

# ONR 34: Warfighter Performance

## **Sustaining the Edge**

Serving the Next Generation Warfighter ... Now

**Expeditionary Warfare Conference**

**Matthew J. Swiergosz, PhD**

**CDR, MSC, USN**

**26 October 2011**



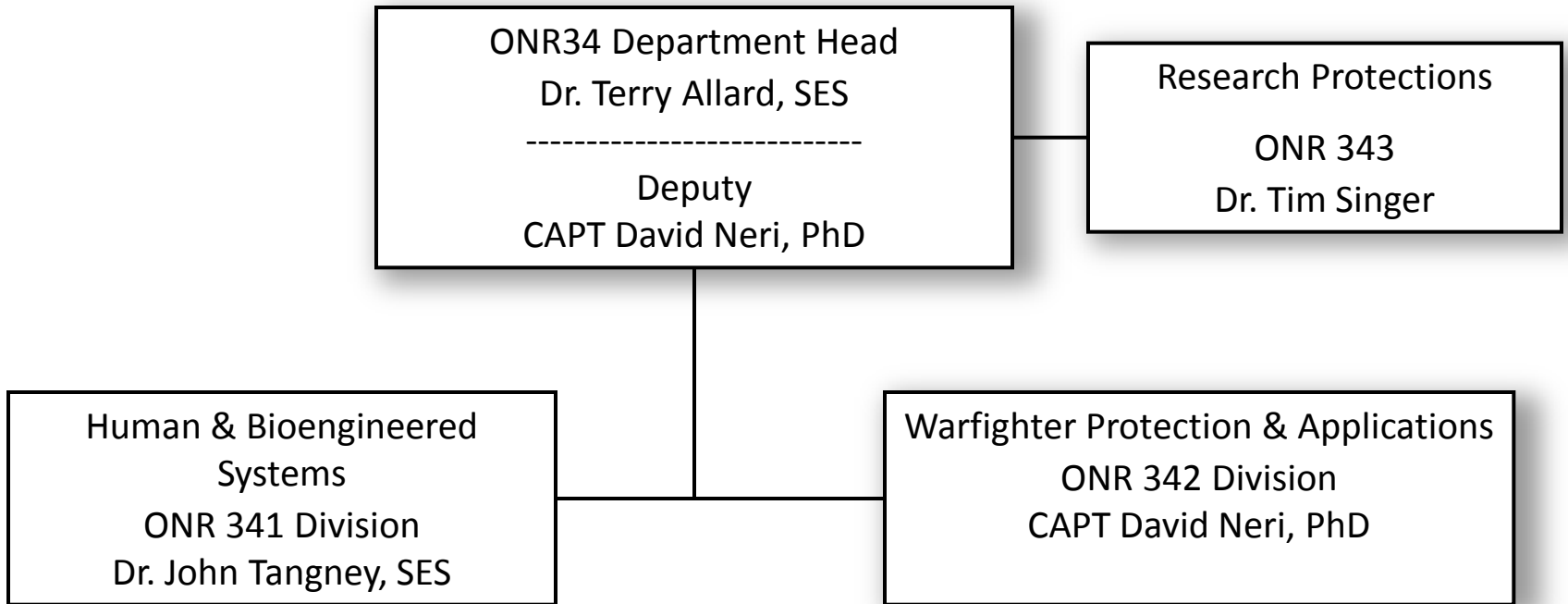
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OFFICE OF NAVAL RESEARCH



# ONR 34 LEADERSHIP



# SCIENCE & TECHNOLOGY COMPETENCIES

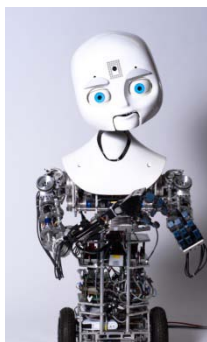
## Human Systems Integration

- Manpower Modeling
- Personnel Selection & Assignment
- Training
- User-Centered Design
- C2 Decision Support
- Safety



## Bio-Engineered Systems

- Marine Mammal Health
- Bio-based Sensors
- Microbial Fuel Cells
- Bio Robotics
- Human-Autonomy Systems



Sentinel/killer cells

## Undersea & Expeditionary Medicine

- Undersea Medicine
- Point of Injury Care
  - Extend "Golden Hour"
  - Treat hemorrhagic shock
- Automated Medical Monitoring /Care / CASEVAC
- Traumatic Brain Injury



