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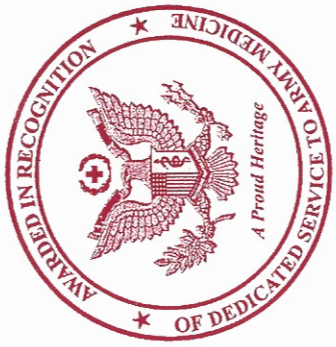

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U.S. ARMY MEDICAL DEPARTMENT
JOURNAL
A Professional Bulletin for the AMEDD Community

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Perspective

Major General George W. Weightman

This issue of our Journal is particularly exciting and I encourage our readers to take some time to see what our authors have to say. One of the big advantages of our Journal is that our articles are timely; it doesn't take 18-24 months for articles to make it from submission to publication. Although we may sacrifice some scientific rigor, I believe that is more than made up in having articles in our Journal that are relevant today and which can have an immediate impact on our medics and Soldiers' lives.

This issue is divided into two major topic areas. The majority of articles concern relevant topics related to our medical operations in OIF/OEF. The AMEDD's Institute of Surgical Research, located at Brooke Army Medical Center, has taken a lead role in the research of trauma, and many of the articles in this issue reflect their cutting edge research. This research has resulted in improved trauma training for providers at all levels, an Improved First Aid Kit being fielded today, and enhanced survivability of our wounded Soldiers on the battlefield. Other articles in this issue range from a discussion of tourniquets, hemostatic agents, medical ethics in detainee/POW care, Tactical Combat Casualty Care Courses, description of burn patient care from the point of injury to our Institute of Surgical Research (Burn Unit), and a comparison of Damage Control surgical capabilities between our Level IIa (FST) and Level III (CSH) facilities. We are learning a tremendous amount about trauma and patient care from our present day experiences and I think that you will quickly see that these articles are relevant, thought provoking, and timely.

The second major area covered in this issue is the management of the Medical Corps, highlighted by an article from the Medical Corps Chief, BG Eric Schoomaker, and his description of how they have utilized Balanced Scorecard methodology to integrate and synchronize the many aspects of MC management and education. An article by COL Jon Jaffin, the MC Branch Chief, takes some of the mystery out of the MC Officer assignment process, as he walks us through all of the processes that the Branch must consider before cutting your orders for your next PCS. These processes are nearly universal throughout the AMEDD and Army and regardless of your Branch, I think you will learn a lot about the process. Colonel John Powers, Chief of Graduate Medical Education, then follows with an excellent review of the entire Graduate Medical and continuing Medical Education processes. These programs are among the best in the world and this article will help you

understand how they work. Finally, Ms R. Clare Layton gives us an easily understandable overview of the complex process used to shape the size and composition of the AMEDD. Those of you who wondered how it was determined how many Soldiers in the various specialties are needed will be enlightened as Ms Layton lays out how the largest and most complicated health care system in the world forecasts and manages its personnel needs.

Colonel Chuck Callahan, recently returned from deployment, gives us some great pointers on leadership, and challenges us to embrace the concept of "officership" in his thought provoking article on "The Intentional Officer." He reminds us of our dual responsibility of being not only technically competent, but great officers as well. Colonel Mike Deaton lays out the pathway that led to the care of medical holdover patients and helps us all understand the present structure and expectations of care for this group of Soldiers who are a new beneficiary population since we started the GWOT. Lieutenant Colonel William Rice challenges us all to reduce practice variation, save money, and enhance the level of care through his business case analysis of Clinical Practice Guidelines (CPGs) in the care of asthmatic patients, in his article entitled "Reduction of Unwarranted Clinical Practice Variation in the AMEDD." The CPGs are a good thing and definitely here to stay and the sooner we can integrate them into our practices the quicker we can realize the financial and patient care benefits. Finally, our Journal has an article from Oleg Novikov and Raul-Allan Kiivet describing a universal challenge for all militaries, being the "Physical Fitness and Morbidity of Conscripts in the Estonian Defence Forces."

Using the U.S. Army's own APFT as a measurement tool, they document the improvement of their initial entry Soldiers through their vigorous physical training program. Good insights for us as we convert our "Gameboy and X Box" recruits into warriors.

Certainly this issue of your Journal highlights the breadth and complexity of what our mission is in the AMEDD: "To Conserve Fighting Strength". From peacetime health care, to Combat Health Support, to education and personnel management, to learning and working with other nation's militaries around the world, our AMEDD is leading the way, and like all great organizations, constantly learning lessons and improving. Thank you for your part in making this a huge success and I urge you to keep contributing to our Journal as we reshape and refine our future.

"Warrior Medics"

Managing the MC Through a Team Approach and the Balanced Scorecard

Brigadier General Eric B. Schoomaker

(BG Schoomaker is Chief, Medical Corps and the Commander, Southeast Regional Medical Command and Commander, Eisenhower Army Medical Center.)

As the Chief, Medical Corps (MC) Affairs, I am excited to have this opportunity to introduce an edition of the ***AMEDD Journal*** devoted entirely to the management and myriad activities of the Army MC. In laying out this series of Journal articles, COL Ney Gore, the MC Corps Specific Branch Proponent Officer (CSBPO) and I had a three-fold ambition. The first is to introduce our many partners and stakeholders in the AMEDD to the principal staff and the work of the MC Affairs office – the MC management team of MC and MS Officers and dedicated civilians who manage the near- and long-term processes and initiatives which are so vital to the success of our Corps and the AMEDD as a whole. Our second goal is to publicize a host of new initiatives undertaken by the Corps to align MC Officer and MC development with the needs of the AMEDD – to prepare MC Officers for their futures as physicians delivering state-of-the-art care in garrison and abroad and to serve as leaders in an Army at war and in transition. The final goal – embodied in the last series of articles – is to highlight issues, both clinical and operational, faced by the Corps and all of Army Medicine in the ongoing Global War On Terrorism (GWOT).

The recognized need for the development of a comprehensive management plan for the MC began with discussions with other AMEDD Corps Chiefs and their principal staffs, involved forging closer relationships with all principal staff offices and officers involved in MC activities and ultimately culminated in a seminal MC strategic planning conference in Feb 03. These MC "principals" – the Director of Medical Education at Office of The Surgeon General (OTSG), MC Branch Chief at Human Resources Command (HRCOM), the Chief of MC Consultants, MEDCOM, and others to be discussed later – met with MC Consultants and reviewed the functional activities of the MC Personnel Management Life Cycle. We could not have asked for a more talented array of senior leaders and highly dedicated civilians – many of whose names are synonymous with their programs in Army Medicine. They have performed magnificently! Strengths and weaknesses of the MC were identified in terms of the key areas of force structure (the size and composition of the MC), acquisition of MC Officers, distribution or assignment of Army doctors, MC Officer development, deployment of physicians in war and contingencies, compensation, sustainment and transition at retirement or departure from active duty. This evaluation allowed for the identification of the issues that the MC needed to address in order to fully support the AMEDD and Army. An early outgrowth of this review was the recognition that a consistent methodology was required to develop physicians who are able to meet the needs of the AMEDD as articulated in the AMEDD Balanced Scorecard (BSC). This dialogue led to the development of the MC's own BSC (Figure 1), approved by the Surgeon General in 2003. The key theme of the BSC strategy map is the identification of the kinds of physicians needed for the current and future AMEDD and the methods that are needed to develop these physicians. Five overlapping, highly complementary "species" of MC Officers were identified as goals for the Corps: those who are clinically proficient; are outstanding leaders; are successful executives; are operationally effective; and are world-class scientists and scholars (identified as C-1 through C-5 on the BSC Strategy Map). Figure 2 outlines the objective statements in support of the development of these physicians and the current measures used to determine our progress.

Similarly, the Corps Affairs Office management team was task force organized to support the implementation of the MC BSC and was aligned with the functional activities of the Personnel Management Life Cycle (Figure 3). A widely dispersed "working group" of uniformed officers – MC, MS, and other – and civilian specialists assigned to a variety of

Department of the Army (OTSG) and MEDCOM staff, as well as other key Major Commands (HRCOM; U.S. Army Recruiting Command – USAREC), these principal staff officers are largely responsible for the ongoing policies and processes which ensure the success of the MC – and through it, the entire AMEDD. Using weekly teleconferences, frequent ad hoc conferences and working groups and the power of electronic communications, these principals have leveraged the experience and relationships of our long Corps history into a series of great advances in the MC over the past 2 years.

The MC management team has the responsibility to provide the means to achieve the goals of the MC BSC and to track the progress of the various initiatives which have been developed. In addition, the management team is responsible for re-evaluating the measures of the scorecard and redirecting efforts when these initiatives have proven either successful or fruitless. "Internal Processes" are aimed at leveraging existing MEDCOM, Army and Department of Defense (DOD) health devices; these are supported by "Learning and Growth" initiatives aimed at training and education of the Corps and are highlighted and described by articles in this edition of the ***AMEDD Journal*** from the Medical Education Directorate, OTSG, Quality Management Division of Health Policy and Services in MEDCOM, the MC Branch of HRCOM and the AMEDD Personnel Proponency Directorate of the AMEDD Center and School.

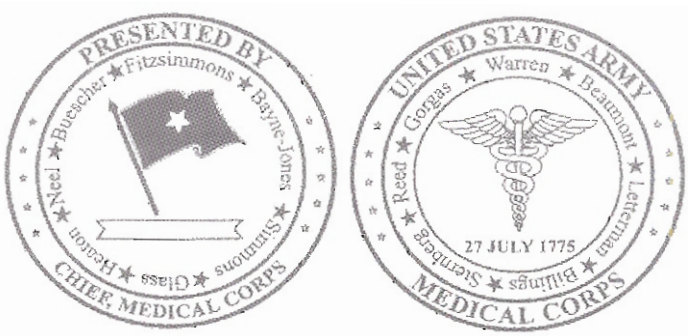
In addition to the initiatives highlighted by these articles, other significant initiatives have been instituted and successes realized. A MC Affairs Office budget was developed to secure resources needed to operate, educate, and train the Corps in a variety of critical challenges. These include the redesign of the Military Unique Curriculum, the development of an MC Consultant training program, and holding tri-annual MC Consultant meetings in conjunction with other large corporate conferences. Closer working relations among MC management team principals and MC Consultants permitted us to redesign the AMEDD officer distribution process (ODP) with other key "stakeholder" AMEDD corps. This new ODP realizes the vision of our former Surgeon General, LTG (Ret) Peake to integrate all clinical officers into the ODP process to provide complementary non-MC AMEDD officer assignments and to distribute MC officers and clinical teams in accordance with business models based upon clinical demand, military treatment faculties (MTF) productivity, and the unique health care market characteristics of each MTF and Regional Medical Command. Finally, the management team has worked on the application of the needs of the AMEDD in support of the GWOT by "rightsizing the MC. This employs a DOD wartime sizing model which drives the force modeling process and the subsequent reconciliation with graduate medical education (GME) trainee starts.

The MC Officer life cycle model (Figure 4) has been redesigned to better reflect the many career educational and professional opportunities which are available for MC Officers and to further define the current military education requirements. This MC Officer life cycle model has come to provide the guidelines that are being followed as the MC portion of the AMEDD Officer Basic course has been revised to better serve the needs of the MC in meeting AMEDD strategic goals. Likewise, the life cycle model is being used as the MC management team provides input to the AMEDD Center and School as the new Captain's Career Course (formerly known as the Officer Advanced Course) is being developed.

One final critical category of initiatives involved better communications with the MC at large and the remainder of the AMEDD. Strategies in this important area include the ongoing migration of the MC web page to Army Knowledge Online (AKO), the development of a variety of online GME opportunities for MC officers, the placement of the Emergency War Surgery Manual and Borden Institute Textbook of Military Medicine on AKO and exploiting every opportunity to meet, speak, or write to members of the Corps – as illustrated by this valuable opportunity afforded by our own ***AMEDD Journal***.

The current issue of the ***AMEDD Journal*** highlights only a few of the many issues which the MC is addressing as we critically examine and re-evaluate our role in the dynamic and changing environment of the present: partnering with our sister AMEDD corps to ensure that Army Medicine remains a leader in American health promotion and health care delivery; our role in joint operations; and our critical need to support a Nation and an Army at War. Many issues remain to be addressed – the priorities and missions of today will not be those of tomorrow. The intent of the current design and management of today's Medical Corps allows for that eventuality.

On behalf of the Army MC, I want to thank all those who made this edition possible. I welcome your contributions to our collective efforts described in this issue and your ongoing suggestions and dialogue.



