

Prehospital Care for Firearm Injuries

Shahid Shafi, MD MPH

C. William Schwab, MD FACS

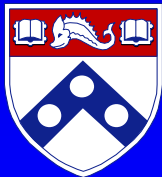
Charles C. Branas, PhD

C. Crawford Mechem, MD FACEP

Div. of Traumatology/Surgical Critical Care

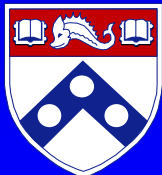
Department of Surgery

University of Pennsylvania School of Medicine

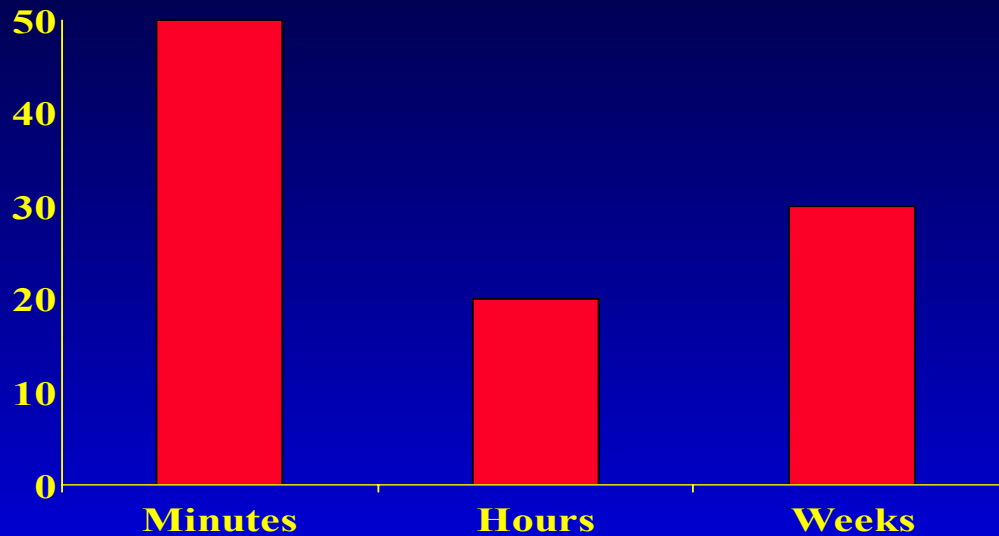


Prehospital Care for Firearm Injuries

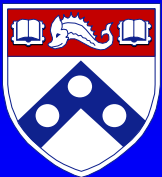
- * **What is prehospital Advanced Life Support (ALS)?**
- * **Does ALS work - published work, PENN data, PTSF data**
- * **Role of prehospital endotracheal intubation**
- * **Role of early resuscitation in trauma**
- * **Where do we go from here?**



Mortality due to Firearms



- * Most common cause of death - Hemorrhagic shock
- * Golden Hour - “early” intervention saves lives



Prehospital Care for Trauma

Basic vs. Advanced Life Support

ALS

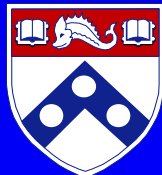
Fluid Resuscitation

Endotracheal intubation

Cricothyroidotomies

Cardiac monitoring

Medications



Needle decompression

BLS

Immobilization

External compression



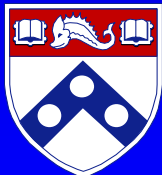
ALS: Does it work? Yes.....

* Alexander RH. Effect of ALS and sophisticated Hospital Systems on Motor Vehicle mortality. J Trauma 24:486, 1984.

Death rate per hundred million miles driven lower in counties with ALS systems.

* US DOT. National Highway Traffic Safety Report: Effectiveness and Efficiencies in Emergency Medical Services. March 1982.

Reduction in mortality from highway injuries from 1966 to 1981



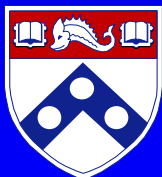
ALS: Does it work? Yes.....

* Messick WJ. The Association of Advanced Life Support Training and Decreased Per Capita Trauma Death Rates. J Trauma 33:850, 1992.

North Carolina per capita county trauma mortality lower in counties with ALS.

* Pons PT. Prehospital Advanced Trauma Life Support for Critical Penetrating Wounds to the Thorax and Abdomen. J Trauma 25:828, 1985.

Case series of 203 patients, laparotomy/thoracotomy, GSW/SW, all received ALS, imp. hemodynamics



ALS: Does it work? No.....

* Eckstein M. Effect of Prehospital Advanced Life Support on Outcomes of Major Trauma Patients. J Trauma 48:643, 2000.

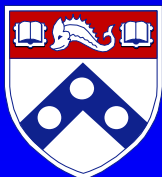
9451 patients, LA county

Expeditious ALS possible, no impact on survival.

* Potter D. A Controlled Trial of Prehospital Advanced Life Support in Trauma. Ann Emerg Med 17:582, 1988.

