CyberTherapy & Rehabilitation

Issue 2 / 2011

The Official Voice of iACToR

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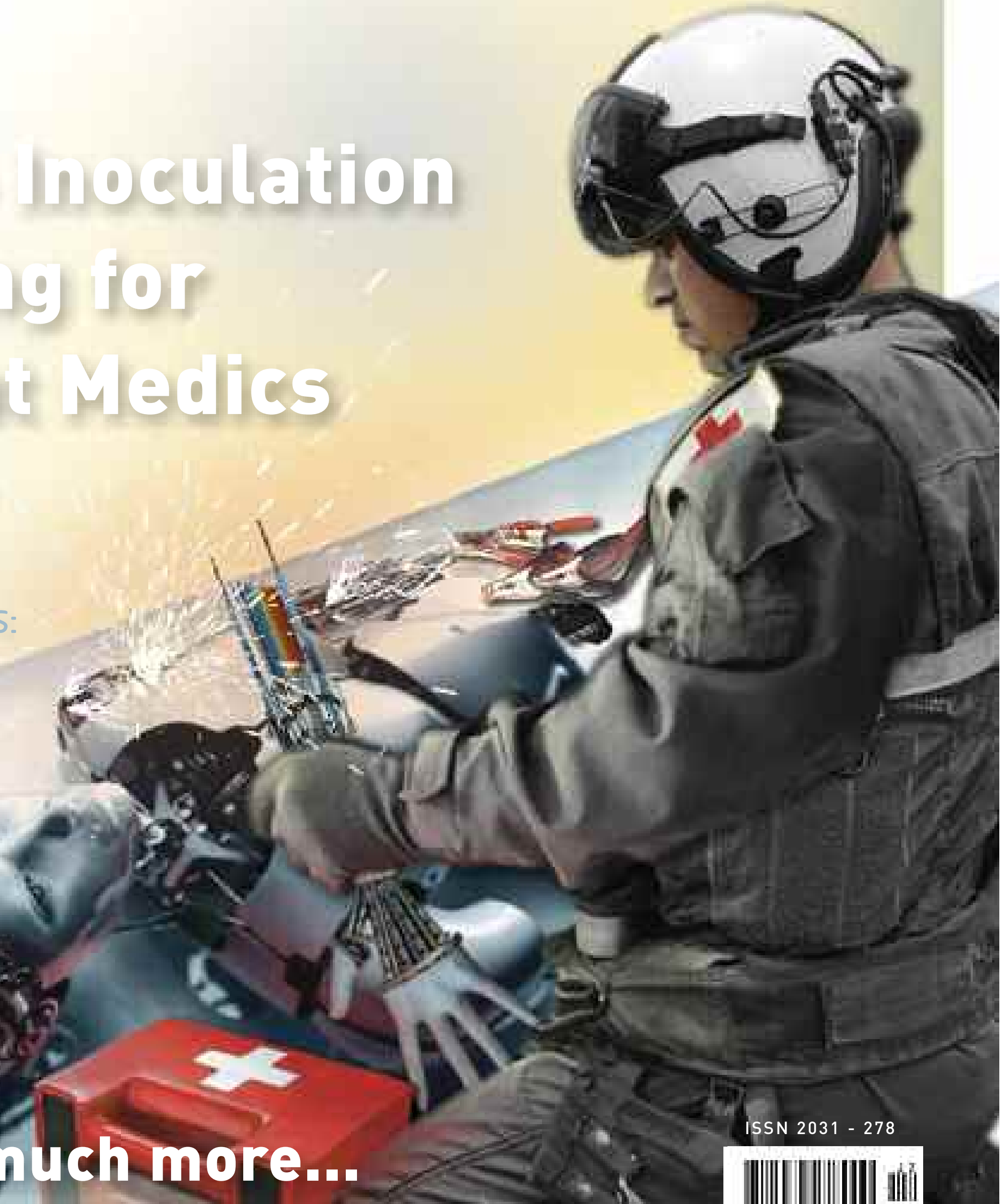

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INJURY CREATION SCIENCE

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- Needle Decompression Skills Trainer
- Bleeding Wound Skills Trainer
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- Burn Wound Skills Trainer
- Odor Wound Skills Trainer

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- Patient Assessment
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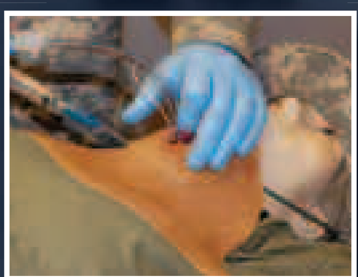
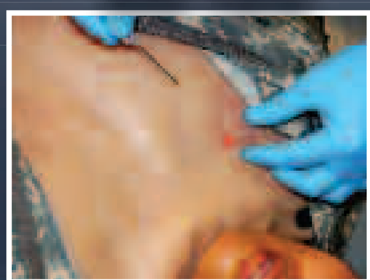
- Fracture Management
- Shock Prevention & Treatment

Cricothyrotomy Skills Trainer



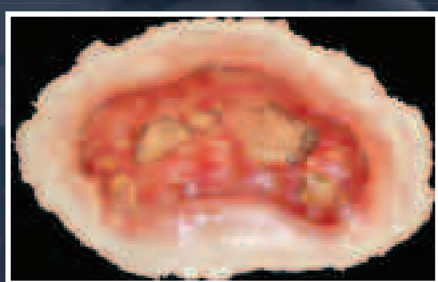
Needle Decompression Skills Trainer



Bleeding Wound Skills Trainer

Severe Amputation Skills Trainer

Simulated Burn Wound Package



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Letter from the Secretary General and Editor-in-Chief

Professor Dr. Brenda K. Wiederhold

"Preliminary results of a study by Stetz and colleagues showed that virtual environments do succeed in stressing medics enough to produce an 'inoculation' effect by increasing anxiety and dysphoria."

Dear Reader,

Stress inoculation training (SIT) is a type of training used to prepare individuals for stressful situations and helps diminish the potential for a negative psychological reaction. In cognitive-behavioral therapy, SIT is accomplished through gradual, controlled, and repeated exposure to a stressor. The goal behind this exposure is to desensitize or "inoculate" the person to the possible stimuli of a stressful situation, avoiding a panic or "fight or flight" response to the real thing. This repetition allows the individual to calmly and accurately accomplish the tasks at hand in a stressful environment. Developed in the late 1970s by Meichenbaum, controlled exposure to stress-related cues continues to be a key feature of resiliency training.

Because SIT is a technique used to help harden individuals to future potentially traumatizing stressors, it makes sense to use this method to help train those who must treat trauma patients. These personnel must often perform in extremely stressful environments, and optimum performance under such conditions requires effective management of physiological, psychological, and emotional responses to stressful stimuli. An acute stress reaction can occur during exposure to exceptionally stressful events, resulting in extreme sympathetic nervous system arousal and impaired performance. Longer-term reactions to these situations can include acute stress disorder, Posttraumatic Stress Disorder (PTSD), and burnout.

One method to attenuate or prevent these reactions is Virtual Reality-enhanced SIT, in which personnel "experience" highly stressful situations in a virtual environment. Repeated exposure enables performers to gradually become desensitized to stimuli that may initially elicit such strong physiological arousal that performance is impeded (e.g., freezing under gunfire instead of moving a wounded soldier to safety), and therefore, psychological trauma should be less likely. Stress inoculation training is associated with a reduction in anxiety and an enhancement in work-related performance. Preliminary results of a study by Stetz and colleagues showed that virtual environments do succeed in stressing medics enough to produce an "inoculation" effect by increasing anxiety and dysphoria.

There is evidence that SIT can reduce PTSD. In a 2000 study by Deahl and colleagues, a group of 106 male British soldiers preparing for a six-month tour of duty in Bosnia received a combination of pre-deployment stress training and post-deployment psychological debriefing. After deployment, participants demonstrated a drastically reduced incidence of PTSD and other psychopathology as compared to controls, approximately 10 times less than figures reported from other military samples. In fact, the level was so low that it precluded any possible debriefing effect.

"Because SIT is a technique used to help harden individuals to future potentially traumatizing stressors, it makes sense to use this method to help train those who must treat trauma patients."

A recent Rand review of the evidence of effectiveness of various treatments for PTSD rated SIT as a Level A intervention as of 2000, based on two well-controlled and two less well-controlled studies in female sexual-assault survivors. Level A is the most rigorous, defined as "Evidence is based on randomized, well-controlled clinical trials for individuals with PTSD."

Letter from the Secretary General
(continued from page 1)

Evidence of the effectiveness of SIT is certain to grow with advances in the fields of psychophysiology and neurobiology. An example of the former is a recent study of Belgian Special Forces candidates, which showed robust increases in cortisol in a high-intensity stress (vs. a no-stress) group, with significant correlations to decreased performance on working memory and visuo-spatial tests.

"Repeated exposure [to VR-enhanced SIT] enables performers to gradually become desensitized to stimuli that may initially elicit such strong physiological arousal that performance is impeded (e.g., freezing under gunfire instead of moving a wounded soldier to safety), and therefore, psychological trauma should be less likely."

An example of the latter is a review article by Lyons and colleagues that uses their longitudinal work with squirrel monkeys to inform areas of investigation for human studies of resilience. Specifically, stress inoculation in monkeys enhances prefrontal-dependent cognitive control of behavior and increases ventromedial prefrontal cortical volumes. These and other findings "suggest that early life stress inoculation triggers developmental cascades across multiple domains of adaptive functioning. Prefrontal myelination and cortical expansion induced by the process of coping with stress support broad and enduring trait-like transformations in cognitive, motivational, and emotional aspects of behavior."

Science points the way for those leading and studying trauma training: Transform such training, protecting the psychological well-being of first responders by including resilience training exercises such as SIT.

Create your own reality!
Brenda Wiederhold

Guest Editorial

Professor Dr. Mark D. Wiederhold

"Such cutting-edge research leads us to believe that in the near future, studies will show that the most effective trauma team training uses this combination of realistic, synthetic materials and virtual environments employing improved haptics."

Dear Reader,

New synthetic materials for "injury" creation enable lifelike casualty trauma simulations, making obsolete the controversial use of animals such as goats and pigs. A combination of human cadaver use, medical simulation, and trauma center training yields the best results in terms of realism, human-specific injuries, and team building. Vu and Price (pg. 19) briefly describe the history of trauma training in their article in this issue about high fidelity patient simulators.

In the past, physicians and medics learned how to care for the trauma patient through a variety of medical simulation tools.

"Combining the use of artificial materials with VR research, another researcher strives to create mechanical and geometric models of tissue to improve the fidelity of force feedback (haptics) for surgeons performing robot-assisted surgery."

The American College of Surgeons endorses the integration of simulators into medical training, citing the ability of "med sim" to enhance patient safety, reduce medical errors, and systematically evaluate physician skills. As Bandiera (pg. 30) writes in this issue, "Trauma care is particularly suited to the use of simulation."

Various training mannequins and part-task trainers are available for training corpsmen and medics to treat battlefield wounds. For example, Simulab's TraumaMan System can teach medics the correct placement of an emergency surgical airway (cricothyroidotomy). Corpsmen can learn needle decompression of tension pneumothorax using the Human Patient Simulator from METI. While SimMan can teach management of hemorrhage, the forced-air bleeding system is expensive (as are all the mannequins) and lacks realism.

This aspect of trauma training, wound simulation, started with moulage in 1834 when artists painted injuries on the body. Moulage filled a role more for the benefit of the organizers of military maneuvers, since the level of realism at the individual medic or corpsman level was low. Hollywood makeup and theatre techniques followed, to provide elements of realism, such as blood and open fractures, to the training simulation. Some examples of well-made artificial wounds appear on the Syfy program Face Off, a competition/elimination series exploring the world of special-effects make-up artists.

Virtual Reality (VR) simulation has finally come of age, as Dr. Rosen wrote in her recent article on the history of medical simulation: "There is currently a proliferation of commercial virtual medical environments to provide visual and auditory experiences. Some laboratories add the sense of touch through haptics. The incorporation of smell has been proposed as a potent stimulus of memory."

Recent research performed by the Virtual Reality Medical Center (VRMC) and the University of Central Florida managed to increase the medical realism of wearable prosthetic devices used to simulate injury, through improved materials and technologies that simulate the smell and feel of organs and blood. This provides an important psychological aspect of simulation immersion, since many civilian-trained medical personnel are not psychologically prepared to face severe wartime traumatic injuries.

Comparison of Surgical Simulation Methods

Model	Strengths	Weaknesses
Animal	Bleeding, individually inexpensive	Ethics/animal rights, anatomy incorrect, single use, logistics
Cadaver	Anatomy correct	Expensive, storage issues, single use, no bleeding
Plastic model	Inexpensive, convenient, repeat use	Realism, needle tracks
Computerized mannequin	Multiple applications, repeat use	Realism, very expensive, precut holes
Virtual Reality	Unlimited use, practice without instructor, multiple scenarios, control degree of difficulty, reset	Realism variable, expense variable, haptic force limitation

In the VRMC research, lipid nanotubes filled with scent oils in the layers of the simulated skin add a realistic odor to simulated wounds. Because the current prosthetics can be used on human actors, patient simulators, or stand-alone devices, this approach could enhance a wide variety of training scenarios.

Related research into the use of nanomaterials uses a nanogenerator technique to transfer ferroelectric thin films to a flexible substrate, with potential application to the creation of artificial skin. This is part of an emerging technology called "flexible electronics."

