Helicopters and trauma: State of the science in support of HEMS

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Disclosures

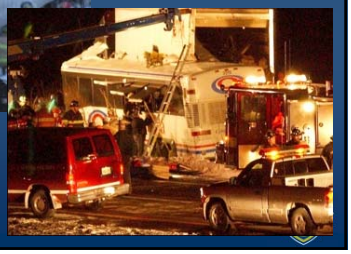
- Mercy Flight Central
  - Vice chair, Board of Directors
  - Associate Medical Director
- American College of Surgeons- COT
  - Associate member- EMS subcommittee
- Publications
- No financial disclosures

Trauma: Why do we care?

- Leading cause of death in the first four decades of life.
- 5 million trauma-related deaths worldwide each year.
- Injury accounts for 12% of the world's burden of disease

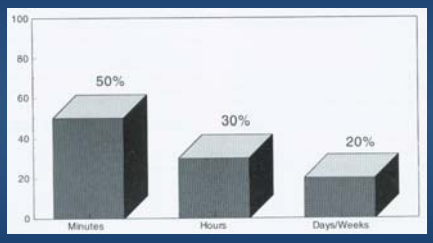
Trauma happens!

No respect for time
No respect for location



Must have comprehensive plan to deal with injured patients in all situations

Distribution of trauma deaths



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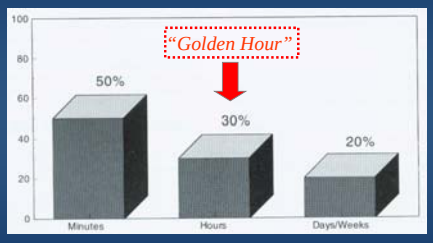

Time Matters

- Time to summon help
- Time to scene
- Time at scene
- Time to hospital
- Time at hospital
  - In ED
  - In OR
  - To ICU

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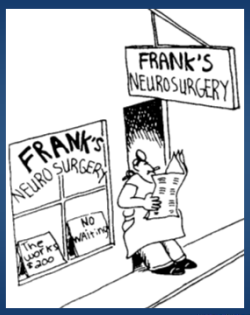
Why is trauma care different?

Why is trauma care different?

- Availability of resources
  - 24/7/365
- Intense use of resources
  - ICU, OR, Radiology
- Specialized care
  - Trauma Surgery
  - Availability of sub-specialists
  - Facilities/staff/support services
- Improved outcomes



Access

62% of US population have access to a trauma center within 60 minutes by ground ambulance

Access

87% of US population have access to a trauma center within 60 minutes by helicopter

Helicopters & EMS in the US

Evolution of the science

Individual center experience

Evolution of the science

Individual center experience

Meta analysis: Combining of Varied experience

Evolution of the science

Individual center experience

Meta analysis: Combining of Varied experience

Large populations
Complex data sets
Better statistics
More power
More general/less specific

Evolution of the science

Individual center experience

Meta analysis: Combining of Varied experience

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Randomized controlled trials in this area not practical/ethical

"Old" debate

VS.

New focus

- HEMS associated with improved survival
  - Most recent literature demonstrates benefit
    - Improved study designs
    - Larger patient populations
    - More rigorous statistics
- Research focus shifting
    - Define/understand benefit
    - Appropriate use (triage)

Helicopters and the civilian trauma system:

National utilization patterns demonstrate improved outcomes following traumatic injury.

Brown, JB. Journal of Trauma, 2010

Objective

Compare patients transported by helicopter and conventional ground ambulance from the scene of injury using national data.

Methods

- NTDB®, version 8 (2007)
  - National Trauma Data Standard
    - First time transport mode included
  - Retrospective review
  - Scene transports by helicopter or ground ambulance
  - DOA excluded

Methods

- Comparison of helicopter and ground patients
  - Prehospital times and *distance*
  - Injury severity markers
  - Hospital resources
- Outcome analysis using stepwise regression
  - Survival to discharge
  - Discharge to home

Methods: Prehospital

- Response time
- Scene time
- Transport time
- Total time
- Transport distance
  - Helicopter @ 150mph based on industry standard
  - Ground Ambulance @ 30mph – 65mph