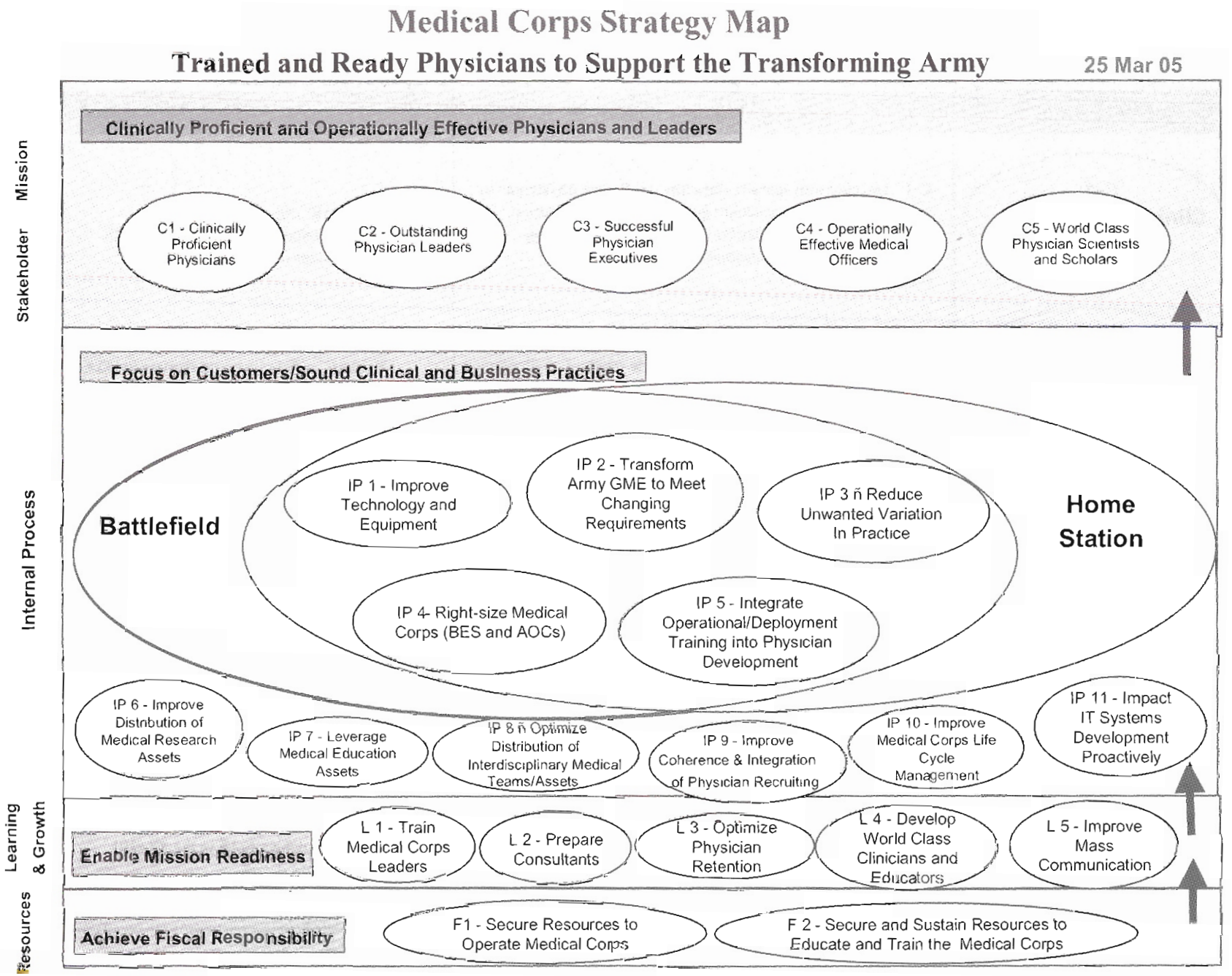

Medical Corps Strategy Map
Trained and Ready Physicians to Support the Transforming Army
25 Mar 05
Mission
Stakeholder
Clinically Proficient and Operationally Effective Physicians and Leaders
C1 - Clinically Proficient Physicians
C2 - Outstanding Physician Leaders
C3 - Successful Physician Executives
C4 - Operationally Effective Medical Officers
C5 - World Class Physician Scientists and Scholars
Internal Process
Focus on Customers/Sound Clinical and Business Practices
Battlefield
Home Station
IP 1 - Improve Technology and Equipment
IP 2 - Transform Army GME to Meet Changing Requirements
IP 3 ñ Reduce Unwanted Variation In Practice
IP 4- Right-size Medical Corps (BES and AOCs)
IP 5 - Integrate Operational/Deployment Training into Physician Development
IP 6 - Improve Distribution of Medical Research Assets
IP 7 - Leverage Medical Education Assets
IP 8 ñ Optimize Distribution of Interdisciplinary Medical Teams/Assets
IP 9 - Improve Coherence & Integration of Physician Recruiting
IP 10 - Improve Medical Corps Life Cycle Management
IP 11 - Impact IT Systems Development Proactively
Learning & Growth
Enable Mission Readiness
L 1 - Train Medical Corps Leaders
L 2 - Prepare Consultants
L 3 - Optimize Physician Retention
L 4 - Develop World Class Clinicians and Educators
L 5 - Improve Mass Communication
Resources
Achieve Fiscal Responsibility
F1 - Secure Resources to Operate Medical Corps
F 2 - Secure and Sustain Resources to Educate and Train the Medical Corps

Fig 1.

GOAL 1: Clinically Proficient and Operationally Effective Physician Leaders

Strategic Objective	Objective Statement	Measures
C-1 Clinically Proficient Physicians	**C-1 Develop and sustain clinically proficient physicians** by providing them with excellent graduate medical education program opportunities, access to all essential continuing medical education, and meaningful clinical practice experiences.	C-1: % of MC officers who re-certify # of Distributive Learning (DL) CME Programs made available on line.
C-2 Outstanding Physician Leaders	**C-2 Produce outstanding physician leaders** by providing effective leader training programs, a wide range of challenging assignments, and mentoring.	C-2: % of War College attendees who are selected % of MC officers who participate in O5A
C-3 Successful Physician Executives	**C-3 Develop successful physician executives** by providing effective and efficient physician-specific executive skills education & training through career management which features diversity of managerial, staff and leader assignments in healthcare facilities and command headquarters.	C-3: # of MC O5/O6s completing Joint Executive Skills Competencies who are subsequently assigned to an executive position. # of Joint Executive Skills held by Department/ Service Chiefs
C-4 Operationally Effective Medical Officers	**C-4 Develop operationally proficient medical officers** by incorporating operational skills in every aspect of physician education & training; through career management which features a diversity of assignments in operational medical environments and units; and by ensuring command and military educational selection of highly competitive MC officers.	C-4: % of MC successfully completing OBC within 1st year of active service.. % of MC with an operational assignment before selection to COL.
C-5 World Class Physician Scientists and Scholars	**C-5 Select and develop world class physician scientists and scholars** by enhancing education and applied military medical research and academics; by selecting MC officers with research and academic interests and skills; and by career management of these officers which feature a diversity of assignments in academic medical and research & developmental billets	C-5: # MC led studies published in a national journal. # MC researchers holding the 8Z skill identifier

Fig 2.

PERSONNEL MANAGEMENT LIFE-CYCLE FUNCTIONS

Chief, MC-BG Schoomaker & CSBPO-COL Ney Gore

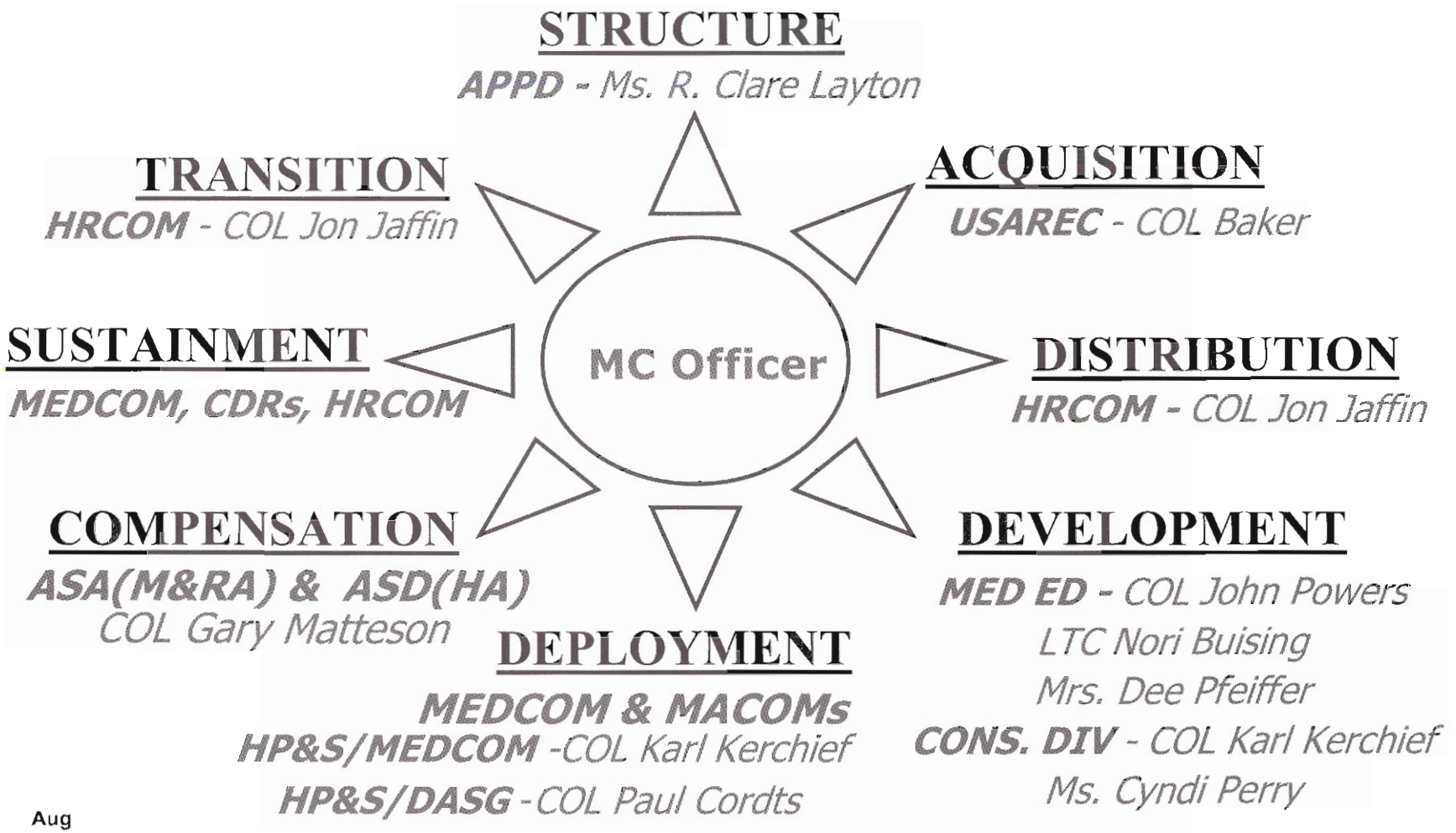


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Fig 3.

Life Cycle Model
Medical Corps (Active Component)

Years of Service Promotion	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 CPT · MAJ · LTC · COL
Military Training	OBC · Captain's Career Course · ILE * · Senior Service College CBRNE Short Course ** · Combat Casualty Mgt
Professional Development	FYGME: Residency · Fellowships/MPH · Subspecialty Board License · Board Certification *** · MBA · Advanced Science Degree Continuing Medical Education
Clinical/Operational Assignments * **	TOE/TDA Physician · BN/BDE/DIV Surg · Staff/CMD Assignments DCCS · Commander Utilization Tour · MEDDAC Staff · MEDCEN Staff/Dept Chief CO CDR/Clinic OIC · DCCS
Education * **	Utilization Tour · Teaching Staff · Residency Dir · Dir Med Ed/USUHS Faculty
Research * **	Utilization Tour · Research Asst · Product Mgr/Div Ch · Dept Ch/Area Dir/CDR · MRDC CDR

- * Medical Corps officers attain MEL B when they successfully complete ILE (Common Core plus Executive Skills Course).
- ** Chemical, Biological, Radiological, Nuclear, Explosive (CBRNE) Short Courses include: Advanced Trauma Management, Advanced Trauma Life Support, Medical Management of Chemical and Biological Casualties (MCBC), and Medical Effects of Ionizing Radiation (MEIR).
- *** The majority of assignments integrate more than one of the areas listed under the operational heading. These assignments are not intended to indicate specific tracts that a Medical Corps officer should follow in career progression; one should expect a variety of challenging assignments commensurate with rank and experience.

