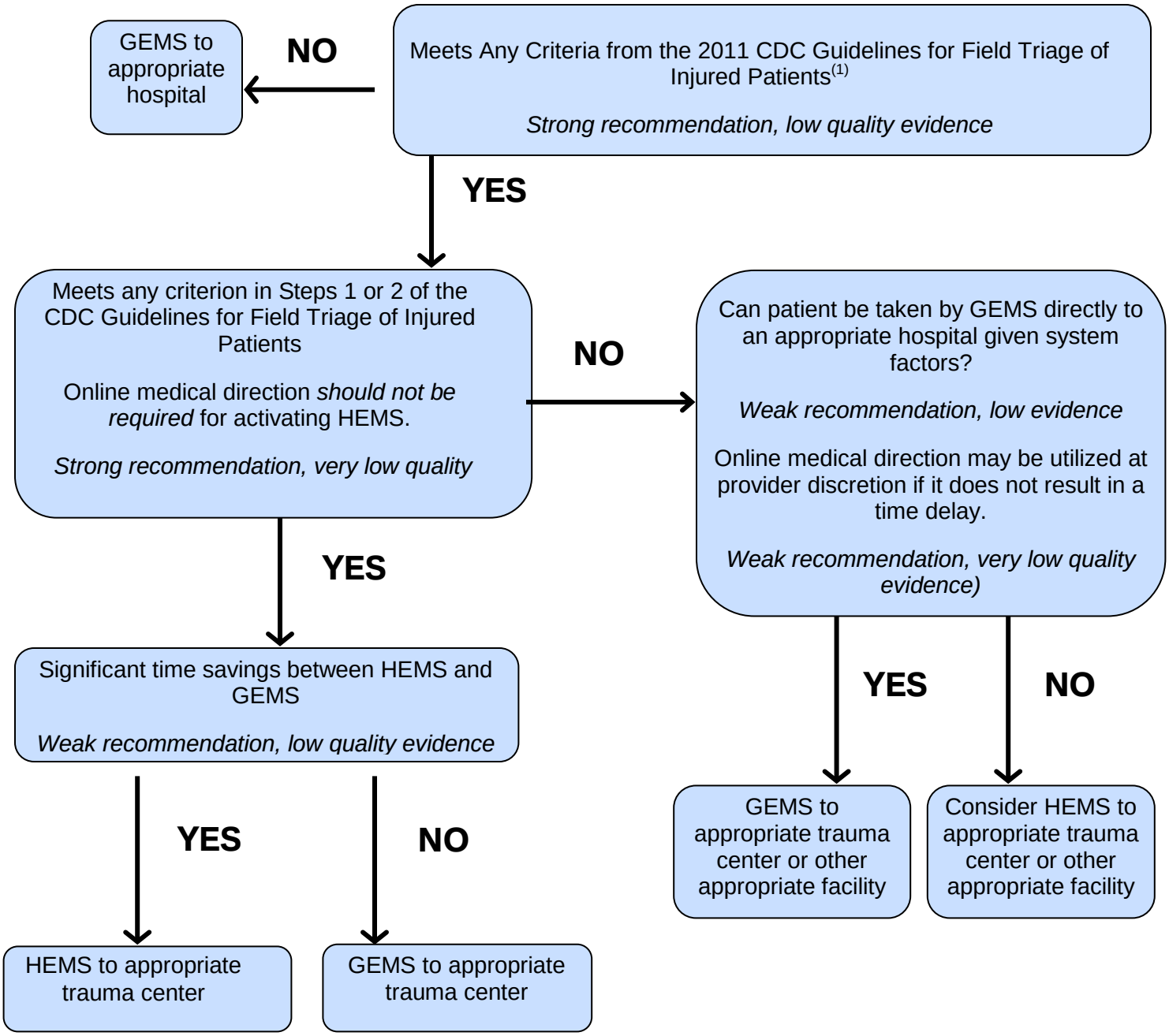
## Appendix C – GRADE Tables

# Figure A


2011 Guidelines for
Field Triage of Injured Patients
Measure vital signs and level of consciousness
1
Glasgow Coma Scale ≤13
Systolic Blood Pressure (mmHg) <90 mmHg
Respiratory Rate <10 or >29 breaths per minute, or need for ventilatory support (<20 in infant aged <1 year)
NO
Assess anatomy of injury
YES
Transport to a trauma center. Steps 1 and 2 attempt to identify the most seriously injured patients. These patients should be transported preferentially to the highest level of care within the defined trauma system.
2
All penetrating injuries to head, neck, torso, and extremities proximal to elbow or knee
Chest wall instability or deformity (e.g. flail chest)
Two or more proximal long-bone fractures
Crushed, degloved, mangled, or pulseless extremity
Amputation proximal to wrist or ankle
Pelvic fractures
Open or depressed skull fracture
Paralysis
NO
Assess mechanism of injury and evidence of high-energy impact
3
Falls
— Adults: >20 feet (one story is equal to 10 feet)
— Children: >10 feet or two or three times the height of the child
High-risk auto crash
— Intrusion, including roof: >12 inches occupant site; >18 inches any site
— Ejection (partial or complete) from automobile
— Death in same passenger compartment
— Vehicle telemetry data consistent with a high risk of injury
Auto vs. pedestrian/bicyclist thrown, run over, or with significant (>20 mph) impact
Motorcycle crash >20 mph
YES
Transport to a trauma center, which, depending upon the defined trauma system, need not be the highest level trauma center.
NO
Assess special patient or system considerations
4
Older Adults
— Risk of injury/death increases after age 55 years
— SBP <110 may represent shock after age 65
— Low impact mechanisms (e.g. ground level falls) may result in severe injury
Children
— Should be triaged preferentially to pediatric capable trauma centers
Anticoagulants and bleeding disorders
— Patients with head injury are at high risk for rapid deterioration
Burns
— Without other trauma mechanism: triage to burn facility
— With trauma mechanism: triage to trauma center
Pregnancy >20 weeks
EMS provider judgment
YES
Transport to a trauma center or hospital capable of timely and thorough evaluation and initial management of potentially serious injuries. Consider consultation with medical control.
NO
Transport according to protocol
When in doubt, transport to a trauma center.