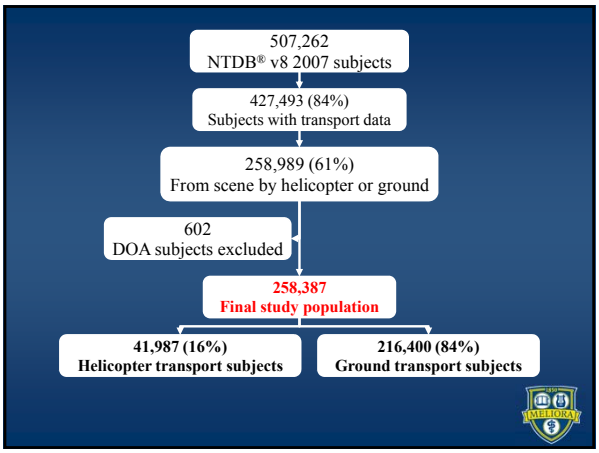
Cunningham P, et al. J Trauma 1997

Methods: Injury severity

- Mean ISS
- Severe injury (ISS > 15)
- Severe head injury (GCS ≤ 8)
- Hypotension (SBP < 90)
- Respiratory distress (RR < 10 or > 29)
- Discharged < 24 hrs

Methods: Hospital resources

- LOS
- ICU admission & LOS
- Mechanical ventilation & vent days
- Need for emergent operation



Results: Prehospital

	HT n=41,987	GT n=216,400
Response time (min±SD)*	19±11	8±7
Scene time (min±SD)*	17±12	16±9
Transport time (min±SD)*	23±19	19±14
Total time (min±SD)*	60±28	45±36
Transport distance (mi±SD)* 150mph vs. 30mph	57±32	21±15
Transport distance (mi±SD)* 150mph vs. 65mph	57±32	10±7

* $p \leq 0.05$

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Results: Injury severity

	HT n=41,987	GT n=216,400	OR (95%CI)
ISS (mean±SD)*	15.9±12.3	10.2±9.5	-
ISS >15 (%)*	43	21	2.83 (2.76-2.89)
GCS ≤ 8 (%)*	19	7	3.26 (3.15-3.36)
SBP < 90 (%)*	5	3	1.45 (1.38-1.52)
RR < 10 or > 29 (%)*	11	5	2.44 (2.35-2.53)
Discharge < 24hrs (%)*	15	25	0.52 (0.50-0.52)

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Results: Hospital resources

	HT n=41,987	GT n=216,400	OR (95%CI)
LOS (days±SD)*	8.5±12.6	5.4±8.6	-
ICU Admission(%)*	44	23	2.58 (2.53-2.64)
ICU LOS (days±SD)*	7.3±10.3	5.4±8.6	-
Ventilated (%)*	21	7	3.30 (3.21-3.40)
Vent days (days±SD)*	7.6±10.6	6.5±10	-
Emergent OR (%)*	19	13	1.60 (1.56-1.65)

* $p \leq 0.05$

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Regression: Survival to discharge

Parameter	Adjusted odds ratio	Confidence interval
Helicopter transport	1.22	1.17 – 1.27
ISS <15	2.97	2.86 – 3.08
Age <55	2.23	2.16 – 2.31
Female gender	1.08	1.05 – 1.11
Penetrating injury	0.54	0.52 – 0.56
No emergent operation	1.13	1.09 – 1.16
No ICU admission	0.70	0.67 – 0.72
No hypotension	2.31	2.23 – 2.40
No respiratory distress	1.41	1.36 – 1.46
No severe head injury	4.30	4.15 – 4.45
No ventilation	1.27	1.22 – 1.31
Level I or II trauma center	0.74	0.69 – 0.80

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Penetrating injury	0.54	0.52 – 0.56
No emergent operation	1.13	1.09 – 1.16
No ICU admission	0.70	0.67 – 0.72
No hypotension	2.31	2.23 – 2.40
No respiratory distress	1.41	1.36 – 1.46
No severe head injury	4.30	4.15 – 4.45
No ventilation	1.27	1.22 – 1.31
Level I or II trauma center	0.74	0.69 – 0.80