Fig 4.

The AMEDD Personnel Proponency Directorate/The Structure Models

R. Clare Layton†

Of the four different types of proponency, (**note 1**) Personnel Proponency is probably the least known and least understood. The Surgeon General (TSG) is the Army Medical Department (AMEDD) Personnel Proponent and is responsible for developing personnel management policies for Department of the Army Deputy Chief of Staff for Personnel (DA G1) approval. The AMEDD Personnel Proponent Directorate (APPD), along with the AMEDD Proponent Steering Committee and the proponent advisor network, assist TSG in his role as personnel proponent. The framework for Personnel Proponency is the eight personnel life cycle management functions: structure, acquisition, distribution, development, deployment, compensation, sustainment, and transition.

Although the framework for APPD activity consists of all eight personnel life cycle management functions, the primary involvement is structure analysis. The APPD works on the macro level and plans structure for the out-years. In contrast to Human Resources Command that manages the distributable force (current inventory), this macro outlook encompasses both future authorizations for AMEDD in training and the future authorizations for fully qualified AMEDD officers, enlisted, and civilians. The difference is "spaces vs faces."

Factors used in determining the correct structure for the AMEDD are many and they are often conflicting – Army Transformation, Base Realignment and Closure, changing conflict scenarios and casualty projections, changes in health care deliver philosophy, Make-Buy initiatives, civilian conversions, roles and capabilities of the Reserve Components, location and physical constraints of Medical Treatment Facilities (MTFs), availability of health care options for beneficiaries, Roles and Mission of the Army, and beneficiary expectations.

Three major models are used in APPD structure analysis. They are the Department of Defense Sizing Model (DODSM), the Total AMEDD Personnel Structure Model (TAPSM), and the Corps Force Models.

As a result of Section 733 of the National Defense Authorization Act for Fiscal Year 1992 and 1993, all services developed a method of justifying and analyzing their medical requirements. For the Army, it was the DODSM. This model determines the Active Component Total Medical Readiness Requirements. Requirements, rather than authorizations, are used because the AMEDD has too few professional Table of Organization and Equipment (TOE) authorizations and fills to required levels via Professional Officer Filler System (PROFIS). The following components comprise the DODSM:

A. Wartime Data – personnel required in the wartime theater to care for casualties. Categories under this variable are:

• Medical TOE Structure derived from the most recent Total Army Analysis (TAA) 2011 (TAA 11) (**note 2**).

• Nonmedical TOE units.

• Non-MTF Table of Distribution and Allowances (TDA)/TDA Generating Force. For example: OTSG, HQ MEDCOM, Army Medical Department Center and School, Center for Health Promotion and Preventive Medicine, and Medical Research and Materiel Command.

•. OPTEMPO Adjustments. This is a new variable, requested by TSG, which is based on MEDCOMs data maintained in AMEDD Resource Tasking System from 1 Jan 02 to 31 Dec 04.

• Active Component/Reserve Component PROFIS – only TOE units.

• Casualty Replacement – to maintain continuity as Active Duty PROFIS health care providers deploy and U.S. Army Reserve (USAR) Soldiers report.

• DOD Veterinary Mission as the Army is the DOD executive agent for veterinary services provided to all services.

B. Day-to-Day Operational Medical Specialties – personnel needed in peacetime where only an active duty military personnel will do, either to develop a trained officer and enlisted force or because it is more economical to staff with a military health care provider.

• Outside Continental United States – Defense Health Program forward deployed.

• Isolated Continental United States – Fort Irwin, CA.

• Proficiency Rotation – rotation back to CONUS MTFs in order to maintain medical skills proficiency.

C. Medical Operational Readiness Requirements (ORR) – the sum of wartime requirements and day-to-day operational requirements, A+B=C.

D. Sustainment – Requirements necessary to permit a continuous flow of qualified personnel into ORR specified jobs as people leave the Services by attrition or move to a higher skill level. Sustainment variables include:

• Officer Transients, Holdees, and Students. For officer, transients and holdees, a factor of the totals of wartime structure, operational structure, and Graduate Medical Education (GME)/ specialty trainers. For the students, a factor or the total of students in the total structure plus CONUS casualty reception plus GME/specialty trainers.

• Enlisted Trainees: consolidated from Amy Training Requirements and Resources System (ATRRS) data.

• Enlisted Students: consolidated from ATRRS data.

• GME: the largest part of the sustainment category.

• GME Trainers.

• Specialty Trainers are the small number of specific trainers who are responsible for conducting the specialty training.

• Uniformed Services University of Health Sciences students – 252 students per year.

By adding the total of the Medical ORR and the Sustainment piece, the DODSM calculates total requirements for each of the AMEDD specialties.

The DODSM feeds into the TAPSM. The TAPSM is an automated process which links several force models to establish personnel assets required to accomplish each of the AMEDD missions at varying workload levels. It is comprised of three major elements. The first element is TOE Combat Health Support that is based on current TAA structure, disease nonbattle injury and casualty rates, evacuation policy, and Army Transformation. The second element is Command Control Support Infrastructure that are the requirements to both manage and support the AMEDD in command and control organizations (both medical and nonmedical), to perform the medical research and material mission; to participate in health promotion and preventative medicine; and to perform the Department of Defense veterinary mission. This element is based on Command Grade Allocations (CGA) and notional TDAs for proposed units. The third element is the Sustaining Base Health Care Services (SBHCS) that includes delivery of health care to each beneficiary category in each catchment area worldwide. Historically, MEDCOM used the Automated Staffing Assessment Model to calculate the Full Time Requirements and used Business Case Analysis to determine this portion of the model.

The sum of these three elements gives the total unadjusted structure for an AMEDD specialty. This total is first decreased by the application of PROFIS. A further reduction by determining the amount of SBHCS (peacetime health care) being provided by Borrowed Military Manpower (BMM), and by reducing the SBHCS by the BMM. This then determines the Adjusted Structure Authorizations. Again, by adding the Structure and Training piece to the Adjusted Structure Authorizations, the TAPSM determines the Budgeted End Strength for each of the AMEDD specialties.

TOTAL AMEDD PERSONNEL STRUCTURE MODEL (TAPSM)

65D Physician Assistant
Structure and Force Structure Support

	CHS	C2/SI	SBHCS		TOTAL
TOTAL STRUCTURE PRIOR TO ADJUSTMENT	421	23	223	=	667
PROFIS ADJ (421-42)	379				
BMM ADJ % (379 x 27.6%)			105		
ADJUSTED STRUCTURE	379	23	118	=	520
SUSTAINMENT & TRAINING (520 x 13%)	68				
FINAL END STRENGTH			588		

The APPD maintains an OFM for each of the AMEDD specialties. These are based on the wartime requirements as determined by the DODSM and by TAPSM, on input from the MACOMs that is received during the annual (October) CGA Conference, and the last 3 years of continuation rates for the specialty. The OFM identifies the ideal specialty mix of fully qualified and those in-training. The model determines the needed inputs to sustain the mix in a steady state assuming a 30-year life cycle. For the Medical Corps, the OFM input numbers become part of the GME School year plan. Collectively, they form the basis for recommending promotion rates, training starts, and recruiting/acquisition goals and sustainment policies.

These models are dynamic. They are not static, but change and evolve as their individual parts change – either by the transforming Army, by changing conflict scenarios, by mandating new Make/Buy initiatives, or by changing any of the other factors. It is through the use of these dynamic models that APPD assists TSG, the AMEDD personnel proponent, in maintaining the integrity of the force by considering the size, training, career field management, and all other variables that may impact AMEDD personnel and structure.

The APPD was originally established in 1983 to be TSG study cell for enlisted personnel issues. The Officer Division was established in 1988. In the Officer Division, Active Duty officers represent five of the AMEDD Officer Corps. Since 1988, a civilian has represented the MC. The MC representative also serves as a member of the Chief, MC Affairs management team. A USAR/ANG cell within the Officer Division was formed in 2002. The Office of the Director, Civilian Proponent Division, Force Structure, and Data Systems Division complete the current organization (**note 3**). A Memorandum of Understanding involving TSG and the Commander, AMEDD Center and School, formally established this organizational structure and the functions.

There is no other office or activity with the AMEDD that deals with the breadth and depth of the total AMEDD personnel management functions like the APPD. It is the link between the AMEDD and the Office of the Deputy Chief of Staff for Personnel that is building tomorrow's AMEDD.

Notes:

(1) The four types of proponency are:

• Functional Proponent – TSG is the functional proponent for worldwide health care.

• Branch Proponent – Corps Chiefs, the Chiefs of Branch Proponency, and the Commander, AMEDD Center and School.

• Specified Proponent – Commander, AMEDD Center and School, is the specified proponent for organizational design for Theater Medical Services and Logistics.

• Personnel Proponent – TSG.

(2) TAA is a resource sensitive process that executes the decision of the OSD, directives and initiatives of the Joint Staff, and the Army Planning, Programming, Budgeting, and Execution System. The TAA serves as the bridge between OSD/JS guidance and the Army force structure planning and program building processes, balancing the Army's force structure requirement (manpower and equipment) against available and planned resources.

(3) To learn more about the activities of the divisions of APPD, visit the web site at **http://appd.amedd.army.mil**.

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Change to the Journal Editorial Board

Sergeant Major Dennis S. Wheeler has replaced SGM Alan E. Graykowski. Sergeant Major Wheeler is assigned as the Corps Specific Branch Proponent Officer, Enlisted Corps, U.S. Army Medical Command.

Army Medical Department Continuum of Medical Education

COL John M. Powers, MC, USA†

The F. Edward Hebert Armed Forces Health Professions Scholarship Program (HPSP) may very well be the starting point for many of our Army health care professionals. As a first step for college graduates desiring a medical degree, HPSP is the beginning phase for the Army's Graduate Medical Education (GME) and Continuing Medical Education (CME) programs. The Army's scholarship program currently sponsors over 1,500 students seeking various health care degrees and provides over 77 per cent of the active duty Army physicians. It is one of the most generous and comprehensive scholarships offered for students seeking to be Physicians, as well as Dentists, Veterinarians, Optometrists, Clinical Psychologists, or Nurse Anesthetists desiring to serve their country in a military medical career. Applications are made through the U.S. Army Recruiting Command, which also conducts competitive selection boards. If qualified and selected, full-tuition scholarships plus a monthly allowance (stipend) is provided and recipients must agree to a period of military service.

To qualify for participation in the HPSP, an individual must:

- Be a U.S. citizen;
- Be enrolled in or accepted for admission to an accredited course of study in the United States or Puerto Rico;
- Sign a service agreement;
- Qualify for appointment as a commissioned officer in the U.S. Army Reserve;

Once accepted, the Army HPSP will pay for required expenses, fees and tuition for up to 4 years, plus a monthly stipend (currently $1,235.00 per month). An HPSP recipient is commissioned as a Second Lieutenant in the Army Reserve and required to serve 6 weeks (45 days) each year on active duty for training (ADT). Recipients are also required to attend the Army Medical Department (AMEDD) Basic Officer Leadership Course when attendance does not compromise their studies. In most cases, the active duty time is spent in an Army military medical facility where the opportunity to learn and work with top Army health care professionals is a special bonus that is long remembered in a medical career. During their exposure to Army medicine, a scholarship participant will learn about Army health care first-hand and get practical experience in various disciplines while earning 45 days of military pay as an Army officer.

The 6-week period of annual ADT is an important and integral part of an Army officer's professional military education and development. During ADT, the scholarship participant could be assigned to work in an Army facility near the school or in one of the Army's world-renowned health care facilities. In any case, the future Army health care officer is exposed to a medical education system that excels at training people for rewarding careers in health care, offers immediate hands-on experience, and unique specialized training and assignment opportunities that are not normally found anywhere else. In addition, if qualified, there may be additional incentive and special pay depending on the specific specialty area chosen for their professional career.

After graduation, the Army health care professional will become a member of the most comprehensive and dynamic health care organizations in the world – the Army Health Care Team. Its mission is to support America's Army at home and abroad. The Army Health Care Team is comprised of six corps: the Medical Corps (MC), the Medical Service Corps, Medical Specialists Corps, the Dental Corps, the Nurse Corps, and the Veterinary Corps. Together, these Corps offer more diversity and learning experiences than can be found in any other health care system.