472 ALS vs. 589 BLS in Australia

improved 24-hr survival, no impact on mortality.



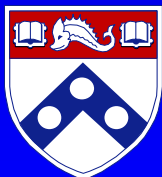
ALS: Does it work? No.....

* Liberman M. Multicenter Canadian Study of Prehospital Trauma Care. Ann Surg 237:153, 2003.

**compared Montreal, Toronto, Quebec City
No survival benefit for ALS**

* Branas CC. Urban Trauma Transport of Assaulted Patients Using Nonmedical Personnel. Acad Emerg Med 2:486, 1995.

**2108 paramedics vs. 1356 non-paramedic
No survival benefit for paramedics**



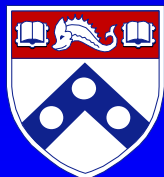
ALS: Impact on Survival - Reviews

* Liberman M. Advanced or Basic Life Support for Trauma: Meta-Analysis and Critical Review of Literature. J Trauma 49:584, 2000.

**15 studies comparing ALS vs. BLS mortality
OR for dying with ALS 2.6 compared to BLS**

* Fowler R, Pepe PE. Prehospital Care of the Patient with Major Trauma. Emerg Med Clin North Am 20:953, 2002.

No clear role for ALS in trauma.



**John L. Sampalis, Montreal, Quebec
Paul E. Pepe, Dallas, TX**



ALS in Trauma

Problems: patients not separated by mechanisms

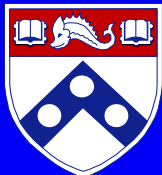
not adjusted for injury severity

inadequate power

Solution: focus on specific injuries

adjust for injury severity

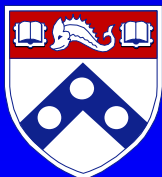
adequate sample size



ALS: Penn Firearm Injuries

707 patients with firearm injuries 1996 - 2000

	<u>ALS</u>	<u>non-ALS</u>	<u>p-value</u>
N	441	266	
Survival	72%	77%	NS
ISS	22	18	.008



ALS: PTSD Firearm Injuries

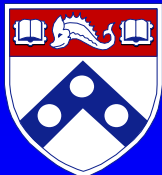
- * **Retrospective review 1996 - 2000**
- * **Inclusion criterion: Firearm injuries by E-Codes**
- * **Exclusion criteria:**

Lack of prehospital care

Prehospital care by non-EMS personnel

Absence of information on prehospital care

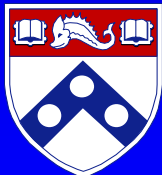
Referrals



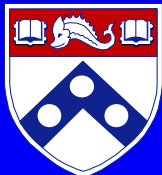
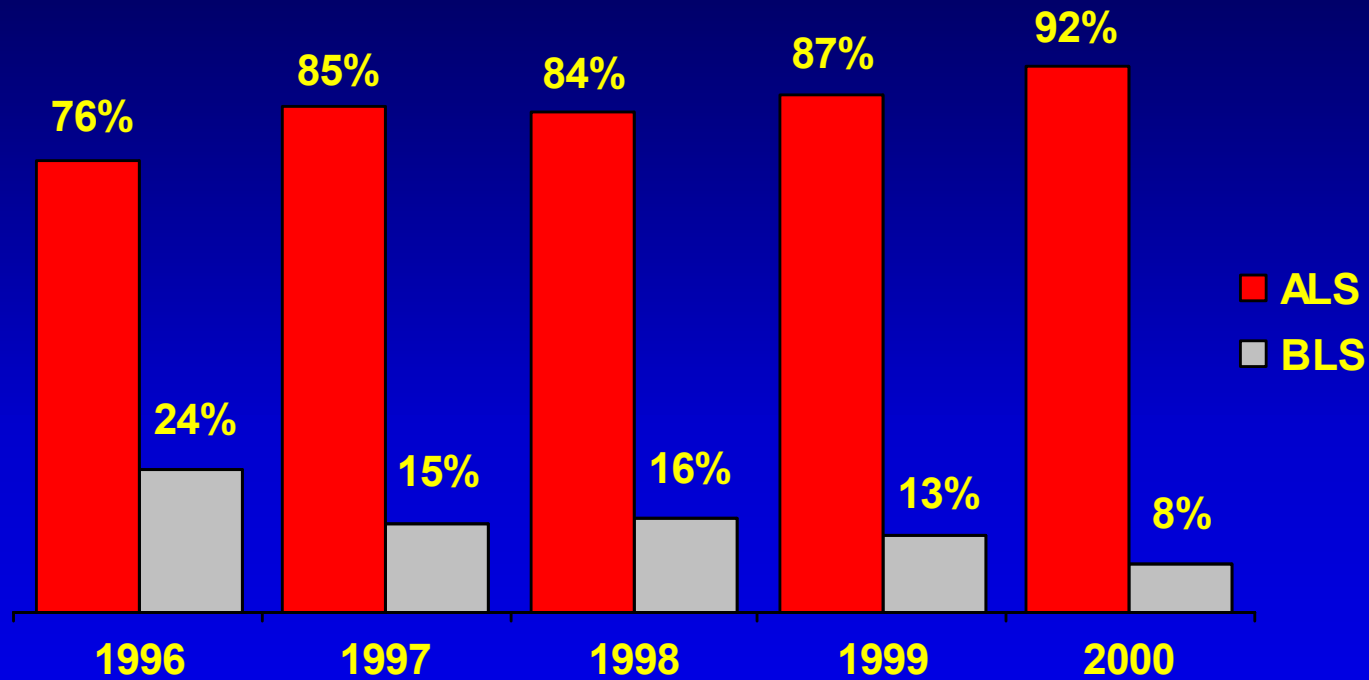
ALS: PTSF Injuries