Regression: Discharge to home

Parameter	Adjusted odds ratio	Confidence interval
Helicopter transport	1.05	1.02 – 1.07
ISS <15	1.54	1.51 – 1.57
Age <55	3.06	3.01 – 3.11
Female gender	0.73	0.72 – 0.74
Penetrating injury	1.40	1.35 – 1.44
No emergent operation	1.27	1.24 – 1.30
No ICU admission	1.41	1.39 – 1.45
No hypotension	1.22	1.17 – 1.27
No severe head injury	1.65	1.61 – 1.70
No ventilation	1.47	1.43 – 1.50
Level I or II trauma center	1.11	1.09 – 1.14

Regression: Discharge to home

Parameter	Adjusted odds ratio	Confidence interval
Helicopter transport	1.05	1.02 – 1.07
ISS <15	1.54	1.51 – 1.57
Age <55	3.06	3.01 – 3.11
Female gender	0.73	0.72 – 0.74
Penetrating injury	1.40	1.35 – 1.44
No emergent operation	1.27	1.24 – 1.30
No ICU admission	1.41	1.39 – 1.45
No hypotension	1.22	1.17 – 1.27
No severe head injury	1.65	1.61 – 1.70
No ventilation	1.47	1.43 – 1.50
Level I or II trauma center	1.11	1.09 – 1.14

Summary

- Scene helicopter patients
  - Come from further away
  - Sicker
  - Use more hospital resources
  - Do better
- Scene helicopter transport was an independent predictor of survival and of discharge home.

Conclusions - 2010

- Helicopter transport from the scene of injury improves outcome and has merit.

Conclusions - 2011

- Similar findings in IF transfers
  - ISS ≥ 15

Brown JB, et al. J Trauma 2011

More support - 2012

Association Between Helicopter vs Ground Emergency Medical Services and Survival for Adults With Major Trauma

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Elliott R. Haut, MD, FACS
S. Nabeel Zafar, MBBS, MPH
Michael G. Millin, MD, MPH
David T. Efron, MD, FACS
George J. Koenig Jr, DO, MS
Susan P. Baker, MPH
Stephen M. Bowman, PhD
Peter J. Pronovost, MD, PhD, FCCM
Adil H. Haider, MD, MPH, FACS

Context Helicopter emergency medical services and their possible effect on outcomes for traumatically injured patients remain a subject of debate. Because helicopter services are a limited and expensive resource, a methodologically rigorous investigation of its effectiveness compared with ground emergency medical services is warranted.

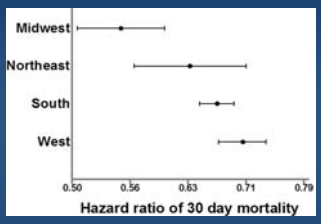
Objective To assess the association between the use of helicopter vs ground services and survival among adults with serious traumatic injuries.

Design, Setting, and Participants Retrospective cohort study involving 223 475 patients older than 15 years, having an injury severity score higher than 15, and sustaining blunt or penetrating trauma that required transport to US level I or II trauma centers and whose data were recorded in the 2007-2009 versions of the American College of Surgeons National Trauma Data Bank.

JAMA, 2012

A new variable

- Geographic variation:

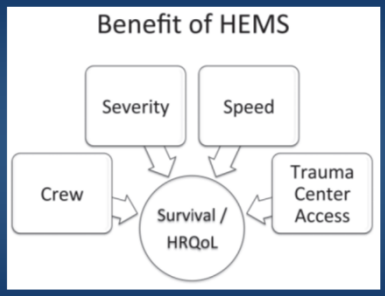


  - 1,679,675 patients
  - Overall, HT was independently associated with 36% reduction in 30-day mortality.
  - Decreased 30-day mortality in all regions, but variable.

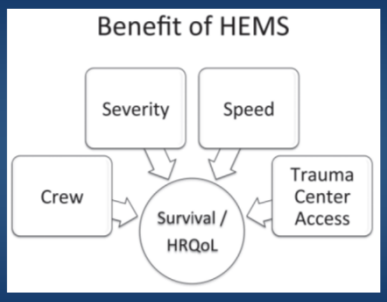
Brown, JB, et al. 2014

Why do they work?

Why do they work?



Why do they work?



We don't really know…probably a combination

Perspective

Perspective

- Most available evidence supports role of HEMS for severely injured patients not in proximity to the trauma center
  - HEMS improves survival
  - Benefit likely combination of speed, crew expertise, etc
- Trauma patients should be at trauma centers
  - Improved survival
  - Better outcomes

Galvagno SM, et al. J Trauma Acute Care 2012

Perspective

- When appropriately utilized, HEMS levels the playing field for injured patients.
- HEMS should give patients not near trauma centers an equivalent rate of survival as those who are already in proximity to expert care.
- Afford equivalent opportunity for good outcome.