# Figure B

## HEMS Evidence Based Guideline (with Trauma Center Designated)



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# Appendix A – Literature Search Strategies

## Clinical Question #1:

| | |
|---|---|
| Patient | In trauma patients of all ages who use 911 services |
| Intervention | do EMS systems which use **triage criteria** based on **physiologic parameters** |
| Comparator | versus systems that use **mechanism of injury**<br>versus systems that use **scoring systems** such as the ISS or RTS |
| Outcome | improve **survival and disability** outcomes |
| Design | in **prospective observational** trials or **well-controlled retrospective** studies ? |

*Exclusions*: secondary transfers, drownings, burns, non-English language

*Databases:* Cochrane database, PubMed, Ovid, Bibliographies

*Search parameters:*

(("Air Ambulances"[Mesh] OR hems OR helicopter* OR “rotary wing” OR “rotary-wing” OR “rotor wing” OR aeromedical OR “air medical” OR airlift* OR “air transport” [Title/Abstract] OR “air evacuation” OR (air and ground))

AND

(trauma OR “traumatic”[title/abstract] OR “severely injured”[title/abstract] OR “severe injuries”[title/abstract] OR “injury severity”)

AND

(“trauma center*” or “trauma centre*” or "Trauma Centers"[MeSH Terms] OR prehospital OR “pre-hospital” OR “out of hospital”)

AND

(criteria OR validity[title] OR validation[title] OR "validation studies"[Publication Type])

AND

("trauma severity indices"[MeSH] OR “criteria”[title/abstract] OR “Severity of Illness Index"[Mesh] OR “trauma score” OR “severity score”[Title/Abstract] or "Triage/standards"[Mesh] OR "Triage/classification"[MAJR] OR classification[MeSH Subheading] OR "Risk Assessment"[Majr] OR "Predictive Value of Tests"[MeSH Terms] or "Algorithms"[Mesh] OR "Decision Trees"[Mesh] or “field triage” OR "Wounds and Injuries/classification"[MAJR] or "Transportation of Patients/standards"[MAJR])

NOT

(Military or combat or war or navy or “air force” or army OR disaster OR ultralight OR "airplane"[Title/Abstract] OR "Accidents, Aviation"[Mesh] OR hems[Author] or "Travel"[Mesh] or “airline"[Title/Abstract] or “airlines"[Title/Abstract]))

OR

(("Air Ambulances"[Mesh] OR hems OR helicopter* OR “rotary wing” OR “rotary-wing” OR “rotor wing” OR aeromedical OR “air medical” OR aircraft OR airlift* OR "Aircraft"[Mesh] OR “air transport” [Title/Abstract])

AND

"Decision Making"[Mesh] AND "Triage"[Mesh]) Will keyword search “criteria”

## Clinical Question #2:

| | |
|---|---|
| Patient | In trauma patients of all ages who use 911 services |
| Intervention | does on-line medical direction (OLMD)* |
| Comparator | compared to alternative forms of medical direction (such as EMS treatment protocols or standing orders) for determining transport modality |
| Outcome | impact mortality or other secondary outcomes** |
| Design | in prospective observational trials (e.g., before/after system trials, time-series analyses, step-wedge methodology) (preferred) or other quasi-experimental studies? |

*OLMD = physician guidance provided to EMS providers via telephone or videoconference

** secondary outcomes considered include EMSOP outcomes: death, disease, disability, destitution, dissatisfaction, and discomfort

*Exclusions:* secondary transfers, drownings, burns, non-English language

*Databases:* Pubmed, Pubmed secondary and tertiary Related Citations search, bibliographies, gray literature

