

Real-time Patient Vital Sign Data Collection Network for Trauma Care

Peter F. Hu MS CNE

Assistant Professor, Program in Trauma and Department of Anesthesiology,
University Of Maryland, School of Medicine

Chief Technologist, R Adams Cowley Shock Trauma Center
University of Maryland Medical Center

Peter F. Hu^{1,3,5} MS CNE, Colin Mackenzie^{2,3} MD, Richard P. Dutton^{1,3} MD, Grant Bochicchio^{1,4} MD,
Kelly Bochicchio^{1,4} RN,MS, Yan Xiao^{1,3} PhD, John Spearman⁵ MBA, Thomas Scalea^{1,2,4} MD.

*1. Program in Trauma, 2. National Study Center for Trauma and EMS, 3. Department of Anesthesiology,
4. Department of Surgery, University of Maryland School of Medicine,
5. R Adams Cowley Shock Trauma Center, University of Maryland Medical Center*

There is a lack of comprehensive physiological data on trauma victims during pre-hospital (field) and in-hospital (bedside) care management.

Colin F. Mackenzie, MD

Former Director of National Study Center for Trauma and EMS

1) Pre-Hospital Vital Signs Data Recorder (VSDR)



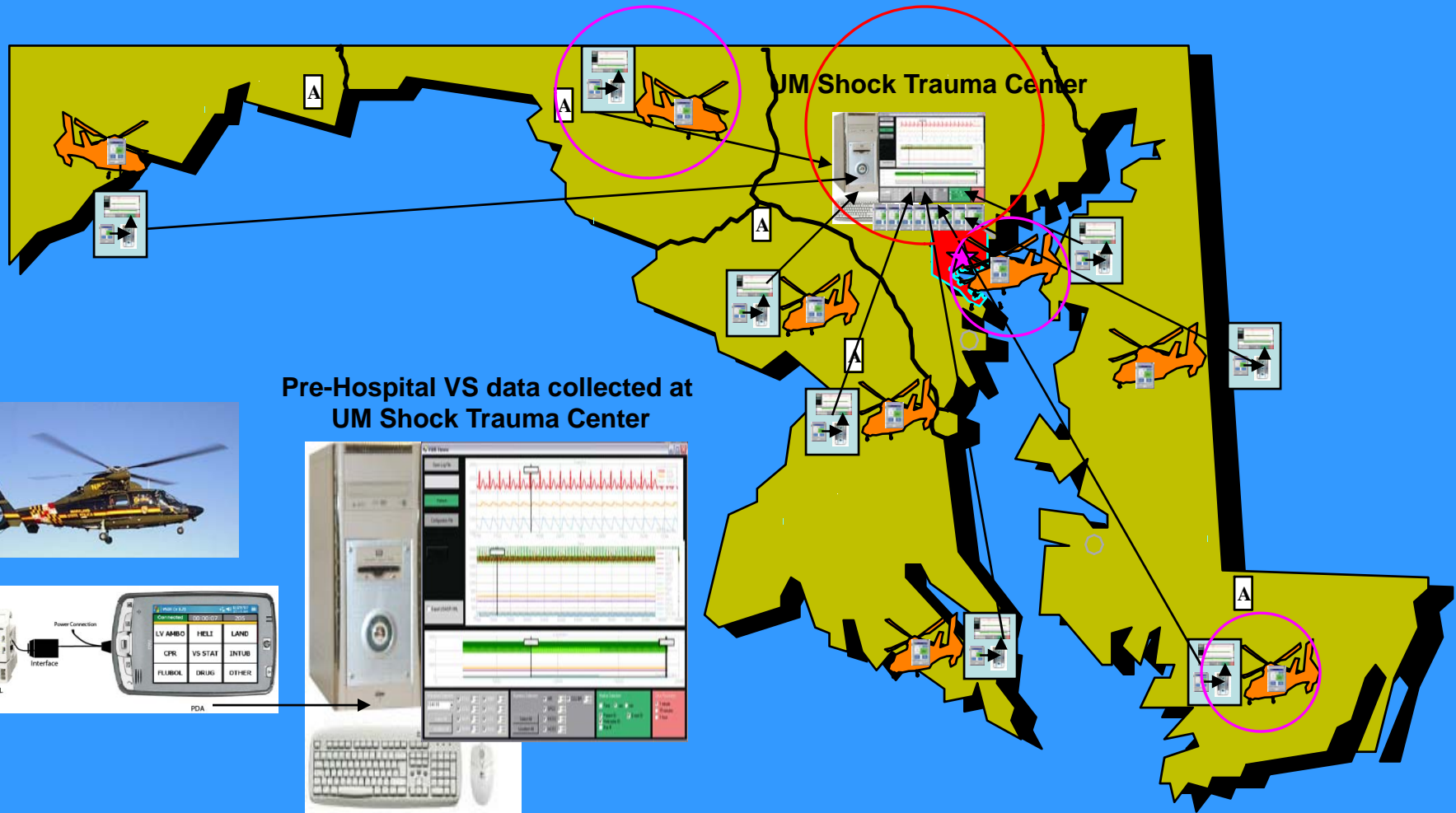
Pre- Hospital VSDR Consists of

- Patient Monitor Propaq 206EL
- Interface Black Box
- PDA (VS record) with Real-time Events Marker
- Wired, Wireless or SD based VS data transfer
- Waveform ECG (182Hz), SPO2/CO2 (90Hz)
- VS Trends (HR, BP, SPO2, ETCO2 RR etc at 1 Hz)
- 1 GB-SD card/PDA= 840 cases (350 Hours)

Event ID	Event Definition
#1	Vital signs STAT
#2	Fluid Bolus
#3	Drugs given
# 4	Bag-valve mask Ventilation
# 5	Field Intubation (RSI)
# 6	CPR
# 7	Other LSI
# 8	Move to Helicopter
# 9	Arrive at trauma center

VSDR Network in Maryland Trauma and EMS System