- * 102,000 patients enrolled in PTSF during the study period
- * 6626 met inclusion criterion
- * 3270 met exclusion criteria
- * Study group 3356 patients -

ALS	2841 (85%)
BLS	515 (15%)

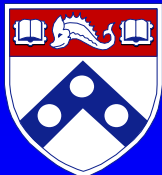


PTSF: ALS over time



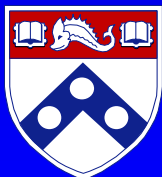
PTSF Injuries

	#	ALS	BLS	p-value
Total Study Population	3356	2841	515	
Injury Severity Score	3355	20 [!] 0.3	17 [!] 0.8	.009
TRISS	3119	0.71 [!] .008	0.78 [!] .017	.000
Revised Trauma Score at admission	3131	5.7 [!] .06	6.2 [!] .13	.001
Intensive Care Utilization	3356	49%	40%	.000
Systolic Blood Pressure [!] 90 at scene	1969	40%	24%	.000
Glasgow Coma Scale [!] 8 at scene	1757	34%	24%	.001
Endotracheal intubations at scene	2756	11%	1%	.000
Length of initial hospital stay (days)	3356	7 [!] 0.2	7 [!] 0.4	NS
Prehospital time (minutes)	2179	25 [!] 1	19 [!] 1	.016
Survival (unadjusted)	3356	68%	76%	.000



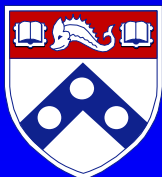
PTSF: Physiologic changes

Group	Parameters	# pairs	Scene	Admission	p-value
BLS	Systolic Blood Pressure (mm Hg)	233	105 ^{!3}	108 ^{!3}	NS
	Heart rate	265	80 ^{!2}	83 ^{!2}	NS
	Respiratory Rate	262	17 ^{!0.5}	18 ^{!0.6}	NS
	Glasgow Coma Scale	234	11.8 ^{!0.3}	12.1 ^{!0.3}	.013
	Revised Trauma Score	156	6.2 ^{!0.2}	6 ^{!0.2}	NS
ALS	Systolic Blood Pressure (mm Hg)	1718	92 ^{!1}	106 ^{!1}	.000
	Heart rate	1916	85 ^{!1}	80 ^{!1}	.000
	Respiratory Rate	1823	17 ^{!0.2}	16 ^{!0.2}	.000
	Glasgow Coma Scale	1506	10.8 ^{!0.1}	10.5 ^{!0.1}	.000
	Revised Trauma Score	1219	5.8 ^{!0.09}	5.7 ^{!0.1}	.007



PTSF: Survival in Severely Injured

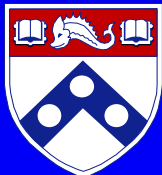
	#	ALS	BLS	p-value
Injury Severity Score ≥ 25	1167	36%	34%	NS
TRISS < 0.5	882	11%	8%	NS
Systolic Blood Pressure ≥ 90 mm Hg at scene	743	42%	39%	NS
Systolic Blood Pressure ≥ 90 mm Hg at admission to the trauma center	975	27%	42%	.000
Endotracheal intubation at scene	228	7%	0%	NS
Glasgow Coma Scale ≥ 8 at scene	579	11%	18%	NS
Glasgow Coma Scale ≥ 8 at admission	1088	15%	14%	NS
Intensive Care Unit admissions	1593	76%	82%	.049



PTSF: Logistic Regression for Survival

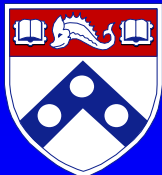
	Variables in the Model	β ! S.E.	p-value
1.	Prehospital Care (ALS=1, BLS=0)	0.016 ! 0.329	NS
2.	Age (years)	- 0.027 ! 0.006	.000
3.	Injury Severity Score (range 1 to 75)	- 0.064 ! 0.008	.000
4.	Prehospital time (minutes)	0.006 ! 0.005	NS
5.	Endotracheal intubation at scene (Yes=1, No=0)	- 1.536 ! 0.422	.000
6.	Systolic Blood Pressure at admission (mm Hg)	0.016 ! 0.002	.000
7.	Glasgow Coma Scale at admission (range 3 to 15)	0.364 ! 0.02	.000

OR for Survival with ALS 1.016 (95% CI 0.5 to 1.9)



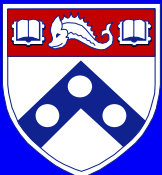
PTSF: Conclusions

- * ALS use increased over time.
- * ALS associated with increased prehospital time.
- * ALS associated with some physiologic improvements.
- * ALS not associated with improved survival.
- * Survival primarily determined by injury severity.