Combining the use of artificial materials with VR research, another researcher strives to create mechanical and geometric models of tissue to improve the fidelity of force feedback (haptics) for surgeons performing robot-assisted surgery. In one such experiment, the investigator made a heart model from silicone, silicone thinner, and pigment with a coffee stir straw embedded to resemble "calcification" in the phantom tissue.

Such cutting-edge research leads us to believe that in the near future, studies will show that the most effective trauma team training uses this combination of realistic, synthetic materials and virtual environments employing improved haptics. That can't happen too soon: Our wounded service members in Afghanistan and other combat zones deserve the best trauma care, now.

Mark D. Wiederhold
Virtual Reality Medical Center

INTERSTRESS
Is a European-funded project

INTERSTRESS

Interreality in the Management
and Treatment of Stress-Related Disorders

The INTERSTRESS project aims to design, develop and test an advanced ICT-based solution for the assessment and treatment of psychological stress.

Objectives:

- Quantitative and objective assessment of symptoms using biosensors and behavioral analysis
- Decision support for treatment planning through data fusion and detection algorithms
- Provision of warnings and motivating feedback to improve compliance and long-term outcome

To reach these goals, INTERSTRESS will use a new e-Health concept: Interreality. What is Interreality? It is the integration of assessment and treatment within a hybrid, closed-loop empowering experience, bridging physical and virtual worlds into one seamless reality.

- Behavior in the physical world will influence the virtual world experience
- Behavior in the virtual world will influence the real world experience

These goals will be achieved through:

- 3D Shared Virtual World role-playing experiences in which users interact with one another
  - Immersive in the healthcare centre
  - Non-immersive in the home setting
- Bio and Activity Sensors (from the Real to the Virtual World)
  - Tracking of emotional/health/activity status of the user and influencing the individual's experience in the virtual world (aspect, activity, and access)
- Mobile Internet Appliances (from the Virtual to the Real world)
  - Social and individual user activity in the virtual world has a direct link with user's life through a mobile phone/PDA

Clinical use of Interreality is based on a closed-loop concept that involves the use of technology for assessing, adjusting and/or modulating the emotional regulation of the patient, his/her coping skills and appraisal of the environment based upon a comparison of the individual patient's behavioural and physiological responses with a training or performance criterion. The project will provide a proof of concept of the proposed system with clinical validation.

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GENERAL INFORMATION

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Game-Based Approaches to Trauma Training

The Telemedicine and Advanced Technology Research Center (TATRC), the Army's high-technology medical pathfinder, among others, have been exploring the use of immersive, simulated environments to create a game-based approach to trauma training. In one computer game, combat medics must respond to an improvised explosive device event, prompting a focus on training of higher order thinking skills, as well as helping to decrease stress through exposure techniques.

High-Tech Wound Simulation

Effectively merging cutting-edge special effects technology with material science research, wound simulation, or "moulage," has become an increasingly effective means of training combat medics. Specially-designed kits enhance the realism of training exercises, helping improve the odds of survival on the battlefield.

Highlights Trauma Training Meetings of Interest

TATRC Pre-Conference Sessions at MMVR18

Newport Beach, California
February 8-12, 2011

At the 18th Annual Medicine Meets Virtual Reality Conference (MMVR) held in Newport Beach, California in February 2011, more than 450 participants from 20 countries presented and assessed groundbreaking developments in simulation, modeling, imaging, robotics and other emerging tools for patient care and medical education.

To focus on specific military needs and bring key innovations to MMVR, the U.S. Army Medical Research and Materiel Command's (USAMRMC) Telemedicine and Advanced Technology Research Center (TATRC) has strategically partnered with conference organizer Aligned Management Associates, Inc., since 2001. This year, TATRC hosted two preconference sessions on medical simulation and clinical skills – "a shot in the arm for Army medical research and training," according to TATRC Director COL Karl Friedl. The two days enjoyed record-breaking attendance, with standing room only.

On Tuesday, February 8, TATRC highlighted the new Armed Forces Simulation Institute for Medicine (AFSIM) in a day designed to share military healthcare needs with developers and potential users of simulation-based training systems. TATRC facilitated the AFSIM Industry Day on behalf of a DoD committee that oversees medical simulation research funding. Event chair Harvey Magee, the technical director of TATRC's Medical Simulation and Training Technology Portfolio, explained, "This focused gathering of government, academia and industry attendees marks the beginning of a new era in simulation-based research to improve training, patient safety and clinical effectiveness. We are excited to inform the public about a new DoD funding source for medical simulation projects."

Left to right – Mr. Harvey Magee, Dr. Jeffrey Stephenson, Dr. Charles Peterson, M.D., MAJ Thomas B. Talbot, M.D. *Photo by Lori DeBernardis.*

TATRC helped create AFSIM to coordinate the JPC1a efforts. At the Industry Day, AFSIM director and chair of the JPC1a-MedSim Steering Committee MAJ Thomas B. Talbot, M.D., introduced the institute and its four major initiatives. Said Talbot, "Healthcare is in need of improvement, from making hospitals safer for patients to training physicians, nurses and medics in skills that vary greatly between deployment and home duties. Advanced simulation technology offers a promising way to improve the quality and quantity of medical training."

On Wednesday, February 9, TATRC hosted a clinical education symposium to focus on the role of simulation in surgical training, skills maintenance, competence assessment and certification. The event was cochaired by Kevin Kunkler, M.D., senior clinician and subject matter expert for TATRC's Medical Simulation and Training Technology Portfolio, and Thomas Knuth, M.D., TATRC Trauma Portfolio manager. Kunkler noted, "It is vital that the military find effective methods to address the deterioration of skills for the thousands of surgeons, anesthesiologists and interventionists who are preparing to perform different specialized procedures during or after deployment. Maintaining clinical skills is also crucial on the civilian side." According to the Centers for Disease Control, medical mistakes cause 40,000 to 200,000 deaths per year in the United States.

TATRC Chief Scientist Charles Peterson, M.D., said, "We organized this meeting as a forum to better understand the current gaps and explore the directions thought leaders are pursuing to address needs in this crucial area. We heard many excellent ideas that could help steer future programs. Our hope is to inspire creative solutions within the healthcare community, whether through technology, standardization, curriculum or other advancements."

For more information on AFSIM or the TATRC Medical Simulation and Training Technology Portfolio, contact Mr. Harvey Magee at harvey.magee@tatrc.org.

International Association of CyberPsychology, Training & Rehabilitation (iACToR)

Conference Participation Report Summer 2011

Med-e-Tel 2011

International Telemedicine and eHealth Forum

Luxembourg / April 6-8, 2011

This year Med-e-Tel, one of the premier events worldwide in the field of Telemedicine and eHealth, welcomed over 450 attendees from 57 countries April 6-8 in Luxembourg, including official delegations with Ministry of Health representatives from countries including Mali, Nigeria, Brazil, Nepal, and Kenya.

Med-e-Tel is organized by the International Society for Telemedicine & eHealth (ISfTeH), which is the international federation of national Telemedicine/eHealth associations and is recognized as an NGO in Official Relations with the World Health Organization (WHO). Med-e-Tel is endorsed by the Luxembourg Ministry of Health, the European Commission, the International Council of Nurses (ICN), the International Association for CyberPsychology, Training & Rehabilitation (iACToR), and European Health Telematics Association (EHTEL), and works together with a wide range of local and international partners who are all involved in Telemedicine and eHealth research, development, funding and implementation.

Through its extensive conference program with 200 presentations and an industrial exhibition and networking area, Med-e-Tel presented and showcased practical experiences, ongoing projects and recent research results of interest for its international audience of healthcare providers, industry representatives, consultants, researchers and policy makers.

Also of particular interest was a symposium presented in cooperation with iACToR, in which four projects funded by the European Commission teamed up to present on "Virtual Reality, Mental Health, Stress-Related Disorders and Rehabilitation." The symposium included members of INTERSTRESS (Interreality in the Management and Treatment of Stress-Related Disorders), MONARCA (Monitoring, Treatment and Prediction of Bipolar Disorder Episodes), Help4Mood and ICT4Depression. The symposium gave international attendees an opportunity to learn of new technological approaches being applied to help those with depression, bipolar, and stress-related disorders.

Program details and presentations are still available at **www.medetel.eu**. The next Med-e-Tel conference is scheduled for April 18-20, 2012 in Luxembourg.

Games for Health

Boston, Massachusetts / May 17-19, 2011

The seventh annual Games for Health conference met May 17-19 in Boston, Massachusetts, bringing together hundreds of top researchers, health professionals and gamers from around the world. The largest Games for Health conference to date, the meeting aims to promote upon and develop ways in which videogames and videogame technologies can work to improve healthcare.

The three-day event featured over 60 presentations, including an opening keynote from Dr. Martin Seligman, Director of the Positive Psychology Center at the University of Pennsylvania. New additions included a Ludica Medica Day, focusing on medical modeling, simulation and learning, which helped to further discussion between medical simulation and serious games. This pre-conference event aimed to compliment larger medical Virtual Reality and simulation events and stressed their potential advantages for use in therapy including lowering costs, ease-of-use, and the ability to reach a new, larger audience.

Talks at Games for Health discussed topics such as active gaming, cognitive exercise, disease management, health behavior change, and biofeedback.

For more information on the meeting, please visit: **www.gamesforhealth.org/index.php/conferences/gfh-2011/.**

World of Health IT

Budapest, Hungary / May 10-12, 2011

World of Health IT, a cornerstone event of eHealth Week 2011 – the largest pan-European conference and an annual gathering of the European eHealth communities – met May 10-12 in Budapest, Hungary. The event consisted of more than 2,300 members of the healthcare community representing 60 countries, meeting to share and discuss initiatives to promote ways in which eHealth can improve and sustain world-class healthcare.

The highest number of speakers yet, 120, spoke at the week-long event. One conference session in particular stood out: *Patient Self-Service in Healthcare – Self Registration, Self Monitoring*, moderated by Mr. Hyleco Nauta and Prof. Dr. A.J.P. Schrijvers from UMC Utrecht, along with the participation of Mr. Casper Marcussen from Denmark and Dr. Hans Kordy from University Hospital Heidelberg in Germany. This conference session was an important opportunity to focus attention on the increasingly active role that patients have in IT-enabled healthcare.

Additionally, the Leaders in Health IT Symposium, a new executive level forum hosted by HIMSS Analytics Europe, was designed to provide top leaders from healthcare IT with the needed tools and information to navigate in a changing healthcare landscape.

eHealth Week 2012 will take place in Copenhagen, Denmark on May 7-9, 2012. For more information on the meeting, please visit: **http://www.worldofhealthit.org/.**

Combining Stress Inoculation Training with Medical Training for Combat Medics

"Improvements in injury simulation technology are aimed at providing superior training for medics in front line care, both in terms of hands-on medical instruction and stress management. The next generation of ICS is focused on the development of prosthetic devices that allow medical specialists to practice actual emergency medical procedures with simulated organs and tissue."

By Nancy Ahmann

Stress Inoculation Training (SIT) is often the umbrella term used to represent a collection of coping strategies provided to the trainee. Often thought of as "mental armor," SIT helps to "inoculate" individuals to future potentially traumatizing stressors, teaching them to psychologically deal more effectively with the stressors. In 1988, a National Research Council study on enhancing military performance found that when a person is given knowledge of future events, stress surrounding those events is then reduced. In general, this occurs because stress is associated with a new, novel task. Stress training therefore renders the task less novel and improves the trainee's self-efficacy, which in turn improves performance.

The goal of SIT is not to eliminate stress but to learn to respond adaptively to stressful situations. The Virtual Reality Medical Center (VRMC) develops immersive three-dimensional computerized virtual environments (VEs) for SIT for combat medics and other first responders.

Figure 1: Military medics practice lifesaving procedures on an actor with simulated injuries.

During Virtual Reality stress inoculation training (VR-SIT), military personnel "experience" highly stressful situations in a VE while being physiologically monitored. Repeated exposure enables personnel to gradually become desensitized to stimuli that may initially elicit such strong physiologic arousal that performance is impeded (i.e., "freezing in the line of fire") and psychological trauma is more likely.

In SIT, individuals are provided with a tool kit of coping strategies, which allows them to construct a personalized coping package and choose those strategies most efficacious for their individual needs and for the particular

Benefits of Stress Inoculation Training (SIT)
SIT presents a collection of coping strategies to the trainee
Trainee chooses the most efficacious for his/her individual needs/situation
Allows trainee to serve as a collaborator in constructing a personalized coping package tailored to his/her own requirements/experiences
Designed to develop coping skills for immediate problems and future stressful situations (proactive defense)

situation. These skill sets are developed with the goal of helping with immediate needs as well as future stressful situations in a proactive defense against trauma. Some of the traditional components used in an SIT regimen include didactic teaching, problem solving, cognitive restructuring, imaginal rehearsal, behavioral rehearsal, relaxation training, self-instruction, self-monitoring, and self-reinforcement.

In providing over 7,000 treatment sessions for a variety of psychological disorders through a combination of cognitive-behavioral therapy and physiological monitoring over the past 15 years, investigators at VRMC have noted that successful treatment of stress and anxiety-related disorders is achieved through skills-based exposure training to increasingly stressful situations. This training allows the patient or trainee to over-learn coping skills and develop a sense of mastery, with the ultimate goal of improved performance and self-confidence in one's ability.