The AMEDD Health Care Team is fully focused and committed to supporting the efforts of the Army's medical education programs. From the scholarship participant at the medical treatment facility or installation to the resident or fellow, the training of our health care professional Soldier is a transitional and seamless process that can only be improved through dedication and commitment from all that are involved in the process of developing the best AMEDD Soldier possible.

The GME is defined as that education beyond completion of medical school which qualifies the physician for the independent practice of medicine, generally in a specialty. Since it is a prerequisite for licensure and practice privileges, GME must be viewed as a mandatory, rather than an elective, experience for all physicians. Additionally, since 95% of graduating medical students pursue specialty training, GME participation is clearly a national standard with which compliance is expected.

The Army GME program is directly tied to two mandates: (1) The need to provide a supply of qualified physicians to

serve in medical units during mobilization for war (readiness mission) and (2) the need to provide high quality, cost-effective health care to military beneficiaries during peacetime (health care benefits delivery mission). The AMEDD considers GME to be absolutely critical to the maintenance of quality health care. The standards, scope of practice, and professionalism required by the teaching program accreditation bodies and supporting clinical investigations activities, directly contribute to the high quality of health care provided in the Army. Vigorous GME programs ensure state of the art care for combat casualties and are key to the recruitment and retention of quality physicians and to the survival of national medical assets such as the Army Burn and Trauma Center at Fort Sam Houston.

As was demonstrated during Operations Desert Shield/ Storm and now during Operations Iraqi Freedom and Enduring Freedom, the physician graduates of our GME programs have proven themselves to be trained, competent providers, able to function anywhere operationally or within the peacetime mission. Their in-theater performance combined with the support of staff physicians, faculty, and trainees at our casualty receiving hospitals gives the AMEDD a continuous chain of combat casualty care that has resulted in medical successes that have been unparalleled in previous endeavors. With additional incorporation of telemedicine, state of the art care can be further projected from our academic Medical Centers to front line casualties as has been previously demonstrated in Bosnia and Somalia as well as current operations. Maintaining such critical wartime skills during peacetime is particularly challenging. State of the art Medical Centers (MEDCENs) with a variety of training programs and a diverse patient population, to include retired beneficiaries and their families, are absolutely essential if clinicians are to acquire and maintain skills crucial to combat casualty care in wartime.

The determination of the number of trainees, mix of specialties, and number of trainees within those specialties' GME programs is a complex process that addresses force structure considerations first, then regional needs and cost-effectiveness considerations, in conjunction with accreditation, licensure, and similar professional requirements. Currently, there are 130 GME programs in the Army – 6-transitional internships, 71 residencies (3 combined, 22 joint), and 53 fellowships (22 joint). Not counting the 17 programs still awaiting final accreditation decisions from site visits conducted in 2004, 55% of Army GME programs have received full accreditation status for the maximum period of 5 years, 23% full accreditation status for a period of 4 years, 15 per cent percent full accreditation status for a period of 3 years, and 3% full accreditation for a period of 2 years or less. There has recently been concern expressed by program directors that accreditation cycle length may be shortening over the past few years. However, a review of accreditation decisions rendered over the past 2 years demonstrates that the percentage of programs receiving either the maximal accreditation of 5 years or 3 years, full accreditation has not changed. There has been a slight decrease in the percentage of programs being awarded full accreditation for 4 years with a proportional increase in the percentage of programs receiving full accreditation for a period of 2 years or less. But until all the 17 pending decisions are received, it is difficult to say anything more definitive.

Army GME offers MC Officers the opportunity for their professional satisfaction, career advancement, and retention. At the current time, a total of 1,369 MC Officers are in training in 11 Army teaching hospitals or other Service facilities, and 88 are in Army sponsored civilian training. An additional 226 trainees are in civilian training programs in a nonfunded (delay) status. Army GME training is available in 25 residency specialties, while over 100 subspecialty choices are available at the fellowship level. The determination each year of the exact number of available positions and locations is determined by a GME school year plan approved by the Army Surgeon General. The school year plan is disseminated in mid July for GME training to begin the following July. The application process for GME is submitted via a web-base program. When beginning the application process, applicable policies and established deadlines are provided to the potential applicant via the GME website: **http://www.mods.army.mil/ MedicalEducation/**. By logging on, one can access a wealth of information concerning Army GME that expands the summary information presented here.

There has never been a time when Army GME has not faced challenges, but it has always been equal to the task; the future will be no different. The only certainty is that the training environment and its demands will not remain static, but will continue to change. Developing the flexibility to respond to such changes, even if unanticipated, will be the best strategy for ensuring continued longevity and excellence for Army GME. This past year has seen a deliberate proactive change initiated to deal with HPSP obligors who have encountered academic challenges which, without immediate intervention, could compromise their future ability to contribute to the AMEDD. Such individuals, when identified, have preferentially been selected for training in military programs so that any academic difficulties can be remediated as expeditiously as possible. This policy has resulted in a slightly larger intern class and increased demands on training program faculty, but in the long run, is the absolute right thing to do. There has also been considerable effort expended to develop a policy for limited deployment of program directors (PDs) which will allow Accreditation Council on Graduate Medical Education (ACGME) standards to still be met by training programs, but allow PDs to both participate in operational mission requirements similar to those of their specialty colleagues and bring back clinical and

operational lessons learned which can then be incorporated into training curriculums. The ACGME feedback to a draft policy has been supportive and a formal incorporation of such a policy into the current deployment policy is being finalized. Finally, the ability to incorporate the distance learning modules of the revised MC AMEDD Captains' Career Course into the curriculum of all Army GME residency training programs is currently under discussion. The goal is to incorporate standardized military unique curriculum requirements with standardized transition to practice requirements and determine what remaining requirements would be necessary to round out the Advanced Course Curriculum in a distance learning format so that the follow on in-residence portion of the course could be markedly reduced. Such changes could consolidate training, reduce duplication/repetition, and enhance career advancement.

Army GME has enjoyed protracted success as evidenced by the 96% first time pass rate of its graduates on specialty certification board examinations. Given the talent of our applicant pool, the expertise and dedication of our faculty and program directors, and the support of our leadership, there is every expectation for such success to continue.

Following completion of GME, the next crucial stage in physician development is CME. The purpose of CME is to facilitate self-assessment and lifelong learning by physicians so that their practices may reflect the best medical care for their patients. Optimal patient outcomes are linked to developing competent physicians, so the goal of CME is to help physicians improve their performance in practice. The responsibility for fulfilling this goal lies with all of us involved in CME – U.S. Army Medical Command (MEDCOM) as the accredited provider, MEDCEN/Medical Department Activity (MEDDAC) CME directors and planners as the activity/meeting planners, faculty and speakers, educators, supporters, and the physician learners themselves.

The MEDCOMs CME office is an integral part of the Medical Education Directorate and the final link in the medical education continuum from student to fully-trained physician to practicing professional. At its last survey review, the Army MEDCOM received "Accreditation with Commendation" by the Accreditation Council for Continuing Medical Education (ACCME) for a period of 6 years, from Jul 03 to Jul 09. As we move forward towards our next accreditation, we will be seeking out best solutions for important issues in the CME community, especially as they impact Army physicians. It is essential that CME be:

- Linked to Quality and Safety
- Effective in improving practice
- Independent of commercial interests
- Based on valid content

First and foremost, we will be updating our policies to conform to the ACCMEs 2004 updated Standards for Commercial Support of CME which will be implemented starting in May 2005. These standards reflect the belief of the ACCME that if the influence of commercial interests is eliminated from the planning and production of CME, then the CME will be free of commercial bias, and thereby ensure patient safety. This requires that Army MEDCEN/MEDDAC jointly sponsor with the responsibility for all aspects of the planning and implementation of CME activities. We will need to make fair and balanced decisions regarding content, faculty, and management of funds, and we will need to identify and resolve conflicts of interest whenever they arise during the planning of an activity.

Another goal of CME providers, aimed at linking CME to quality health care, is to develop CME that is based on valid content. When we put our accreditation statement on a CME activity, it should indicate that we are promoting recommendations that are either evidence-based or fall within the body of knowledge and skills generally recognized and accepted by the profession. The CME community intends to be accountable to the public and the medical profession to ensure we are not presenting activities that promote treatments that are known to be ineffective or that have risks that outweigh the benefits. Evidence-based medicine bases medical decision-making on concepts proven by reproducible, scientifically conducted studies. The American Academy of Family Physicians, an accredited CME provider, has taken the lead in promoting evidence-based CME by putting it in its own category of CME, allowing the participating physicians to be more educated consumers when selecting CME activities.

Performance Improvement (PI) initiatives have emerged as an important mechanism for physicians and other health care providers to systematically assess their practice, and identify areas where education can effect changes in clinical practice that result in improved patient care and better patient outcomes. The CME is also committed to contributing to improvement in physician practice and performance, and can provide crucial support to PI initiatives by providing background information so that physicians understand the evidence behind the performance measures. The American Medical Association's (AMA) Division of Continuing Physician Professional Development conducted a PI Pilot Project over the last 3 years, which culminated in their approving new rules in Sep 04 governing how PI activities could be conducted for AMA Physician Recognition Award (PRA) category 1 credit. Physicians may be awarded incremental AMA PRA category 1 credit for completing each successive stage of a performance improvement activity:

Stage A: Learning from current practice performance assessment (5 credits)

Stage B: Learning from the application of performance improvement to patient care (5 credits)

Stage C: Learning from the evaluation of the performance improvement effort (5 credits)

An additional 5 credits (for a maximum of 20 credits) can be awarded for completing, in sequence, all three stages of a structured PI activity, as the best learning is associated with completing a well-designed PI activity. Further information on the AMA PRA Rules for PI activities is found at **http://www.ama-assn.org/ama/pub/category/13151.html**.

Organizations in medical education such as the American Board of Medical Specialties, the ACGME, and the American Osteopathic Association are actively addressing issues of competency-based education, specialty-specific core curricula, maintenance of licensure, and maintenance of certification. As they work towards greater alignment of their goals, CME should continue to support these goals by providing quality, unbiased, educational activities based on sound medical evidence. Our CME programs are committed to providing Army physicians-in-training with a Military Unique Curriculum (MUC) in addition to their specialty-specific curricula. As we continue to serve a nation at war, we must adapt the MUC to meet the needs of our physicians deploying to various theatres of operation. Over the next couple of years, all Army physicians will complete an online clinician course on Chemical, Biological, Radiological, Nuclear and (High Yield) Explosives Emergency Medical Preparedness and Response. In the next few months, the MEDCOM CME office will report the results of the Deployed Physicians Needs Assessment (DPNA) which assessed the educational needs of deployed Army physicians for various clinical topics, most with an operational focus. The intent of the study is to share the information and feedback from deployed physicians with Army CME directors and planners, specialty consultants, and other Army medical educators who plan local and distance learning CME activities, Postgraduate Professional Short Course Programs, and the MUC. The results of the DPNA will hopefully enhance the development of relevant training and CME for Army physicians during active and future operational theatres.

For those who are interested in planning and conducting a CME activity in Army facilities, our office would be happy to assist in ensuring the activity conforms to MEDCOM and ACCME policies. It would be helpful to have identified the need for the topic, the target audience, and the learning objectives prior to contacting us. Our website is also a good resource for our policies and current CME offerings: **https://conus.mods.army.mil/emeweb/secured/**. As history has shown, it will be the talent and creativity of our AMEDD staff that will inspire our medical education enterprise to meet the challenges of health care in the 21st century.

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The Medical Corps Assignment Process

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Introduction

One of the most anxiety-provoking processes throughout a military career is the assignment process. Everyone has heard horror stories of last minute changes and individuals assigned to their last choices. In this article, we will help reduce some of that anxiety by detailing how the assignment process works for the Medical Corps (MC). This article will discuss the roles of MC Branch, the Office of The Surgeon General (OTSG), the consultants to the Surgeon General, and the Officer Distribution Plan (ODP) in the process. It will also provide information on what each officer can do to improve their own chances of getting the assignment of their choice.

All assignments start with the Army Medical Department (AMEDD) Personnel Proponency Directorate. Their role is to provide technical advice to the U.S. Army G-1 to come up with the appropriate authorizations for all the AMEDD branches in the Army's Objective Force. The end result is a manning document known as the Personnel Manning Authorization Document. This document provides the authorizations against which all assignments are made. It is important to remember that the presence of an authorization (or a space) does not necessarily mean that an officer will be assigned to that position (a face).