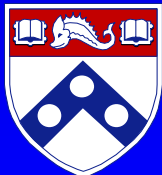
Current Projects

- * Retrospective analysis of national data.
- * Pilot project for a RCT of ALS.
- * Paramedic survey of ALS procedures.



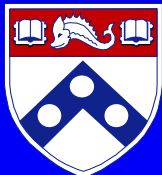
Philadelphia Fire Dept. Paramedic Survey

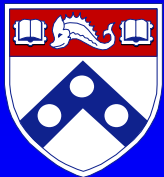
ALS Intervention	Always helpful	Frequently helpful	Occasionally helpful	Neither helpful, nor harmful	Occasionally harmful	Frequently harmful	Always harmful
Intravenous fluids							
Endotracheal intubations							
Drug administration							
Spine immobilization							
Needle Thoracostomy							
Chest compressions							
Defibrillation							
Control of external bleeding							



Philadelphia Fire Dept. Paramedic Survey

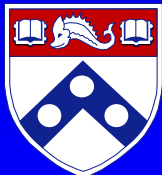
ALS Intervention	Further Research needed?	Willing to participate in trials?***
Intravenous fluids		
Endotracheal intubations		
Drug administration		
Spine immobilization		
Needle Thoracostomy		
Chest compressions		
Defibrillation		
Compression of external bleeding		





ALS: Why doesn't it work?

- ? **Increased prehospital time**
- ? **Molecular mechanisms of hemostasis**
- ? **Specific patient sub-groups**
- ? **Specific interventions for specific indications**



Prehospital time (PHT)

Injury

911 Call

Dispatch

Arrival at scene

Patient accessed

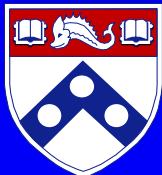
ALS Interventions

Patient loaded

Transport to trauma center

Unload

Arrival in ED



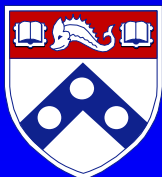
Impact of ALS on Prehospital Time

Turner J. A Randomized Controlled Trial of Prehospital Intravenous Fluid replacement therapy in serious trauma. Health Tech Assess 2000, Vol. 4

1309 patients

Two arms - Prehospital IVF vs. none.

Scene time 12- 13 minutes longer with IVF.



Impact of ALS on Prehospital Time

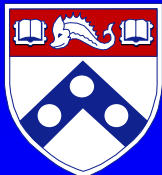
Cornwell EE. Emergency Medical Services (EMS) vs Non-EMS Transport of Critically Injured Patients. Arch Surg 135:315, 2000.

38 EMS vs. 38 non-EMS matched

Prehospital time 26 vs. 30 min (p=NS)

ISS 13 or more- EMS 28 minutes

non-EMS 15 minutes



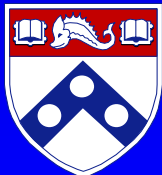
Impact of ALS on Prehospital Time

Kaweski SM. Effect of Prehospital Fluids on Survival in Trauma Patients. J Trauma 30:1215, 1990.

6855 patients

Prehospital IVF vs. none

Mean PHT 36 minutes in both groups.



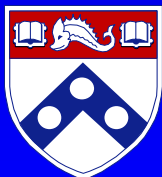
Impact of ALS on Prehospital Time

Jacobs LM. Prehospital Advanced Life Support: Benefits in Trauma. J Trauma 24:8, 1984.

80 ALS patients vs. 98 BLS in Boston

No difference in prehospital time

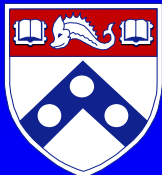
(Actual time not reported)



Impact of ALS on Prehospital Time

Bottom line

Prehospital time probably prolonged with ALS.



Prehospital time and survival

* Sampalis JS. J Trauma 34:252, 1993.

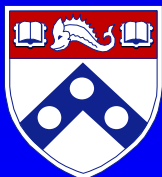
360 severely injured patients

Odds of dying increased 3X when PHT > 60 min.