*Search Parameters:*

•("Air Ambulances"[Mesh] OR hems OR helicopter* OR "rotary wing" OR "rotary-wing" OR "rotor wing" OR aeromedical OR "air medical" OR airlift* OR "air transport"[Title/Abstract] OR "air evacuation" OR (air and ground)) AND ("Medical direction"[title/abstract]) OR (("Air Ambulances"[Mesh] OR hems OR helicopter* OR "rotary wing" OR "rotary-wing" OR "rotor wing" OR aeromedical OR "air medical" OR airlift* OR "air transport"[Title/Abstract] OR "air evacuation" OR (air and ground)) AND ("Medical direction"[title/abstract] OR "Physician Executives"[Mesh] OR "Physician's Role"[Mesh] OR "physician's role"[title/abstract] OR ("physician"[title/abstract] AND ("led"[title/abstract] OR "role"[title/abstract] OR "directed"[title/abstract] OR "leadership"[title/abstract])) OR "Professional Competence"[Mesh] OR "Clinical Competence"[Mesh] OR "Interprofessional Relations"[Mesh] OR "Patient Care Team"[MAJR] OR "Telecommunications"[Mesh] OR teletrauma[title/abstract] OR teleconsults[title/abstract] OR telepresence[title/abstract] OR telehealth[title/abstract] OR telemedicine OR radio[title/abstract] OR telephone OR video[title/abstract] OR "medical control"[title/abstract] OR online[title] OR "on-line"[title/abstract] OR "online medical command"[title/abstract] OR "on-line medical command"[title/abstract] OR "medical control"[title/abstract]) AND (trauma OR "traumatic"[title/abstract] OR "severely injured"[title/abstract] OR "severe injuries"[title/abstract] OR "injury severity" OR EMS[title/abstract]) AND ("trauma center*" OR "trauma centre*" OR "Trauma Centers"[MeSH Terms] OR prehospital OR "pre-hospital" OR "out of hospital" OR "Emergency Medical Services"[Mesh] OR time OR survival OR mortality OR morbidity) NOT (Military OR combat OR war OR navy OR "air force" OR army OR disaster OR ultralight OR "airplane"[Title/Abstract] OR "Accidents, Aviation"[Mesh] OR hems[Author] OR "Travel"[Mesh] OR "airline"[Title/Abstract] OR "airlines"[Title/Abstract] OR burns OR drowning))

## Clinical Question #3:

| | |
|---|---|
| Patient | In trauma patients of all ages who use 911 services |
| Intervention | Does transportation by air based on particular physiologic, anatomic, and mechanistic characteristics |
| Comparator | As compared to transportation by ground |
| Outcome | Affect morbidity and mortality? |
| Design | In systematic reviews or high-quality randomized controlled trials? |

*Exclusion*: secondary transfer, drownings, burns, non-English language studies

*Databases:* Cochrane, PubMed, Ovid, Bibliographies

*Search strategy*

(("Air Ambulances"[Mesh] OR hems OR helicopter* OR “rotary wing” OR “rotary-wing” OR “rotor wing” OR aeromedical OR “air medical” OR airlift* OR “air transport” [Title/Abstract] OR “air evacuation” OR (air and ground))

AND

(trauma OR “traumatic”[title/abstract] OR “severely injured”[title/abstract] OR “severe injuries”[title/abstract] OR “injury severity”)

AND

(“trauma center*” or “trauma centre*” or "Trauma Centers"[MeSH Terms] OR prehospital OR “pre-hospital” OR “out of hospital”)

AND

(criteria OR validity[title] OR validation[title] OR "validation studies"[Publication Type])

AND

("trauma severity indices"[MeSH] OR “criteria”[title/abstract] OR “Severity of Illness Index"[Mesh] OR “trauma score” OR “severity score”[Title/Abstract] or "Triage/standards"[Mesh] OR "Triage/classification"[MAJR] OR classification[MeSH Subheading] OR "Risk Assessment"[Majr] OR "Predictive Value of Tests"[MeSH Terms] or "Algorithms"[Mesh] OR "Decision Trees"[Mesh] or “field triage” OR "Wounds and Injuries/classification"[MAJR] or "Transportation of Patients/standards"[MAJR])

NOT

(Military or combat or war or navy or “air force” or army OR disaster OR ultralight OR "airplane"[Title/Abstract] OR "Accidents, Aviation"[Mesh] OR hems[Author] or "Travel"[Mesh] or “airline"[Title/Abstract] or “airlines"[Title/Abstract]))

OR

(("Air Ambulances"[Mesh] OR hems OR helicopter* OR “rotary wing” OR “rotary-wing” OR “rotor wing” OR aeromedical OR “air medical” OR aircraft OR airlift* OR "Aircraft"[Mesh] OR “air transport” [Title/Abstract])

AND

"Decision Making"[Mesh] AND "Triage"[Mesh]) Will keyword search “criteria”

OR map to “standards” [subheading]