VRMC's Student State Assessment, a three-year study funded by Defense Advanced Research Projects Agency (DARPA) completed in July 2005, included a combat medic training scenario in which medics received SIT training using a computerized VE and, separately, VRMC's Injury Creation Science (ICS) simulator prototype. The prototype employed prosthetics to simulate a number of battlefield injuries on human actors. In these scenarios, injuries were simulated with dynamic "bleeding" wounds. In addition, trainees were able to cut the "skin," insert a chest tube, and stitch the wound closed. Participants said it was the most intense, realistic training they had ever received.

Now VRMC is improving the injury simulation technology to provide this advanced training for medics in front line care, both in terms of hands-on medical instruction and stress management. The next generation of ICS is focused on the development of prosthetic devices that allow medical specialists to practice actual emergency medical procedures with simulated organs and tissue. These procedures include bypassing a compromised airway, inserting an intravenous port, preventing blood loss as a result of arterial and venous wounds, dressing burns, and expanding a collapsed lung. Other injury simulation capabilities are currently under development.

The VRMC team believes that an SIT component may be equally important to the acquisition of appropriate medical triage and trauma training skills. Most medical training does not include a stress-hardening component, even though reports of high levels of stress and Posstraumatic Stress Disorder (PTSD) in medical personnel makes evident the need for improved attention to this growing problem. Although other groups are developing training programs for psychological resilience in military personnel (e.g., Battlemind, Army Center for Enhanced performance/ACEP, Warrior Reset), there remains a division between these concepts and skills-based (hands-on) medical training. VRMC's approach is to blend SIT with skills-based medical training with the added component of novel, highly realistic injury simulation technology (e.g., ICS). The intent is not to replace other programs but to build upon and potentially integrate these technologies for a more comprehensive and effective medical training experience.

VRMC foresees this type of fully-immersive, customizable training used not only to enhance the skills of military personnel, but also others who perform in high-stress situations (doctors, emergency responders, etc.). Finally, it is hoped that this type of training can act as a preventative measure against PTSD and other stress-related reactions.

"During Virtual Reality stress inoculation training (VR-SIT), military personnel 'experience' highly stressful situations in a VE while being physiologically monitored. Repeated exposure enables personnel to gradually become desensitized to stimuli that may initially elicit such strong physiologic arousal that performance is impeded (i.e., 'freezing in the line of fire') and psychological trauma is more likely."

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Hemorrhage Control in the Battlefield: Role of Modeling and Simulation to Support Training of Combat Medics

"Hemorrhage control is the most important life saving aspect in battlefield medicine. Approximately 85% of potentially survivable deaths are attributed to hemorrhage. A Soldier can go into hypovolemic shock and bleed to death within minutes after severing a large blood vessel. The Army is seeking innovative and realistic ways to support hemorrhage control training of Combat Medics. When dealing with traumatic injuries, modeling and simulation play an important role in creating realistic scenarios to support stress inoculation training. Realistic scenario-based training provides first responders with the ability to overcome initial reluctance to treat and opportunities to practice their procedural skills in a relevant environment."

By Teresita Marie Sotomayor & Don Parsons

During the Vietnam War over 2,500 Soldiers died due to hemorrhage from extremity wounds. In current conflicts hemorrhage continues to be the leading cause of preventable death in combat, therefore, it is the responsibility of every Soldier to know how to control hemorrhage on the battlefield. For most extremity wounds the use of a temporary tourniquet has been essential in stopping life-threatening hemorrhage. If the wound is not an extremity wound and a tourniquet is not applicable as in the case of neck, axillary, and groin injuries, the application of a hemostatic agent with pressure is necessary to control the bleeding. The location of the wound is the factor that drives the tools necessary to control the bleeding. The more proximal the extremity wound the more difficult the application of a tourniquet. These types of wounds currently necessitate the use of a hemostatic agent in addition to direct pressure and eventually a pressure bandage to control bleeding. Wounds of the axilla, groin, and neck can be fatal if a means of controlling the hemorrhage is not readily available.

Frequently, medics rely solely on tourniquets to stop bleeding for extremity wounds. However, they need to have the experience of attempting to use a tourniquet that may not work on a very proximal wound. This requires them to reevaluate their intervention and successfully transition to another hemorrhage control measure if their initial attempt is unsuccessful. In addition, hemostatic agents are also taught as a means of transitioning away from a tourniquet in the event of a delayed evacuation and the possibility of extremely prolonged use of a tourniquet. Hemostatic agents are substances that promote homeostatic coagulation when applied to a hemorrhaging injury. Use of such agents has drastically reduced the number of deaths that could be prevented on the battlefield. In the last decade, significant advances have been made on hemostatic agents. Each class of hemostatic agent differs in application and mechanism of action; combat gauze is currently the agent recommended for use by the U.S. Army. There is currently a package of combat gauze in every Soldier's Individual First Aid Kit (IFAK), and in every combat lifesaver's and combat medic's aid bags.

Army Combat Training Schools and medical simulation training centers rely on simulated capabilities to conduct realistic hands-on training and evaluation of hemorrhage control using tourniquets and hemostatic agents.

The U.S. Army Simulation and Training Technology Center (STTC) Human Dimension, Simulation and Training Directorate, Army Research Laboratory (ARL) executed a three-year (FY07-10), joint Army Technology Objective (ATO) with the U.S. Army Medical Research and Materiel Command (MRMC), entitled Severe Trauma Simulations. The mission of the ATO was to research and develop innovative technologies to realistically simulate the look, feel, and smell of severe trauma to prepare medics, combat lifesavers, and Soldiers to deal with the injuries encountered on the battlefield. The results from this effort produced enhanced tools for realistic medical training enabling the Army to maintain better trained medics and to improve the ability to save lives on the battlefield.

Figure 1: An ICS Kit contains prosthetic appliances designed to affix to a human actor or mannequin and consists of simulated skin, underlying tissue, representation of organs or structures, and a protective layer next to the wearer's skin.

Figure 2: TraumaFXTM is an end-state high fidelity simulator of a lower body injury using state-of-the-art special effects technology. TraumaFXTM can be worn by human patient simulators or human actors to support realistic hemorrhage control training. The system provides stress inoculation training to physically and emotionally prepare Soldiers to deal with severe wounds.

"Wound simulation, or 'moulage,' is an integral part of scenario-based medical training, especially in live training. This kit allows for the quick and easy application of prosthetic entry, exit, and shrapnel wounds for live training exercises focused on enhancing realism."

By merging the latest special effects technology with material science research, prosthetic human tissue and wounds were developed for a realistic live training capability. A kit containing extremely realistic simulated wounds, or "moulage" was developed based on user requirements. Wound simulation, or "moulage," is an integral part of scenario-based medical training, especially in live training. This kit allows for the quick and easy application of prosthetic entry, exit, and shrapnel wounds for live training exercises focused on enhancing realism.

Another technology developed under the Small Business Innovative Research (SBIR) program to support the ATO, introduced movement to enhance realism of the scenarios via animatronics technology. These two efforts are examples of technologies that have been commercialized and successfully transitioned to support the Warfighter. Research in severe trauma simulations continues with a focus on technologies to enhance realism and immersion to support training. Development of these technologies has greatly improved the realism of scenario-based training, effectively supporting the training of Army Combat Medics and allowing Soldiers to be immersed in relevant situations to conduct realistic, performance-based, hands-on training of hemorrhage control.

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U.S. Military Takes on High-Tech and High-Adventure to Train for Wartime Lifesaving

The Telemedicine and Advanced Technology Research Center (TATRC), the Army's high-technology medical pathfinder, has adopted an aggressive approach to revitalizing existing methods for trauma training including game-based approaches focusing on training higher order thinking skills, as well as developing interactive virtual human personalities that will eventually be integrated into advanced training robots.

By Thomas B. Talbot

The Telemedicine and Advanced Technology Research Center (TATRC), the Army's high-technology medical pathfinder, has been intensifying advances in wartime trauma training through the use of advanced, and sometimes unexpected, approaches.

One of the most successful research and development efforts to date has been the COMETS manikin, designed from the ground up to be fully autonomous, ruggedized and purposed for trauma. COMETS was designed and developed by the CIMIT Simulation Group, led by Dr. Steve Dawson, and a team of researchers at Massachusetts General Hospital. The COMETS prototype was extremely successful and has been commercialized by defense giant CAE, renaming it CAESAR.

When asked what makes CAESAR unique, Mark Owens, CAE Health Care Vice President states, "CAESAR represents the most realistic and physiologically advanced trauma patient simulator available while allowing learners to develop critical thinking skills and core treatment modalities that are important in reducing morbidity and mortality in combat care."

Other work sponsored by TATRC involves game-based approaches to training. One example is a computer game for combat medics who must respond to an improvised ex-

Figure 1: CAESAR acts as a fully autonomous, ruggedized trauma patient simulator.

Figure 2, 3: Screen shots from the SimQuest explosives event triage game.

plosive device (IED) event. To encourage innovation, separate awards were made to both SimQuest and MYMIC, both leading medical game developers. The SimQuest version focuses on simplified patient encounters and triaging a large number of casualties, while the MYMIC game gets into more detail with fewer casualties.

Regarding the games' approach, Harvey Magee, TATRC medsim technical director explains, "We wanted to focus on training higher order thinking skills. Games are a great format to do this because they allow learners to try new things and take risks. As sponsors, we sometimes maximize innovation by going with parallel approaches to see what the different developer teams come up with."

Since 2009, TATRC has led a tri-service team with $250 million in funding over five years and has established the Armed Forces Simulation Institute for Medicine (AFSIM). It is hoped that much greater funding and an all-military approach will achieve breakthrough gains in medical training. The first fruits of this effort have been the Combat Casualty Training Consortia, two independent teams that are to conduct the largest comparisons between animals and simulators for trauma training to date. It is hoped that the research will identify areas where technology can replace animals in training and identify specific areas where technology needs improvement.

The AFSIM has continued the TATRC gaming tradition with three game-based approaches in 2010; one for anesthesia training, one using Microsoft Kinect™ for physical therapy, and another for mass casualty exercises. The mass casualty game, CBRNE GAME by Breakaway LTD, is designed to be an online multiplayer real-time strategy simulation with large numbers of casualties flooding a hospital from both weapons of mass destruction and explosive device incidents. The training will focus on teamwork, resources and judgment.

Future plans to improve trauma training are on an aggressive schedule. There is a significant focus on developing interactive virtual human personalities that employ a natural language interface and are capable of sustained conversations. Initial uses will include virtual human coaches for patients and virtual standardized patients for training. Eventually, the personality agents will be integrated into advanced training robots and intelligent talking task trainers. The intent is to overcome the artificial sensation of training on something that the trainer may see as a hunk of plastic. Future simulators will more convincingly emulate interactions of a real human casualty.

The fact that combat injuries are often bloody, disfiguring and grotesque takes a toll on people who care for the injured. Researchers are also asking if trauma training can be conducted in a way that improves the psychological resilience of the medical force. Current research also includes an investigation into the sense of smell and how it contributes to the formation of traumatic memories. Future efforts will tap into promising results from Virtual Reality (VR) therapy and employ more game-based simulations and VR environments.

TATRC has publicly shared the AFSIM long-term strategy online and at the February, 2011 Medicine Meets Virtual Reality (MMVR) conference.

Additional details of current research and future plans are available at http://www.tatrc.org/ports _medSim.html.

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Large Scale Simulations in Pediatric Cardiology:

Towards the Personalized Virtual Child Heart

Sim-e-Child has successfully created an "international simulation and validation environment for pediatric cardiology" and aims to move "beyond the state-of-the art by providing comprehensive, patient-specific models for the anatomy, function and hemodynamics of the left heart, with a focus on the congenital aortic arch disease and repair." This modeling helps in assessing aortic arch disease more comprehensively and objectively and, in addition, allows to simulate the effects of potential interventions resulting in a more effective, personalized and predictive management of pediatric cardiology patients.

By William W. McFadden & Michael Suehling

The treatment of pediatric congenital heart disease is hampered by the scarcity of relevant cases, the lack of integrated data and the limited opportunities for clinical comparison among others. Yet, advances in pediatric cardiac surgery, interventional cardiology, intensive care and non-invasive imaging have led to a substantial increase in life expectancy for many patients with congenital heart disease. However, difficult challenges still persist due to the evolving nature of a child's heart and vascular system.

Since the development of the project's proposal, Sim-e-Child (SeC), a project funded by ICT for Health, European Commission, has aimed to improve clinical outcomes of pediatric cardiology patients. In order to achieve better and more reliable risk stratum, to improve and personalize therapies, and to ultimately increase the patient survival rate, SeC is focused on developing comprehensive and accurate computer models from patient-specific data and simulated physical constraints.

SeC aims to strengthen the impact of "Health-e-Child" (HeC), which was completed in April 2010. HeC had created an international simulation and validation environment for pediatric cardiology, supported by integrated data repositories. SeC is working to go beyond the state-of-the art by providing comprehensive and patient specific models for anatomy, function and hemodynamics of the left heart, with a focus on the congenital aortic arch disease and repair.

Sim-e-Child's Grid Infrastructure

The first 16 months of work has seen SeC develop the first Trans-Atlantic platform for large-scale simulations in cardiology. SeC's clinical applications are being built on an evolution of HeC's original grid infrastructure based on the EGI Grid middleware (the gLite technology and European Grid Infrastructure - www.egi.eu) and the enabling GÉANT network, that together provide virtually unlimited computing power, data storage capacity and network bandwidth.

