

# **Combat Casualty Care Research at the U.S. Army Institute of Surgical Research**

**David G. Baer**

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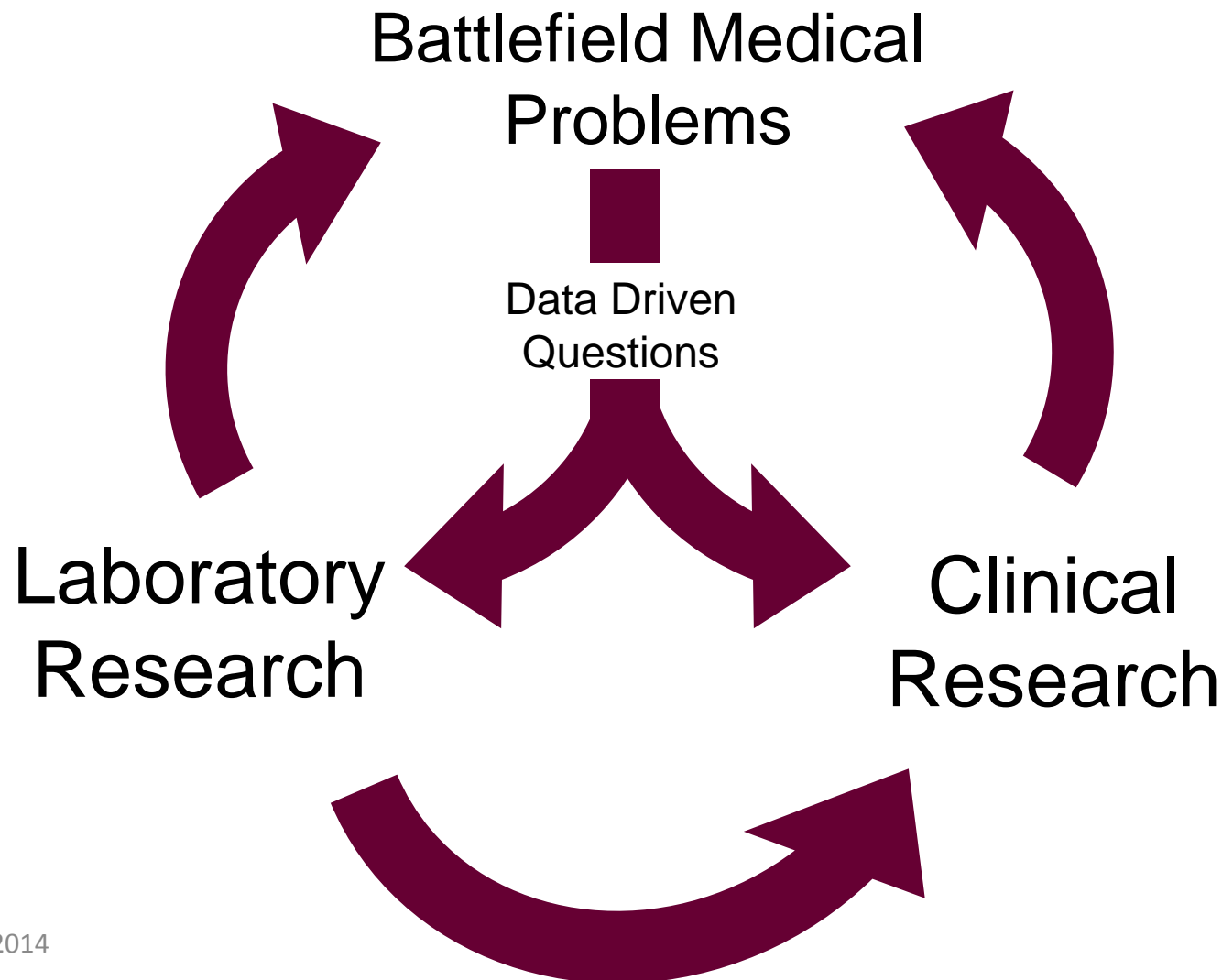
# Mission of the US Army Institute of Surgical Research