Galvagno SM, et al. J Trauma Acute Care 2012

Time window of survival benefit in a national cohort for helicopter transport in trauma.

Brown, JB, et al. 2014

Objective

Evaluate whether the survival benefit of HT in trauma varies across spectrum of prehospital transport time (PHTT)

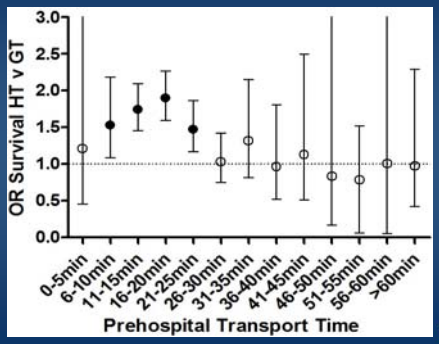
Methods

- NTDB® (2007-2012)
  - Age ≥ 16 undergoing HT or GT from scene
  - PHTT stratified by 5 minute increments
  - Propensity score matching used to account for differences between HT and GT groups
  - Excluded DOA or missing PHTT

Results

- 1,288,164 patients
- HT subjects required ICU admission, emergent surgery and mechanical ventilation more often than GT patients ($p<0.01$).
- PHTT:
  - HT independently associated with increased survival between 6-25 minutes.
  - Peak 16-20min

Results



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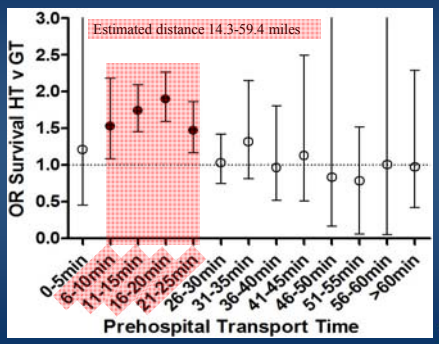


Conclusions

- Survival benefit for HT in trauma concentrated in a PHTT window between 6-25 minutes.
- Corresponds to estimated transport distance between 14.3 and 59.4 miles.
- These results highlight logistical considerations
  - Time matters
  - System/protocol design implications

HEMS triage

The National Trauma Triage Protocol: Can this tool predict which patients with trauma will benefit from helicopter transport?

Brown, JB. Journal of Trauma, 2012

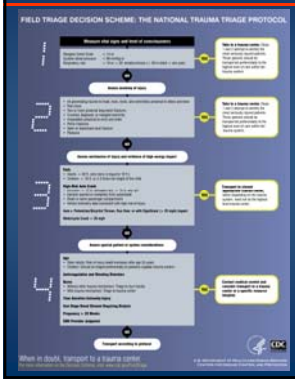
Background

- Trauma patient triage vs. aeromedical triage
  - Who benefits from trauma center care
  - Who needs to fly to trauma center
- Assuming that existing trauma triage guidelines serve as adequate surrogates for identifying patients that benefit from air transport is probably flawed.

Objective

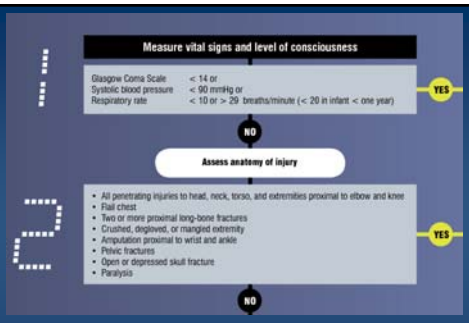
- Assess the ability of the NTTP to identify trauma patients that *would benefit from helicopter transport* to trauma center.
  - Prospective tool for pre-hospital care providers?