The early stages of SeC's work also saw the conclusion of a significant infrastructure setup and migration, aimed at interconnecting HeC and SeC, with the ultimate goal of making HeC's mature components sustainable and therefore, reusable in SeC, while giving SeC a significant technical basis onto which further expansion will take place for the duration of the project.

Sim-e-Child's Web Portal

The SeC Web portal is now well advanced, and through public and private sections, is providing users with access to the grid and integrated applications. As a result of SeC's first year's work, the partners have started utilizing the high bandwidth pan-European GÉANT research network to:

• Establish a multi-site, web-accessible database of pediatric cardiology data, information and knowledge for translational research.

• Develop a grid-based platform, supporting the definition, execution and sharing of scientific cardiac modeling and simulations.

Some of the operational features include:

• The SeC Grid infrastructure and computing resources, using a standard and internationally recognized GridPMA certificate. The Portal is cross-platform and therefore works under MS W7/XP, major Linux distributions and Mac OS X.

• The SciPort database and interfaces for manipulating data and simulations' outputs is being integrated to the security infrastructure so that it will be possible to enter SciPort directly once logged in the SeC portal.

By integrating the portal and the grid infrastructure, SeC will provide pediatric cardiology professionals in Europe and the U.S. with a Virtual Physiological Human based decision-support system and virtual laboratory. This will enable them to construct and validate multi-scale and personalized models of a growing child's heart and blood vessels. Ultimately, this will support their clinical decisions and allow better understanding of their patient's condition.

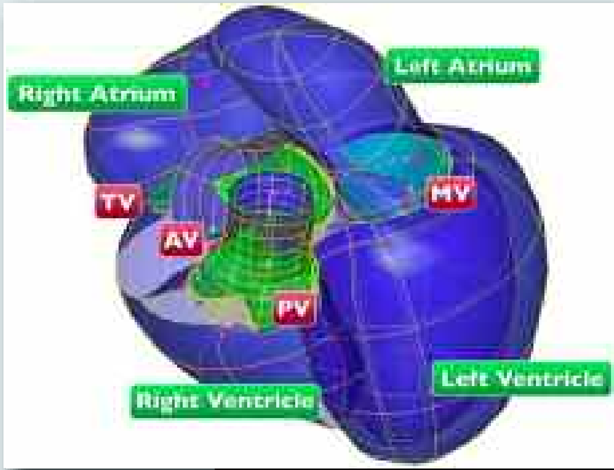

Figure 1 (above): Comprehensive model of the heart illustrating the four chambers and valves.

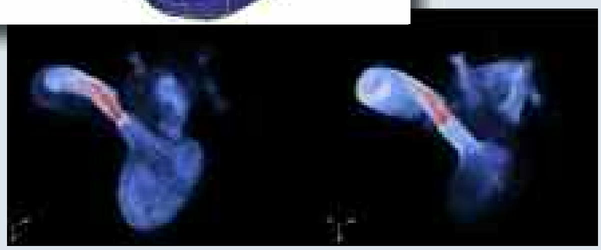

Figure 2 (below): CFD blood flow simulation results based on patient-specific anatomical model: Vorticity pattern in patient with bicuspid aortic valve during early systole (left) and mid systole (right).

Sim-e-Child's Heart Modeling Results of 2010

Besides technical interoperability requirements elicitation and infrastructure bridging, work focused also on the development and validation of a comprehensive cardiovascular anatomical model enabling first patient-specific hemodynamics simulations. The main achievements have been:

"By integrating the portal and the grid infrastructure, SeC will provide pediatric cardiology professionals in Europe and the U.S. with a Virtual Physiological Human based decision-support system and virtual laboratory."

• The existing HeC heart models were validated by the clinical partners in the U.S. on MRI data from Tetralogy of Fallot (TOF) cases. Using linear regression and Bland Altman plots, left and right ventricular systolic (LV ESV and RV ESV), diastolic volumes (LV EDV and RV EDV) and ejection fractions (LV EF, RV EF) were compared between manual and automated methods.

• The existing HeC heart models were extended by integrating and enhancing existing Siemens Corporate Research models, of the aortic and mitral valve. To exploit the morphological, functional and pathological dependencies and variations of the different heart valves, the pulmonary valve (PV) and tricuspid valve (TV) have been modeled, in addition. The heart valves represent a critical component for the analysis, modeling, and simulation of the whole heart function and this work represents the first data-driven modeling of the complete valvular apparatus.

Patient-Specific Cardiac Blood Flow Simulations

Clinicians at SeC's clinical centers were provided with the first, simulated, patient-specific cardiac blood flow across the entire cycle. Thanks to this work clinicians will, for instance, benefit from a better understanding of the vorticity which can convey crucial information about the formation and dynamics of potentially harmful "spins." By integrating these elements, SeC will provide pediatric cardiology professionals in Europe and the U.S. with a Virtual Physiological Human based decision support and virtual laboratory. This will enable them to construct and validate multi-scale and personalized models of a growing child's heart and blood vessels. Ultimately, this will support their clinical decisions and allow better understanding of their patient's condition.

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Current Concepts in Trauma Training: New Applications for High Fidelity Patient Simulation

"Trauma is multidisciplinary by nature; patients commonly have multiple injuries and the trauma team leader must be able to work with his team to rapidly assess, simultaneously treat and diagnosis injuries, and quickly create a resuscitation plan that will involve multiple medical specialists."

By Mark P. Vu & James W. Price

The wail of an ambulance siren announces the arrival of a trauma patient to the emergency department. Paramedics unload an injured woman from their ambulance and rush her towards the emergency department. Inside, a team of doctors and nurses await, ready to deal with her life threatening emergency. Intravenous lines are started to administer life sustaining medication, breathing tubes and chest drains are inserted and scans are performed on all parts of her body. "Call the operating room, we are coming up STAT!" is the consensus from the doctor in charge. As paramedics and emergency department personnel fade into the background, a new team of doctors and nurses in the operating room take over the young woman's care. After three hours of harrowing surgery, her vital signs stabilize, and she is transferred to the Intensive Care Unit. In all, more than 50 people will be involved in her care in the first five hours after her car crash. The efficiency and skill with which the team functions in this high intensity environment is the result of years of training and experience. This article will share some of the new methods that trauma professionals are training with today in order to provide assistance to people who suffer life threatening injuries requiring advanced medical care.

History of Trauma Training

Education in trauma care has evolved enormously over the years. Training can range from a weekend refresher course to yearlong training "fellowships" for subspecialist trauma physicians. Many of these educational experiences are essentially an apprenticeship where doctors, nurses or paramedical personnel learn their trades by a system of graded responsibility, initially observing senior colleagues, later assisting, and finally, performing the complex tasks on their own.

In addition to the technical skills required by medical personnel involved in trauma management such as the placement of life sustaining breathing tubes, medical educators are recognizing the importance of expertise in non-technical skills in addition to expert technical skills. Non-technical skills emphasize the importance of human interaction in medical emergencies. Advanced medical care is universally provided by a highly functioning team of people. The model of the operating room is a perfect example of this: in order for a surgery to be successfully performed, a team of doctors and nurses must work seamlessly together, communicating in a language and according to a set of rules that they all abide by. While each individual must be an expert in their specific technical field (i.e., surgery, anesthesia and nursing), they must all have expert non-technical skills too (i.e., leadership, communication, delegation, cooperation).

High Fidelity Patient Simulation: New Tools for High Stakes Learning

Prior to this decade, non-technical skills were not routinely taught to trauma care providers, however, this is changing as educators recognize the importance of strong teamwork and communication in high stakes medical situations.

How do we teach and practice concepts like "team work," "communication" and "leadership" to trauma care professionals? It is widely held that non-technical skills are best taught by "doing," but is it safe to let a novice trauma care trainee "practice" on a patient who is unstable and near death? Clearly the answer to this question is "no." Trauma care is high intensity and time pressured; complex decisions must be made by individuals and by the team in seconds or minutes in order to save patients' lives. High fidelity patient simulators may hold the key to teaching technical and non-technical skills to junior trainees.

High fidelity simulation is a training method long employed in industries such as aviation and engineering. In commercial aviation, professional pilots participate in regular training on multi-million dollar flight simulators. These simulators replicate emergency in-flight scenarios so that pilots can practice their responses to emergency situations in the cockpit. Their training includes non-technical skills such as communication skills and leadership in a crisis situation. Similarly, medicine is using this model to teach these same non-technical skills in trauma care. Air medical crews working on rescue helicopters rehearse their treatment protocols for trauma patients inside the modified fuselage of a helicopter that doubles as a classroom. The inside of the mock-helicopter cabin is identically configured to their usual rescue aircraft, except that there is a mannequin in the stretcher in the place of a real patient.

High fidelity patient simulators are being used in hospitals throughout the world to teach similar skills to physicians and nurses. Trauma is multidisciplinary by nature; patients commonly have multiple injuries and the trauma team leader must be able to work with his team to rapidly assess, simultaneously treat and diagnosis injuries, and quickly create a resuscitation plan that will involve multiple medical specialists. High fidelity patient simulator laboratories are designed to replicate a trauma bay or operating room almost identically. These rooms will have real equipment, medication, anesthetic and surgical equipment, as well as a highly sophisticated mannequin that provides biofeedback to the doctors based on their treatment decisions during the simulated scenario. Mannequins can "breathe" and "talk," and trainees can perform procedures similar to real trauma situations. Trauma teams are able to rehearse their coordinated response to a complex trauma patient in real-time. The mannequin's vital signs (i.e., heart rate, and blood pressure) can be made to improve or deteriorate depending on what the instructor is trying to teach the trauma team. Classes are video recorded, and after the case is completed, a debriefing occurs allowing the team to critically analyze their performance. This trauma training model was used to prepare the multidisciplinary trauma teams for the Vancouver-Whistler 2010 Olympic Games with great success.

Trauma is a dynamic, high stakes specialty of medicine that requires the coordinated, specialized technical and non-technical skills of multiple specially trained medical personnel. New educational tools, such as High Fidelity Patient Simulators, are helping trauma care educators train the next generation of expert trauma specialists.

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Figures: Vancouver-Whistler 2010 Olympic Trauma Team rehearse on a high fidelity patient simulator. *Photo provided courtesy of Dr. Tom Phu and Dr. Orlando Hung.*

Trauma Teams and Training: Making the Sum Greater Than the Parts

"The term 'simulation' spans a wide variety of formats, from the low-tech actor portraying a standardized patient to high fidelity mannequin-based human patient simulators and Virtual Reality-based task trainers. In fact, simulation includes any technology or process that recreates the contextual background of a healthcare environment ... "

By Marjan Siadat & Rosemarie Fernandez

Trauma is the leading cause of death in the first four decades of life, with trauma-related injuries constituting more than 25% of all emergency department visits in the U.S. In 1980 the American College of Surgeons introduced the Advanced Trauma Life Support (ATLS) system as an evidence-based approach to providing trauma care. While ATLS does recognize the importance of team member interactions and leadership performance, far more time and attention is paid to technical skill development versus teamwork and team processes, e.g., communication, coordination, and situation monitoring. Unfortunately, review of the literature suggests that these teamwork competencies are critical to providing safe and effective trauma care.

Teams in Healthcare

Over 50 years of psychological research demonstrates that teams collectively possessing high levels of expertise, resources, and commitment to success can still fail without strong teamwork skills. Current literature goes a step further to state that, in fact, it is teamwork that guarantees effectiveness. In other words, the sum is only greater than the parts when teamwork is highly developed. This is especially true for interdisciplinary action teams such as aircrews, military command and control, and trauma teams where specialized expertise is required under uncertain and time-pressured conditions. Klein, et al. describe trauma teams as extreme action teams, "whose members (1) cooperate to perform urgent, highly consequential tasks while simultaneously (2) coping with frequent changes in team composition, and (3) training and developing novice team members whose services may be required at any time." In action teams, the quality of teamwork and team effectiveness often means the difference between life and death.

In 2008 a multidisciplinary group of experts in healthcare and team performance met to propose a core taxonomy of teamwork competencies for emergency medical teams. This taxonomy was later adopted at the 2008 Academic Emergency Medicine Consensus Conference. While not specific to trauma teams, this taxonomy addresses the functions and processes critical for extreme action teams. Deficits in these key competencies, e.g., back-up behavior, coordination, communication, and leadership, have been shown to negatively impact clinical outcomes in trauma patients. Fortunately, the team literature demonstrates that well-designed training can improve team performance and mitigate errors in interdisciplinary action teams.

Healthcare Simulation-Based Training and Assessment

Simulation has been used in healthcare, aviation, and military team training. The term "simulation" spans a wide variety of formats, from the low-tech actor portraying a standardized patient to high fidelity mannequin-based human patient simulators and Virtual Reality (VR)-based task trainers. In fact, simulation includes any technology or process that recreates the contextual background of a healthcare environment, allowing providers the opportunity to experience an authentic clinical interaction with patients and other healthcare team members. Simulation-based training does not rely on chance encounters but rather creates a need for team interaction. Events begin with a "trigger" to activate the team and create the requirement for some type of team interaction. Well-designed event sequences are also careful to minimize the interdependence of performance quality. This allows educators and researchers to identify not only what happened (outcome measures), but also why it happened (process measures). As such, simulation can provide a platform for training and assessment that is diagnostic of individual, team, and, potentially, systems-based threats to ensure successful performance.