## Clinical Query #1: Evidentiary Tables

| Study | Patient | Intervention | Comparator | Outcome | Design | Remarks |
|---|---|---|---|---|---|---|
| Tortella (1996)[1] | 3 years of HEMS and GEMS scene responses to single adult/pediatric TC | HEMS | GEMS | Injury severity adults vs. pediatrics | Retrospective registry-based | • same system analysis<br>• no focus on which criteria best predict ____<br>• pediatric ISS> 15 for HEMS and GEMS |
| Black (2004)[2] | Trauma scene patients | HEMS transport | n/a | Production of triage algorithm | Algorithm based on panel consensus | • attempts to address both HEMS and trauma centre criteria<br>• broad statements based on thin evidence base<br>• superficial treatment of critical areas (ie: physiology)<br>• UK based study |
| Moront (1996)[3] | Consecutive pediatric (<15) trauma admissions, 75% scenes | Triage criteria | n/a | Identification of optimal triage criteria (GCS, Ps, ISS, mortality) | Retrospective, registry-based HEMS/GEMS *n* = 1460/2896 | • Relatively large *n* (nearly 3000 scene air/ground transports)<br>• Assessment/reporting of a specific set of possible triage criteria: (GCS<12, HR <160)<br>• Lack of validation<br>• Results as to triage sensitivity/specificity not consistent with other trauma triage literature<br>• Lack of subsequent data analysis confirming appropriateness of GCS/HR-based trauma triage |
| Eckstein (2002)[4] | Pediatric (<15) trauma scene patients over 3 years | HEMS triage for ground tport time>20' | GEMS | Injury acuity (RTS, ED ETI, ICU admit, OR, ISS) | Retrospective, records-based | • Focus on pediatric trauma<br>• Reporting on field-available data (*i.e.* not ISS)<br>• Relatively complete dataset (*i.e.* all pedi trauma transports for 3 years)<br>• Low numbers (<200 patients)<br>• Incomplete discussion of literature (*e.g.* Fischer/ALS interventions) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | • Selective discussion of medical points (*e.g.* "hyperventilation is standard of care for TBI")<br>• Uncertain basis for some conclusions (*e.g.* HEMS EMTPs should have RSI capability) |
| Kotch (2002)[5] | Pediatric (<16) and adult trauma scene patients 5 years<br>Pedi *n* = 143;<br>Adult *n* = 819 | HEMS | N/A | Injury severity (ISS, RTS, Ps, LOS) | Retrospective, registry-based | • Focus on pediatric trauma<br>• Relatively complete dataset (*i.e.* all transports for 4 years)<br>• Simplicity of analysis (univariate comparisons)<br>• Low numbers (only 143 pediatric patients with about 800 adults)<br>• Some inconsistency in results/conclusions<br>• Didn't address absolute performance of triage criteria, just equality between adults/pediatrics |
| Young (1998)[6] | Scene and interfacitliy trauma transfers to same trauma center who survived 24 hrs | Scene transport<br>*n* = 165 | Interfacility<br>*n* = 151 | Hosp LOS, ICU LOS, unexpected deaths (TRISS), overall mortality | Retrospective, registry-based | • Straightforward comparison of direct vs. indirect trauma center transport<br>• Same-hospital study (minimizing confounding by trauma center care)<br>• Doesn't help triage (use of ISS and hospital-survival 24-hour cutoff to define study entry)<br>• Relatively low numbers<br>• Apparent *a posteriori* definition of study eligibility as those surviving at least 24 hours<br>• Most study significant results were found only in the *a posteriori*-defined cohort mentioned above<br>• Authors note study doesn't provide data useful for triage-time determination as to who needs direct TC transport |

| | | | | | | |
|---|---|---|---|---|---|---|
| Mulholland (2008)[7] | Adult (>15 yrs) scene HEMS response | EMTP-applied acuity stratifier<br>*n* = 207 | N/A | Identification of injury acuity (mortality, ISS>15, any AIS at least 3, ICU >24 h, urgent OR) | Prospective EMTP application of triage instrument | • Prospective design<br>• Study results convincing: Failure of specificity even with built-in bias<br>• Definition of "major trauma" consistent with most literature<br>• Inclusion of sens/spec/PPV/NPV of various prehospital triage criteria<br>o a - HR, SBP, RR, GCS, Spo2: sensitivities ranged 10-53%<br>o b - Triage-RTS sensitivity: 31%<br>• Delineation of specific cases of "overtriage" as reasonable<br>• External validity to populations with lower injury severity (62% patients met criteria as "major trauma")<br>• Unclear ability to extrapolate from EMTP assessment of HEMS need, to those who actually dispatch HEMS |
| Shatney (2002)[8] | 11 years' scene transports to same trauma center | HEMS<br>*n* = 947 | N/A | HEMS appropriateness: Time savings, early OR, hospitalization with ISS>8 | Retrospective records review | • Strong common-sense argument that guidelines are needed<br>• Direct clinical correlation of definition to "need" for HEMS<br>• Attempt to incorporate logistics into HEMS needs assessment<br>• No determination of why HEMS was actually used in a given case<br>• Retrospective assessment of key logistics outcomes, by MD/RN/EMTPs a decade after transport<br>• No answer with respect to what prospective triage criteria should be used |
| Wigman (2011)[9] | Trauma scene response criteria for European HEMS services | Survey on dispatch criteria<br>*n* = 55 services (85% of 65 surveyed) | N/A | Level of uniformity in HEMS dispatch | Questionnaire | • Relatively high (85%) response rate<br>• High number of respondents (55 organizations)<br>• Relatively simple results<br>• Vague triage items (*eg.* "lengthy extrication and significant injury")<br>• No link of triage items on questionnaire, to actual correctness/utility of those items in triaging to TC/HEMS |
| Purtill (2008)[10] | HEMS dispatch criteria updating | Updated triage criteria<br>n=478 | 56-month period pre-update<br>n=676 | Correct identification of major trauma (2 "hits" on MOI, anatomy, physiol score system) | Before-and-after (triage rules modification) | • Specific triage items/tools are provided<br>• Very clear delineation of how triage system works<br>• Tie-in relevance to HEMS; relatedness of who-needs-TC to who-needs-HEMS issues<br>• Missing data in about 10% of cases (possibility of selection bias)<br>• Study period did incur a higher false-positive rate which seems |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | underemphasized (and is statistically significant)<br>• Proportion of Triage+ pts with minor trauma nearly doubled (from 17% to 29%) |
| Cunningham (1997)[11] | Consecutive HEMS and GEMS transports to 8 designated TCs | HEMS<br>*n* = 1346 HEMS | GEMS<br>*n*=17144 GEMS | Mortality | Retrospective registry-based | • Classical stratification complemented by multivariate modeling<br>• Focus on survival as a function of injury acuity<br>• Common-sense content of conclusions (need better triage)<br>• Lack of ability to identify triage-available parameters to improve HEMS utilization<br>• Insufficient attention to other (*eg.* logistic) indications for HEMS use in rural states<br>• Low power (HEMS improved outcome in all 8 mid-range strata but *p* significant in only 2 strata) |
| Barnoski (1998)[12] | Consecutive HEMS trauma center transports, with hospital stays <3 days | AAMS triage guidelines<br>*n* = 511 HEMS | N/A | Severe injury (ISS>14, RTS<10, GCS<12) or Mortality | Retrospective registry/records | • Application of triage tests to actual set of delineated guidelines<br>• Abstract available only -- limited review |
| Wuerz (1996)[13] | Consecutive HEMS transports to Level I TC | ACS triage guidelines<br>*n* =333 HEMS | N/A | Severe injury (ISS>14) | Retrospective registry/records | • Application of triage tests to actual set of delineated guidelines<br>• Specific statistical testing of each criteria using ISS>15 as severity endpoint<br>• Straightforward analysis<br>• Failure to offer solutions as to how to improve triage |
| van Wijngaarden (1996)[14] | Consecutive HEMS transports 2 months | HEMS<br>*n* = 97 | N/A | Panel-adjudicated appropriateness (RTS, ISS, Ps, procedures, logistics, outcomes) | Prospective panel review | • Prospective design seems likely to have improved data quality<br>• Discussion of actual triage criteria used in a system<br>• Discussion of the importance of minimizing undertriage<br>• Mention of "economics and requirement for advanced care" reasons for HEMS use<br>• Abstract available only -- limited review<br>• Low numbers precluded robust analysis (*eg.* ISS of MD/23 vs. non-MD/15 groups not statistically significant) |
| Coats (1993)[15] | One year of consecutive HEMS transports | Accident-site HEMS crew triage<br>*n* = 574 | N/A | Appropriate transport to specialist center | Retrospective records review | • Unusual approach of using on-scene physician for triage<br>• Abstract available only -- limited review<br>• Favorable results not easily reproducible in other studies, including assessment of interfacility (MD) vs. scene triage |