* Feero S. Am J Emerg Med 13:133, 1995

848 major trauma patients

Survivors 21 min vs. non-survivors 29 min, p=.02



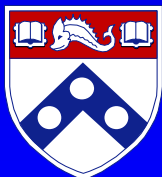
Prehospital time and survival

* Pepe PE. Ann Emerg Med 16:293, 1987

**498 patients, penetrating injuries, SBP 90 or less
No correlation with survival up to 60 minutes**

* Petri RW. Prehosp Disast Med 10:43, 1995

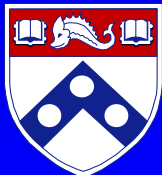
**5215 patients with ISS > 10
No impact of PHT up to 90 minutes**



Prehospital time and survival

Bottom line

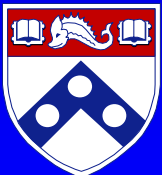
**Probably a limited impact in urban settings
in patients who do not die at the scene.**



Impact of ETI on survival

Theory: **Prehospital ETI should save lives by
providing airway protection, especially in
those with head injuries.**

Reality ????????



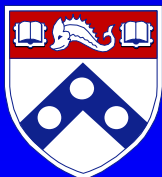
Impact of ETI on survival

Murray JM. Prehospital Intubations in Patients with Severe Head Injury. J Trauma 49:1065, 2000.

852 patients, GCS 8 or less, LA County-USC

ETI vs. non-ETI

**Mortality 80% in ETI vs. 43% in non-ETI
(adjusted for injury severity)**



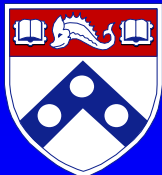
Impact of ETI on survival

Winchell RJ. Endotracheal Intubation in the Field Improves Survival in Patients with Severe Head Injury. Arch Surg 132:592, 1997.

1092 patients, GCS 8 or less, San Diego

Mortality ETI 26%, non-ETI 36%

Isolated severe head injury 23% vs. 50%



Impact of ETI on survival

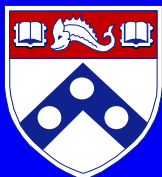
Davis DP. Prehospital Intubations in Patients with Severe Head Injury. J Trauma 49:1065, 2000.

Prospective study of paramedic RSI in San Diego

209 patients ETI, GCS 8 or less

Historic controls non-ETI

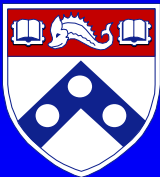
Increased mortality with ETI 33% vs. 24%



Impact of ETI on survival

Bottom Line

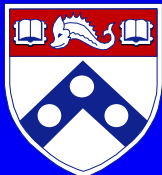
Impact of prehospital ETI on survival is unclear.



Impact of Fluid Resuscitation on survival

Theory: **Early and aggressive fluid resuscitation
should improve survival by quickly
reversing hemorrhagic shock.**

Reality ??????????????????????



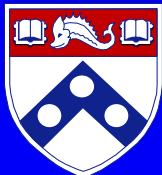
Impact of Fluid Resuscitation on survival - Animal studies

Krausz MM. Crystalloid and Colloid Resuscitation of Uncontrolled Hemorrhagic Shock Following Massive Splenic Injury in Rats. Shock 16:383, 2001.

Standardized massive splenic injury, uncontrolled

No Resusc. vs. LR, HTS and HES resuscitation

**Increased bleeding and shortened survival with
resuscitation.**



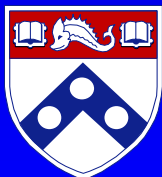
Impact of Fluid Resuscitation on survival - Animal studies

Sakles JC. Effect Of Immediate Fluid Resuscitation on the Rate, Volume and Duration of Pulmonary Vascular Hemorrhage in a Sheep Model of Penetrating Thoracic Trauma. *Ann Emerg Med* 29:392, 1997.

Sheep model, lacerated pulmonary vessels

No Resusc. Vs. LR 30 ml/kg

**Increased rate, volume and duration of hemorrhage
with resuscitation.**



Impact of Fluid Resuscitation on survival - Animal studies

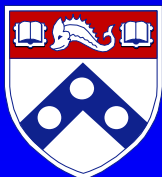
Capone AC. Improved Outcome with Fluid Resuscitation in Treatment of Hemorrhagic Shock. JACS 180:49, 1995.

Tail amputation with uncontrolled hemorrhage

None vs. Resuscitation to MAP 40 or 80 mm Hg

Increased hemorrhage and mortality with MAP 80

Best survival in MAP 40 group.



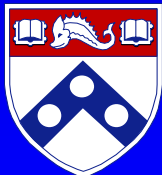
Impact of Fluid Resuscitation on survival - Animal studies

Stern SA. Effect of Blood Pressure on Hemorrhage Volume and Survival in a Near-Fatal Hemorrhage Model Incorporating a Vascular Injury.
Ann Emerg Med 22:155, 1995.

Swine model of aortotomy, uncontrolled

None vs. Resusc. to MAP 40, 60 or 80 mm Hg

Increased hemorrhage/higher mortality with MAP 80



Impact of Fluid Resuscitation on survival - Clinical studies

Bickell WH. Immediate Versus Delayed Fluid Resuscitation for Hypotensive Patients with Penetrating Torso Injuries. NEJM 331:1105, 1994.