The AMEDD Officer Distribution Plan

The next step in the process is to make a corporate decision as to which of these authorized spaces will get filled. The Surgeon General is responsible for the distribution of all AMEDD officers. He must fulfill the Chief of Staff of the Army's priorities of fill while meeting the requirements of the medical mission. The procedure that aligns these priorities is the ODP process. The ODP is designed to ensure the best utilization of MC Officers across the MEDCOM and other commands.

The ODP applies only to the distribution of officers controlled by the MEDCOM commander. The Army staffs Modification Table of Organization and Equipment (MTOE) units at 100%. In the AMEDD, this means that each authorized MTOE slot is either filled with an assigned officer or MEDCOM fills it through the Professional Filler System. The ODP conference discusses personnel assigned to MTOE units, but does not have control over their fill.

The process starts in the summer, after the summer permanent change of station moves are complete. The consultants contact the physicians in their specialty to determine who will leave the service, who wants to move, and who wants to apply for Graduate Medical Education (GME). They work closely with the career managers in MC Branch to determine what the distributable inventory of physicians will be for the next assignment cycle. The distributable population is those physicians available for assignment into clinical positions in that specialty. It is calculated from the total inventory of trained physicians in that specialty who are not retiring or leaving the Army minus those officers who are in GME, administrative (60A or 05A) positions and those in 62B (field surgeon) and 61N (flight surgeon) positions.

The next step for the consultant is to match this number against the known vacancies. This creates a "straw man" for a proposed distribution. This initial distribution plan is entered into the Medical Occupational Data System (MODS) by MC Branch. The distributable inventory is almost always less than the number of positions available. The ODP process attempts to find the most mission-effective distribution for these scarce assets.

After the consultant creates the straw man, the major commands and Regional Medical Commands (RMCs) view it on MODS. The medical treatment facilities can request additional assets. These requests get forwarded to the RMCs for their evaluation. The RMCs then compile all their requests and forward them to the MEDCOM Strength Management Office and the Health Services Division (HSD), Human Resources Command. The career managers and consultants evaluate the requests and prepare to discuss them at the ODP Planning Conference.

In early December, OTSG and HSD host the ODP Planning Conference. The Deputy Surgeon General hosts the conference and the commander or his representative from each RMC, 18th MEDCOM and the FORSCOM surgeon attend. The conference lasts 2 full days and consists of briefings given by the MC Consultants to TSG. Each consultant briefs

initial distribution plan for their specialty, and addresses the requests for additional assets submitted by the various commands. During briefings and the following discussion, representatives from HSD, MEDCOM, and OTSG take notes and provide information as needed. The goal is to resolve all distribution issues before the consultant leaves the room. Each consultant prepares and gets approval for a contingency plan for distribution if the specialty ends up with more or fewer assets than in the distributable inventory.

At the completion of the ODP Conference, the career managers and consultants discuss any changes in the distribution plan. The career managers update the distribution plan in MODS. The MACOMs and RMCs are able to view the changes to ensure that all of the changes have been made. Once the new distribution plan is confirmed, then HSD prepares a final briefing for TSG.

The U.S. Army Surgeon General is the final approval authority for the distribution of medical officers. The entire distribution planning process culminates with a brief to TSG. The timing of the brief is currently the middle of January. Once TSG approves the distribution plan, then the consultants and career managers know what positions they will have to fill.

It is important to remember that the entire process, to this point, has focused only on authorizations and which ones will be filled – the spaces side of the process. After the ODP receives approval from TSG, the consultants and career managers start on the faces side of the process - deciding which officer will fill which position.

Assignment Process

The consultants now start placing officers against the slots approved in the ODP. These assignments are made based on the following priorities. First are the needs of the Army. Second, is the officer's professional development. The final priority are the officer's preferences. For this reason, it is important for all officers to communicate both their preferences and their long-term career goals to their consultant or career manager. The consultant and career manager work closely together to ensure that each position receives the right officer.

During this time, the administrative or 60A positions get filled as well. These are the leadership and administrative positions. These are important both for career development and to provide medical staff work and leadership within the MEDCOM and the rest of the Army. Examples of these positions include the noncommand select list command billets, the division, corps, and MACOM surgeons, and the Deputy Commander for Clinical Services. Most of these positions are for LTCs and COLs. They demonstrate to boards a commitment to leadership and to the AMEDD. These jobs are posted on the MC Branch website at **https://www.perscomonline.army.mil/OPhsdMc/medcorps.htm.** This site is a wealth of information regarding jobs, boards, personnel records and courses. It also includes contact information for the career managers and branch chief.

After the consultants and branch chief make up their slates, the career managers cut Requests for Orders or RFOs and send them to the individual stations. The standard is to get the RFOs to the officers at least 90 days before their report date. This allows the local personnel office to cut orders and for the officer to make all the arrangements necessary to move to his or her next duty station. The vast majority of moves occur in the summer as that is least disruptive to families and fits in with the GME schedules. In certain circumstances, a high priority position or a GME failure requires an off-cycle move. After the summer moves, the cycle starts over again.

Keys to Success

Now that we have explained the process, how does an individual physician end up with the position that best fits their desires, family, and career. First, keep communicating with your consultant and career manager. If they don't know your needs and desires, they won't be able to take them into account. Second, be flexible. Not everyone can go to Fort Carson or Fort Lewis. If you don't have some realistic back-up choices, you may end up at your last choice assignment. Third, remember the first priority is the Army's needs. We will try to match your desires with the Army's needs, but in case of a tie, the needs of the Army will win out. Finally, don't forget some of the nonclinical and nontraditional approaches. One of the advantages of being in the Army is that there is no financial penalty for trying a different career path, whether it is administrative, teaching, operational, or research. Many of the current leadership never thought they would be where they are today, and wouldn't be, if they hadn't taken chances and tried new and challenging jobs.

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The Reduction of Unwarranted Clinical Practice Variation in the AMEDD

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Unwarranted variation in clinical practice patterns can be inefficient, ineffective, and wasteful of limited health care resources. A business case is presented for a corporate-wide quality improvement initiative that uses data from published literature and combines it with internal Army Medical Department (AMEDD) data. The analysis reveals a cost avoidance of $1.6 million in its first 4 years, followed by an annual cost avoidance of $672,000 for a stand-alone project. The Army Medical Corps (MC) leadership has embraced the desire to reduce unwarranted variation in clinical practice by including it in its strategic plan and by training its specialty leaders to identify unwarranted variation in their respective specialties and to design quality improvement projects aimed at reducing variation that strays from evidence-based practice.

Introduction

Recent decades have witnessed a notable evolution, perhaps even a revolution, in the quality management of health care.[1] Prior to this revolution, the quality of care had been assessed by professional judgment, most often by subjective means on individual patients.[2] But the accountability for health care quality is no longer in the exclusive realm of individual health care providers. Governmental agencies, accrediting bodies, and others staking a claim to health care quality dominate the current climate. The assessment of quality is now a multifactorial and multidisciplinary function.

In recent years, a confluence of circumstances has led to an increasing awareness and acknowledgement of quality shortcomings within the medical industry (Table 1). In a seminal report on health care quality in the United States, the Institute of Medicine mentioned the need to decrease unwarranted variation in clinical practice as a means to improve quality in American health care systems. The report explicitly states that "Care should not vary illogically from clinician to clinician or from place to place."[3]

Quality is considered to be inversely proportional to variation in health care services. Although not all variation is unwarranted since it can be explained on the basis of medical need, most variation in health care is wasteful and ineffective. Wennberg defines unwarranted variation as "care that is not consistent with a patient's preference or related to a patient's underlying illness."[4] Wennberg further divides unwarranted

Work by Wennberg on unwarranted variation gains traction among academicians and practitioners, providing for a general acknowledgement of unfounded variations in patterns of care
The Institute of Medicine describes a quality chasm in U.S. health care
Health care stakeholders demand quality in the health care service lines that they finance, purchase, and/or use
Sensing the environment of accountability for health care quality, large health systems embrace health care quality initiatives
The science of evidence-based practice advances, resulting in the development of several evidence-based clinical practice guidelines
Accrediting agencies demand a demonstration of quality (JCAHO requires evidence of process improvements and the Accreditation Council for Graduate Medical Education [GME] expects competency in practice-based learning and improvement in GME graduates)
Newer financing schemes, including TRICAREs Revised Financing, rewards health care organizations for gaining efficiency and thereby increasing capacity and access to care
Competition increases among health care organizations
Information systems emerge and mature, making useful data more readily available
Health care costs continue to increase faster than the rate of inflation
Clinical epidemiology and outcomes research undergoes substantial growth

Table 1. Key Circumstances that Have Led to an Increasing Awareness and Acknowledgement of the Need to Improve Quality Within the Medical Industry

variation into three categories of care: preference-sensitive care, supply-sensitive care, and effective care. The latter category is the focus of this article.

Effective care is care that is evidence-based. When evidence-based care is underused, unwarranted variation occurs, resulting in potentially ineffective care. Studies generally show underuse of effective care in health care systems. Underuse of effective care can be remedied by monitoring the processes of care at the hospital and physician group levels.[5] These data are then used to drive improvement activities.

Several groups have codified evidenced-based practice through the formulation of clinical practice guidelines (CPGs). A collaborative effort between the Department of Defense (DOD) and the Veterans Health Administration (VHA) has resulted in the design of 24 CPGs.[6] This collaboration continues to develop more CPGs while revising earlier ones as evidence becomes available that might result in a change to the guideline. Since CPGs are evidence-based, they serve as excellent models around which to design quality improvement projects designed to reduce unwarranted variation in effective care.

The economic benefit from quality improvement initiatives is derived through cost avoidance. Each performance improvement project may result in cost avoidance through reduction of undesirable outcomes. Such outcomes may include preventable hospital admissions or preventable emergency department visits.

In 1999, the DOD and VHA developed a CPG for the management of asthma in adults and children age 6 years and over.[7] This article presents a business case for increasing compliance with one aspect of this CPG, ensuring that persistent asthmatics are prescribed inhaled corticosteroids (ICS).

Methods

A business case is presented that uses existing published data from several sources that are combined with internal business data within the AMEDD. A similar methodology has been presented by Fetterolf and West.[8] The study population is the Army TRICARE-Prime enrollees (patients who are provided care through the Army's direct care system, the civilian equivalent to an HMO option for enrollees) who meet the Health Plan Employer Data and Information Set (HEDIS) definition for persistent asthmatics.[9] Using data published in a National Quality Management Program report on asthma management in the Military Health System (MHS), hospital admission rates and emergency department (ED) visit rates are calculated for asthmatic patients that have been prescribed ICS (hereafter referred to as ICS asthmatics) and for asthmatic patients that have not been prescribed ICS (non-ICS asthmatics).[10] Using these calculated rates of admission and ED visits, the number of preventable admissions and ED visits is calculated. Preventable admissions and ED visits are defined as the difference between the number of admissions and ED visits that are occurring with current ICS prescription rates in the study population versus the number of admissions and ED visits that would occur if the AMEDD could achieve a 95% ICS prescription rate for its enrolled population of persistent asthmatics. Next, the average cost of a hospital admission for asthma and the average cost of an ED visit for asthma are calculated using published national data.[11] Finally, the magnitude of the annual cost avoidance that would be achieved if the AMEDD could achieve a 95% ICS prescription rate for its enrolled population of persistent asthmatics is calculated using the average national costs and the number of preventable admissions and ED visits.

Results

Tables 2 and 3 show the calculation of asthma-related hospital admission rates and asthma-related ED visit rates for ICS asthmatics and non-ICS asthmatics. These rates are derived using data from 2002 that were presented in a contracted report for the National Quality Management Program.[10] At that time, the Army had 14,326 HEDIS-defined persistent asthmatics enrolled in the direct care system (TRICARE-Prime). Forty-nine percent were appropriately prescribed ICS; thus, 7,020 were prescribed ICS while 7,306 were not prescribed ICS. Four ICS asthmatics were admitted to the hospital for asthma and 151 non-ICS asthmatics were admitted. This represents a 36-fold difference in admission rates between these two groups. Similarly, as seen in Table 3, 89 ICS asthmatics were seen in the ED for asthma while 954 non-ICS asthmatics visited the ED for asthma. This demonstrates a greater than 10-fold difference between the two groups.