| | | | | | | |
|---|---|---|---|---|---|---|
| Rhodes (1986)[16] | Consecutive HEMS patients in rural setting | Triage using VS, MOI, logistics<br>*n* = 130 | N/A | Appropriate transport to trauma center (defined by authors) | Prospective single-cohort | • Prospective analysis of on-scene flight crew recording of triage variables<br>• Abstract available only -- limited review<br>• Flight crew used ground provider vital signs |
| Sasser (2009)[17] | Adult and pediatric trauma patients (all transport modes) | Expert panel review of evidence | N/A | Appropriate transport to trauma center | Expert panel (CDC) | • Based upon prolonged analysis of evidence over years, by experts<br>• Provides specific, easily teachable criteria with some room for judgment<br>• Recommendations are only as precise/discriminatory as supporting evidence |
| Hopkins (2011)[18] | Adult scene trauma patients (all transport modes) | HEMS transport | Ground EMS | Requirements for various high-level prehospital, ED, and hospital trauma interventions | Prospective cohort | • Relatively low rates (about 10%) of missing scene physiology data<br>• Focus on factors leading to need for HEMS use (“on-point”)<br>• Rigorous application of methodology to reduce risk of overfitting recursive partitioning model to the specific dataset<br>• Sensitivity analysis to rule out impact of missing variables on main results<br>• Limitation of focus on winter resort injuries of patients with mostly single-system trauma, occurring in areas relatively close to receiving trauma center (external validity)<br>• Scene study, but some patients came from “clinic” type settings at winter resorts<br>• Study generates prediction rule; no validation phase reported |
| Stewart (2011)[19] | Adult and pediatric scene trauma patients (all transport modes) | HEMS transport | Ground EMS | 2-week mortality | Retrospective cohort.<br>Propensity score analysis of HEMS-associated outcomes improvement | • Relatively low rates (7-10%) of missing scene physiology data<br>• Rigorous multiple imputation (Markov Chain Monte Carlo) of missing prehospital vital signs<br>• Appropriate limitation of multiple imputation (no MI for missing times, distances)<br>• Study goal was assessment of HEMS' impact on outcome, not HEMS triage<br>• Standard limitations attendant to registry-based research apply<br>• RTS-based findings not likely sufficiently precise to directly |

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| | | | | | | translate to triage |
| King (2009)[20] | Adult scene trauma patients transported by HEMS | Monitoring of heart-rate variability, SDNN (standard deviation [SD] of the normal-to-normal R-R interval) | N/A | High base excess; severe injury (ISS>15); operative interventions; mortality | Prospective blinded (clinicians not aware of SDNN results in realtime) | • Prospective, blinded design<br>• Extension of known physiology to real-patient investigation<br>• Comparison of SDNN to other parameters (*e.g.* vital signs) to assess for incremental benefit of using the new approach<br>• Small *n*<br>• Inconsistency with previous studies (reported that prehospital vital signs were not predictive of outcomes)<br>• Studied only patients who were already triaged to HEMS transport (no ground EMS group) |
| Giannakopoulos 2011 (*Emerg Med J*)[21] | HEMS trauma scene dispatches | HEMS transport | | Identification of major trauma (ISS at least 16, emergency interventions, ICU admit, or death) | Retrospective cohort Derivation (using logistic regression) of criteria for cancellation of HEMS | • Results suggest potential for meaningful power (sensitivity for major trauma, 99.4%) for application (if results are validated)<br>• Derivation model; no validation study done yet<br>• Abstract only available for review |
| Giannakopoulos 2011 (*J Emerg Med*)[22] | Adult trauma patients by HEMS or ground EMS | HEMS transport | N/A | Identification of major trauma (ISS at least 16, emergency interventions, ICU admit, or death) | Analysis as to whether maximum (normal) RTS rules out major trauma (and thus rules out need for HEMS) | • Simple question/design<br>• If max RTS would work for HEMS cancellation, easily applied in clinical practice<br>• Small *n*<br>• Inconsistency with previous studies (arguably already known that physiology alone doesn't rule-out major injury)<br>• Failed to assess other combinations of parameters along with max RTS |