# HISTORY OF SUCCESS

Pharmaceuticals



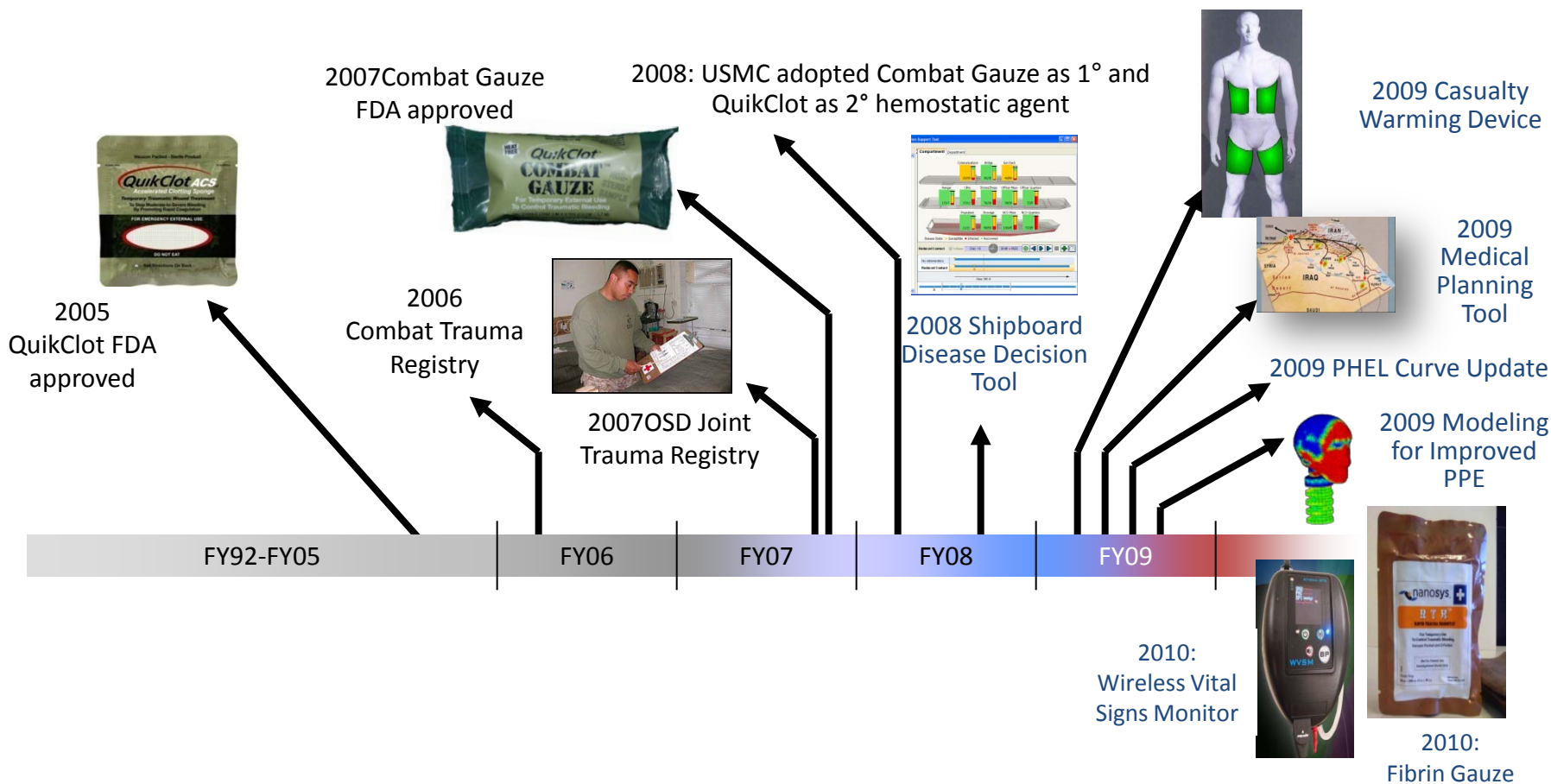
Blood



Devices



Discoveries



# WIRELESS VITAL SIGNS MONITOR

- Small, lightweight, highly-mobile, patient-worn medical monitoring system
- WiFi technology to collect and display a patient's vital signs.
- Enables medical personnel to be in touch with remote or on-site monitoring
- Connects wirelessly to Smart Phones, PDAs and multiple PCs.



- ONR Force Health Protection FNC Product demo in 2007, FDA-approved in 2010
- Integrates **standard medical technologies, e.g., blood oxygenation sensor (SPO<sub>2</sub>), non-invasive blood pressure (NIBP) monitor, Heart rate, and electrocardiograph (ECG)**, already on the market – thereby minimizing product acquisition and support costs
- Attaches to the standard blood pressure arm cuff for sedentary & mobile patients
- Development / evaluation by SOCOM (mini-Medic), NECC for Expeditionary Resuscitative Surgical Suite (ERSS), Army & civilian MEDEVAC helicopters

ONR PI, Dr. Peter Rhee, used WVSM to track vital signs of Congresswoman Giffords. Dr. Rhee was key to ONR's development of QuikClot, now in wide use across DOD.

# FORCE HEALTH PROTECTION (FHP)

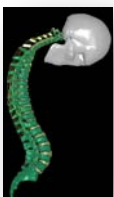
FUTURE NAVAL CAPABILITY (FNC) PROGRAM

FY08

## Casualty Prevention



Treatment for Decompression Sickness



Models of Head and Cervical Spine

FY08

## Warfighter Restoration



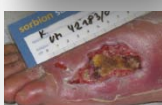
Hearing Loss Prevention and Treatment



Post-Traumatic Stress Mitigation



Repetitive Neurotrauma Mitigation

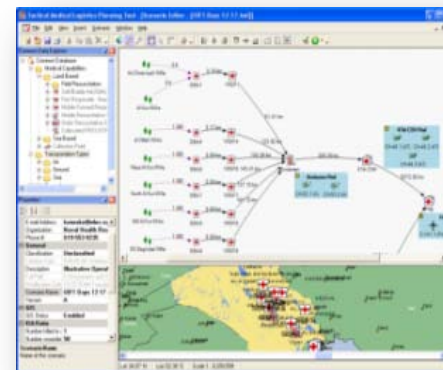


Wound Repair Wound Healing

Dr. Tim Bentley, FHP FNC Deputy

FY10

## Human Injury Treatment Models



FY08

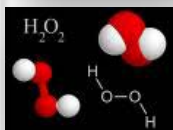
## Advanced Forward Care



Closed Loop Fluid Delivery



Closed Loop Ventilation



Oxygen Generation

FY08

## Rapid Blood Treatment



Hemostatic Agents FY13



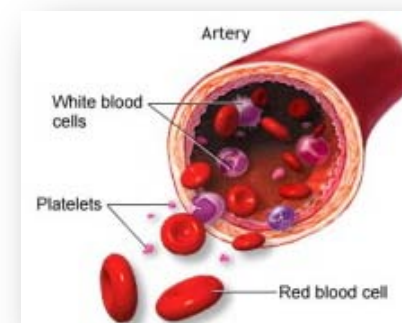
Pharmacologic Resuscitation FY13



Transfusion Safety FY13

FY11

## Multi-Functional Blood Substitute





# FORCE HEALTH PROTECTION (FHP)

FUTURE NAVAL CAPABILITY (FNC) PROGRAM

## FHP-FY12-01: Automated Critical Care System

En Route Care - efficient and lighter with integrated physiological systems



Provides:

Physiological Monitoring  
Mechanical Ventilation  
Supplemental Oxygen

Therapy

Analgesia/Anesthesia  
Fluid & Drug Therapy  
Casualty & Fluid Warming  
Patient data storage and transmission