## Optimizing Combat Casualty Care

- Provide requirements driven combat casualty care medical solutions and products for injured soldiers from self-aid through definitive care across the full spectrum of military operations
- Provide state-of-the-art burn, trauma, and critical care to Department of Defense beneficiaries around the world

# The Research Philosophy of The U.S. Army Institute of Surgical Research

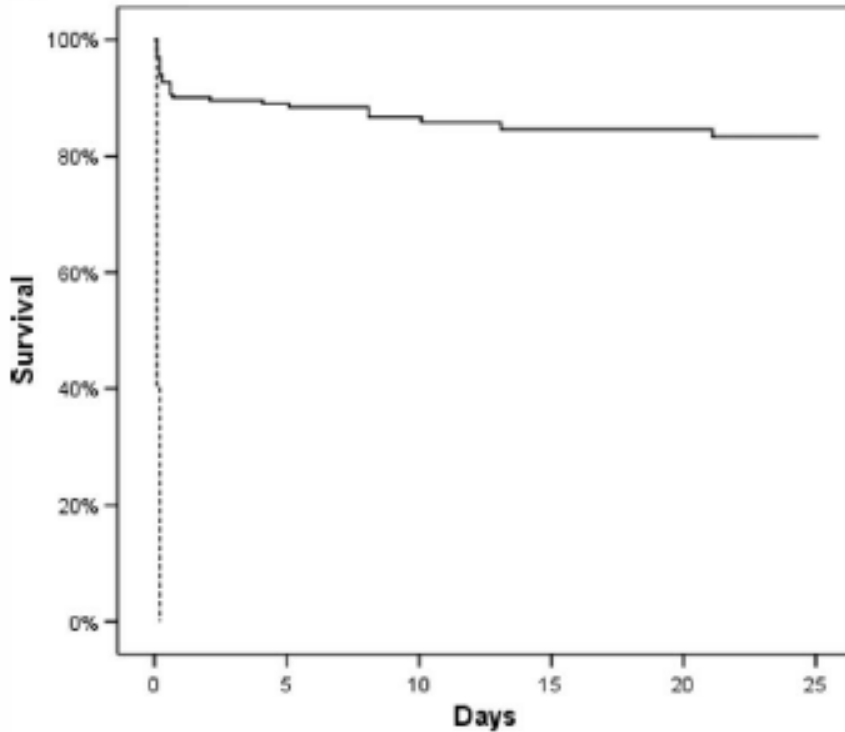


# Survival With Emergency Tourniquet Use to Stop Bleeding in Major Limb Trauma

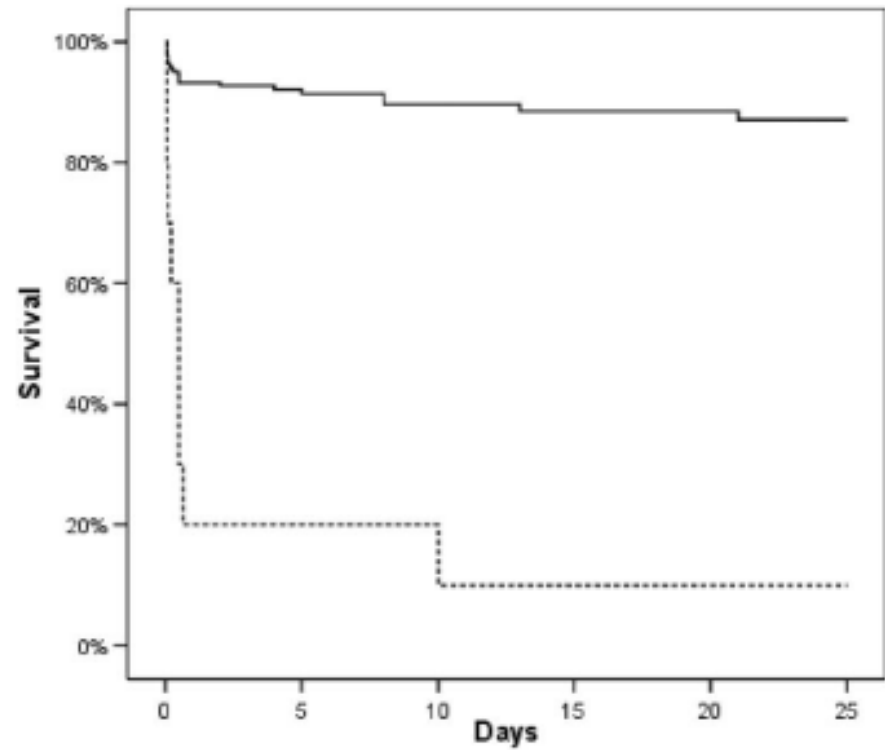
COL John F. Kragh, Jr., MC, USA,\* Thomas J. Walters, PhD,\* David G. Baer, PhD\*;  
LTC Charles J. Fox, MC, USA, Charles E. Wade, PhD,\* Jose Salinas, PhD,\*  
and COL John B. Holcomb, MC, USA\*