Pre-Hospital VSDR covers 3 Medvace Helicopter bases (6 Medical Helicopters)



Pre-Hospital VS data collected at
UM Shock Trauma Center



MSP MedEvac Bases (8) Deployed T1,3,6



Shock Trauma Center & MIEMSS



Areawide Trauma Centers

2) Pre-Hospital Post Run Paramedic Data Collection (www.vsdr.org)

Information collected includes:

Clinical:

Fluid administration,
Life Saving Interventions (LSI),

Rapid Fluid Bolus
Drug Given
BVM assisted ventilation
Intubation
CPR

Lowest Glasgow Coma Scale (GCS) score,

Lowest NIBP, Lowest HR

The likelihood of abdominal injury

Comments / Mechanism of Injury

Logistics:

Date and Time of Admission

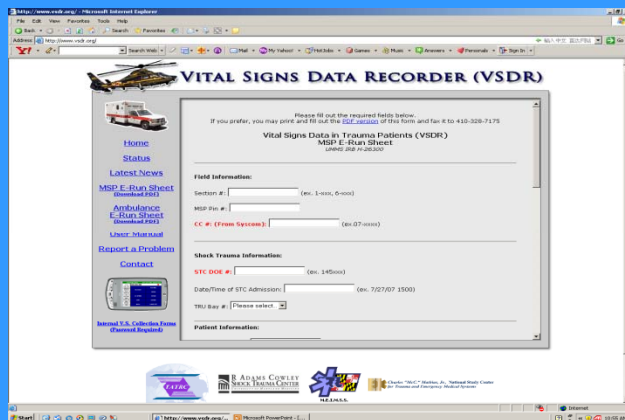
Trooper / Helicopter ID #

State Police AeroMedica Pin #:

Transfer ID #:

Shock Trauma Center Medical #:

Trauma Resuscitation Bay #:

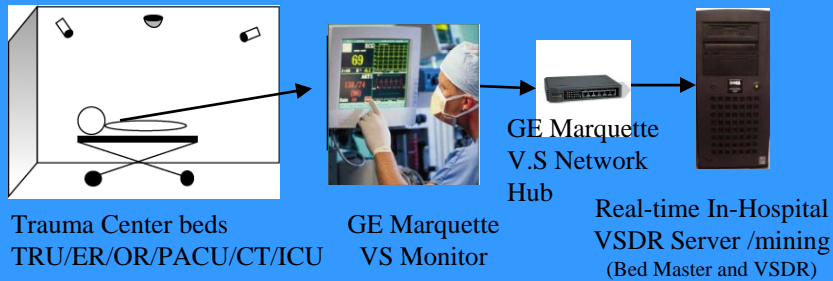


The screenshot shows the VSDR website's registration page. It features a navigation menu on the left with links for Home, Status, Latest News, MSP E-Run Sheet, Ambulance E-Run Sheet, User Manual, Report a Problem, and Contact. The main content area is titled 'VITAL SIGNS DATA RECORDER (VSDR)' and contains a form for registration. The form includes sections for 'Field Information' (Sector #, MSP Pin #, CC #), 'Shock Trauma Information' (STC Code #, Date/Time of STC Admission, TRU Bay #), and 'Patient Information'. A note at the top of the form asks users to fill out required fields and provides contact information for assistance.