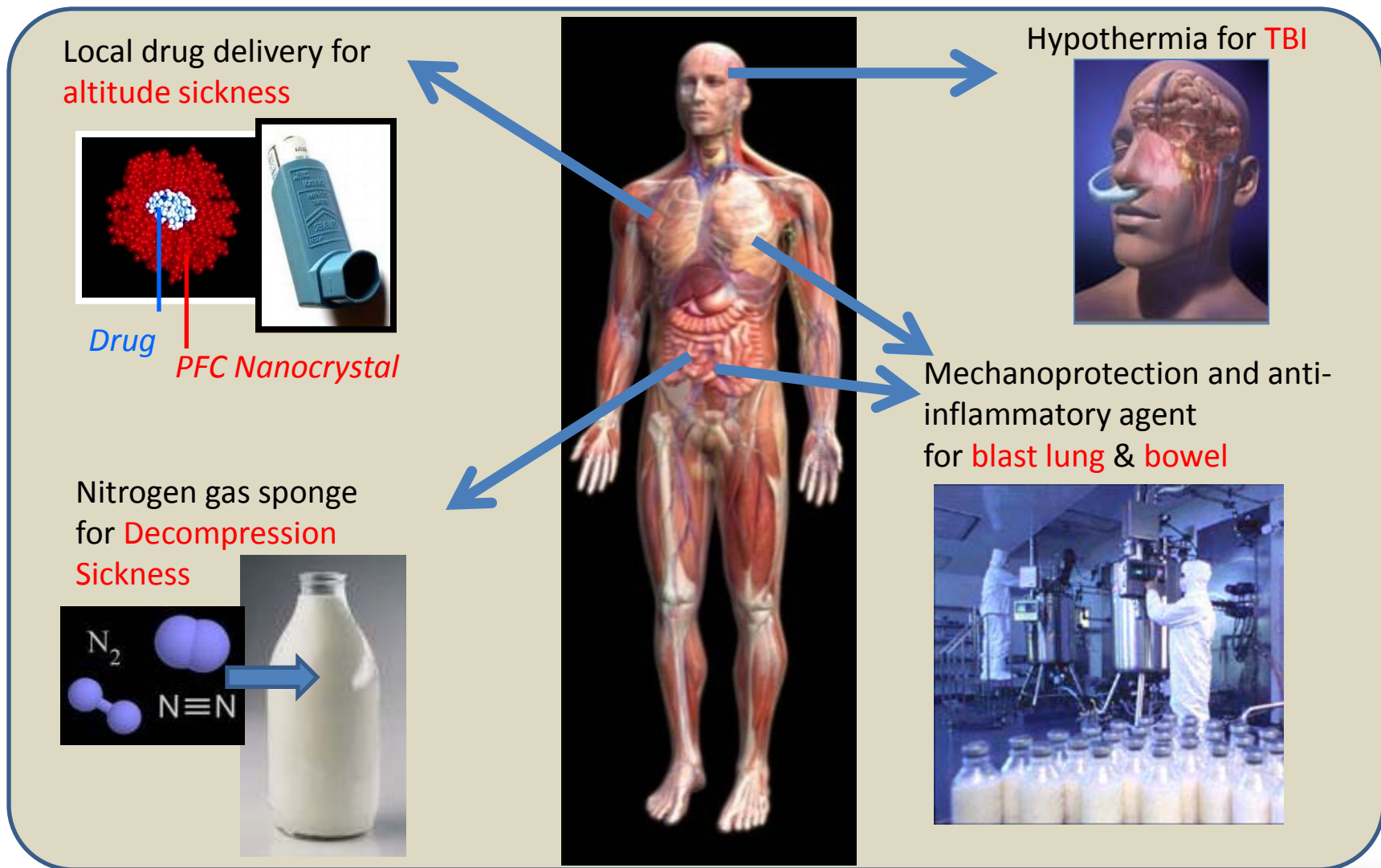
Exploring Joint Acquisition Strategy

Dr. Michael Given EC Manager

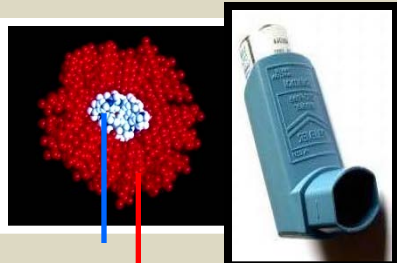
# FORCE HEALTH PROTECTION (FHP)

FUTURE NAVAL CAPABILITY (FNC) PROGRAM

## FHP-FY12-02: Saving Lives with Emergency Medical Perfluorocarbons in the Field (SEMPer Fi)



Local drug delivery for altitude sickness



Drug

PFC Nanocrystal

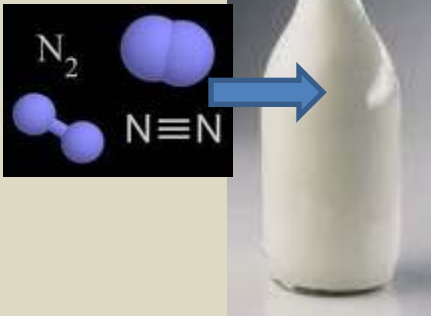
Hypothermia for TBI



Mechanoprotection and anti-inflammatory agent for blast lung & bowel



Nitrogen gas sponge for Decompression Sickness



CDR Sheri Parker EC Manager

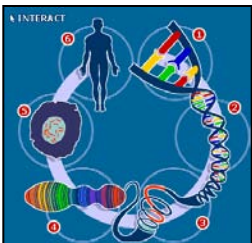


# UNDERSEA MEDICINE PROGRAM

NATIONAL NAVAL RESPONSIBILITY

BASIC

## Decompression Illness



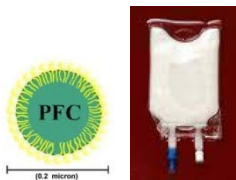
Gas transport through channels  
 Allometric Scaling of DCS  
 Biochemical Markers of DCS  
 Neutrophils in DCS

APPLIED



Bubble Detection  
 Basis and Treatment of AGE  
 Platelet-Neutrophil Aggregation  
 PFC Treatment  
 Autonomic Nervous System Effects

ADVANCED

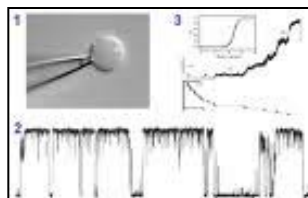


PFC treatment

## Oxygen Toxicity



Cellular Mechanisms  
 Hyperoxemia-induced Stress in CNS Cells  
 CNS-Pulmonary Interaction in OxTox  
 Ca<sup>2+</sup>-mediated impairment of CNS  
 Neutrophil Adherence



Fatigue & Exercise Intolerance  
 Biosensor for Ectrophysiology  
 Vigabatrin Treatment

## Submarine / Diver Health and Performance



Epidemiology: Medical Events  
 Ultrasonic Hearing  
 Women in Subs: Reproductive Toxicity



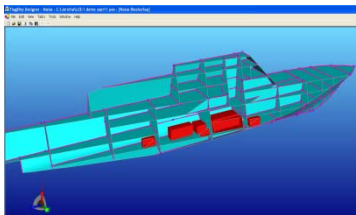
Respiratory Work at Depth  
 Inert Gas & Hyperbaric Pressure in the Hippocampus  
 Bone Health  
 Scalable Hyperbaric Patch Clamp

CDR Matthew Swiergosz Ph.D.