**A** Survival: Tourniquet Used vs. Not Used (1st 25 Days)



**B** Survival: No Shock vs. Shock Tourniquet Use (1st 25 Days)





vival

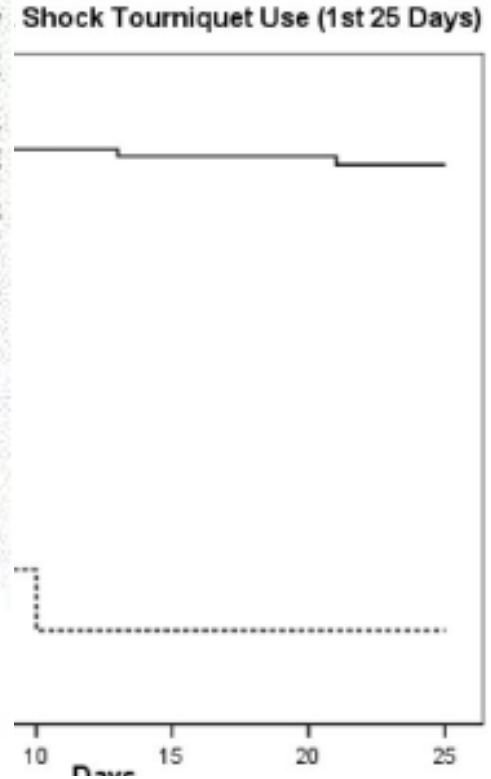
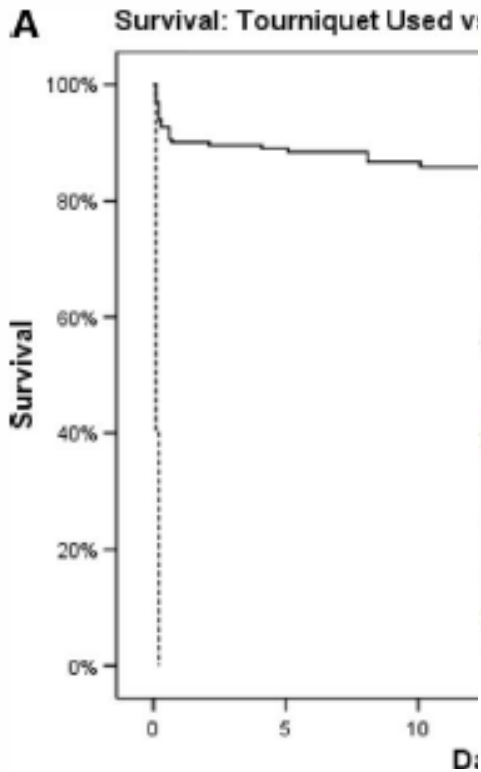
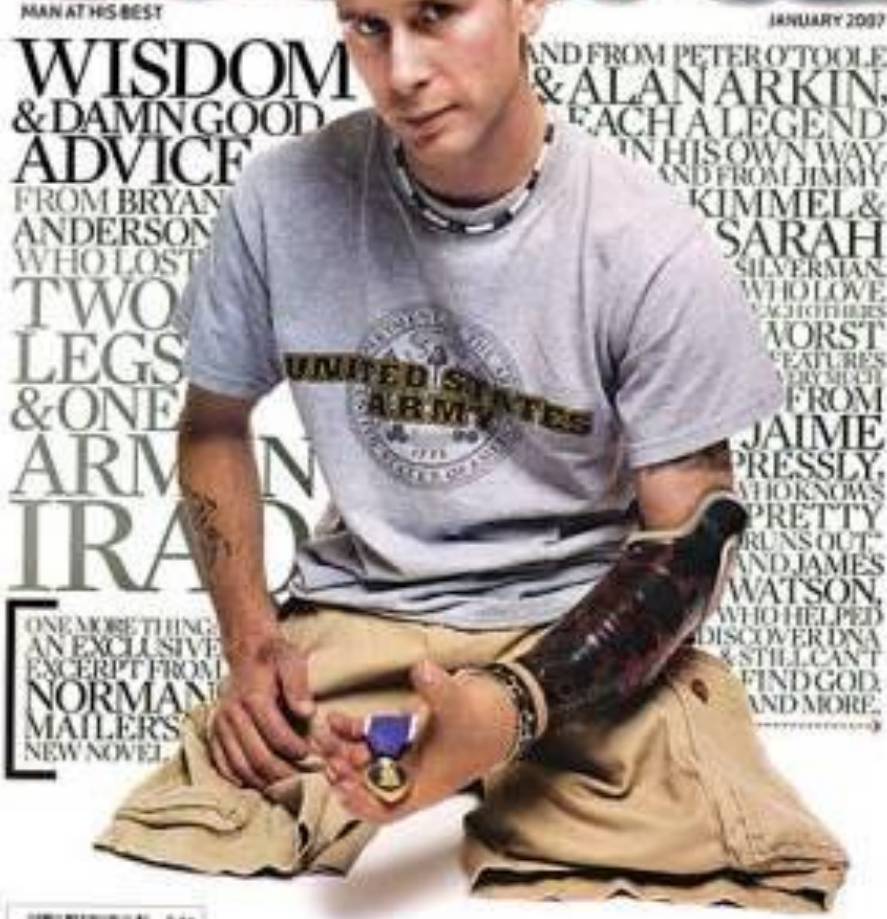
COL John  
LTC C