## Clinical Query #2: Evidentiary Tables

| STUDY | Population | Intervention | Comparators | Outcome | Design | Quality | COMMENTS |
|---|---|---|---|---|---|---|---|
| Champion (1988)[23] | Patients triaged to a trauma centre using one of three methods<br><br>(N = 176) | Assessed injury severity<br><br>System 1 (EMT decision): n=31 | System 2 (Physician input): n=42<br><br>System 3: (Transfer): n=103 | Physician input resulted in patients admitted with a higher median level of injury severity<br><br>Conceivably could decrease cost (Outcome: "Destitution") | | LOW<br><br>--Not directly helpful | • Describes the fact that "prehospital personnel receive little training in structured triage decision making"<br>• Authors state that their study has implications for controlling "over-triage."<br>• Doesn't give any info about MD impact on other outcomes. |
| Lubin (2005)[24] | Patients transported from scene or via interfacility transfer<br><br>C vs. trans from EDs. Found no difference among 658 scene pts and 345 ED trans. | Transfer from scene<br><br>n=658 | Transfer from Community ED's<br><br>n=345 | Patients exhibited similar ISS scores, LOS, and disposition<br><br>No difference found (unclear if sufficient power to detect Type II statistical error).<br><br>Prehospital providers may triage patients to HEMS transport with | Retrospective comparison of injury severity (RTS, ISS, etc)<br><br>Single system data | VERY LOW<br><br>- indirectly related | • Retrospective<br>• Limited face validity that confounders could have been adequately identified and adjusted for |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | "proficiency similar to that of community ED physicians" | | | |
| Tortella (1996) [25] | Motor vehicle collisions<br><br>n=167 | HEMS scene times to trauma center (TC) | Computer derived driving times to same incidents | best person to request HEMS varies by location<br><br>The OLMC model resulted in a longer mean value for time to TC by HEMS than did the model for all ground transport settings. Differences in mean values for time in urban settings were small (ground: 42 min, air: 36 min), whereas those for the suburban (ground: 52, air: 41), and those for rural (ground: 69, air: 47) "were significant clinically." | Computer mapping programs were used to model the most rapid driving time to the closest trauma center from 167 actual HEMS responses to the scene of MVCs. | VERY LOW<br><br>--Not directly helpful | • TNTC<br>• Assumes that minutes to TC >10 is "clinically significant"<br>• If the computer model is correct (which is not at all proven), OLMC lengthens dispatch to TC Interval.<br>• In theory, could impact outcomes.<br>• However, no outcomes were evaluated, and, in fact, ALL cases were flown.<br>• Thus, this does NOT actually compare air vs. ground decisions at all. |
| Air Medical Physician Association (2003) [26] | Position statement by AMPA related to the importance of Medical Direction of HEMS. | | | Strong position of requirements for MD leadership of HEMS<br><br>Nothing specific about ONLNE vs. OFFLINE medical control | | VERY LOW | • No refs/no supporting literature. Simply a position statement by an authoritative body.<br>• Related but not helpful for this question. |
| Rottman (1997) [27] | Consecutively enrolled patients who met | Online medical control by | Protocol care by | On-scene time, appropriateness of | Prospective before-and- | | • |

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| | protocol inclusion criteria and presented with altered level of consciousness, nontraumatic chest pain, or shortness of breath. | EMS-certified nurses<br><br>(n=287) | paramedics<br><br>(n=294) | therapy, and accuracy of paramedic clinical assessments<br><br>On-scene time was 1 minute shorter during phase 2<br><br>From phase 1 to phase 2 inappropriate treatment decisions decreased from 7.4% to 5.1%.<br><br>Small improvements in both on-scene time and the appropriateness of therapeutic decisions<br><br>Protocol care for these three chief complaints is clinically safe and, by reducing training and staffing considerations, may offer a cost-effective alternative to OLMC. | after series in a single urban municipality using a single base station. | | |
| Holliman (1994) [28] | Urban paramedic service in the northeastern United States with OLMD from three local hospitals | Patient care interventions by standing orders<br><br>(n=2453) | Patient care interventions by direct medical command<br><br>(n=143) | In 61 cases (6.1%), medical command ordered a potentially beneficial intervention not specified by standing orders or not done by the paramedic. | Prospective identification of patient care measures done as part of a prehospital quality assurance | | • |