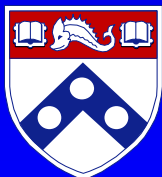
598 patients, penetrating torso injuries, SBP 90 or less

Immediate resuscitation - prehospital

Delayed resuscitation - not until reaching OR

Survival - 62% vs. 70% (p 0.04)

Complications - 30% vs. 23% (p 0.08)



Impact of Fluid Resuscitation on survival - Clinical studies

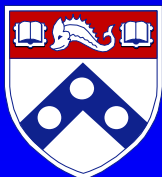
Dutton RP. Hypotensive Resuscitation During Active Hemorrhage: Impact on in-Hospital Mortality. J Trauma 52:1141, 2002.

110 patients, hemorrhagic shock, SBP 90 or less

Target SBP >100 mm Hg vs. 70 mm Hg until homeostasis

Mix of blunt and penetrating injuries

No difference in survival or duration of hemorrhage



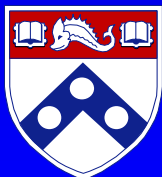
Impact of Fluid Resuscitation on survival - Clinical studies

Turner J. A Randomized Controlled Trial of Prehospital IVF Replacement Therapy in Serious Trauma. Health Technology Assessment 4:iii, 2000.

1309 blunt patients, deaths or Hospital LOS 3 days

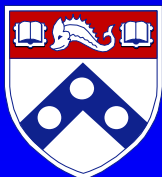
Prehospital IVF vs. no IVF

No difference in survival.

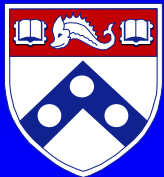
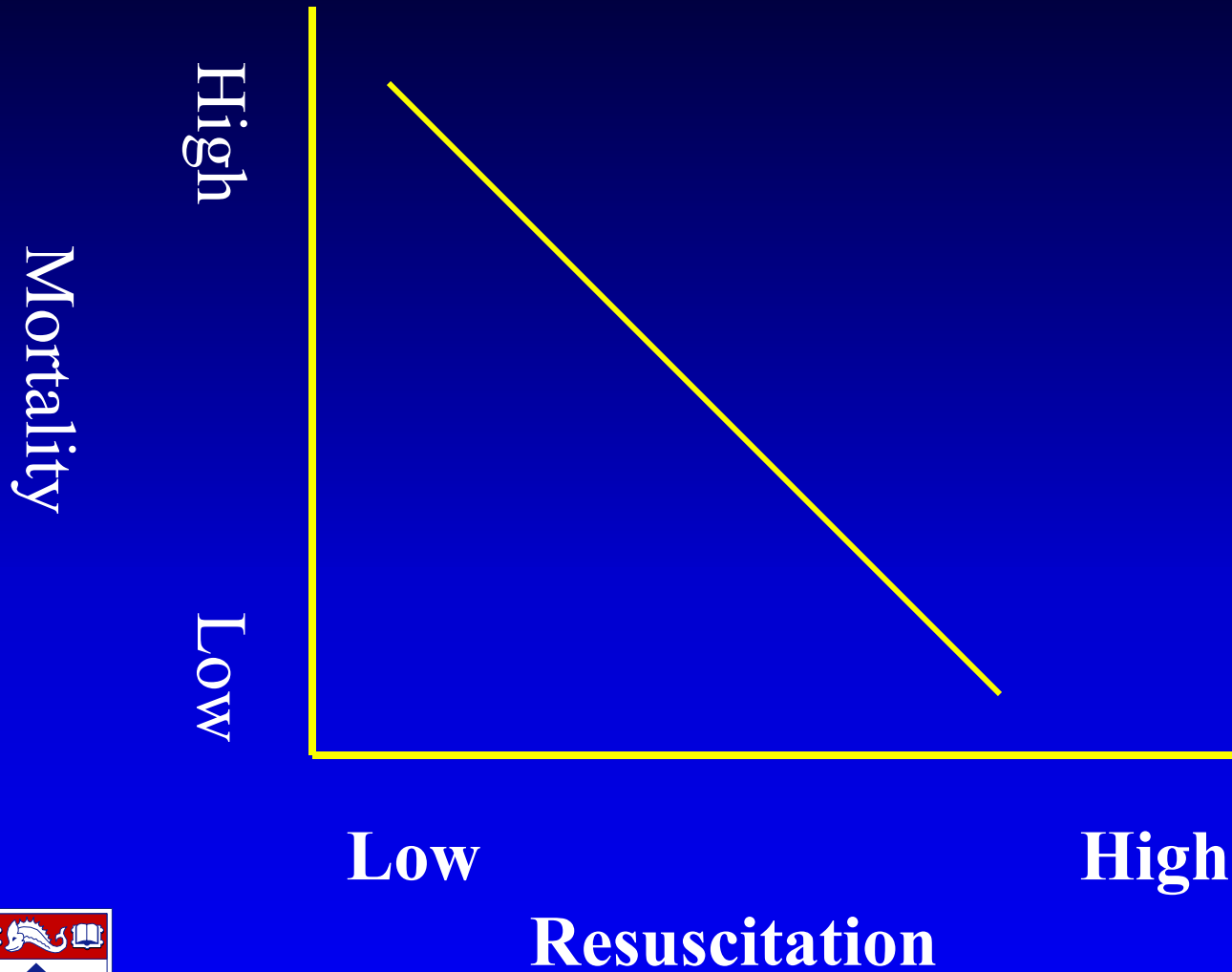