# The Meaning of Life

## Esquire

to Stop

er, PhD\*,  
PhD,\*



**The life of Bryan Anderson was saved with 3 tourniquets**

# ISR Contributions to Improved Combat Casualty Care For Soldiers

2004 Army Greatest Invention – Hemcon Dressing

2005 Army Greatest Invention – Combat Tourniquet

2007 Army Greatest Invention – Damage Control Resuscitation

2008 Army Greatest Invention – Combat Gauze Dressing

2009 Army Greatest Invention – Burn Resuscitation Decision Support

- **Hemostasis Innovations**
- **rFVIIa to treat coagulopathic bleeding**
- **Fluid warmers to prevent hypothermia**
- **Hypothermia prevention kit**
- **Intraosseus Infusion Systems**
- **Hextend**
- **Antibiotics by medics**
- **Pain control by medics**
- **Improved burn wound diagnostic tool**
- **Joint Theater Trauma System**
- **Battlefield burn prevention**
  - **Safe burning of waste**
  - **Use of Nomex gloves**
  - **Burn prevention shirt**
- **Needle Thoracentesis to treat pneumothorax pre-hospital**
- **Ultrasound to diagnose pneumothorax**
- **Individual First Aid kit**
- **Vehicle First Aid kit**
- **Fresh Whole Blood**
- **Tourniquet use guidelines and doctrine**
- **Hypotensive resuscitation guidelines**
- **Renal replacement therapy for burn**
- **Blood product resuscitation**
- **Impedance threshold device for hypovolemia**