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| | | | | Paramedic error rate was 0.6%, and the medical command error rate was 1.8%<br><br>Direct medical command gave orders in 14% of cases in this standing-orders system, but 35% of command orders only reiterated the standing orders. | program. | | |
| Erder (1989)[29] | Mostly non-trauma patients | n=5522 | n= 2329 | OLMD associated with an eight minute longer scene time and infrequent physician-directed deviation from treatment protocols (3.7% of all calls) | Retrospective QI review | VERY LOW | • Non-use of OLMD was a protocol violation<br>• Unrelated to air vs. ground decision |
| Gratton (1991) [30] | All physiologically unstable trauma patients transported to a Level I trauma center by ambulance.<br><br>(n=197) | Implementation of standing orders for invasive procedures.<br><br>(n=110) | Contact with base station prior to standing procedures<br><br>(n=87) | On-scene times in trauma patients<br><br>Mean scene times for the control group (15.3 +/- 8.4 minutes) and for the standing orders group (15.1 +/- 7.6 minutes) were similar (P = .18) | Retrospective review of case series in a single-tiered emergency medical services system. | | |
| Eckstein (2001) [31] | Patients with 7 chief medical complaints and | Implementation of standing | No standing | The most frequently used SFTPs were for | A prospective, consecutive | | |

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| | all traumas | field treatment protocols for 7 chief medical complaints and all traumas<br><br>(n=2177) | protocols | altered level of consciousness (29%), and chest pain (25%).<br><br>The most common errors found were failure to document reassessment of the patient after each medication administration (45% fallout rate), and failure to document and attach a copy of the ECG to the EMS report (40%).<br><br>The mean fallout rate for failure to establish or attempt IV access, administer oxygen, or provide cardiac monitoring was 7%.<br><br>Out of 1,450 incidents with outcome data provided by the receiving hospitals, only 3 cases (2%) involved incorrect treatment, with an additional 2 involving the unnecessary use of lidocaine. None of these instances resulted in adverse effects or | observational study in a large, urban EMS system. | | |

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| | | | | complications. SFTPs were integrated into a large EMS system with few procedural errors or adverse outcomes. | | | |
| Mulholland (2008)[7] | Helicopter paramedics in Victoria prospectively recorded the severity of injury to the head, thoracic, and abdomen regions, and whether the patient required a major trauma service, for primary response adult (>15 years) trauma patients. | Paramedic prediction of injury severity<br><br>n = 207 | Actual injury severity | The sensitivity of paramedic predictions ranged from 57.6 (95% confidence interval [CI]; 45.4-68.9) for the head to 38.5 (95% CI; 22.1-57.9) for the abdomen. Specificities ranged from 98.3 (95% CI; 93.5-99.6) for the thorax to 93.5 (95% CI; 87.9-96.6) for the head region.<br><br>The sensitivity and specificity of paramedic predictions of a major trauma status were 97.7 (95% CI; 93-99.2) and 28.2 (95% CI; 19.3-39.1), respectively.<br><br>The paramedics correctly categorized all patients who were admitted to an intensive care unit, | | | |

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| | | | | required urgent surgery or died in hospital as major trauma. | | | |
| Wuerz (1996)[13] | Ten emergency physicians, 50 advanced life support providers. | Prehospital treatment was directed by standing order | Prehospital treatment was directed by physician order | Frequency with which physician, on-line medical direction (OLMD) [direct medical control] of prehospital care results in orders, to describe the nature of these orders, and to measure OLMD time intervals.<br><br>OLMD results in orders for clinical interventions in 19% of cases. On-line medical direction requires about four minutes of physician time per call. This constituted about one-third of the potential field treatment time interval in this system. | Blinded, prospective study in a university hospital base station center<br><br>Independent observers recorded event times and the characteristics of OLMD. | | |

## Clinical Query #3: Evidentiary Tables

| Study | Patient | Intervention | Comparator | Outcome | Design | Remarks |
|---|---|---|---|---|---|---|
| Brathwaite (1998)[32] | Multiple trauma patients | Transportation by HEMS (n=15938) | Transportation by GEMS (n= 6473) | Survival<br><br>Subgroup of ISS between 16 and 60 had improved outcomes | Retrospective registry review<br><br>Unable to assess times | Quality - Moderate (size) |
| Falcone (1998)[33] | Trauma patients transported by HEMS | HEMS from scene | HEMS for interfacility transfer | Mortality<br>Time<br>Complications<br><br>-HEMS from scene saved 2.5 hrs<br>-HEMS from scene reduced complications and reduced mortality | Retrospective registry based<br><br>Some insight into time savings but not direct comparison of GEMS vs HEMS | Quality - Low |
| Black (2004)[2] | Multiple trauma patients | No intervention Expert panel | None | Recommendations took into account factors such as traffic, time, specific mechanism<br><br>HEMS if > 45 min difference by ground HEMS if critical and > 20 min difference by ground | Expert panel | Quality – Very low |
| Lerner (2000)[34] | Multiple trauma patients transported from scene to trauma center | Times for HEMS patients direct from scene | Times for patients with rendezvous at hospital helipad | Patients who were picked up at hospital helipad had greater txport time | Retrospective registry review | Quality - Low |

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|---|---|---|---|---|---|---|
| Ringburg (2007)[35] | Multiple trauma patients transported by HEMS | HEMS | GEMS | On scene time<br>Interventions<br>Time to definitive care<br><br>On scene time increased by 9 minutes<br><br>Interventions performed on scene<br><br>Golden hour "compressed" | Retrospective registry based | Quality - low |
| Moront (1996)[3] | Pediatric multiple trauma patients | HEMS | GEMS | -Survival<br><br>Urban peds patients appeared to benefit from HEMS<br><br>GCS < 12<br>HR > 160<br>Appear to be predictors in peds patients | Retrospective registry based | Derivation set in need of validation<br><br>Quality - low |
| Eckstein (2002)[4] | Pediatric trauma patients | HEMS | GEMS | -Survival<br>ICU or OR<br><br>GCS < 10<br>RTS <= 6.5<br>Predictors<br><br>Large amount of overtirage | Retrospective chart review | Derivation set in need of validation<br><br>Quality - low |
| Giannakopoulos (2011)[22] | Multiple trauma patients | HEMS | GEMS | RTS prediction of injury<br><br>Significant undertriage with RTS as predictor<br><br>Overall found HEMS | | |