The screenshot shows the VSDR website's user manual download page. It features a navigation menu on the left with links for Home, Status, Latest News, MSP E-Run Sheet, Ambulance E-Run Sheet, User Manual, Report a Problem, and Contact. The main content area is titled 'VITAL SIGNS DATA RECORDER (VSDR)' and contains a section for 'User Manual Download (PDF)'. The section includes a 'Vital Signs Data Recorder - VSDR User Manual V3.0' link and a 'Download (PDF)' button. There are also images of the user manual and a note about the manual being available in both English and Spanish.

3) In-Hospital Trauma Center Vital Signs Data Recorder (VSDR) Network

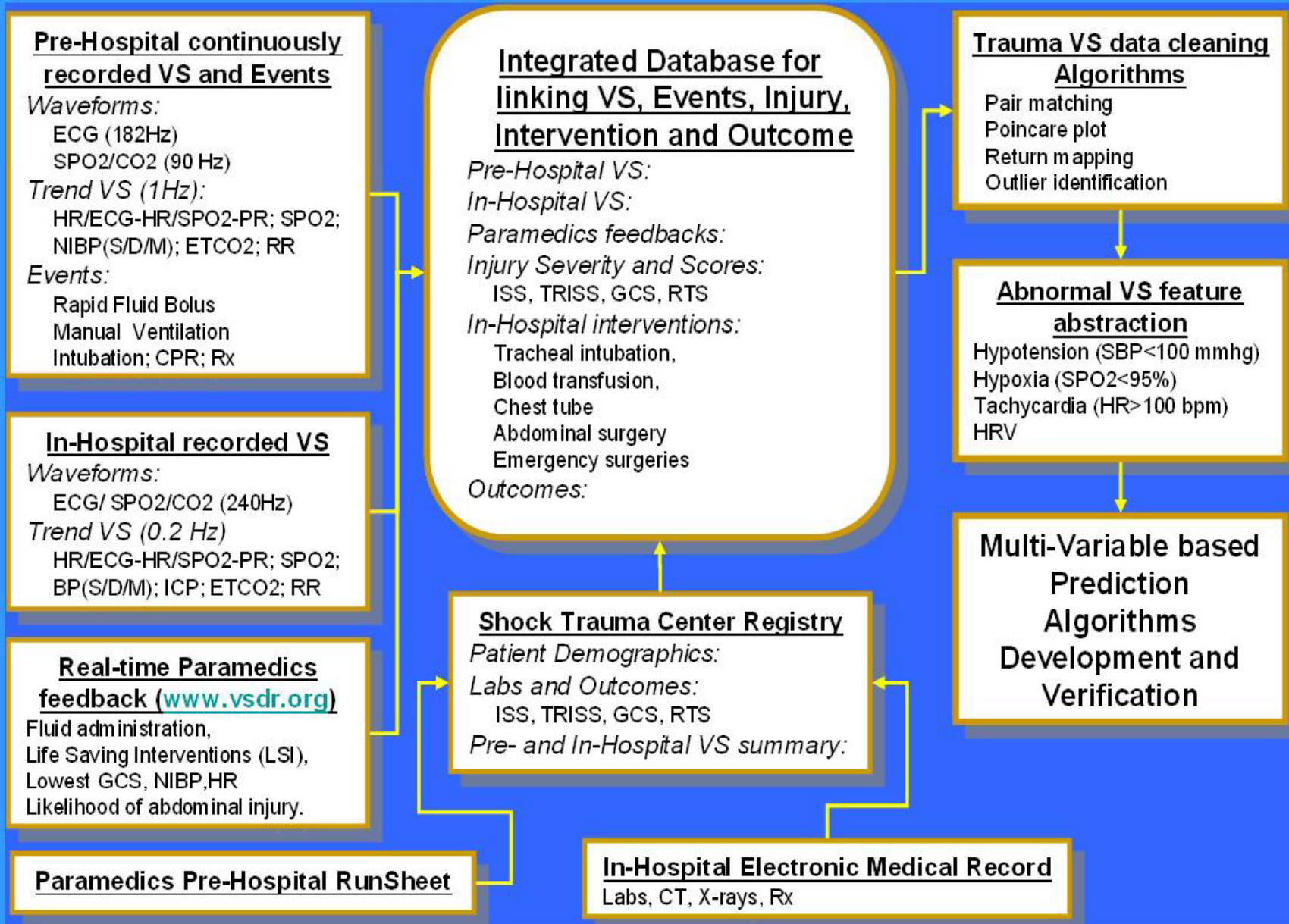


In-Hospital VSDR consists of

- GE Marquette VS Monitor
- VS Network
- In-Hospital VSDR Server and Data Mining
- VSDR collected up to 80 VS parameters
(Waveforms 240 Hz and Trends 0.2 Hz)
- VSDR System Start from 1992
- Covers 67 Critical Care Beds