# Damage Control Resuscitation

- Recent Accomplishments
  - Tourniquets
  - 2<sup>nd</sup> and 3<sup>rd</sup> Generation Hemostatic Dressings
- Current Focus Areas – Reducing KIA and DOW Rates
  - Hemostatic Resuscitation – Restore volume, avoid coagulopathy, provide oxygen carrying capacity
  - Avoid giving blood products to those who do not need them
  - Prevent hypothermia



# Blood Research Program

- Recent Accomplishments
  - Transition of Freeze-Dried Plasma and Cryo-Preserved Platelets to Advanced Development (clinical trials)
- Current Focus Areas
  - Understanding basic mechanisms of trauma-induced coagulopathy
  - Developing improved platelet storage systems
  - Developing blood product pathogen reduction technologies





# Extremity Trauma & Regenerative Medicine

- Recent Accomplishments
  - Defining the injury patterns and resulting functional outcomes
    - Open fractures
    - Soft tissue defects (muscle and nerve)
    - Wound irrigation and debridement

## Current Focus Areas

- Animal modeling of traumatic injury
  - Segmental defects (bone and muscle)
  - Wound contamination and infection
- Muscle Regeneration
- Delivery of autologous stem cells to treat defects
- Establishment of the Major Extremity Trauma Research Consortium
  - Partnership between military treatment centers and civilian trauma centers
  - Clinical trials comparing
    - Autograft vs. allograft with recombinant Bone Morphogenetic Protein -2
    - External fixation (circular fixation) vs. early internal fixation
    - Systemic antibiotic therapy vs. antibiotic therapy with local antimicrobial delivery



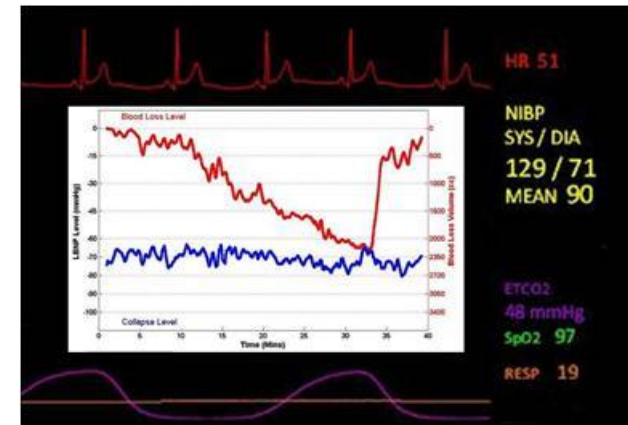
# Pain Control

- **Recent Accomplishments**
  - Defining the relationship between pain control and Post Traumatic Stress Disorder
  - Influence of anesthetic agents on Post Traumatic Stress Disorder
- **Current Focus Areas**
  - Use of virtual reality immersive environments for pain control
  - Intranasal ketamine for battlefield pain control
  - Intravascular thermal regulation during surgery



# Advanced Capabilities for Emergency Medical Monitoring

- **Recent Accomplishments**
  - Impedance threshold device to support cardiac output during central hypovolemia
- **Current Focus Areas**
  - Investigation of mechanisms of tolerance to hypovolemia
  - Development of wearable physiologic status monitor
  - Remote triage devices and algorithms