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| | | | | benefit | | |
| Sullivent (2011)[36] | Multiple trauma patients | HEMS | GEMS | Mortality<br><br>Improved mortality with HEMS | | |
| Stewart (2011)[19] | Multiple trauma patients | HEMS | GEMS | Difference in factors that determine whether air or ground was chosen<br><br>Only real determinant for mode of transport was distance | | |

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## Recommendation:

In patients of all ages, who are victims of trauma and use 911 services, ***field triage criteria should include anatomic, physiologic, and situational components*** in order to risk-stratify injury severity and guide decisions as to destination and transport modality.
(Strong recommendation, low quality evidence)

**Critical Outcome:** Identification of patients with severe injuries requiring timely/HEMS transport to trauma centers

| Quality assessment | | | | | | | Summary of findings | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | No of patients | | Effect | Quality |
| **No of studies** | **Design** | **Limitations** | **Inconsistency** | **Indirectness** | **Imprecision** | **Other considerations** | **Intervention Triage Criteria** | **Control/ Comparison** | | |
| 22 | Retrospective (15); prospective (3); panel (3); survey (1) | Serious (-1) | Many problems across studies (-1) | Little direct data on who needs HEMS (-1) | Most studies with reasonable numbers | Consistent association of at least a broad view of anatomic, physiologic, and some MOI criteria with injury acuity | | | | **Low** |

## Recommendation:

We recommend that EMS providers should not be required to consult with online medical direction (OLMD) before activating HEMS for patients meeting appropriate physiologic and anatomic criteria. * (Strong recommendation, low quality evidence)

We suggest that for all other trauma patients, online medical direction may be used to determine transportation method as long as it does not result in a significant delay. (Weak recommendation, very low quality evidence)

### Critical Outcome: Mortality

| Quality assessment | | | | | | | Summary of findings | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | No of patients | | Effect | Quality |
| No of studies | Design | Limitations | Inconsistency | Indirectness | Imprecision | Other considerations | Intervention Triage Criteria | Control | | |
| 1 | Prospective observational | Lack generalizability to other systems (-1) | | Poorly related to clinical question (-2) | | OLMD not studied at all | 207 | | OLMD not studied | Very low |

### Critical Outcome: Morbidity

| Quality assessment | | | | | | | Summary of findings | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | No of patients | | Effect | Quality |
| No of studies | Design | Limitations | Inconsistency | Indirectness | Imprecision | Other considerations | Intervention Triage Criteria | Control | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 (Erder 1989) | Retrospective QI review | | Mostly not trauma<br>Mostly not air vs. ground decision | | | Not using OLMD was, by definition, a protocol violation | 5522 | 2329 | On scene interval increased by 8.4 min | Very low |

## Outcome: Process Related Outcomes (ie: on-scene time, OLMD interval, error rates, additional treatments)

| Quality assessment | | | | | | | Summary of findings | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | No of patients | | Effect | Quality |
| **No of studies** | **Design** | **Limitations** | **Inconsistency** | **Indirectness** | **Imprecision** | **Other considerations** | **Intervention Triage Criteria** | **Control** | | |
| 5 | Variable | Process outcomes | Yes | Profound | Yes | Generally unrelated to the question | Variable | Variable | N/A | Very low |

## Outcome: Cost

| Quality assessment | | | | | | | Summary of findings | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | No of patients | | Effect | Quality |
| **No of studies** | **Design** | **Limitations** | **Inconsistency** | **Indirectness** | **Imprecision** | **Other considerations** | **Intervention Triage Criteria** | **Control** | | |
| 3 | | Serious (-1) | All studies different | Most did not directly study OLMD (-1) | | Not a single studied true comparison | | | | Very LOW |

## Recommendations:

Transport patients meeting appropriate physiologic and anatomic criteria* for serious injury to an appropriate trauma center by HEMS if there will be a significant time-savings over GEMS.
(Weak recommendation, very low quality evidence)

Transport all other patients to an appropriate hospital by GEMS so long as system factors do not preclude safe and timely transportation.
(Weak recommendation, very low quality evidence)

### Critical Outcome: Morbidity

| Quality assessment | | | | | | | Summary of findings | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | No of patients | | Effect | Quality |
| **No of studies** | **Design** | **Limitations** | **Inconsistency** | **Indirectness** | **Imprecision** | **Other considerations** | **Intervention Triage Criteria** | **Control** | | |
| 10 | 9 retrospective 1 expert panel | Almost all based on review of large registries. | Methodology of data collection to registries is questionable at best | | | A few very large studies recently. Appears that there is HEMS benefit but determining the patient population is difficult.<br><br>No randomized trials. No direct comparisons of various criteria | HEMS | GEMS | Some improvement on mortality<br>However – difficult to determine the population that benefits.<br>Perhaps peds?<br>Some data showing tha age > 55 may not benefit. | Low |