(TRU/ER/OR/PACU/CT/ICU)

Units		# Beds	Waveforms	Alarms	Trends	On-Line date
Trauma Resuscitation Units act as Emergency Room	TRU/ER	12	Y	Y	Y	1992
Computerized Tomography Scan Room	CT	2	Y	Y	Y	1992
Angiography Room	Angio	2	Y	Y	Y	2000
Operating Room	OR	6	Y	Y	Y	1992
Post Anesthesia Care Units	PACU	9			Y	1992
Neuro Trauma Intensive Care Unit	NT-ICU	12			Y	2007
Neuro Trauma Intermediate Care Unit	NT-IMC	12			Y	2007
Multi Trauma Intensive Care Unit	MT-ICU	12			Y	2007
Total Beds cover by VSDR		67				

4) Trauma VS database and mining for prediction algorithm development Could Continues Real-time Vital Signs Predict Injury and Intervention ?



5) Results and Initial Findings

A) Pre-hospital: 6 Month of field operation, 157 Cases of 798 system usage, 157 cases for VS based study Pre-Hospital

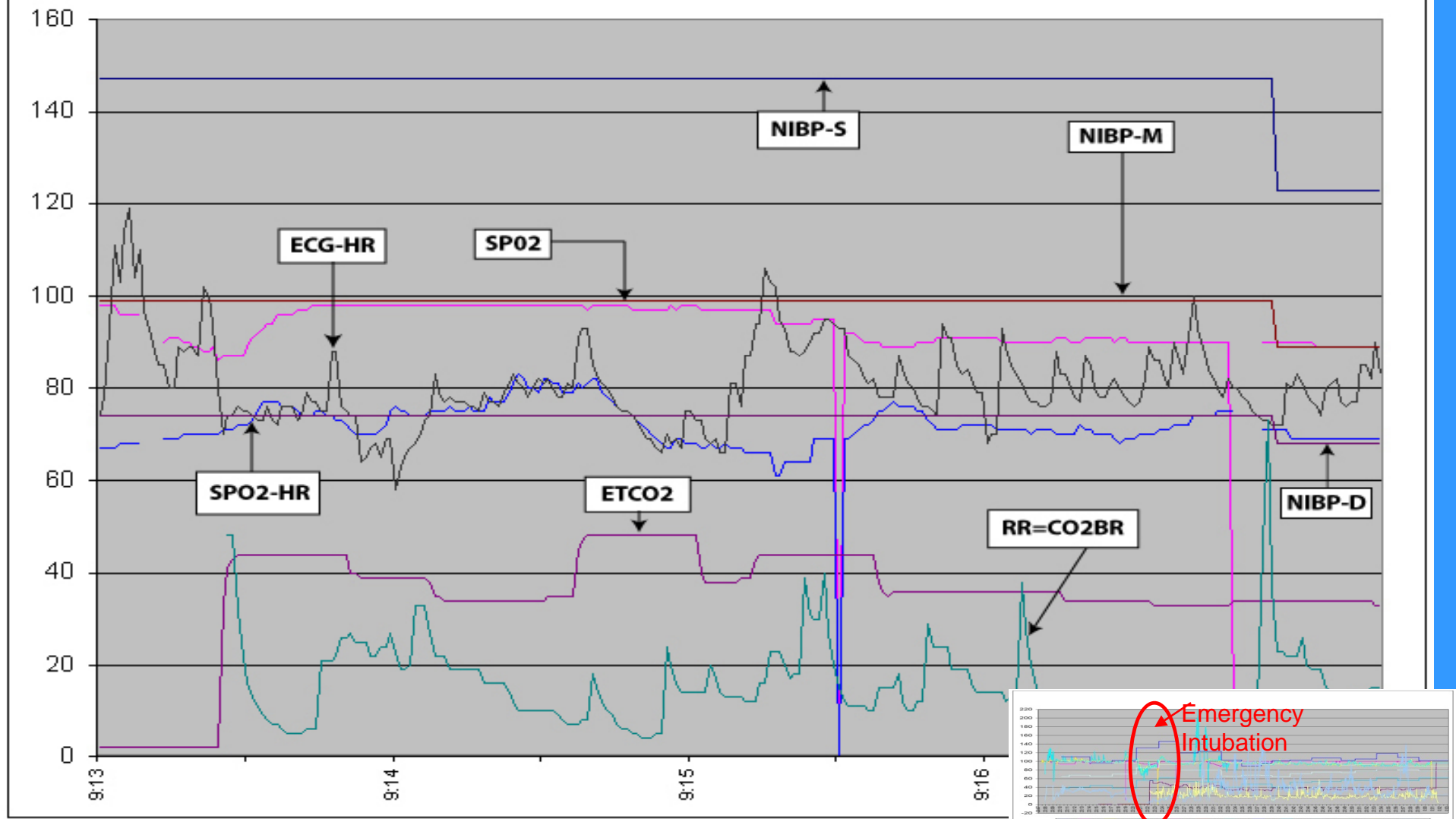
Trooper #	STC-Cases	Potential-Cases	Test-Case	subtotal
T1	94	115	184	393
T3	30	64	73	167
T6	33	74	131	238
	157	253	388	798