Using these calculated health service utilization rates, the number of expected asthma-related admissions and ED visits can be calculated for the 17,984 persistent asthmatic TRICARE-Prime enrollees in 2004 (Table 4). The compliance rate for prescribing ICS to the enrolled persistent asthmatic population is 71.6% in 2004. At this compliance rate, one can expect 113 yearly hospital admissions for asthma and 830 yearly asthma-related ED visits. As shown in Table 5, with an ICS compliance rate of 95%, the total expected admissions decreases to 29 and the total expected ED visits decreases to 334 Preventable admissions and ED visits are those visits that would not occur if the AMEDD increased its compliance rate from the current 71.6% to the goal of 95%. If this change were to occur, then there would likely be 84 fewer admissions per year and 496 fewer ED visits per year (Table 6).

	Source	
(A): HEDIS-Defined Asthmatics	NQMP, May 2003[10]	14.326
(B): % of HEDIS-defined asthmatics on ICS	NQMP, May 2003[10]	49
(C): # ICS Asthmatics	A x B	7,020
(D): # Non-ICS Asthmatics	A - C	7,306
(E): # Admissions for ICS Asthmatics	NQMP, May 2003[10]	4
(F): # Admissions for Non-ICS Asthmatics	NQMP, May 2003[10]	151
(G): ICS Admission Rate	E / C	5.7*
(H): Non-ICS Admission Rate	F / D	206.7**
*per 10,000 ICS Asthmatics per year **per 10,000 Non-ICS Asthmatics per year		

Table 2. Calculation of Asthma-Related Admission Rates in Patients with or without ICS Prescriptions

	Source	
(A): HEDIS-Defined Asthmatics	NQMP, May 2003[10]	14,326
(B): % of HEDIS-defined asthmatics on ICS	NQMP, May 2003[10]	49
(C): # ICS Asthmatics	A x B	7,020
(D): # Non-ICS Asthmatics	A - C	7,306
(E): # ED Visits for ICS Asthmatics	NQMP, May 2003[10]	89
(F): # ED Visits for Non-ICS Asthmatics	NQMP, May 2003[10]	954
(G): ICS ED Visit Rate	E / C	126.8*
(H): Non-ICS ED Visit Rate	F / D	1,305.8**
*per 10,000 ICS Asthmatics per year **per 10,000 Non-ICS Asthmatics per year		

Table 3. Calculation of Asthma-Related ED Visit Rates in Patients with or without ICS Prescriptions

	Source	
(A): HEDIS-Defined Asthmatics	MHSPHP*	17,984
(B): % of HEDIS-defined asthmatics on ICS	MHSPHP	71.6
(C): # ICS Asthmatics	A x B	12,875
(D): # Non-ICS Asthmatics	A - C	5,109
(E): # Expected Admissions for ICS Asthmatics	C x $G_{(Table\ 2)}$	7
(F): # Expected Admissions for Non-ICS Asthmatics	D x $H_{(Table\ 2)}$	106
(G): Total Expected Admissions	E + F	113
(H): # Expected ED Visits for ICS Asthmatics	C x $G_{(Table\ 3)}$	163
(I): # Expected ED Visits for Non-ICS Asthmatics	D x $H_{(Table\ 3)}$	667
(J): Total Expected ED Visits	H + I	830
*Military Health System Population Health Portal (as of November 2004)		

Table 4. Calculation of Expected yearly Asthma-Related Admissions and ED Visits in 2004 for Asthmatics with or without ICS Prescriptions

	Source	
(A): HEDIS-Defined Asthmatics	MHSPHP*	17,984
(B): % of HEDIS-defined asthmatics on ICS	Given	95
(C): # ICS Asthmatics	A x B	17,085
(D): # Non-ICS Asthmatics	A - C	899
(E): # Expected Admissions for ICS Asthmatics	C x $G_{(Table\ 2)}$	10
(F): # Expected Admissions for Non-ICS Asthmatics	D x $H_{(Table\ 2)}$	19
(G): Total Expected Admissions	E + F	29
(H): # Expected ED Visits for ICS Asthmatics	C x $G_{(Table\ 3)}$	217
(I): # Expected ED Visits for Non-ICS Asthmatics	D x $H_{(Table\ 3)}$	117
(J): Total Expected ED Visits	H + I	334
*Military Health System Population Health Portal (as of November 2004)		

Table 5. Calculation of Expected Yearly Asthma-Related Admissions and ED Visits if the ICS Compliance Rate Reached 95% of the Enrolled Persistent Asthmatic Population

	Source	
(A): Preventable Admissions	$G_{(Table4)} - G_{(Table\ 5)}$	84
(B): Preventable ED Visits	$J_{(Table4)} - J_{(Table\ 5)}$	496
(C): Total National Direct Cost for Asthma Admissions	Smith, *et al*[11]	$2,799,500,000
(D): Total National Admissions for Asthma	Smith, *et al*[11]	445,000
(E): Average Cost per Admission for Asthma	C / D	$6,291
(F): Total National Direct Cost for Asthma ED Visits	Smith, *et al*[11]	$348,000,000
(G): Total National ED Visits for Asthma	Smith, *et al*[11]	1,200,000
(H): Average Cost per ED Visit for Asthma	F / G	$290
(I): Potential Annual Cost Avoidance for Asthma Admissions	A x E	$528,444
(J): Potential Annual Cost Avoidance for Asthma ED Visits	B x H	$143,840
(K): Total Potential Annual Cost Avoidance	I + J	$672,284

Table 6. Calculation of Potential Annual Cost Avoidance

Using national estimates of the economic costs of asthma, Table 6 shows the calculation of the national average cost of a hospital admission for asthma and an ED visit for asthma.[11] Applying these costs to the magnitude of preventable admissions and ED visits, the cost avoidance for preventing unnecessary admissions and ED visits would amount to $672,000 per year. This is the magnitude of the cost avoidance that can be realized annually if the AMEDD compliance rate for prescribing ICS to persistent asthmatics could be increased from the current rate to the target rate of 95%.

Discussion

The business case presented above describes only one quality improvement project out of several that could be established at the corporate level. This singular project would provide a positive return on investment as long as the compliance goal is being met and the cost of the administrative support structure is less than the cost avoidance realized by the project. For each percentage gained in compliance over the baseline level, $28,730 would be realized in cost avoidance. If a project were established in which the goal of 95% compliance would be reached in 4 years, straight-line progress would result in cost avoidance of over $1.6 million. In order to break even in such a project, the cost of the project must be kept below $420,000 per year. By realizing economies of scale, several projects can be established with smaller incremental cost of administration.

It should be noted that the business case presented in this article has weaknesses that relegate the analysis to be one of estimation rather than one of precise prediction. The cost figures for hospital admissions and ED visits are based upon 1994 dollars, which would make the analysis a conservative one. Additionally, using the HEDIS definition of persistent asthma may underestimate the size of the asthma population of interest. Again, this would underestimate the magnitude of the return on investment. In an analysis done using a less restrictive definition of asthma and using near-actual cost for the cost of a hospital admission for asthma and CMAC (CHAMPUS Maximum Allowable Charges) rates for an estimated cost for an asthma-related ED visit, the cost avoidance over 4 years is estimated to be over $2.4 million. By employing an administrative support structure costing $600,000 over 4 years, the return on investment would be nearly $1.8 million with a break-even point at 1.1 years (data not shown; available upon request to the author).

The business case analysis presented above demonstrates that quality improvement in the health care setting can have a positive influence on the bottom line. However, one should remain cognizant of the intangible benefits that accompany such efforts.[12] Intangible benefits include the promotion of an organizational culture of quality and excellence; moving the organization in the strategically-desired direction; promoting an image and reputation of the AMEDD as a quality-focused organization; differentiating the AMEDDs direct care system as the higher-quality alternative; demonstrating evidence of improved value for the taxpayers' health care dollars; the improvement of retention and recruitment of health care providers who desire employment in a health care system known for its quality; and, evidenced-based medicine is good medicine for our patients.

Within the context of TRICAREs Revised Financing, reduction of unwarranted variation results in more efficient use of limited resources.[13] By reducing preventable hospital admissions and ED visits, the capacity of individual military treatment facilities (MTF) is optimized and access to care for other health services increases. With this increased capacity, the need to send enrolled beneficiaries to the purchased care system (care provided by nonmilitary facilities and providers) decreases. This, in turn, decreases the amount of the MTF commander's budget that must be spent on care purchased outside of the direct care system for enrolled beneficiaries.

The AMEDD recognizes the benefits that have been outlined above. A recent business planning guidance document specifies the need to increase the use of evidence-based health care.[14] It touts benefits such as increased production efficiency and increased clinical effectiveness. In short, the document describes evidence-based medicine as doing the right thing more often.

Recognition of the need to reduce unwarranted variation in practice can also be seen in the alignment of organizational strategic goals. An AMEDD strategic objective is the implementation of clinical and business best practices.[15] This is aligned with higher organizational objectives of the Army and the MHS.[16,17] In addition, the Army MC, representing the uniformed physician workforce in the Army, has devised a strategic map and supporting balanced scorecard. The MC strategy strongly and explicitly supports the reduction of unwarranted variation in practice through the following specific goal: "Reduce Unwarranted Variation in Practice."[18]

On the coattails of the MC Balanced Scorecard, the concept of reducing unwarranted variation has begun to catch hold within the MC, resulting in the beginnings of a new strategic initiative known as the Reduction of Unwarranted Variation Initiative (RUVI). Achieving success with the RUVI will require a culture change within the organization. Leaders of the organization must recognize quality shortcomings in the form of unwarranted variation in practice and embrace the organizational desire to correct it. In order to start this culture change, the physician consultants to the Army Surgeon General have embraced the concept. Each consultant, representing a specific medical specialty, has been asked by the Army's Chief of the MC to examine their respective specialties for unwarranted variation and opportunities to reduce that variation. After multiple training sessions on variation in clinical practice and techniques of quality improvement by the nation's leading subject matter experts, the consultants are poised to support corporate-level RUVI projects that may impact their respective specialties. The time has arrived to make a concerted organizational effort to foster a culture of quality, improve care to our beneficiaries, and demonstrate to our stakeholders our success in improving health care quality.

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Medical Management of Medical Holdover Patients

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In Oct 03, a series of media reports alleged poor treatment of Reserve Component (RC) Soldiers at several installations, most notably, Forts Stewart and Knox. Congressional interest soon led to hearings on the matter. The term "languishing" became popular as the reports claimed substandard housing, poor access to medical care, and discriminatory treatment toward RC Soldiers. The Army Surgeon General (TSG), LTG Peake, immediately directed personal, on-site General Officer evaluations of each medical treatment facility (MTF) caring for what would soon become known as Medical Holdover (MHO) Soldiers.*

Those evaluations revealed several things. Foremost was that we had a large number of MHOs: 4,852 as of 25 Oct 03. In the early days of the Global War on Terrorism, mobilized RC Soldiers who were unfit to deploy had to remain at the mobilization station. They stayed there until they were sufficiently healed ("fixed") to deploy, or until they went through the medical evaluation board (MEB)/physical evaluation board (PEB) process. Many of the MHOs on hand at the end of Oct 03 had never deployed. (This is what led to the term MHO: the Soldiers were "held over" at the mobilization station.)

The evaluations also revealed that many of the MHO Soldiers were living in barracks appropriate for transient, mobilizing populations. These billets, however, were not conducive to the healing process. Some of the Soldiers had unclear chains of command. Their units were in Theater, with no rear detachment at the mobilization station or home station. Data from the MTFs showed that MHOs received access to care equal to or better than their active component counterparts, and in accordance with TRICARE access standards. For the MHO population, however, TRICARE access standards were insufficient to prevent rapid accumulation of even more MHOs.

Several immediate actions followed the evaluations. The Assistant Secretary of the Army for Manpower and Reserve Affairs (ASA[M&RA]) assumed oversight of all MHO operations, and created a MHO Tiger Team. Forces Command was made the executive agent for MHO (though it took several months to fully implement this). Installation Management Agency assumed responsibility for command and control of MHOs, and tasked each installation garrison commander to establish a MHO unit. Like the rest of the MHO program, these units have evolved over time, and are now referred to as Medical Retention Processing Units (MRPU). The Assistant Chief of Staff for Installation Management also directed that MHO Soldiers be housed in so-called Tier I housing. Tier I housing is climate controlled, has a modern latrine in the same building, and has no more than four Soldiers to a room.

The ASA(M&RA) in conjunction with the Army G-1 developed policy that now allows the Army to send home mobilized Soldiers if they are medically unable to deploy. Dubbed The 25 Day Rule, this policy allows the Army to send RC Soldiers home if their pre-existing conditions are found in the first 25 days of mobilization. If their conditions are discovered after Day 25, the Soldiers should be retained on active duty for treatment.