# NOISE INDUCED HEARING LOSS PROGRAM

Mr. Kurt Yankaskas & CDR Matthew Swiergosz Ph.D.

## Reduce Noise at the Source



Shipboard noise assessment



Jet noise measurement standards



Laboratory scale tests of jet noise reduction

## Personal Protective Equipment (PPE)



Shipboard PPE



3D Digitization for "Prescription" Ear Plugs

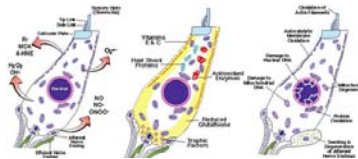


In-Ear Dosimetry



Underwater comm's & hearing protection

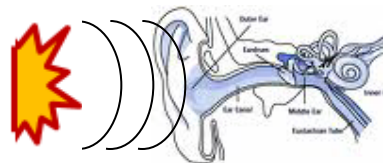
## Medical Prevention & Treatment



Cell regeneration



Pharmacologic interventions

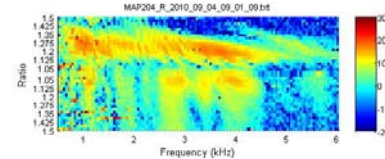


Blast interventions



Pulmonary and nasal drug delivery

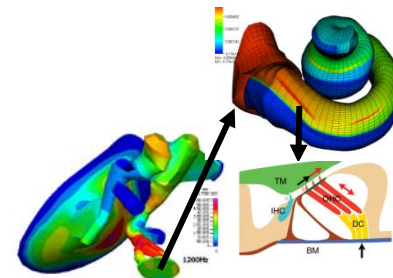
## Incidence, Susceptibility & Evaluation



Assessment tools



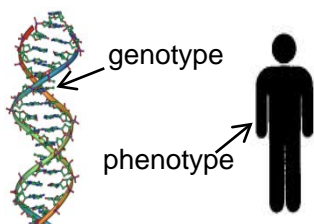
Hearing loss simulator



Modeling Tools

# BASIC BIOMEDICAL PROGRAM

## Sleep / Fatigue



Phenotypic and Genotypic Markers of **Performance Vulnerability** to Sleep Loss



**Work-related Fatigue** on Deadly Force Decision Making

## Blast



**SEMPer Fi** Continuation (support of EC) PFC-TBI Funding



Management of acute and sub-acute **traumatic brain injury**: Can **hyperbaric oxygen therapy** improve outcome?

CDR Sheri Parker, Ph.D.

## Environment



Exertional **Heat Illness** Biomarkers for Prediction and Return to Duty

In Vivo Animal Model (and Biomarkers) of **Environmental Heat Stress**



Identification of Markers of Endothelial Permeability in **High Altitude**

# CAPABLE MANPOWER (CMP)

FUTURE NAVAL CAPABILITY (FNC) PROGRAM

## CMP-FY08-01

### Game-Based Training



Advanced Technologies for Automated Performance Assessment in Games FY11



Deployed training games Ship and shore

Automated Performance Assess & After-Action Review FY11



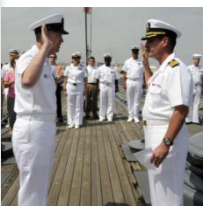
Integrated System for Language Education and Training (ISLET) FY11



Tools for Game-based Training and Assessment of Human Performance FY11

## CMP-FY08-05

### Strategy for Our People



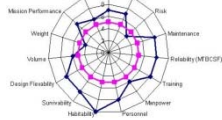
Navy Manpower and Personnel Modeling, Simulation, and Optimization Tools FY12

## CMP-FY08-03

### Human Systems Integration



Exceptional Expertise for Submarine Command Team Decision Making FY11



HSI Design environment FY12



State of the Art, Multimodal Tools for Increased Situational Awareness in Sonar FY10



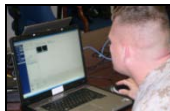
Unmanned Vehicle Control & Monitoring HCI for Amphibious Operations FY11

## CMP-FY08-06

### Training & Assessment for Expeditionary Warfare



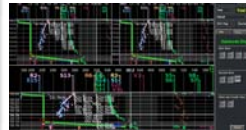
Behavioral Analysis and Synthesis for Intelligent Training FY11



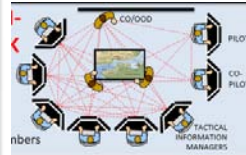
Next Generation Expeditionary Warfare Intelligent Training FY11

## CMP-FY10-01

### Information Architecture for Improved Decision Making



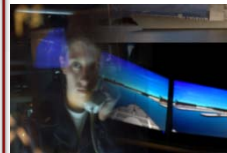
Data Triage FY14



Display Information with Uncertainty FY14

## CMP-FY10-02

### Adaptive Training to Enhance Individual and Team Learning and Performance



For Combat Information Center Teams FY14

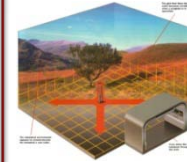


For Submarine Navigation & Piloting Teams FY14

Kip Krebs, Ph.D.