Three Helicopter bases (T1,T3,T6) with 6 Helicopters

5) Results and Initial Findings

B) Pre-hospital: What does In-Flight Trauma Patient Vital Signs look like ?

Pre-Hospital Emergency Intubation Vital Signs



5) Results and Initial Findings

C) What kinds of trauma patient VS were monitored during the air transfer?

VS variables (Waveforms)	ECG-WF	SPO2-WF	CO2-WF	Resp-WF *
Total N=157	145	156	6	17
% of cases	92.36%	99.36%	3.82%	10.83%

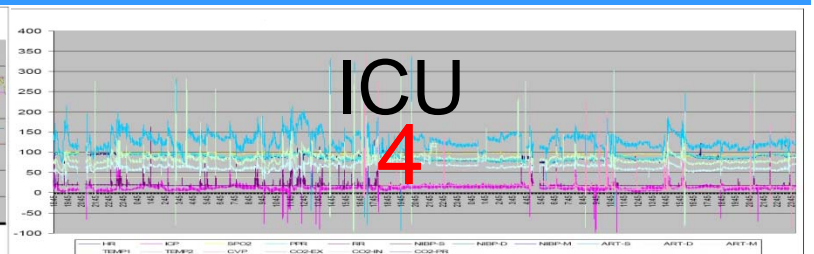
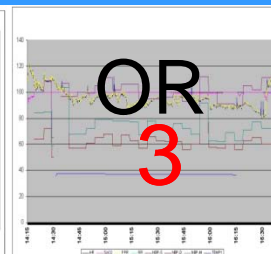
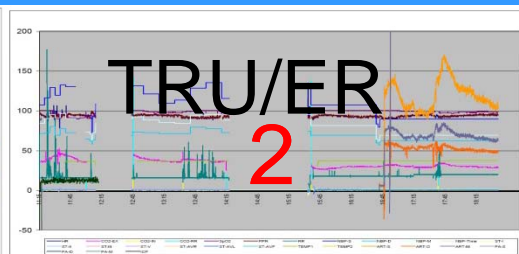
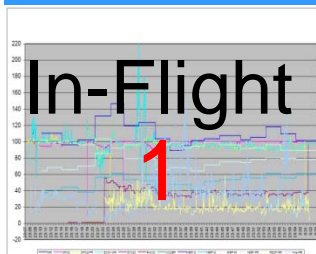
VS variables (Trends)	HR	SPO2	SPO2-RP	ECG-HR	ETCO2	NIBP-S/D/M	Resp RR *
Total N=157	157	154	153	147	5	153	44
% of cases	100.00%	98.09%	97.45%	93.63%	3.18%	97.45%	28.03%

* Both respiratory waveform and respiratory rate contains great amount of artifacts

5) Results and Initial Findings

G) How large are the data sets (#of Point and Size)?