The Surgeon General also took immediate action. Recognizing that TRICARE access standards were insufficient to meet the access needs of MHO Soldiers, LTG Peake mandated enhanced access standards for MHO patients. These were, and remain, 72 hours for all specialty referrals, 1 week for all diagnostic studies, and 2 weeks for scheduled surgeries. Additionally, he directed that all MEB performed on MHOs should be done within 30 days of the time the permanent profile was written until the MEB was mailed to the PEB. The usual standard for that process is 90 days.

These were all necessary and appropriate interventions. However, the one thing none of them accomplished was to get the Soldiers home. Healing takes time, and so does processing a MEB/PEB. Mobilized Soldiers therefore remained on installations for months to achieve final disposition. Therefore in Dec 03, the acting Secretary of the Army approved a plan to create the Community Based Health Care Organizations (CBHCO). The CBHCOs have been described as installations without real estate, and MTFs without clinics. Their mission is to allow healing mobilized Soldiers to live in their own homes, provide Title X work for them near their homes, and acquire health care for them from the Soldiers' home communities. The pilot project began in Arkansas, California, Florida, Massachusetts, and Wisconsin. Each CBHCO was staffed with

*Medical Holdover refers to a RC Soldier, mobilized for the Global War on Terrorism, who needs to remain on active duty to receive medical treatment. This should not be confused with a Soldier who, in accordance with AR 40-40 is assigned to the MTF medical hold company or detachment.

30-35 personnel, primarily mobilized Guardsmen, half for command and control, the other half for case management and medical processing. Each provided care for up to 300 Soldiers within their respective state boundaries. The program subsequently expanded such that each CBHCO was responsible for a multi-state region. It expanded again to add three more CBHCOs in Alabama, Utah, and Virginia, and extended capacity to 500 patients per CBHCO. Notably, the CBHCOs do not fall under MEDCOM. Rather, they belong to FORSCOM. The MEDCOM provides technical support to and quality assurance for the CBHCOs.

Despite these interventions, concern over MHO remained high. The MHO became a weekly part of the Army leadership's "Balcony Briefing" in the Army Operations Center, and a bi-weekly meeting on the Director of the Army Staff's calendar. As well, trips to Capitol Hill by members of the "MHO Team" became commonplace as members of Congress and their staffs repeatedly asked for information on MHO.†

One reason that interest remained high is that Soldiers continued to have problems. For instance, when a Soldier came to the end of his mobilization orders, the only mechanism to keep him on active duty to receive medical treatment was Active Duty Medical Extension (ADME). The ADME program, however, was designed for Guardsmen and Reservists injured during annual training or on drill weekends. It was never designed to accommodate the thousands of Soldiers in MHO. Thus, when Soldiers came to the ends of their ADME orders many "fell off" their orders and sustained gaps in their pay and benefits. Manpower and Reserve Affairs and Army G-1 subsequently created Medical Retention Processing (MRP). The MRP is a streamlined process in which mobilized Soldiers volunteer to remain on active duty to receive medical treatment, and in which extensions of orders are automatic after the first 179 days.

Because MHO was an important issue, the ASA (M&RA) directed the MHO Team to visit every site providing care to MHOs, and assess performance of the MTFs and MRPUs. Between Aug 04 and Dec 04, the team conducted more than 40 site visits. Each included multiple sensing sessions with patients. Findings included problems with access to care, perceptions that RC Soldiers received a different priority for care than active component Soldiers‡, rear detachments that refused to allow their Soldiers to go to the MRPUs, MHO Soldiers who were assigned jobs not commensurate with their rank and skills, and inconsistencies in assignments of MHO Soldiers. Some were assigned to MRPUs, while others were assigned or attached to MTF medical hold detachments/companies. These issues have all been addressed, but some recur as new units mobilize/demobilize, and personnel change over and have to learn the rules and processes of MHO.

One thing that frustrates both the command and control and the clinical side of MHO is Soldiers who "fight their Boards." These are Soldiers who take advantage of every process and appeal available at every stage of healing and the MEB/PEB process to remain on active duty, and to garner every bit of disability possible. The MHO Team found that Soldiers fight their Boards for a variety of reasons. Perhaps the most noble is the Soldier who derives a great deal of self-esteem from serving. Today's Army is, after all, all volunteer. The notion of a Golden Wound, one that guarantees separation from the Army is less acceptable to an all volunteer force. Another type of Soldier who fights his Board is one who knows he cannot return to his civilian job because of his disability. That Soldier prolongs things in an effort to continue to provide for himself and his family. The lesson learned for those Soldiers is that we must provide benefits counseling early, clearly, and often. We must balance that, however, against giving the appearance that we are trying to rush the Soldier's healing process. The Soldier who in-processes one day, and meets the Physical Evaluation Board Liaison Officer the next day is likely to develop that perception.

The current status of MHO is that we have nearly 5,600 on hand. About 1,700 are at the CBHCOs, and the remainder is on our installations, receiving care from our MTFs. The average MHO patient has four patient encounters per month. The number already processed through the system since 1 Nov 03 is almost 16,000. Approximately 10,000 were successfully returned to the Army, fit for further duty. The rest underwent MEBs. The average patient spends 182 days in MHO. Those who are released from active duty (REFRAD) spend approximately 158 days. Those who require a Board action, however, require approximately 335 days. Of those 335 days, only 161 are dedicated solely to healing. The remainder is required for the MEB, PEB, and subsequent administrative processing.

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†The current MHO team is a subset of the original MHO Tiger Team, and consists of officers, civilians, chief warrant officers, and noncommissioned officers from Manpower and Reserve Affairs, Forces Command, Office of The Surgeon General, Medical Command, Installation Management Agency, and Human Resources Command.

‡RC Soldiers were receiving a different standard: they were being put at the head of the line for care, in front of active component Soldiers. However, because they were being asked "Are you Guard or Reserve?" they perceived adverse discrimination. We stopped asking the question.

The future of MHO, then, must include even more efforts to streamline administrative processing.[§] Reducing the amount of time required to obtain 20-year letters, calculate accurate retirement points, and generate DD 214s are among current goals. Thus far, the Army Medical Department's (AMEDD) stance has been "don't mess with healing time." That is probably good advice for anyone and everyone outside the AMEDD. Within the AMEDD, however, the data on MHO must be used to point out both best and not so best practices. Those best practices have to be applied at every site that cares for MHOs. Moreover, they must be applied in such a way that no MHO Soldier feels he or she is being given "The bum's rush" with regard to treatment.

The future must also include plans to conduct MHO operations without the assistance of mobilized Guard and Reserve Soldiers. Funds to hire personnel are scarce, but RC Soldiers available for CONUS missions are becoming even scarcer. The AMEDD, as well as the Army, and Health Affairs must plan on having MHOs long after the war in Iraq ends. Predictive analyses performed by the Surgeon General's Decision Support Cell show that for any given daily cohort of MHO patients, at least 1% of them will still be in MHO 411 days later.

In the aggregate, or at the level of the individual patient, MHO is a good news story. The AMEDD has provided, and continues to provide, quality care to large numbers of mobilized RC Soldiers. Some are unable to attain retention standards, and have to proceed to MEB/PEB. The majority, however, heals. Those Soldiers rejoin their units and continue to serve. It is an effort everyone who helps care for MHO Soldiers can be proud of.

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§Thus far, the AMEDD has hired additional assistant Physical Evaluation Board Liaison Officers, the Physical Disability Agency has created a fourth, roving PEB, and Human Resources Command has placed 37 noncommissioned officers at the mobilization stations to assist with processing orders and personnel actions for MHOs.

Medical Ethics in Detainee/Enemy Prisoners of War Care

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(The author is the Consultant in Medical Ethics to the Surgeon General. The assertions contained here are solely the opinions of the author and may not represent the official views of the Army Surgeon General, the Department of the Army, or the Department of Defense.)

Since Oct 01, more than 65,000 individuals have been processed as detainees or enemy prisoners of war (EPW) in the Global War on Terrorism (GWOT). These detentions and incarcerations have occurred in numerous locations around the world and in some instances have resulted in prolonged imprisonment. The U.S., through its military services, has assumed the medical care of the majority of these individuals. In late 2003, media reports began to surface regarding the possible abuse of some of these detainees. Some reports further implicated U.S. medical personnel in these allegations of abuse and the Army Medical Department (AMEDD) has expressed concern about such implications.

The U.S. government initiated several investigations into these allegations. Specifically, an investigation conducted at Abu Ghraib prison resulted in recommendations for Uniform Code of Military Justice action against two medical personnel, among others. Further, the recently released Church Report, which reviewed DOD detention operations, indicated that in three instances of prisoners' death, medical personnel may have attempted to conceal the accurate cause of death. Other assessments continue, one of which is an assessment initiated by the Surgeon General specifically reviewing the medical care of detainees/EPW.

Basic Standard for Ethical Behavior

Guidelines for the ethical treatment of prisoners of war have a long history of evolution. In 1863, the Resolutions of the Geneva International Conference specified in Article 8 that medical personnel shall wear a "white armlet with a red cross." The Geneva Conventions of 1949 dealt with the sick and wounded on land, prisoners of war, and civilian populations. The 1977 Protocols were added to the Geneva Conventions of 1949, but have not been ratified by the U.S. Senate. With regard to EPW, the U.S. is a signatory to the Geneva Convention. The specific policy which implements how EPW are to be treated in accordance with Geneva is Army Regulation 190-8 (EPW, Retained Personnel, Civilian Internees, and other Detainees). The General Protection Policy is described in 1-5, which states that all detainees and EPW shall be given humanitarian care and treatment. The specific acts of torture, sensory deprivation, collective punishments and threats or acts of violence are clearly prohibited.

From a standpoint of medical ethics, all writings emphasize the importance of the physician maintaining an advocacy role for his patient. While the physician-patient relationship may not be the physician's sole responsibility, it must remain his primary one.

Sources of Conflict

From a practical, as well as philosophical perspective, the military physician and health care provider encounters the conundrum of mixed agency. Mixed agency is obligation or allegiance to two (or more) values, and it may represent a source of conflict for military providers, creating tension and anguish. The most commonly encountered conflict is that between allegiance to professional ethics and the duty to nation. Military providers are frequently cast into the conflict between duty to conserve fighting strength and the requirement to serve as the individual patient's advocate. Examples might include military medical triage in a combat situation or the treatment of combat fatigue.

In the current environment, there may have been additional specific sources of conflict which became manifest in the issue of detainee/EPW medical care. Although there was never a directive from the National Command Structure to disregard the medical aspects of detainee care under the Geneva Conventions, there was widely reported discussion regarding specific designation of status of enemy forces in GWOT. Where the duties of intelligence gathering and provision of security intersect with medical care, as in detention centers, there may have been a lack of understanding of the ethical requirements of medics, at least on the part of intelligence and security operatives. Finally, as the GWOT demonstrated the changing face of warfare, some may have viewed that society's values may also be changing (for example, an emphasis on security and order over that of individual autonomy).

Conflict Resolution

How is conflict between individual patient advocacy and

military expediency resolved? In every instance, the details of the requirement should be elucidated, from the command as well as the position of the provider. The value of frank discussion as well as the antecedent study of hypothetical cases cannot be overemphasized. Once such details have been studied, then frequently resolution may be obtained. Consultation with the technical chain is often beneficial as well.

In extreme cases, the choices may be quite difficult. In such cases, the physician/provider may be required to request relief from duty and possible court martial or, alternatively, to subject themselves to sanctions for unethical behavior. Recusal from a particular issue of conflict may be an alternative although recusal is not guaranteed.

Medical Ethics Education in the AMEDD

In DOD facilities and within the AMEDD, there exist several venues for training in medical ethics. A key source of military medical personnel is the Uniformed Services University of the Health Sciences where medical ethics is both a requirement and an additional elective for medical students.

Within the AMEDD, there are three primary sources of medical ethics training. At the AMEDD Center and School, lessons on the Law of Land Warfare are provided in both officer and enlisted training programs. Additionally, there are ten AMEDD sites where graduate medical education (GME) is conducted. Each GME site conducts a yearly medical ethics seminar for incoming medical interns. Finally, there is medical ethics training provided in unit-specific venues tailored to that unit's particular mission.

The AMEDD continues to be confronted with the acute issues of medical ethics as related to combat. Much recent attention has been focused on the medical care rendered to detainees/EPW and the potential conflicts seen therein. Further assessments of detainee care are pending which may reveal additional specific problems with detainee care in GWOT.

As issues of medical ethics move towards resolution, it is important to recognize that within the conflict some ethical values shall be, at least partially, unmet. Despite this, the call to the AMEDD remains to address these difficult issues so that the ultimate goal of delivery of care to patients and conservation of the fighting strength is accomplished.