Impact of Fluid Resuscitation on survival

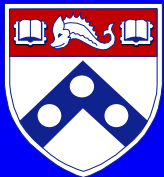
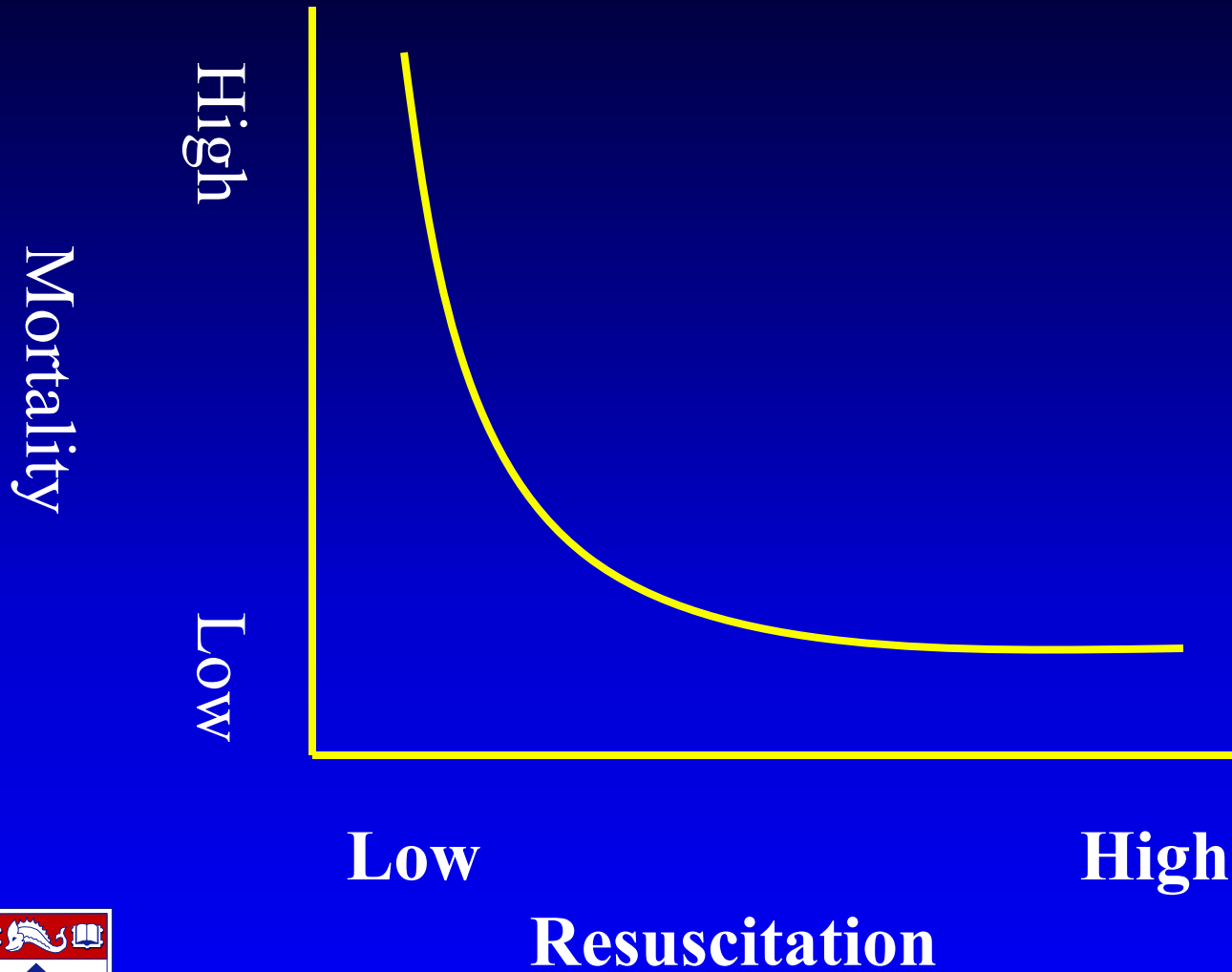
- * Resuscitation improves survival in hemorrhagic shock.
- * Resuscitation increases hemorrhage when source of bleeding uncontrolled.
- * Traditional target SBP 100 mm Hg may increase bleeding.
- * Timing and endpoints of resuscitation need to be defined.