Location	Care Units	VS Trends / Waveform	Sample Case Duration	VS Data Points	Un Compress ed File Size	Compress ed File Size	VS Collection Rate (data Points per second)
Pre-Hospital, Field	In-Flight 1	Trends	56 Min	50K	3MB	600KB	1 Hz
		Waveform	56 Min	150K	10MB	2MB	90/182 Hz
In-Hospital (Trauma Center)	Trauma Resuscitation Unit / Emergency Room(ER): 2	Trends	7Hours	50K	5MB	100KB	0.2 Hz
		Waveform	7Hours	24M	500MB	10MB	240Hz
In-Hospital	OR 3	Trends	2.5H	12K	1.2MB	24KB	0.2 Hz
		Waveform	2.5H	10M	300MB	6MB	240Hz
In-Hospital	ICU 4	Trends	2Day 5Hours	300K	30MB	600KB	0.2 Hz



What's Next

We predict well patients well,
but we predict severely injured patients poorly

Richard P. Dutton, MD

Chief Anesthesiology, R Adams Cowley Shock Trauma Center

- Continuous High Bandwidth Trauma Patient VS collection from the Field to Bedside
- Predict Shock and Trauma

Other Real-time Vital Signs based studies

Trauma Care Focused:

- DoD/TATRC (MD), J. Reifman
- US Army ISR (TX) J. Holcomb, J. Salinas
- US Army V. Convertino,

ICU Focused:

- Multi-Parameter Intelligent Monitoring for Intensive Care
MIMIC2/PhysioNet, MIT, R. Mark
- Vanderbilt University, J. Morriss, P. Norris
- Improved Monitoring for Brain Dysfunction (IMPROVE),
- Complex System Laboratory (CSL), Portland OR
- Massachusetts General/ Marquette Foundation (MG/MF)
- APACHE-II, Project IMPACT, SAPS-II



Acknowledgements:

Federal Grants, *industry* and Institutional Support

Grants Support

DoD W81XWH-07-2-0118
DoD-TATRC#W81XWH-05-0374
SBIR-W81XWH-06-C-0034
NSF IIS-0534646
NASA NCC2-921
DoD/ARL MEDTEAMS 96-002
NIH/NLM N01-LM-85606
TATRC / Operating Room of
the Future 03-06

Industry Support

GE Medical System
Welch Allyn / Propaq
Inovamar LLC
Excel Medical Inc
Northrop Grumman/TRW
Cisco Systems Inc
Active Signal Inc
Banyan BioMarker Inc

Institutional support:

State Maryland Police Aviation Command
Maryland Institute for Emergency Medical
Services Systems (MIEMSS)
National Study Center for Trauma and EMS
R Adams Cowley Shock Trauma Center
University of Maryland School of Medicine

Trauma Vital Signs Investigator (TVSI) Group

Colin F. Mackenzie ,MD,
Peter F. Hu MS, CNE,
Richard Dutton, MD,
Thomas Scalea, MD,
Ayan Sen, MD
Deborah Stein, MD,
Bizhan Aarabi, MD,
Nader Habashi, MD
Yan Xiao, PhD,
John Spearman, MBA,
Christopher Handley, MS, EMT-P
Douglas Floccare, MD, MPH
Grant Bochicchio, MD
Steven Johnson, MD

Trauma Vital Signs Research (TVSR) Associates:

Steven Seebode, BS,
Sean Jordan MHS, EMT-B,
Anne Conway RN MS
Ryan Gens BA,
Betsy Kramer RN,
Rebecca Webb BA, CCRC,
Danny Ho MS,
Peter Smitt, EMT,
Lisa Gettings, MS,
David Overturf BA ,
Karen Murdock, PT,
Kelly Bochicchio, RN, MS,
Melvin Alexander MS

Thank You



- Open Collaboration (Institutions and Industries)
- Website: hfrp.umm.edu