## CMP-FY11-01

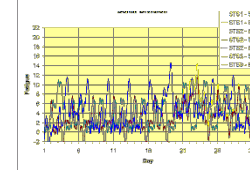
### Naval Next-Generation Immersive Technology



Augmented Immersive Team Trng: FY15  
Percept Trng Systems & Tools: FY15

## CMP-FY11-02

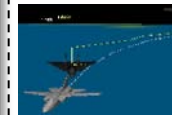
### Performance Shaping Functions for Environmental Stressors



Performance Shaping Functions FY15

## CMP-FY12-01

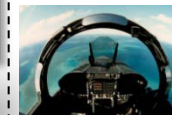
### Live, Virtual, and Constructive Trng Fidelity



Tactics & Speech Capable Semi-Auto Forces: FY16



Cognitive Fidelity Synthetic Environment FY16



Virtual/Constructive Reps on Live Avionics Displays: FY16



# ONR WARFIGHTER PERFORMANCE S&T DEPARTMENT

**ONR34 : WARFIGHTER PERFORMANCE Science & Technology Department**  
**Dr. Terry Allard, Department Head / CAPT David Neri PhD, Deputy**

<b>341: HUMAN &amp; BIO-ENGINEERED SYSTEMS</b>		<b>342: WARFIGHTER PROTECTION &amp; APPLICATIONS</b>	
<b>Dr. John Tangney, Division Director</b>		<b>CAPT David Neri PhD, Division Director</b>	
<b>Name</b>	<b>Program</b>	<b>Name</b>	<b>Program</b>
<b>Dr. Linda Chrisey</b>	<b>Naval Biosciences</b>	<b>Dr. Tim Bentley</b>	<b>Force Health Protection FNC Deputy</b>
<b>CDR Joseph Cohn PhD</b>	<b>Division Deputy</b>	<b>Dr. Ami Bolton</b>	<b>Human Systems Design</b>
<b>Dr. Rebecca Goolsby</b>	<b>Social Networks/ Anthropology</b>	<b>Dr. Mike Given</b>	<b>Casualty Care &amp; Mgmt</b>
<b>Dr. Harold Hawkins</b>	<b>Training S&amp;T, Modeling &amp; Simulation</b>	<b>Dr. Laura Kienker</b>	<b>Naval Biosciences</b>
<b>Dr. Tom McKenna</b>	<b>Neuroscience/Biorobotics/ Biometrics</b>	<b>Dr. Kip Krebs</b>	<b>Capable Manpower FNC Deputy</b>
<b>Dr. Jeffrey Morrison</b>	<b>C2 Decision Support</b>	<b>CDR Sheri Parker PhD</b>	<b>Division Deputy, Basic Biomedical</b>
<b>Dr. Ray Perez</b>	<b>Training &amp; Education S&amp;T</b>	<b>CDR Matt Swiergosz PhD</b>	<b>Undersea Medicine Program</b>
		<b>Mr. Kurt Yankaskas - NAVSEA</b>	<b>Noise Induced Hearing Loss (NIHL)</b>



BACK-UP

## Hemorrhage and Resuscitation

FHP-FY08-13 [Rapid Blood Treatment](#)



Spray Dried Plasma  
Fibrin Gauze

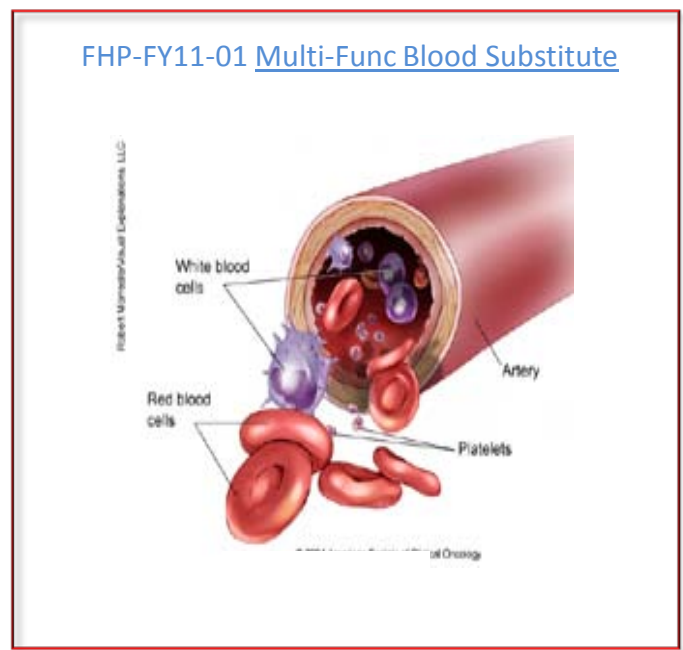
Pharmacologic  
Resuscitation



Transfusion  
Safety

**Hemorrhage is the #1 cause of preventable death on the battlefield**

FHP-FY11-01 [Multi-Func Blood Substitute](#)

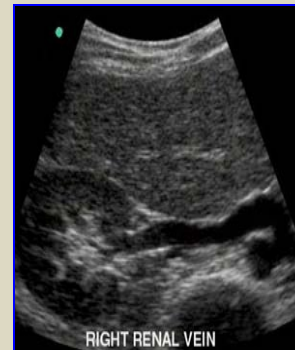


Dr. Michael Given EC Manager

## Proposed FHP-FY13-01: Sound Diagnostics

### Enhancements for Hand-Held Ultrasound

#### Non-expeditionary



#### Expeditionary



4D-Imaging capability  
(HW/SW)

Computerized  
training modules

SPIO-platelets for  
detection of  
internal bleeding

Pulmonary and  
transcranial imaging

Dr. Michael Given EC Manager





# ONR Strategy for Force Health Protection

## A Continuum of Care

### Pre-Deployment Care & Prevention



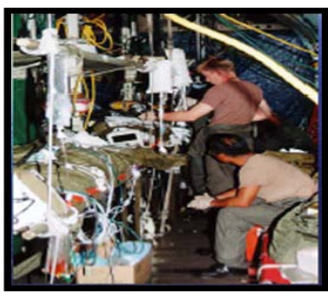
- Hearing Loss Prevention & Treatment
- PTSD Prevention & Mitigation
- Modeling & Simulation for Improved PPE
- Submariner Health

### Advanced Forward (Point-of-Injury) Care



- Hemostatic Agents
- Pharmacologic Resuscitation
- Rapid Blood Typing & Pathogen Detection
- TBI detection