Methods



- NTDB®
- NTTP (12 criteria)
  - PHY (GCS ≤ 14)
  - ANA
  - Age (>55 years)
- Sequential approach

CDC, 2006

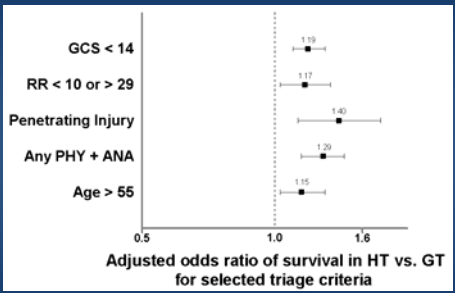


Plus: Age > 55 years
Any PHY
Any ANA
Any PHY + ANA

Results

- 258,387 patients (84% GT, 16% HT)
- Helicopter patients were sicker, used more hospital resources, traveled further and had longer prehospital times.
- 5 criteria were identified in which HT was independently associated with improved survival.

Results



Triage criteria in which helicopter transport was an independent predictor of survival (logistic regression)

Penetrating trauma

- "Urban" issue with no benefit from HT
- HT group and GT group differ
  - 42% HT self inflicted or accidental (vs. 19%)
  - Mean transport times differ
- Penetrating injuries by HT:
  - Come from further away
  - More likely to be hunting accidents, suicide attempts and accidental shootings
  - Different from GT group

Conclusions

- Five criteria in the NTTP protocol confer survival benefit with high predictive value for TCN in HT population.
- Helicopter transport in patients with these criteria justified by need for trauma center care and validated by improved outcomes.
- Impact on development of protocols?
- Development of prehospital tool?

Development and validation of the Air Medical Prehospital Triage (AMPT) Score

Brown, JB, et al. 2014

Objective

Develop and validate a triage tool that can *prospectively* identify trauma patients who would benefit from HEMS transport.

Methods

- NTDB® (2007-2012)
  - Age ≥ 16 years old
  - Scene transports
  - Helicopter or ground transport
  - Study sample divided
    - Training set (2007-2009)
    - Validation set (2010-2012)

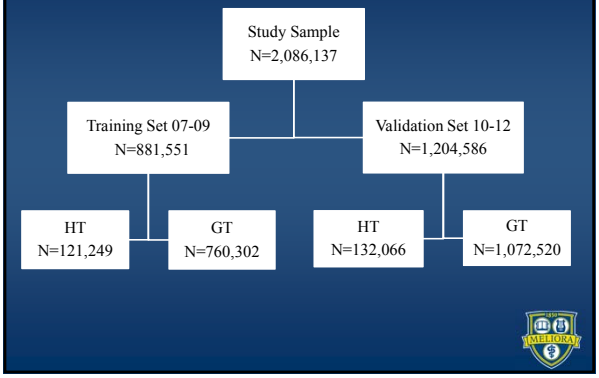
Methods: Score development

- Based on commonly available criteria
- Criteria evaluated for inclusion in AMPT
  - Training set used to identify triage criteria that were associated with improved in-hospital survival for HT *and* practical for use in field.
    - Each individual criterion assigned a point
    - Combinations were assigned double points

Methods- Score validation

- Validation
  - Point totals calculated for each patient
  - All patients triaged to HEMS or GEMS
  - Various point cutoffs assessed
    - Score validated if subjects triaged to HEMS by AMPT score had improved in-hospital survival.
    - Score further validated if no difference seen in patients triaged to GEMS (transport mode not associated with survival)

Results: Study population



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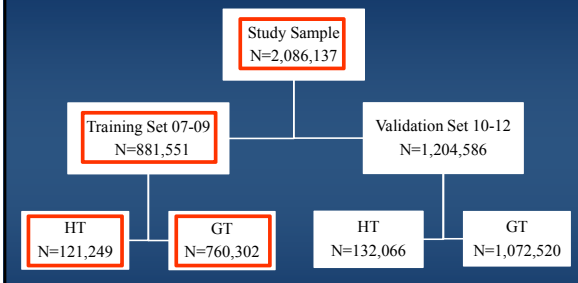

Results: AMPT score development

Criterion	AOR	95%CI	*q* value
Age >55	1.17	1.09 – 1.26	0.019
GCS <14	1.13	1.07 – 1.20	0.016
SBP <90	0.91	0.81 – 1.02	0.159
RR <10 or >29	1.23	1.11 – 1.35	0.013
Penetrating	1.12	0.97 – 1.29	0.159
Unstable chest	1.22	1.08 –1.38	0.022
Open skull fracture	1.17	0.99 – 1.38	0.112
≥ 2 proximal long bone fracture	0.99	0.81 – 1.21	0.917
Pelvic fracture	1.04	0.95 – 1.14	0.535
Crush injury	1.22	0.70 – 2.16	0.544
Amputation	1.07	0.73 – 1.57	0.764
Paralysis	1.48	1.11 – 1.97	0.025
Hemo/pneumothorax	1.16	1.07 – 1.25	0.009
Cardiac injury	1.23	1.11 – 1.36	0.006
Multisystem trauma	1.31	1.07 – 1.60	0.028
PHY + ANA	1.27	1.18 – 1.36	0.003