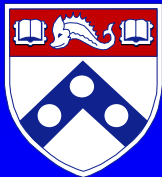
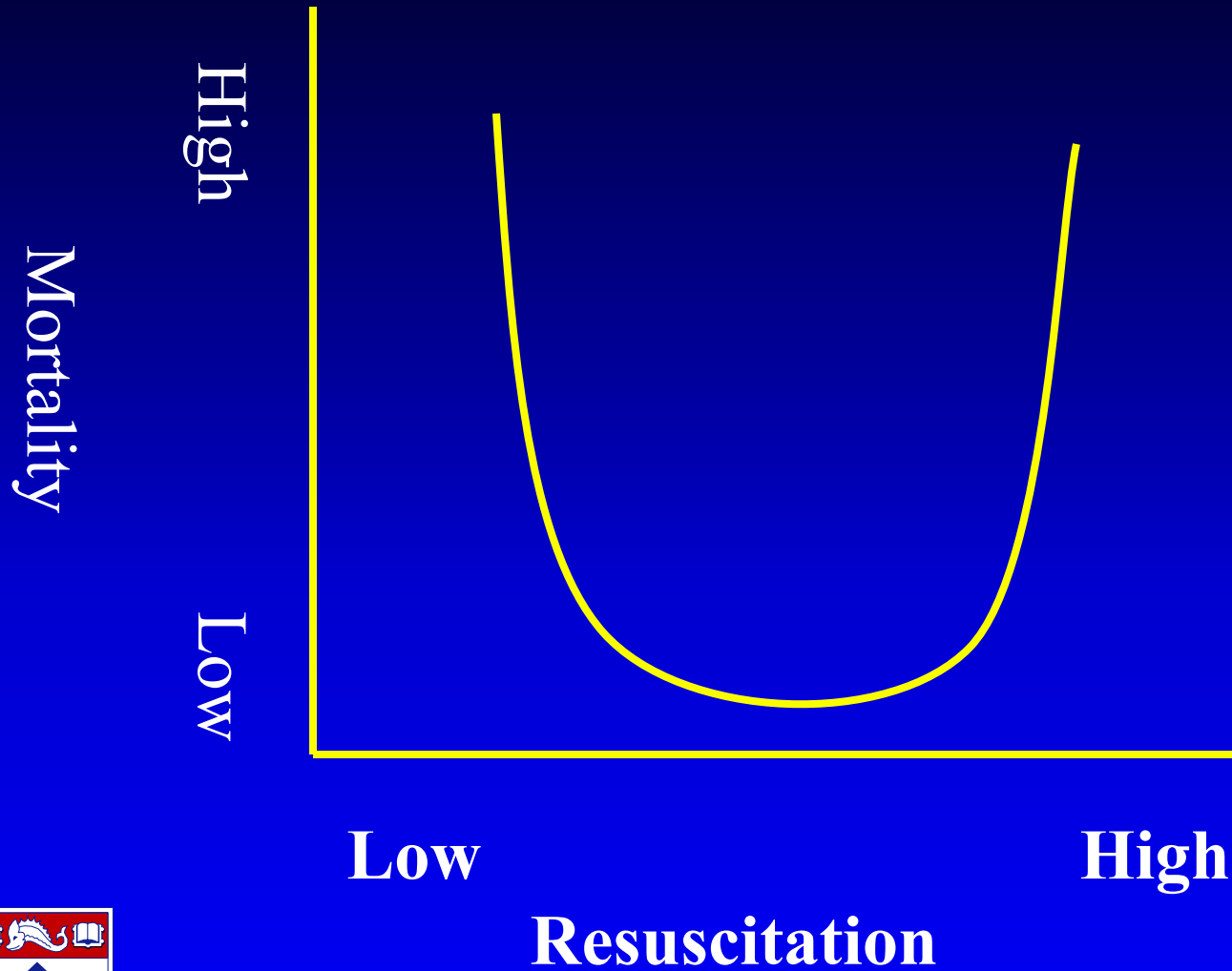
Resuscitation and Survival - Old Model



Resuscitation and Survival - Current Model

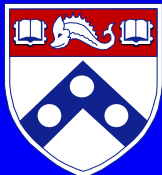


Resuscitation and Survival - Proposed Model



Prehospital Care for Firearm Injuries

- * **What is prehospital Advanced Life Support (ALS)?**
- * **Does ALS work - published work, PENN data, PTSF data**
- * **Why doesn't it work**
- * **Role of prehospital endotracheal intubation**
- * **Role of early resuscitation in trauma**



Conclusions

- * **Prehospital ALS interventions in firearm injuries have not been associated with improved survival.**
- * **Early and aggressive fluid resuscitation may be associated with increased bleeding and mortality.**
- * **Large RCT with adequate sample size are needed to define precise indications for specific interventions.**