### En Route and Automated Care



- Closed Loop Fluid & Ventilation System
- Oxygen Generation, Patient Warming

### Post-Deployment Care, Treatment, and Restoration



- Wound Healing
- Wound repair
- AFIRM:  
Armed Forces Institute of Regenerative Medicine

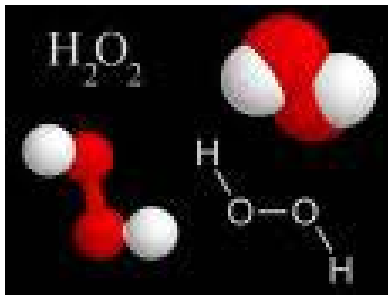
FHP-FY08-02 Advanced Forward Care



Closed Loop Fluid Delivery



Closed Loop Ventilation



Oxygen Generation Without Power

Better Care / Force Multiplier for Seabasing and Distributed Operations

### ACCS



Dr. Michael Given EC Manager



# Casualty Warming Device (CWD)

**Description:** Hypothermia prevention product

**Naval Need:** Solution that is...

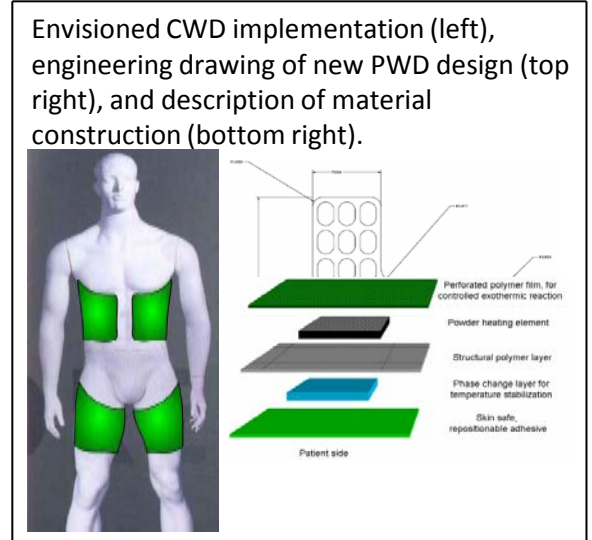
- Lightweight & disposable
- Compact & shelf-stable
- Low-cost
- Has no power generation requirement

**Discovery and Invention Efforts Leveraged:**

In clinical studies, Infoscitex demonstrated CWD maintained skin interface temperature at 40°C (104°F) for 8 hr, greatly surpassing stability of other devices

**Impact:** Hypothermia prevention that...

- Requires no external power
- Achieves self-regulation achieved by unique dual layer technology
- Enables safe, unattended operation
- Provides stable temperature up to 8 hr



*FY10: Transitioned to MCSC for evaluation with other casualty warming technologies. NECC will accept MCSC recommendation.*

# Synthetic Fibrin Dressing

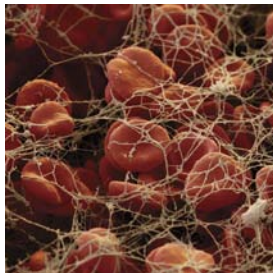
**Description:** Nanofiber bandage with desired properties of blood absorbability and biodegradability over period of days

**Naval Need:**

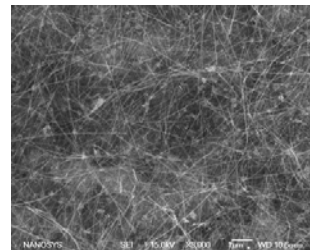
- Reducing hemorrhage -- leading cause of death on battlefield
- A solution with point-of-injury use, adequate resorption (so can be left in wound), and capability of internal use

**Impact:**

- Improved hemorrhage control
- Will reduce killed-in-action rate
- Will reduce requirement for blood / resuscitation fluids on the battlefield



Fibrin mesh trapping rbc's and platelets



Synthetic "Fibrin" mesh



"Rapid Trauma Hemostat" Dressing

*FY10: External use submitted to FDA for approval; internal use submission to follow*

**Description:** Closed-Loop-Control (CLC) system for fluid resuscitation

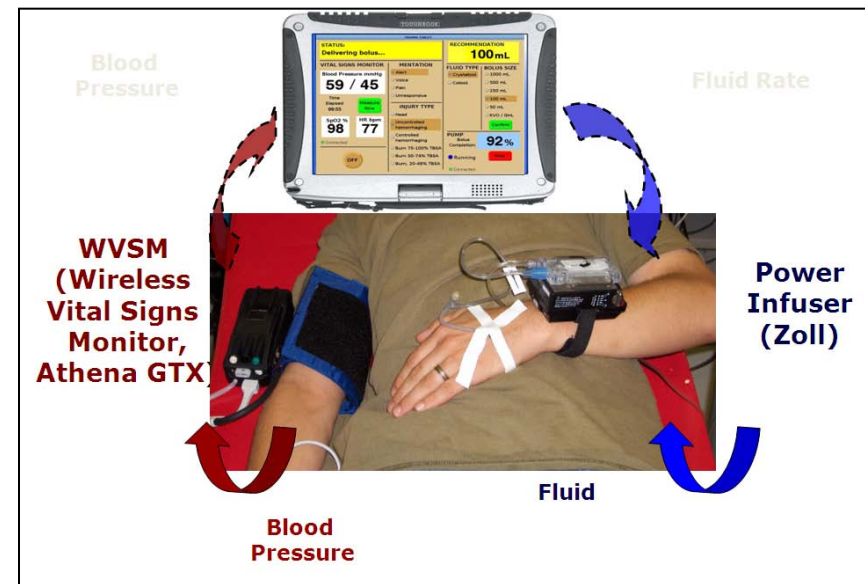
**Naval Need:**

- Continuous patient monitoring
- Less outside intervention
- Improved patient care for better outcomes

**Impact:**

- 24/7 patient monitoring
- Reduced risk of over/under fluid resuscitation and subsequent med issues
- Decision-Assist provides recommendations for acceptance or rejection
- Fully autonomous-care-capable
- Reduced logistics: 80% reduction in fluid required to maintain target blood pressure

Current prototype of the closed-loop control system for fluid resuscitation.