Simulation in Trauma Training

The use of simulation in trauma team training mirrors its use in aviation and other areas of healthcare, where the focus is interdisciplinary communication and interaction. Scenarios, whether created using a life-sized human mannequin or VR-based avatars, force participants to interact under time-pressured and complex conditions. Teams must then utilize their individual knowledge and teamwork skills to treat a patient(s) in an appropriate manner. Additional complications, such as power outages, mass casualties, and difficult coworkers can be brought into the scenario to meet training objectives. Simulations can target specific components of teamwork to help teams understand the various roles and responsibilities inherent in a trauma team. Such shared understanding (shared mental models) positively impacts team performance, especially under stress.

Mannequin-based simulation training has the advantage of allowing healthcare team members the opportunity for hands-on training. Events happen in real-time, often in an environment created to mimic a true emergency room or operating room setting. In fact, technology now allows for portable mannequins that can be brought directly into actual patient care areas, further enhancing the richness of the training experience by allowing trainees experience within their own system and with their usual equipment. In a small pilot study, Knudson, et al. demonstrated improved teamwork skills in individuals trained using mannequin-based simulation combined with didactic training versus didactic training alone. These results are supported by a study conducted by Falcone, et al., demonstrating improved trauma management of pediatric patients following multidisciplinary simulation-based trauma team training.

While mannequin-based team training holds significant promise for improving team performance, there are also limitations that are important to mention. First and foremost, high fidelity mannequin-based simulations can be quite costly, both from equipment and personnel (faculty trainer) standpoints. Simulation sessions are complex to develop, and as such, significant faculty time is required to develop each case. Additional costs are incurred when trainees are pulled from their work duties to participate in training, and often release time is difficult to obtain. Furthermore, mannequin-based training is, by design, hands-on. Training must therefore be done in small groups to allow team members the opportunity to interact as they normally would. This places an additional burden on faculty trainers, as many more faculty hours are required to conduct mannequin-based simulations versus a large lecture-based didactic session.

Figure 1: Trainees work together in a realistic resuscitation setting to care for a critically ill "patient" simulator.

To address some of these limitations, researchers have turned to technology in the form of computer-based virtual worlds. Medical virtual worlds are housed on the Internet and use many of the features common in the gaming industry, including avatars. Trainees can therefore take on the role of an avatar and interact in a virtual patient care scenario as a physician, nurse, etc. Patient avatars (or robotars, if prescripted computer characters) provide opportunities for trainees to interact via their avatars. In this virtual world, teams can practice teamwork and trauma skills through their avatars from remote sites spanning the globe. Multiple patient triage, challenging environments, and tactical missions can all be programmed in to meet the objectives of the trauma training. Metrics, such as time to critical action (e.g., IV start, blood transfusion, etc.) or teamwork (e.g., communication, coordination of functions, etc.) can be assessed to provide measures of individual and team performance. Virtual world-based training is not hands-on and can be challenging for gaming novices, however, it does offer an alternative approach to team training that can overcome some of the logistical challenges inherent to large-scale mannequin-based training programs.

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Product Comparison Chart: Trauma Training Devices

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PRODUCT	DESCRIPTION OF PRODUCT	MANUFACTURER
Trauma FX	a line of durable, wireless, trauma training mannequins combined with special effects technology and made with artificially formulated tissue, the simulated battlefield injuries prepare professionals for real-life medical emergencies and stressful conditions	Kforce Government Solutions
METI LIVE	an educational tool set in a virtual world, delivers medical simulation training by recreating virtual hospitals with existing patient simulators; patients are virtually controlled by an operator	Meti
Injury Creation Science (ICS) Kits	developed from a physiologically-based research program, consists of the cricothyrotomy, needle compression, and wound management skills trainers; each trainer is built with prosthetic tissue and simulated wounds to provide medical trainees with practice and life saving skills for emergencies with real injured patients	Virtual Reality Medical Center
ActFast Anti Choking Trainer	learning tool for CPR students, Anti Choker Trainer vest prepares individuals for emergencies related to choking and breathing; during practice, a foam plug will shoot into the air, indicating both accuracy and survival in a realistic scenario	ActFast Medical LLC
Bioterrorism Simulated Medical Emergency Response (BioSimMER)	VR-based tool prepares individuals to respond in fast-paced, stressful situations like terrorist attacks; in this virtual scenario users are expected to act quickly to address casualties and injuries	Sandia National Laboratories
Ultimate Hurt	mannequin contains realistic aspects that enforce practice on itself rather than patients; various injuries can be simulated, allowing students to perform learned procedures on the human-like subject	The Israel Center for Medical Simulation
Trauma Team	a 3-D Nintendo Wii game used as a surgery simulator, patients have visible injuries while characters (controlled by the players) perform treatments based on their specializations	Atlus
VIRGIL	system consists of an anatomically correct mannequin with a PC-based graphical interface that tracks the internal position of chest darts and chest tubes during training – because any mistakes made on this simulator could potentially occur in real-life instances, the system encourages practice and learning in a simulated trauma scenario	The Simulation Group at CIMIT
iStan	high-performance, realistic, wireless patient simulator with reactive eyes, among other interactive features, and ruggedized body for medical education and critical care in the classroom or in the field	Meti
Emergency Room: Code Red	PC game designed to place players in different emergency room scenarios that contain real-life medical injuries, tools, and instruments; users play the role of an ER doctor and are expected to stabilize patients, determine the cause of various conditions, and administer effective treatments	Legacy Interactive

Wounds of War III: Coping with Blast-related Traumatic Brain Injury in Returning Troops

EDITED BY:
Professor Dr. Brenda K. Wiederhold, Ph.D., MBA, BCIA

WOUNDS OF WAR III: COPING WITH BLAST-RELATED TRAUMATIC BRAIN INJURY IN RETURNING TROOPS
On February 20-22, 2011 the NATO Advanced Research "Wounds of War III: Coping with Blast-related Traumatic Brain Injury in Returning Troops" drew over 30 eminent experts from 11 countries to discuss the topic of increased Traumatic Brain Injury (TBI) in our service men and women.

Held in Vienna, Austria at the Hotel Regina, discussion topics included increased TBI as a result of missions, as well as how TBI may be prevented. Research has shown that those who have served in both combat missions and peacekeeping operations are at an increased risk for TBI. The ultimate aim of the workshop was critical assessment of existing knowledge and identification of directions for future actions. The co-organizers of the workshop alongside Professor Brenda K. Wiederhold included Professor Kresimir Cosic, Professor Mark D. Wiederhold and Colonel Carl Castro.

Full papers were published with IOS Press
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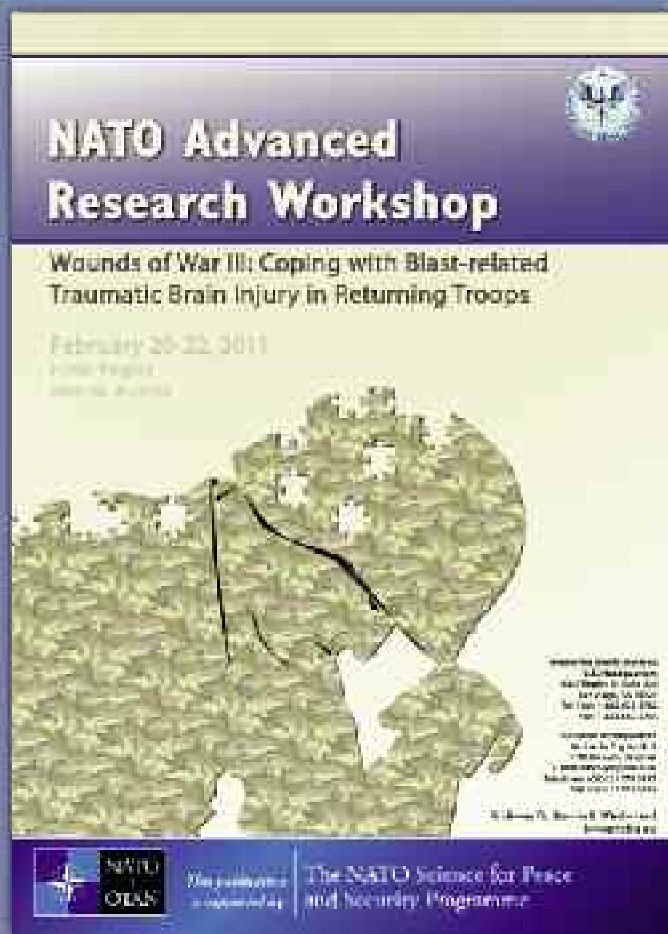

The post-conference book reflects the key topics discussed in the four sections at the workshop:

First Session - Characterization of TBI
Second Session - Diagnostic and Assessment Issues Surrounding TBI
Third Session - Treatment of TBI
Fourth Session - Quality of Life

The Interactive Media Institute
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Preoperative Patient-Specific Liver Surgical Simulation

"The liver is the most frequently injured intra-abdominal organ in situations involving abdominal trauma. However, hepatic surgery remains an essentially difficult procedure due to the high vascular variation of the liver's anatomy ... our work aims at overcoming these limitations by offering preoperative surgical simulation based on patient-specific modeling."

By Luc Soler, Didier Mutter & Jacques Marescaux

Violent behavior and road accidents account for the majority of liver injuries. Liver injuries, secondary to blunt trauma, are typical in Europe, while penetrating injuries are the most frequent in North America. If liver trauma represents between 15-20% of blunt trauma, its mortality rate grows to 50% of all blunt trauma deaths. Surgical procedures remain the option that offers the foremost success rate. Regretfully, surgery remains complex due to huge vascular variations in the liver vascular anatomy from one patient to another. Our work, developed within the scope of the European PASSPORT Project of the 7th Framework Programme, aims at overcoming these limitations by offering preoperative surgical simulation based on patient-specific modeling.

Geometrical and Anatomical Modeling

There is a large set of medical image processing methods providing liver segmentation. These systems are usually limited to the liver and its internal structures, which is of course not sufficient to develop patient-specific hepatic surgical simulation. Indeed, such surgery requires the modeling of surrounding organs in order to be realistic enough. To overcome such limits, we have developed and validated a new method based on hierarchical segmentation of visible organs, from the simplest to the most complex. This method allows us to visually extract the main organs of the thoraco-abdominal area. The second step then delineates veins, the liver and its internal lesions.

"Combined with the SOFA open-source framework, resulting patient-specific models will lead to a preoperative surgical simulator that could be used for planning and education. Moreover, the multicentric clinical validation will be pursued in order to prove clinical benefits of the new anatomical modeling in link with patient-specific surgical planning."

Anatomical Patient Modeling

For many years, the anatomical segmentation of the liver has been the topic of many discussions. The Couinaud segmentation is currently the reference used by most surgeons but is criticized by authors who point out the limitations or even the errors of that segmentation. Couinaud himself described such topographic anomalies in 2002. In order to solve this problem, we have defined a new correct functional anatomy. This new definition is based on a simple rule applied specifically to

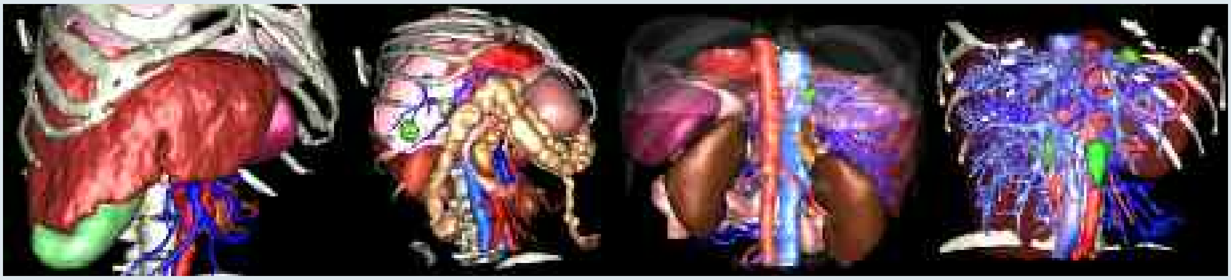

Figure 1: Patient-specific geometrical modeling: image segmentation followed by 3-D mesh generation.

Figure 2: Preoperative surgical simulation of three different liver resections.

each patient: two portal venous sub-networks can only be in a same segment if and only if they come from the same crossing of a same portal branch. For the sake of rigor and in order to use that definition in clinical routine, we proposed to implement a labeling system based on numbers and letters close to Couinaud's classification. Our validation shows that the new labeling is always topologically correct, due to the definition.

Software Integration: From Modeling to Surgical Planning

We have first developed an Image Viewer Software working on Windows, Linux and MacOS. VR-Render WeBSurg Limited Edition©IRCAD2010, available freely on WeBSurg, (www.websurg.com/softwares), has been downloaded and is used by more than 8,000 users. We have then developed a virtual surgical liver resection planning software. VR-Planning©IRCAD2010 offers the opportunity to resect the liver into several topological components. Thus, it allows for multi-segmentectomy. It also automatically computes the future liver remain rate and volume after resection.

Clinical Validation

In order to collect anonymous patient-specific data and to validate 3-D modeling and surgical planning software, we have opened a free online service for the European PASSPORT project partners. More than 300 clinical cases have been modeled since 2008. Each 3-D modeling was realized and validated by experts using VR-Render and VR-Planning software. The resulting algorithm shows 93% sensitivity and 94% specificity, 1.46mm of average precision in three-minute processing. First clinical applications show the great benefits of using such software for preoperative hepatic liver surgery.