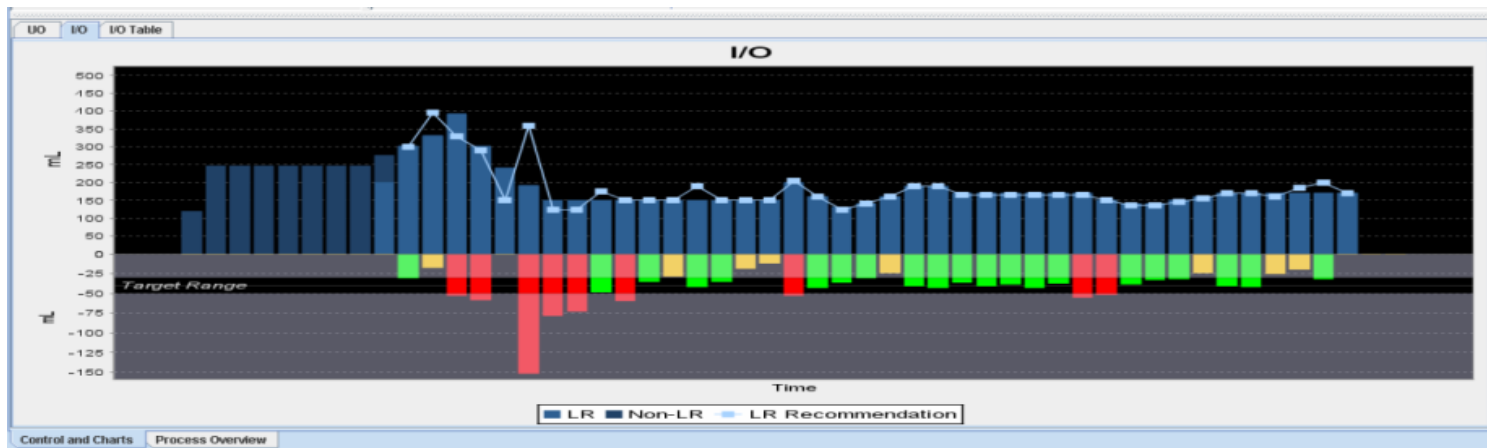
# Combat Casualty Care Engineering

- **Recent Accomplishments**

- Development of decision support technology for burn resuscitation
- Analysis techniques for vital signs to improve situational awareness

- **Current Focus Areas**

- Integration of existing vital signs to improve decision support
- Analysis of vital signs collected in the deployed pre-hospital and emergency department environment
- Ventilator support after lung injury (smoke inhalation and blunt trauma)
- Development of improved metrics for adequacy of resuscitation

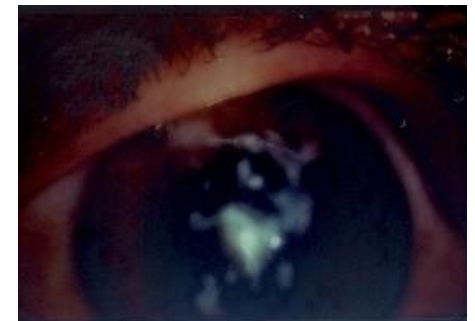


# Clinical Trials

- **Recent Accomplishments**
  - Continuous renal replacement therapy
  - Burn injury prevention through fire retardant garments
- **Current Focus Areas**
  - Multicenter clinical trials
    - Engineered skin grafts
    - Transfusion triggers in burn surgery
    - Assessment of rehabilitation requirements
    - Donor site dressings
    - Prospective evaluation of transfusion ratios
    - Decision support, decision assist

# Medical Countermeasures for Ocular Trauma Science Program

- Assessment of military ocular trauma
  - **Laser-induced eye injury from military systems**
  - **Ocular Injury from blast (new – FY2011)**
  - **Biophysical models**
  - **Ocular trauma research roadmap**
- Triage and Treatment of Ocular Trauma
  - **Retinal Injury: Mechanisms and Taxonomy**
  - **Pharmacological Intervention- Stem Cell Therapies**
  - **Advanced imaging diagnostics (OCT, SLO)**
  - **Vision and performance metrics**
  - **Advanced Aidman Vision Screener**
  - **Informatics – Laser exposure incidents**
- Laser Bioeffects – Force Protection
  - **Exposure Guidelines - Field Safety (AR 11-9)**
  - **Injury prevention – Health Hazard Assessment**
  - **Military eye protection systems (MEPS)**





# Summary

- ISR provides requirements driven combat casualty care medical solutions and products
- ISR's mission space is trauma, head to toe, minus the brain
- Extensive collaborations with clinicians ensures rapid response to emergent problems
- The partnership between the ISR and the DHB Tactical Combat Casualty Care subcommittee has been extraordinarily successful