Dr. Michael Given

*FY10: Decision-Assist component submitted to FDA for approval*

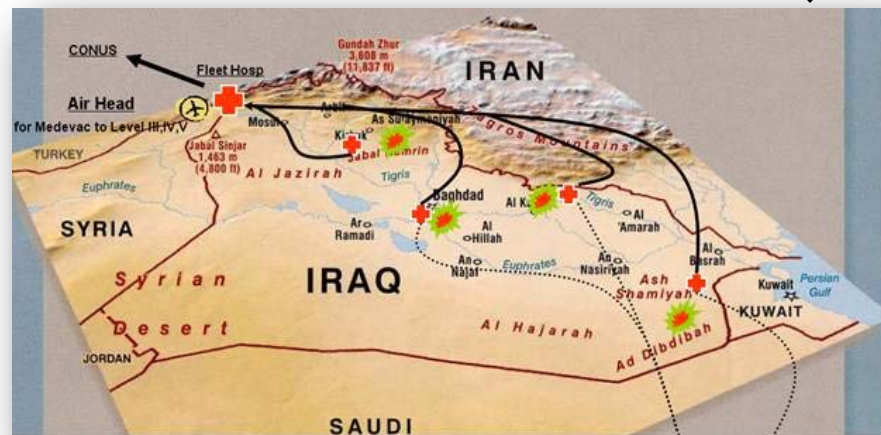


# Died-of-Wounds Projection

**Description:** Dynamic Military Treatment Facility (MTF) planning tool and decision aid for medical combat developers

**Naval Need:**

- In-theater decision aid to redeploy medical assets to meet changing operational conditions
- Objectively model the effects of treatment delays on mortality



Snapshot of Combat Operations and MTF Network in the Iraqi Theater

**Warfighting Payoff:**

- Quickly examine reasonable Courses of Action (CoA) for an MTF network in dynamic situations
- Supports USMC “Distributed Operations” concept
- Medical planner can select best CoA based on associated field operational and medical system constraints

*A Medical Planning Tool to Optimize Deployment of Limited Medical Assets  
FY10: Transitioned to Marine Corps Combat Dev Command; Used in OIF and OEF Theater*

Dr. Michael Given

**Description:** High fidelity computational model of human head and ears to simulate blast/noise energy transfer from air to inner ear. Model is being validated in Marine Corps Breachers study.

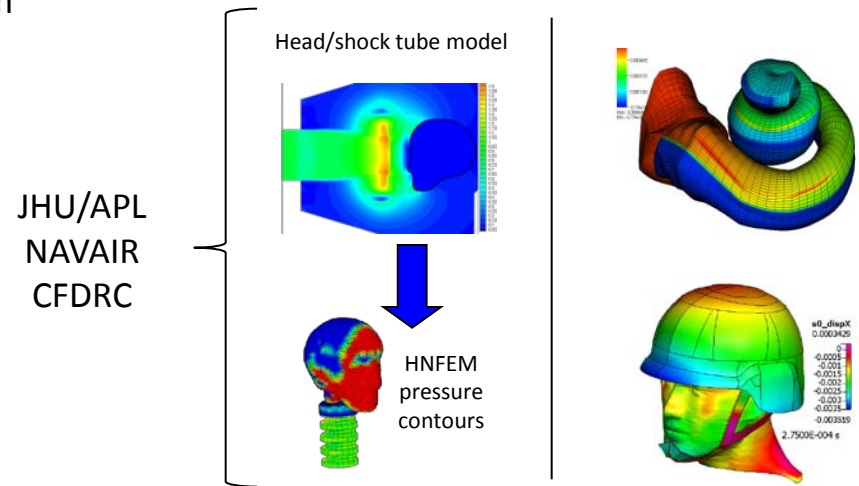
## Naval Need:

- Modeling and simulation of blast injuries
- Protection for head, neck and spine
- Accurate enhancement of specs for Personal Protective Equipment (PPE)
- Fewer injuries associated with blast effects on the head and neck.

## Warfighting Payoff:

Accurate pressure profiles to enhance protection against:

- IEDs (ground)
- rapid ascent from depth (diving)
- flight ops acceleration (altitude)
- ejection G stress (flight ops)
- Noise (everywhere)



- Project Funded by ONR Force Health Protection, Undersea Medicine & Noise Induced Hearing Loss
- Represents collaboration between government labs, academia and industry

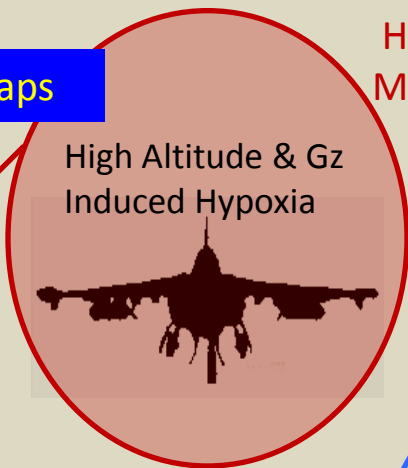
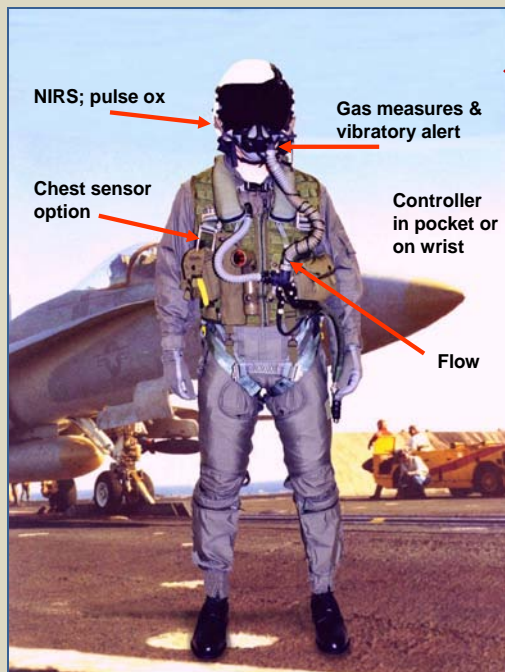
*Addresses occupational head, neck and spine injuries from blast, noise, pressure and acceleration forces*