Future Applications

Our work, developed in the scope of the European project PASSPORT, has allowed the development of patient-specific geometrical and anatomical modeling. Combined with surgical planning software dedicated to liver surgery, it offers new possibilities allowing the improvement of hepatic surgery. The last year of the project will aim at finishing software integration by adding mechanical and biological modeling. Combined with the SOFA open-source framework, resulting patient-specific models will lead to a preoperative surgical simulator that could be used for planning and education. Moreover, the multicentric clinical validation will be pursued in order to prove clinical benefits of the new anatomical modeling in link with patient-specific surgical planning.

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Pre-Deployment Simulation Training for U.S. Army Forward Surgical Teams

Forward Surgical Teams deployed to Iraq and Afghanistan "receive intensive, focused training in clinical management, teamwork, and resource utilization in a controlled environment rather than on the battlefield." The use of realistic patient simulation models, such as the SimMan 3G, serve as a valuable adjunct to more traditional methods of training and clinical instruction.

By Mark L. Ryan et al.

Since September 2001, the Army Trauma Training Center (ATTC) at the University of Miami has provided instruction and training in the management of combat casualties for every Forward Surgical Team (FST) deployed to Iraq or Afghanistan. Each FST is composed of medics, nurses, and physicians with varying degrees of combat experience. It is therefore essential that teams receive intensive, focused training in clinical management, teamwork, and resource utilization in a controlled environment rather than on the battlefield. Participants are subjected to a two-week educational rotation composed of didactic instruction, cadaveric surgical exposure training, and a porcine-model mass-casualty exercise. An essential component of FST training involves simulation of acute injury using an advanced clinical simulator, the SimMan 3G.

The SimMan 3G (Laerdal Medical, Wappingers Falls, NY) is a patient simulation model with advanced clinical functionality combined with vital signs monitoring and an interactive software suite. It allows for testing and training in standard ACLS resuscitation protocols, as well as user-customized treatment scenarios. Mannequins are capable of manifesting clinical symptoms, such as pupillary dilation, eye secretions, blinking, breath and cardiac sounds, palpable pulses, convulsions, hemorrhage, and other signs of shock. Models also demonstrate physiological responses to treatment with medications as well as procedural interventions (chest decompression, intubation, ventilation, thoracentesis, defibrillation/cardioversion, foley catheterization). The device has been deployed as an instructional tool in several U.S. Army Medical Simulation Training Centers around the world for the simulation of battlefield injuries.

> *"The SimMan 3G (Laerdal Medical, Wappingers Falls, NY) is a patient simulation model with advanced clinical functionality combined with vital signs monitoring and an interactive software suite. It allows for testing and training in standard ACLS resuscitation protocols, as well as user-customized treatment scenarios."*

At the ATTC, the SimMan 3G is utilized as an adjunct to the clinical instruction provided at Ryder Trauma Center, a level 1 trauma center located in Miami-Dade country with approximately 4,500 admissions per year and a high frequency of penetrating injury. Participants receive simulation training before starting the rotation and once more upon its completion. Prior to beginning the exercise, trainees are given the opportunity to survey the room and familiarize themselves with the equipment.

Figure 1 (left): Simulation exercises are conducted in a recreation of a surgical tent similar to that used in the field.

Figure 2 (below): Initial assessment of a simulated patient by members of a Forward Surgical Team.

They are then brought into an adjacent room, where they are informed of the patient's mechanism of injury and provided a brief overview of their clinical status. The model is made to simulate a patient who has suffered either a blast injury or a gunshot wound. Participants are expected to rapidly address the patient's injury while adhering to Advanced Trauma Life Support Protocols. Over the course of the exercise, progress is monitored by the instructor via a wireless tablet PC. The instructor is also able to input changes in clinical status to further challenge the team as necessary. The team then participates in an After Action Review (AAR) to evaluate their clinical performance. This simulation exercise serves as a valuable tool to assess team readiness prior to the initiation of their clinical duties, as well as for evaluating improvements in performance upon completion of their rotation.

"[SimMan 3G] has been deployed as an instructional tool in several U.S. Army Medical Simulation Training Centers around the world for the simulation of battlefield injuries."

Although the device has proven extremely useful for clinical simulation and team readiness, there are multiple scenarios for which the use of a simulator is not yet feasible. The limited portability of these devices has restricted their utility in our mass-casualty exercises, where rapid triage, treatment, and evacuation from the patient treatment areas are required to adequately simulate combat conditions. Also, there is currently no adequate simulation tool for the advanced operative management of battlefield injuries. A model capable of providing instruction in methods of hemorrhage control, organ exposure, and patient stabilization prior to evacuation would be extremely valuable in providing a consequence-free environment in which to hone these skills. Animal and cadaveric training are extremely expensive and labor-intensive. With current funding limitations and increased scrutiny of animal exercises, it is essential that novel, cost-effective simulation models are developed in order to alleviate our current dependence on these methods.

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Simulation in Trauma Education – More Than Just "How Real is That?"

"Simulation has allowed researchers to further their understanding of how certain factors in a learner's environment can affect learning and performance ... One particularly interesting line of research is into the effects of stress on learner performance ... These findings have huge implications for the role of repeated exposures, desensitization protocols and explicit stress mitigation teaching that has thus far not been part of most medical education curricula."

By Glen Bandiera

Medicine has a long tradition of learning within a clinical environment under the watchful eyes of experienced supervisors. While this model still forms the backbone of most post-licensure medical education, the old adage of experiential learning, "See one, do one, teach one," has fallen by the wayside in favor of more controlled, deliberate, and evidence-based curriculum delivery. Medicine has been slow to take up simulation as a means to formalize learning, but concerns about patient safety resulting from physicians learning in practice, reduced resident work hours limiting opportunities for patient contact (and thus learning), and increasing evidence in support of competency-based education models have stimulated accelerated adoption of new methods. Thankfully technology, and more importantly, the fields of cognitive psychology and learning theory, have also risen to the challenge. Trauma care is particularly suited to the use of simulation. The dynamic, fast-paced and diverse practice of responding to acute severe injury combines elements of protocol-driven practice with quick information processing, complex decision-making and effective team management. Simulation shows promise to help with all of these dimensions of care, but the most effective use of simulation may not necessarily be the high-tech Virtual Reality wonders that might come to mind. Sometimes, simple solutions matched to specific educational needs are all that is required.

Effective trauma care is contingent upon skillful performance of procedures. High fidelity (life-like) part-task trainers (physical models simulating various body organs and cavities) have been developed and deployed to teach the mechanics of individual procedures with great effect.

"Beyond the procedures themselves, decision-making is critical to successful trauma care. To effectively teach and assess this, it is desirable to replicate the clinical environment as closely as possible, and computerized high fidelity simulation clearly is the preferred choice."

Even low fidelity models have been shown to improve subsequent performance of procedures on real patients (Figure 1). Such simulations can be delivered in a laboratory environment outside of a formal trauma resuscitation room and can be delivered to large numbers of learners at once, increasing the appeal. A common scenario involves a group of learners rotating from station to station with a different procedure at each station supervised by a senior faculty member. In addition to traditional measures such as time on task, error rates and global assessment of end results, technology has allowed the use of haptic responses, time-motion analysis, pressure sensing, and paucity of move-

Figure 1: More basic simulation to test motor skills.

ment scales to gauge learner progress. The ability to create "variations on the normal" (e.g., anatomical variations or unanticipated swelling of the upper airway during an attempt to pass a tube into it) has been introduced to test a learner's response to complications. In addition, portable technology has allowed computerized mannequins to be embedded into a real environment (for example, placed in a real emergency department treatment room to carry out a pre-planned specific simulated case during a regular shift) or into non-traditional educational environments such as a simulated mass casualty incident in a local gymnasium.

Beyond the procedures themselves, decision-making is critical to successful trauma care. To effectively teach and assess this, it is desirable to replicate the clinical environment as closely as possible, and computerized high fidelity simulation clearly is the preferred choice. Learners must be able to recognize the context, there should be minimal need for them to suspend disbelief, and most importantly, they must be able to translate what they learn back and forth from the simulation lab to real life. Mock trauma resuscitation rooms and trauma operating theaters are easily created and a single simulation lab can be converted from one to the other in about 30 minutes. When outfitted with all necessary medical equipment and equipped with relevant real-time monitoring and on-line operator control (to allow a tailored response to learner actions), almost any clinical contingency can be replicated to test a learner's ability to think on the fly. As important as the technology are the cases used for teaching, including detailed goals and objectives for the case, precise scripts and roles for all participants, and clear expectations for performance including, if in an evaluative setting, what constitutes satisfactory versus unacceptable performance. The development of such cases requires considerable time and expertise and has been a major limiting factor to the effective deployment of simulation as a teaching and evaluation method. Advances in these areas, informed by curriculum development theory and supported by on-line repositories and libraries, have helped the field move forward in recent years.

More than anything, trauma care is about teamwork and simulation has been successfully adopted to test teams, rather than individuals. Despite the fact that individuals from multiple healthcare professions are expected to work together in practice, true interprofessional education, wherein practitioners from these disciplines learn with and from each other, is new. Simulation has provided an opportunity to embrace this form of education and focus on skills that have until recently not been explicitly taught. Crisis resource management techniques, adopted from the airline industry by the specialties of anesthesia, critical care and emergency medicine/trauma, have formed an appealing basis for establishing performance and evaluation standards for teams. Designing scenarios and evaluating the participants not on individual decision-making and technical skills but rather on communication, interpersonal dynamics and role awareness, is seen as a ripe frontier and is the focus of ongoing research in medical education.

Finally, simulation has allowed researchers to further their understanding of how certain factors in a learner's environment can affect learning and performance. Until the advent of realistic simulation, it has been difficult to sufficiently create and control an environment for experimentation of this type to take place. One particularly interesting line of research is into the effects of stress on learner performance. By measuring perceived stress using validated questionnaires and physiologic stress using salivary cortisol levels, it has been shown that careful variations in a scenario can significantly vary the stress experienced by a participant without necessarily changing the complexity of the decisions, procedures or medical care required. Researchers have shown that increased stress can have a negative impact on performance of complex cognitive tasks and that this effect can be minimized with repeated exposure. These findings have huge implications for the role of repeated exposures, desensitization protocols and explicit stress mitigation teaching that has thus far not been part of most medical education curricula.

For complex, high stakes fields like trauma care, where the real environment is unpredictable and hard to control, simulation has proven to be an invaluable aid to educating the future generation of practitioners. With ongoing focus and judicious deployment, we can expect safer, more evidence-based education and care in the future.

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Ask the Expert:

Q&A Robert Madelin

Director General for Information Society and Media, European Commission

"... using ICT to make behavioral help available in a private, non-stigmatizing, autonomous way for individuals would be a huge bridge between almost infinite additional need and very constrained resources."

Brenda K Wiederhold: I am here today at the European Commission in Brussels, Belgium with Mr. Robert Madelin. Thank you for this opportunity Mr. Madelin. In 2010 you were appointed to a new position in the Commission. Can you tell me what position that is please?

Robert Madelin: Yes, I was appointed in April 2010 as the Director General for the Information Society, which means that I coordinate that part of the Commission's work that deals basically with research in ICT and policymaking and regulatory interventions across the range of electronic communications and audiovisual media.

BKW: Excellent. I want to ask you some more about your current position, but first I want to take a step back and read you something I found about your previous position and let you comment on that. It was said of you, "Madelin had transformed the way the Health and Consumers Directorate was run. He took risks and established what he called cooperative voluntarism as the new way of doing things, getting stakeholders to sit around a table and sign up to voluntary commitments as an alternative to legislation." Can you speak to that please?

RM: Well I think that it's a bit too flattering in the sense that the conception of having cooperative voluntarism is something that has been around both in Europe and I think in many parts of the world, as an efficient alternative to some previous state interventions. So I wouldn't say I invented anything. But this past decade in Europe has been a good time to run such experiments and in particular in 2004, '05, '06 where we were looking at issues like controlling the advertising of high-fat-salt-sugar food to children, promoting physical activity, encouraging a reduction of harmful use of alcohol. All these issues turned out to be very good candidates for multi-stakeholder interventions and at the same time, the different stakeholders both in civil society, health professions and the corporate sector were ready to try.

BKW: So right time, right place?

RM: Yes.

BKW: And in your current position? What do you see as some of the things that you want to accomplish?

RM: Well in a sense I am lucky because I come to this job at the time that the new Commission has adopted a "Digital Agenda for Europe," which really covers the whole set of issues where this part of the Commission should be active. Getting the research protocols right for the next ten, fifteen years is a big piece of the discussion in the current oncoming years and similarly implementing better regulatory frameworks so that the Internet can really take off in Europe like everywhere else as a good basis for helping citizens to have more of what they want to have – better lives.

BKW: And had you always been in the field of healthcare legislation policy?

RM: No, not at all. I started as a public servant at the end of the 1970s in London, and I began spending about twenty, twenty-five years doing international economic relations. So, with the World Trade Organization negotiations, for example. I came to health in 2003, 2004 but at that time I found I had actually already done quite a lot of work around health regulatory issues, both with health services in the context of the trade negotiations and on food-chain regulation, also from the trade perspective. So it was a bit like moving up the value chain instead of dealing with the consequences of regulation being responsible for it.

BKW: What would you consider to be the ICT for health's main achievements in 2010 and what are the priorities looking beyond?