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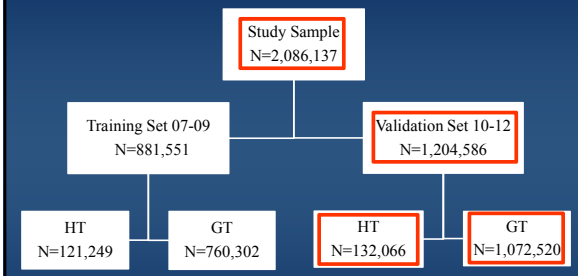
Results: AMPT Score

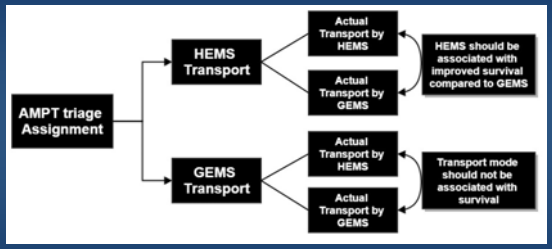
Criterion	Points
GCS <14	1
RR <10 or >29	1
Unstable chest wall	1
Hemo/pneumothorax	1
Paralysis	1
Multisystem trauma†	1
PHY + ANA*	2

† 3 or more anatomic body regions injured
** Any 1 physiologic criterion AND any 1 anatomic criterion present from ACS field triage guidelines*

Results: Study population



Methods: Validation



Summary

- 7 triage criteria identified with higher odds of survival if undergoing HEMS.
  - Appropriate for use in field.
- Optimal cut-off for AMPT score triage to HEMS is ≥ 2 points.
  - If triage to HEMS- survival benefit with HEMS
  - If triage to GEMS- no survival benefit with HEMS

Conclusion

- AMPT score can be used to inform triage decisions in prehospital setting.
- Tool to identify trauma patients who would benefit from HEMS.

Limitations

- Retrospective
- NTDB® variables
- External factors
  - Regional
  - Environmental
  - Situational
  - Geographic
- Heterogeneous trauma systems & patients
- Criteria for transport, not dispatch (launch)

Role of HEMS in trauma care

GUIDELINES

Appropriate use of Helicopter Emergency Medical Services for transport of trauma patients: Guidelines from the Emergency Medical System Subcommittee, Committee on Trauma, American College of Surgeons

Jay Doucet, MD, Eileen Bulger, MD, Nels Sanddal, PhD, REMT, Mary Fallat, MD, William Bromberg, MD, Mark Gestring, MD,
and endorsed by **the National Association of EMS Physicians (NAEMSP),** *San Diego, California*

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COT recommendations

1) HEMS and the trauma system:
- Optimal use of HEMS requires integration with the trauma system.

COT recommendations

2) HEMS dispatch and triage criteria
- Field trauma triage criteria (like CDC) should be standardized within the trauma system and be used by both EMS and HEMS to identify patients in need of trauma center care.
- Dispatch best accomplished by regionalized medical dispatch system collaborating with the trauma system.

COT recommendations

3) Trauma PI and HEMS:

- Use of all EMS transport modalities (including HEMS) must be reviewed by a PI process for the trauma center with effective feedback to medical directors and crews.

COT recommendations

4) Training and equipment for trauma care:

- HEMS crews must have access to prehospital trauma care training on an ongoing basis. COT recommends courses like TNCC, ATCN and/or PHTLS to supplement ongoing CME.
- Aircraft must have appropriate space and equipment for care of the trauma patient.

Summary

- HEMS associated with survival advantage in trauma
  - Bigger, better studies
  - Less specific to particular region
  - Working to understand why

Summary

- HEMS integral part of trauma system
  - Appropriate use should be data driven
  - Triage algorithms should be evidence-based and practical

Summary

- Regional factors important