CDR Sheri Parker PhD

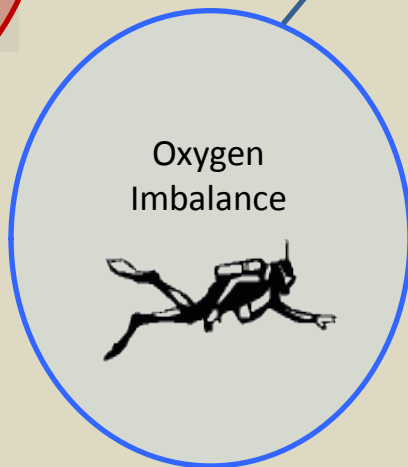
Expeditionary Medicine,  
Undersea Medicine

## Approved FHP-FY13-03: Extreme Operations

### Reduce Class A Aviation Mishaps



Hypoxia Alert and Monitoring System



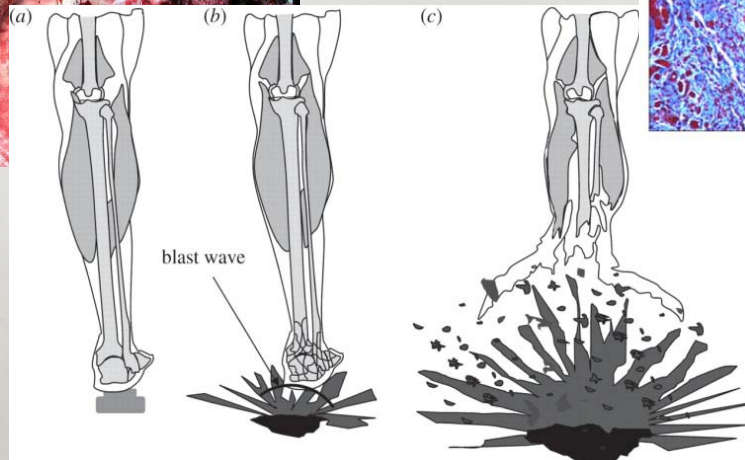
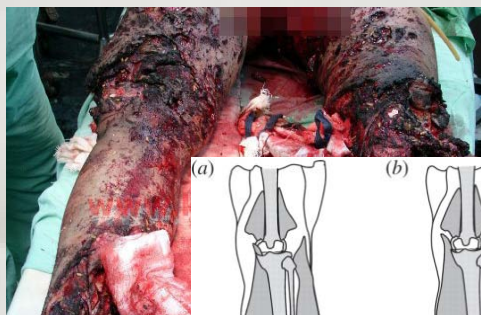
DCS & OxTox:  
New indications for already  
FDA-approved treatments

CDR Sheri Park EC Manager

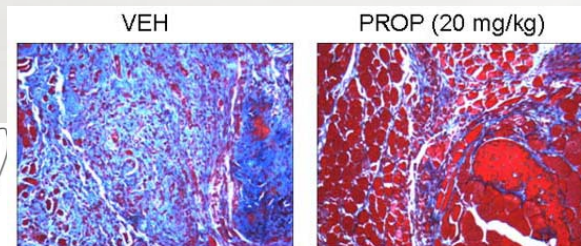
Expand Diver Range / Improve DISSUB rescue



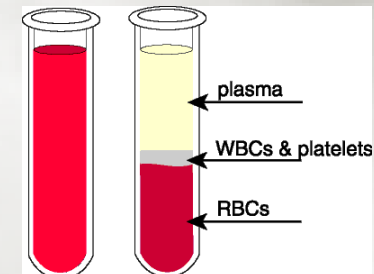
# Dismounted Complex Battle Injury a Marine Corps Priority



## Tissue Regeneration

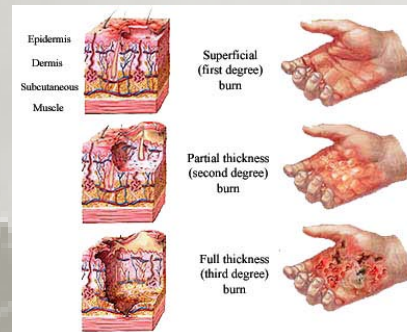


## Resuscitation



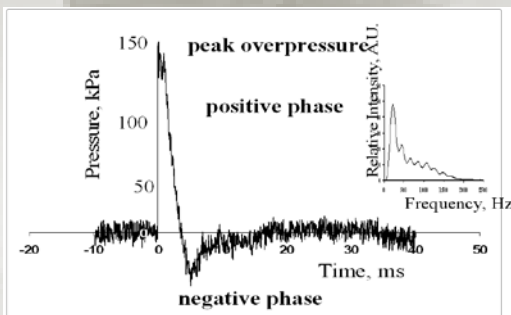
## ACCSIL

### Tissue Preservation & Limb Sparing



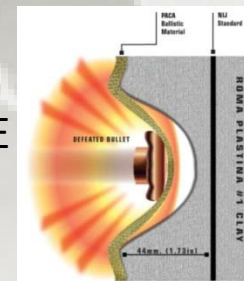
## Neurotrauma

### Blast Sensing and TBI Detection



## I PREDICT

### Computational Tool for PPE Improvement





# Navy Medical Research

## Coordinated strategy

### CNO Special Interest

#### Noise-Induced Hearing Loss

- Comprehensive S&T program approved by ASN
- ONR's cross-component leadership
- Linkage to VA, Army, Defense Health Program
- Coordination with BUMED Audiology

#### Women in Submarine Force

- RDT&E program includes S&T, Advanced Development, O&M,N funding
- BUMED programmatic leadership (Prusaczyk)
- Builds on ONR Health Surveillance Undersea Medicine leadership

#### ASD (Health Affairs) Defense Health Program

- Cross-component transition strategy
- Navy in Joint Program Committees
- Cross-component reviews (ASBREM)
- Coordinated AFIRM funding strategy

### CMC Special Interest

#### Combat Casualty Care

- Point of Injury Care
- Casualty Evacuation Technologies
- TBI / PTSD
- AFIRM
- Warfighter Resilience
- Dismounted Complex Battle Injury\*

\* New working group by direction of ACMC.  
Report by ~Thanksgiving 2011

#### Unified DoN RDTE investment plan

- Strong ONR / BUMED cooperation with Navy Advanced Development program (CAPT Montcalm-Smith / Dr. Prusaczyk)

#### NASA Human Health & Performance Ctr

- Coordination, Collaboration, Leverage
- Industry, Academia, Gov't