RM: I think in 2010, one of the main achievements that we had was a policy achievement, rather than a research breakthrough, which is to get agreement across the college of Commissioners, the Parliament and all member states to a new form of partnership. What we are going to develop is a European Innovation Partnership where you take the people who are working around health as an issue, the ICT and research actors, but also member state governments, regional authorities, health insurers, civil society, and we try to bring ICT benefits for health more quickly to the individual citizen. I see that as quite an interesting breakthrough with parallels to my past life.

BKW: Quite a big endeavor. What do you see as some of the biggest obstacles facing the implementation of ICT in Europe?

RM: Specifically in the health field, it's clear that developing a trustable solution to privacy problems is essential, both for the individual patient and for the individual health professional. The second challenge I think more on the side of the professionals is to make it clear that ICT makes life easier. If it just looks like another set of tools to learn and yet more folders to fill in, then health professionals may very rapidly reject innovation. So I think overcoming both obstacles to adoption by health professionals and obstacles to trust on the part of the patients are the twin obstacles to more rapid rollout.

BKW: C&R is focused on behavioral healthcare. We were talking earlier about this. Can you speak to me about some of the Commission's priorities in behavioral healthcare?

RM: I think that behavioral healthcare is the area in Europe where there is the most health gain to be made. In most developed countries infectious diseases and pandemics continue to be a threat: let's not forget TB, for example. But what's really killing us Europeans is the way we live. Therefore, the huge gain to be made comes from help with behavioral issues, whether it's more responsible use of nutrition or alcohol, smoking cessation, mental health management. These are issues where people need day-to-day help so that they can take charge and yet health-professional help is constrained. There aren't enough experts to go around. So using ICT to make behavioral help available in a private, non-stigmatizing, autonomous way for individuals would be a huge bridge between almost infinite additional need and very constrained resources. It's a very exciting area because some of the ICT solutions can be relatively low-tech.

BKW: If you had to choose one thing that you were most proud of in your career what would that be?

RM: So far?

BKW: Yes so far.

RM: Can I choose two? I mean I think there was a day or two in 1993 when I think I made some contribution to finishing the "Uruguay Round" of global trade negotiations. It was very important at the time to create a more open platform for growth everywhere, including in developing countries. And then from my time in the health field, I would pick the creation in 2005 of the first multi-stakeholder platform to promote better nutrition and reformulation of processed food and physical activity, which after five years has got a positive health check this year from the evaluators. In my current job I haven't been here long enough to achieve something.

BKW: And what do you want to accomplish then?

RM: In a job such as this I have a five, six-year mandate. I think in that time delivering really on the goals we have now set for ourselves in the digital agenda would be huge. The challenge that I think is very important is, in a way our slogan, is "enabling every European to be digital." Not forcing them, but enabling them. Thirty percent of European citizens have not yet ever gone online, and in some countries it's more like half or more than half, and in some poorer communities in some member states of the union it may be seventy-five percent. So we are looking at a huge disparity across Europe and if we can level up so that every European citizen has that opportunity and doesn't just go online to sort of do superficial things but finds the tools for better health, for better government service, for better community life, then I think we can begin to have made a difference.

BKW: And how long do you think that will take?

RM: Well if you look at a country like the United Kingdom they are aiming by 2012 to have everybody online. So it doesn't take so long if you can stretch out and find all the people in the communities and in all peoples' homes, in workplace settings, in apprenticeship colleges and work with that; you can't do it from the top down. But many different member states in Europe are trying to pursue this in the ways that work in their communities. In Poland they are using the rural public libraries and in Malta they are using the prison service and apprentice colleges. So I think that helping the different member states to do more of that is really the way forward.

BKW: What gets you up every morning? What is your passion, your true passion?

RM: I believe that the job I do, the professional pursuit of the public good is a very big challenge. It's an even bigger challenge at a time of budget austerity and societal transformation and that gets me out of bed.

BKW: And can you say a bit about EU-U.S. cooperation?

RM: Yes, so on the international front, on research, for example, we want the best ideas and the best research from across the world. So we have taken a very open stance to partnering on the research end of our work with institutions and individuals from wherever. Equally I think the EU-U.S. relationship around policy and regulation is also a very strong one and in the area of healthcare, health promotion and so-called eHealth, there is a long tradition of dialogue. We are signing with the U.S. Administration a new protocol to work together on eHealth, particularly ICT in healthcare settings. But my personal belief is that our partnerships can go much more broadly than that and to issues of behavioral health promotion and assistance to citizens. There is already some tradition of working together around subjects such as nutrition and physical activity, but we haven't yet built in the ICT components of this work to do that as well.

BKW: Anything else you would like to add?

RM: No, I think that's about it.

BKW: Okay, thank you very much for your time.

FURTHER AFIELD:
Awakening the Realm of Trauma Care in India

By Lingjun Kong

India's healthcare industry has been experiencing tremendous growth and is expected to be a major component of the country's economy. Due to factors such as the increasing accessibility to health insurance, the growing senior population, and the influx of people from overseas seeking world-class quality of medical treatments at affordable rates, India's healthcare, currently estimated at $37.5 billion in 2008 according to a Technopak Advisors' report, is expected to grow by a factor of two over the next year, and a factor of 10 by 2022. However, the rapid economic growth in the healthcare industry has left little time for the industry to upgrade its system to the proper standards, especially in emergency and accident-related trauma care. Nearly 20% of all emergency hospital cases in India are associated with trauma, making it the ninth leading cause of death. By 2020, it is estimated that trauma will move to the third leading cause of death.

There is a great need for a well-developed emergency care system in India. Natural disasters such as earthquakes, cyclones, landslides, and floods, as well as man-made mishaps such as road accidents and industrial injuries, put great pressure on the hospitals. India has not yet developed a uniform hospital emergency phone line due to the various levels of government, corporate, and personally owned clinics across the country. Those in rural environments are usually unable to obtain the basic care available in the urban facilities, and those in urban facilities are unable to access specialized care which is only available in major cities.

In addition to the lack of formal regulations for trauma care procedures, most hospital personnel are not equipped with the education and training to properly care for trauma victims. In 2005, only 4% of paramedics had formal training, many of whom worked for private hospitals. One-third of the country's ambulances are used solely for inter-hospital transportation purposes and only half have the ability and equipment for providing airway support and splintage. Thirty-percent of emergency patients in India die before even reaching a hospital. The need to improve the training infrastructure and educational exposure of India's healthcare personnel is urgent.

Fortunately, the investment opportunities in India's healthcare industry are strengthening trauma care to raise it to the proper standards. Many educational programs have been established to improve the skills of India's healthcare personnel. One prime model is the SRM/STRATUS Centre for Medical Simulation of SRM University, a medical center that collaborates with the Neil and Elise Wallace STRATUS Center for Medical Simulation of Harvard Medical School to bring cutting-edge simulation programs to train India's medical personnel. Equipped with state-of-the-art technology, the SRM Centre is a highly advanced educational facility that provides training for medical professionals through reality-based patient care simulations. One program offered at the center, Laerdal's SimMan, is a high-fidelity simulator that can be physiologically monitored, defibrillated, and administered medications, among other diagnostic and therapeutic procedures. The center has an Operation Theatre that mimics an operation room for surgeons-in-training. For practicing non-invasive surgery techniques, clinicians can attend to the Arcade Room. The Partial-Task Room allows students to learn essential skills such as IV cannulation, airway management, and central lines.

Among the programs offered at the SRM Centre, such as Basic Life Support and Advanced Cardiac Life Support, the Basic and Advanced Trauma Life Support programs will have a large impact on India's healthcare quality. These programs familiarize medical professionals with the equipment used in trauma care, both in-hospital and in the field. In the basic training program, essential skills such as intubation, chest tube insertion, cricothyroidotomy, and Focused Assessment through Sonography in Trauma examinations are taught. In the advanced program, the students learn triage and trauma safety, shock management, airway and ventilator management, system-specific trauma care, and resuscitation and initial stabilization of trauma victims.

As shown through the SRM/STRATUS Centre, trauma care in India is already undergoing improvement efforts. To sustain this improvement, two key changes must occur. The first is the acknowledgement of and commitment to the need for policy reform of the healthcare system and the establishment of unified trauma systems. The second is a continuous stream of funding for the advancement of the quality of trauma care. With these needs met, the people of India, as well as visitors and those traveling to undergo medical procedures, will greatly benefit in the future.

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Pain Assessment for Designing a Painless Microneedle

" ... we propose a pain evaluation test to design a painless microneedle to determine the maximum diameter to mitigate pain."

By Kazuyoshi Tsuchiya, Kagemasa Kajiwara & Minoru Kimura

Using a microneedle mimicking the size of a female mosquito's labium, which collects blood almost painlessly, is an effective way to mitigate injection pain for patients. Here, we have a microneedle production technique which uses a type of sputtering deposition method. In the production procedure, firstly, a microneedle material on a rotating wire substrate at the speed of 3-5 rpm by the sputtering deposition method is deposited. Secondly, the wire substrate is etched by a chemical solution after a heat treatment. Finally, the titanium microneedle is produced (outer and inner diameter: 60 μm and 25 μm) in the size mimicking that of female mosquito's labium (see Fig.1).

Here, the inner diameter of the injection needle is decreased when the outer diameter is decreased in order to mitigate pain, hence, the rigidity of the needle is decreased and the pressure drop by pipe friction is increased. Therefore, a little larger size than the female mosquito's labium is needed to satisfy the mechanical properties for the painless microneedle. However, we do not have any evaluation techniques to judge the pain quantitatively.

In this study, we propose a pain evaluation test to design a painless microneedle to determine the maximum diameter to mitigate pain.

Generally, the techniques for measuring physiological stress changes of blood pressure, heartbeat, diaphoresis, etc., are enumerated as an objective evaluation technique for pain. It is observed that stress generally arises due to a physical stimulus. However, it is difficult for the physiological stress change to be easily influenced by the measurement environment and to evaluate only the pain. When the sympathetic nerve system becomes active due to a physical stimulus such as the injection of a needle, the digestive system is inhibited and only the salivary gland is active. The amount of α-amylase in saliva is changed by an activity change in the sympathetic nervous system, so that the value rises due to unpleasant conditions or the value decreases in comfortable conditions. Therefore, the pain is defined as a psychological stress caused by the injection of a microneedle in this research, and we focus on the change in the amount of α-amylase in saliva as a pain evaluation test. Here, the advantage of using the amount of α-amylase in saliva as a measurement technique to evaluate stress is firstly, it ensures a quick response after a physical stimulus, and secondly, it is easy to

Figure 1: SEM images of a painless microneedle.

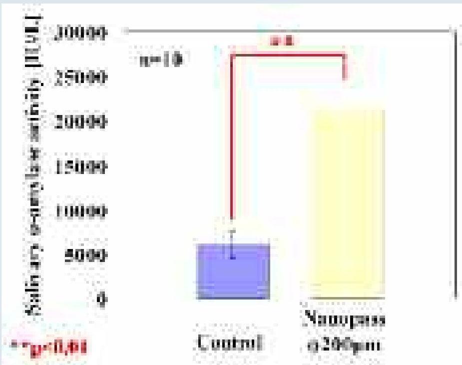

Figure 2: Comparison of amount of α-amylase in saliva between injection of Nanopass 33 and the control.

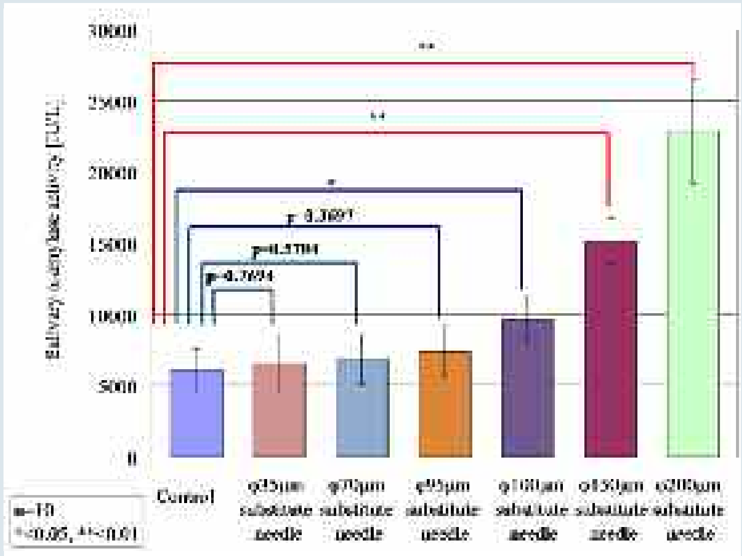

Figure 3: Salivary α-amylase activity when each needle with various outside diameters is injected into the skin.

measure the value quantitatively, and lastly, it is a non-invasive test.

In this study, we adopted the amount of α-amylase in saliva for mice, and the relation between stress and the pain resulting from the injection of a needle was evaluated. The needle injection in a mouse is consistent to measure the amount of α-amylase in saliva, compared with that of a human, and there are few individual differences between mice. Here, the experimental conditions to investigate the relation between stress and pain for injection of a needle, are described. (1) Nanopass 33 (TERUMO Corporation, 100 μm and 200 μm in inner and outer diameter) (2) substitution needles (the leading end was polished at 12 degrees; outer diameters: 35, 70, 95, 100, 150, and 200 μm) were used. Institute of Cancer Research (ICR) mice were used in the study. The needle was injected in the femoral region where the nerves are concentrated. Also, for the extraction of the mouse's saliva, a micro pipette was inserted into the mouth. The extraction volume of saliva for mice was 1 μl. The extracted saliva is diluted by phosphate buffered saline because the clinical biochemistry automated analyzer for α-amylase needs the solution amount of 100 μl. The saliva sample was extracted 10 times on each condition and an average was taken. The schemes of the effectiveness for the pain assessment are the following.

(1) The amount of α-amylase in saliva for injection of Nanopass 33 compared with its control as a stable condition. Two groups (the data for injection needle and the data for control) were statistically compared using the Mann-Whitney-U assay. As a result, the p (probability) value of two groups was significant at the level of 0.01. Therefore, the effectiveness for the proposed pain evaluation test to measure the amount of α-amylase in saliva was confirmed (see Fig. 2). The proposed pain assessment to measure the amount of α-amylase in saliva is effective.

(2) There are no commercial-based needles with a diameter smaller than NANOPASS 33, therefore, the amount of α-amylase in saliva for injection of substitution needles compared with its NANOPASS 33 and the effectiveness for the substitution needle was confirmed. Here, we have confirmed that there is no difference for the amount of α-amylase between Nanopass 33 and a substitution needle (outer diameters: 200 μm). We have also confirmed that the stress attributed to pain was not dependent on the difference between the shape of leading ends and the surface condition.

(3) The amount of α-amylase in saliva for various outer diameters in substitution needles compared with its control. In order to evaluate pain for injection needles with various outer diameters, two groups (each data for injection needle and the data for control) were statistically compared using the Mann-Whitney-U assay. Fig. 3 shows the comparison of amount of α-amylase in saliva between injection of substitution needles and the control. As a result, the significant difference has been confirmed in all the needles except smaller needle groups (less than 100 μm outer diameter against the control group). Here, it was confirmed that a significant difference was 0.05 between the control group and the injection of 100 μm outer diameter needle as a substitution needle. Therefore, it is clear that the maximum outer diameter to mitigate the pain for a microneedle is 100 μm or less.

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Credited with establishing psychology as an academic discipline after the first experimental psychology lab was opened in 1879, Germany has a history of proactive research in the field. The country and its people have overcome appalling historical setbacks. Now, healthcare researchers and officials are working towards a brighter future in the field.

In Germany, psychology was formulated as a field of study in the 19th century as the trends in science began to be applied to the mind. Many early psychologists were in fact physicists, doctors, and experimental physiologists. The connection between science, technology and psychology was established early on, and the integration of the fields persists today.

Psychology as an Academic Discipline is Born

One such scientist, Wilhelm Wundt, whose students included Emil Kraepelin, James McKeen Cattell, and G. Stanley Hall, opened the first experimental psychology lab in Germany at the University of Leipzig in 1879. Germany is credited with establishing psychology as an academic discipline, and the trend quickly spread to universities. Journals, such as PSYCHE, began circulating, discussing innovations and new theories that developed as Germany became more prominent in the field. German was an important and often-used language for psychological publications and Germany continued to be a leader in the field of scientific psychology through the first third of the 20th century.

Revolutionary work in the field included research done by Hans Berger, a student at the University of Jena who invented and recorded the first electroencephalogram (EEG) after becoming obsessed with the idea of "psychic energy," by Hermann von Helmholtz who studied attentional processes, and Hermann Ebbinghaus' experimental studies into memory. The results of their successful research continue to have an impact on psychological practices today.

Theories of psychoanalysis developed by Sigmund Freud, from the neighboring country of Austria, along with Carl Jung, caught on quickly in Germany and institutions were established to utilize and build on these new practices. The Berlin Psycholanalytic Institute, founded by Karl Abraham and Max Eitingon, was opened in 1920 to develop upon these new approaches and foster the development of the field. Institutions, in turn, transformed psychology into a profession as well.

The Impact of National Upheaval

The devastation that followed World War I led to an immense economic depression, as well as a loss in morale that inevitably gave rise to Nazi Germany. Under Adolf Hitler's Third Reich, Freud's practices were banned and many of his books were burned throughout Germany. Instead, Hitler carried out his own philosophy of ridding Germany of all that he deemed unfit for his country. The mentally ill and the disabled were the first targets of persecution.

In 1933, the Sterilization Law was passed in Germany that allowed the obligatory sterilization of anyone suffering from hereditary

Population (Million)	82.6
Life Expectancy (Years)	80.2
Fertility Rate	1.3
Population Median Age (Years)	44.9
Percentage of Urban Population	74%
Unemployment Rate (Native Born)	7.8%
Suicide Rate (Per 100,000)	9.1
Psychiatric Hospital Beds (Per 100,000)	0.5
Number of Universities Offering Psychology Programs	45
Percentage of the Population Satisfied with Current Healthcare System	50%
Lifetime Prevalence of Unipolar Depression (Percentage of General Population)	17.1%
Lifetime Prevalence of Panic Disorder (Percentage of General Population)	3.9%
Lifetime Prevalence of Mood Disorders (Percentage of General Population)	18.6%

diseases such as schizophrenia, manic-depressive insanity, hereditary epilepsy, and any severe hereditary deformity. The sterilization and legalized murder of mental undesirables caught the attention and admiration of many eugenicists of the time and helped fuel the eugenics movement worldwide. In Nazi Germany, mental patients were sent to extermination camps alongside Jews. Thousands were killed in the gas chambers, and camps, and many were subjects in lethal experiments.

Although many psychologists still had respect for Freud's theories, non-Jewish institutions were established in order to continue practicing under Hitler. The German Institute for Psychological Research and Psychotherapy in Berlin was opened in 1936 under the leadership of Matthias Heinrich Goring. Eminent Jewish psychologists were harassed, fired from their jobs, or murdered, leading others to immigrate or resort to suicide.

Academic psychology was dealt a devastating blow and Germany's scientific output dramatically decreased as experts in the field fled the country or were murdered. Increasingly, psychology professors at German universities held positions based less on their history of scientific excellence, and more on their political loyalty to the Nazis. More than half the professors in West Germany were former members of the Nazi party in 1947. After the war, the field's deficits were not addressed and only a few of the emigrated scientists returned home; only one psychology professor was invited to return to his previously held chair.

Following the defeat of Nazi Germany at the end of World War II, survivors of the war, particularly those who survived concentration camps, suffered from severe psychological distress. The need to rehabilitate survivors was a major concern for medical professionals and researchers in postwar Germany, and sparked the reemergence of mental healthcare. In 1961, psychoanalyst William G. Niederland created the term "Survivor Syndrome" to describe the effects experienced by Holocaust survivors. The syndrome encompassed a wide range of symptoms including anxiety related to death that often resulted in physical deterioration such as ulcers and colitis, withdrawal, emotional numbing, distrust in relationships, reoccurring dreams, depression, images and thoughts about death triggered by smells and other senses, and guilt about surviving while so many others perished. Niederland's outline provided a basis for treatment to try to alleviate some of the pain and anguish that plagued survivors.

The Reform of Healthcare

In the mid 1970s, during a time of drastic social and political reform, Germany adopted a community-based mental healthcare system. The deinstitutionalization of the system continued, and in 1990, when East and West Germany were reunited, dramatic changes in

the overall structure and quality of care resulted. Organized as a subsidiary system controlled by the 16 federal states, German healthcare is spread among many sectors and characterized by regional differences.

Although the general population is satisfied with the current healthcare system, services and care remain costly. The main concern then, is if and how the system can be adequately maintained without increasing costs.

Current ICT Research for Mental Healthcare in Germany

A recent report by a German health insurance company pointed to the dramatic increase in sick leaves due to psychopathological distress in recent years. With an increasing workload and resulting stress negatively effecting the population, this trend calls for new, improved treatment approaches.

While most labs implementing Virtual Reality (VR) in a research context are primarily involved in the fields of engineering science or neuroscience, a small number are dedicated to work involving psychology and clinical psychology.

In these labs, VR is used as a tool for basic research into emotions and anxiety and, in particular, to examine treatment of phobias including flight phobia, height phobia, spider phobia, claustrophobia, and social phobia. For analyzing treatment mechanisms, cue and especially contextual fear conditioning, paradigms are realized with the help of VR.

Professor Paul Pauli and Professor Andreas Mühlberger are involved with the psychology department at the University of Würzburg, a public university of Bavaria, and said, "[We conducted] basic research on fear, anxiety and anxiety disorders, and recently established a VR paradigm for contextual conditioning; we found that high trait anxiety is related to enhanced context conditioning."

Other examples of work include Dr. Oliver Stefani's use of VR in the field of engineering with the Visual Technologies Team at Fraunhofer addressing effects of lighting and displays on humans. This work studied how light emitting diodes (LED)-backlit computer screens affect circadian physiology and cognitive performance in subjects.

Labs in Germany benefit from mutual collaboration and research with many international groups, including other European countries and the U.S. Germany also draws many international students to develop and diversify their studies; it is the most common destination for foreign studies among Eastern European students.

Zukünftige Anwendungen

Professor Pauli believes that ICT research has a strong future in Germany and will help to aid the "exact analysis of behavior in ecologically valid virtual environments; unravel the laws of human behavior and to be able to develop more effective therapeutic tools for treatment."

These tools will undoubtedly be strengthened by further research and support as ICT methods gain national support and funding in Germany. With a rich history and unwavering ability to overcome past obstacles, Germany is establishing a stable, efficient mental healthcare system for its people.

Sources:

Personal communication with Paul Pauli, Ph.D., Andreas Mühlberger, Ph.D., Oliver Stefani, Ph.D., and the Organization for Economic Cooperation and Development.

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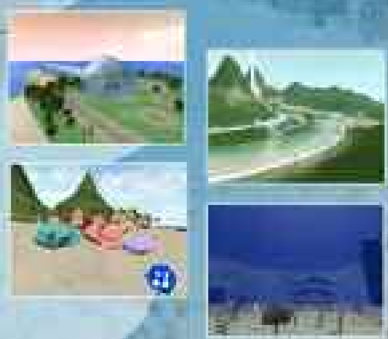

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Wounds of War II: Coping with Posttraumatic Stress Disorder in Returning Troops

EDITED BY:
Professor Dr. Brenda K. Wiederhold, Ph.D., MBA, BCIA

WOUNDS OF WAR II: COPING WITH POSTTRAUMATIC STRESS DISORDER IN RETURNING TROOPS

On October 18-21, 2009 the NATO Advanced Research Workshop "Wounds of War II: Coping with Posttraumatic Stress Disorder in Returning Troops drew 30 eminent experts from 14 countries to discuss the impact of war-related stress on participants from current and past conflicts, particularly when it results in increased risk and incidence of PTSD. Held in Klopeiner See, Südkärnten, Austria at the Hotel Amerika-Holzer, discussion topics included increased PTSD as a result of missions, as well as how PTSD may be prevented. Often thought of as an "invisible wound of war," PTSD may manifest in very visible ways, affecting behavior, relationships and society. The ultimate aim of the workshop was critical assessment of existing knowledge and identification of directions for future actions. The co-organizers of this workshop alongside Professor Brenda K. Wiederhold included Professor Kresimir Cosic and Professor Dragica Kozaric-Kovacic of Zagreb, Croatia and Colonel Carl Castro from the United States.

Full papers were published by IOS Press

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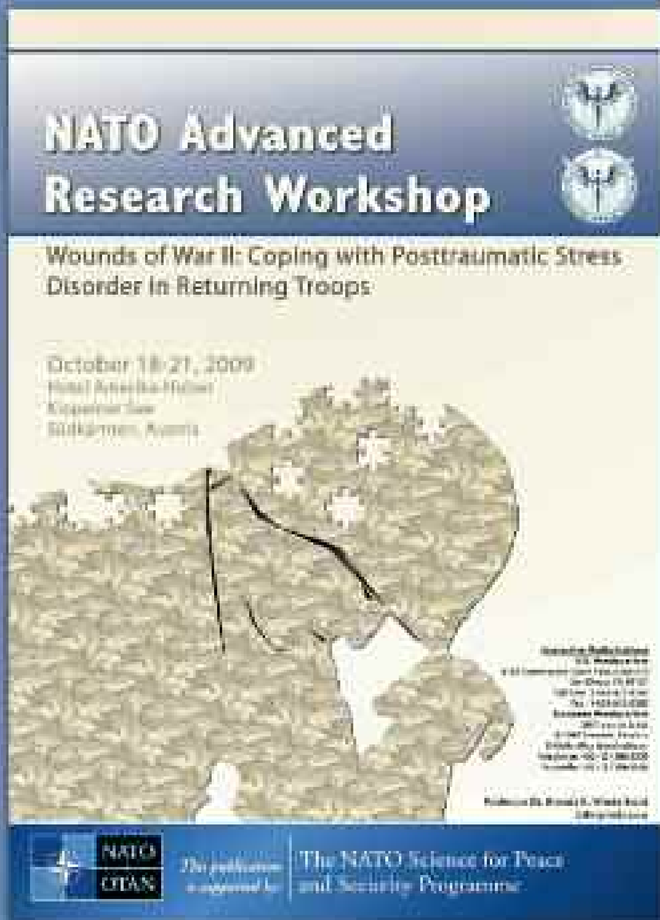

The post-conference book reflects the key topics discussed in the five sections at the workshop:

First Session – Vulnerability

Second Session – Diagnosis and Assessment

Third Session – Training and Treatment

Fourth Session – Technology-Based Training and Treatment

Fifth Session – PTSD and Comorbidity

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Second, The Impact of New Technologies
CT17 will investigate how new technologies are influencing behavior and society, for example, through healthy aging initiatives, positive and negative effects of social networking tools, and online gaming.

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