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The "Intentional" Officer

COL Chuck Callahan, MC, USA†

Introduction

In the 1986 novel "The Accidental Tourist" by Anne Tyler, Macon Leary is a travel writer who hates travel and strangeness. He much prefers the predictability and comfort of his "average" life. He has the wrong temperament for his line of work, and one wonders how he ended up in such an unsuitable profession. In the Army today, there are no "accidental" officers. There may have been some 35 years ago. At the height of the war in Vietnam, doctors were drafted or joined through the Berry or Senior Student Plans, beneath at least the shadow of coercion. But it is certainly no longer the case. There are no longer any Medical Corps (MC) "conscripts." We are all volunteers. It is an especially critical concept to grasp, as we will likely all wear desert camouflage uniforms (DCUs) in the coming years.

Rather than being "accidental" officers in much the same way that Macon Leary found himself a travel writer, we should be "intentional" officers. We have all agreed to serve, some to reimburse medical school costs or loans. Others have chosen to enter active duty for any of a host of reasons. But we volunteered. We signed on some dotted line at some point in our careers. The system we serve prepares us well to practice our craft, but sadly, teaches far too little about the culture in which we practice it.

Philosophy

A good friend of mine, who recently passed away, retired from the Army MC sooner than he would have liked because of failing health. He told me more than once how much he missed wearing woodland camouflage and the times we spent in the field. "I love the Army," I recall him saying. When I find myself saying the same thing, I wonder, "What is it that I love?" Certainly it is not the snappy polyester Class A jacket and pants. And how about waiting in line for company uniform updates when I have no company uniforms? Or repeatedly having to sign-in for quarterly equal opportunity training? These are the things that chase people away from the Army. I realized back while we were still wearing plain green field uniforms, that I agreed with General Creighton Abrams, who said, "The Army is not made up of people, it is people." When I say "I love the Army," it is the people that I love.

One of my R.O.T.C. instructors in college taught us that as officers, we would be able to order our newly tailored uniforms on credit. This credit was based solely on our promise to pay, because once we were commissioned, "our word was our bond." I remember thinking as a 19 year old, "That is the kind of person I want to be, and that is the kind of people I want to be around." More than two decades later, I am still impressed by the Army's *tradition of honor*. I have encountered time and again people who live with honor; people who generally do the right thing for themselves and for others. For the last decade, we have lived in military housing, surrounded mostly by families from all branches of the Army. They look out for my children, and I look out for theirs. I know that they would care for my family if I were deployed because they have done it in the past. It is a *community of principle*, people who know the right thing to do.

Not long ago, I sat with one of the mothers from my neighborhood in the waiting area by the pharmacy. Several of her children were sick and they were waiting for prescriptions. She had four children ages six and under, and her husband had been asked to deploy for 6 months. "The other two officers they could send are newlyweds, or have newborns," she told me. "So I think it is best for my husband to go." It may be best, I thought to myself, but it won't be easy. She embodied the *culture of sacrifice* we live in, where people routinely do the right thing for others without regard for themselves.

I love the people I have met in the Army. No, they are not all perfect. But I have met many who are people of honor, of principle, and sacrifice. These are the kind of people I want to be like, and the kind of people I would like my children to become. My leaders are generally people I can look up to, my co-workers are people I can respect and work alongside of, and those for whom I work are people I am proud to be able to serve. I love the Army, because I love the people.

Pragmatics

The practical aspects of being an intentional officer begins with the crux of successful leadership. Retired General William Cohen, in his book *The Stuff of Heroes*, writes that the first principle of leadership is to maintain absolute integrity. Integrity is consistency. It is complete dedication to a single set of principles and values, so that a person looks the same regardless of the context. Loyalty is one of the core values of the Army. Simply put, loyalty is being true to ourselves and to others. We must first be true to ourselves and to our vision of who we will become. When junior officers join our department, I tell them that I expect that they will take the time to "play and pray," stressing what I consider essential aspects of who we are as people. Make time for exercise, hobbies, and for worship.

If we do our jobs right, there will be time to demonstrate loyalty to our spouses and children while still supporting and caring for colleagues. And finally, we must be loyal to our patients. The men, women, and children who come to us for care are looking for someone who will share ownership of their health. They are looking for someone to bear their burdens with them, and they know immediately when we are just going through the motions.

The "Officer Image" is a critical part of who we are as leaders. The practicalities of the officer's image are stressed in *The Officer's Guide* (Crocker LP, 47th ed Stackpole Books, 1996). This is a book every officer should own. Buy it and page through it on the plane on your next TDY or on your way to your next assignment. The book stresses proven pragmatics for officers: be strong on the principles we mentioned above. Be cool-headed and not given to temper tantrums. Be flexible in working for an organization where the rules of engagement can change overnight. Leaders should avoid the use of first names for superiors and for subordinates. Remember that "rank has its privileges," but don't assume the privileges for yourself. Be liberal in the use of "Sir" and "Ma'am" in addressing superiors whether they ask for it or not. Don't offer excuses for jobs not done or not done well. Avoid servility, slander, and coarse language.

When you get to your next new assignment, make an appointment to meet the Commander and the Deputy Commander for Clinical Services, the "doctor's boss." Do it now, if you have yet to meet them. Have a simple card made with your name, rank, corps and perhaps specialty, and leave it with the Commander's secretary when you make your office call. It is an old Army tradition. (There is usually a dish for the cards on the secretary's desk.) Make sure that your hair, shoes, and haircut are all appropriate before you show up. Bad first impressions are tough to undo.

As silly as it sounds, take time now and then to look at your hand salute in the mirror, and practice getting it right. Your salute tells Soldiers and other officers what you think of them. A departing pharmacy officer stopped me at graduation several years ago and thanked me for the way I returned his salutes on the way to and from the parking garage. He told me that taking time to come to attention, make eye contact and return the salute demonstrated my respect for him. I didn't even know it was happening.

No one will look out for your career if you don't. Get in the habit of reviewing your Officer's Record Brief. Know what the boxes mean. Get an appointment with the Troop Commander at your hospital or clinic if you can't figure it out. Stay in touch with your specialty Consultant and keep him or her informed of your long-range plans. I ask the officers in my department to "back-plan." Start by asking yourself what a "good day" looks like for you. Is it pure patient care that you really like? Research? Teaching? How about administrative tasks? Once you know, then ask what you need to be doing in 5 or 10 years to be having a lot of "good days." What kind of job do you hope to be doing? If you aren't sure, look at what the Majors and Lieutenant Colonels are doing in your department. Who do you want to be like? What do you want to be doing? Once you have an idea, back-plan even knowing that the plan can change. Figure out what it will take to get there from where you are now. Pay careful attention to service schools (Officer's Advanced Course, Intermediate Level Education) and to professional training.

As MC Officers, we will all spend time with "TOE" or "field" units at some point in our careers. Some might be heading to Brigade or Battalion Surgeon slots right out of training. For those heading to hospitals and clinics, a Professional Officer Filler System (PROFIS) assignment and deployment to the Gulf is almost inevitable. Prepare yourself for those duties. As soon as you receive your PROFIS assignment, schedule a meeting with the PROFIS Company and Battalion Commanders or at least call them. Meet the other professional staff assigned to the unit, especially the Physician's Assistant (PA). The PA will keep you out of trouble, tell you who to look out for, and what you really need to know for the field. (For more on deployment preparation, download the "Deploying Health Care Provider" booklet from the Center for Army Lessons Learned website: **http://call.army.mil/**. Click on the "DOD Only" link in upper left corner. Under the right column at "Training for War," click the "Special Editions/ Studies.")

When you show up for the field assignment, or the day you report for the Brigade Surgeon's job, wear the unit patch on your shoulder, not the MEDCOM patch. It says to the unit that you know who you belong to and you are ready to be part of the team. Stay current in the skills you need for the field, no matter what your specialty. Keep up with Advanced Trauma Life Support and Advanced Cardiac Life Support as well as the basic orthopedic evaluations and treatments. Don't write a single profile for anyone until another doc or PA from the unit has sat you down and explained the Command's policy. New docs are like lightening rods and the Soldiers are smart enough to sometimes come and try to get their profile "rewritten." Finally, whenever you have the chance, especially while you are young, try to get to as many Army schools as you can (airborne, air assault, flight surgery) and get the Expert Field Medical Badge. It is a lot harder to do as you get older (and don't heal as well).

Pitfalls

The things that most often trip up officers, young or old,

fall into three large groups. The first is the pursuit of *self*. To quote James Kitfield in his excellent book *Prodigal Soldiers* about the military between Vietnam and the Gulf War, too often the motto, "duty honor, country" becomes "me, my ass, and my career." Early on in any military career, an officer needs to ask him or herself, "What am I working for?" And be honest about the answer. Sometimes the things we are working for are really not worth it.

One of the senior physicians at Tripler tells a story of when he was acting hospital commander, and a white-haired gentleman was wandering the halls of the hospital looking unsuccessfully for a clinic. It was General William Westmorland, Army Chief of Staff from 1968 to 1972. No one knew who he was. Could you pick any of the last several Surgeon Generals out of a line-up? It is discouraging that they could be forgotten so quickly. Take the last four Army Medical Department (AMEDD) Lieutenant Generals. They wore twelve stars between them. They contributed more than a century of service to the Army. These men reached the pinnacle of power and prestige in the AMEDD, and many of us can't remember a thing about them. We don't know them by name or by face. I don't know these men at all, and I know nothing of their motivations while they were in the Army. But I would venture to say that if they spend three decades pouring themselves into their "careers" at the expense of their personal lives, their families and their friends, then they left the Army with very little.

Every officer in the MC must ask him or herself a simple question, "What am I working for?" If you are working to become a general, ask yourself "why?" Anyone can sew two stripes on their trousers. Are you interested in the job the general does? Do you know anything of the headaches and the aggravation? Do you know that you won't get to see patients anymore? I know that some who read this will one-day wear stars. My hope is that they pursue the position of leadership for the opportunity to use their gifts and talents to serve the Army and the country. I hope that it is not just a matter of ambition. As a wise MC Colonel once told me, "Just because the ladder has another rung, it doesn't mean you have to step up on it." Mostly, I hope that those who become generals do not do it at the expense of their personal lives, their spouse, their children, colleagues, or comrades. Within a few years of taking off green polyester, the Army and the country will forget us. If family, friends, and outside interests are gone, it will be a very lonely life.

After "self," the next area that shipwrecks many officers is *sex*. My first PROFIS battalion commander was relieved for having an affair with an enlisted Soldier in his command. When I was stationed at Fort Hood, a Commander whose children I cared for was relieved for an affair with a Lieutenant in his unit. I would wager that neither officer set out to destroy their career. Probably everyone on active duty knows someone who ruined his or her life through sexual indiscretion.

Each officer, male and female, will have to set his or her own standards for keeping out of this kind of trouble. For example, don't be alone with a member of the opposite sex who is not your spouse. Don't be in a car alone (if it can be avoided), don't work late together, don't allow a member of the opposite sex to come to your hotel room alone when you are TDY. To some, these may seem foolish and unnecessary. Every officer should decide for him or herself, just how big a "fence" to construct to keep out of trouble. Sexual harassment is another potential "career-ender." Don't comment about the appearance of members of the opposite sex at work, either favorably or not. Don't touch them and don't joke about them.

Sexual indiscretion often results from the third of the three pitfalls: "*sauce*" or alcohol. The officer corps has moved from the obligatory Friday afternoon "happy hours" with the commanders. But a single "DUI" will end a career faster than almost any other cause. I have known several former officers for whom this is the case. Drink in moderation when off-duty and only when you know you won't be driving. Decide before hand what and how much you will drink, and stick to that limit. Look out for other officers. And make arrangements for another driver or taxi if things get out of hand.

Pearls

It has been said that one man's trash is another man's treasure. So it may be with my "pearls." But consider these regardless. General John Wickam said that "the Army is not an institution, it is an occupation." What we do in the Army is our occupation. We may be doctors or nurses, corpsmen or technicians, tankers or infantrymen. These are all the things that we do. Being an officer is who we are. The character and leadership that goes with the commission doesn't come off with the BDUs or DCUs at the end of the day. That person is who we are when we go to the kids' school play, to church, to the beach, or to the kitchen table with our spouses and children. George Washington said that "An army of asses led by a lion is infinitely better than an army of lions led by an ass." If we are asses as officers at work, we will be asses at home and in our neighborhoods. We are always officers.

As officers, the Army will offer you countless opportunities to assume responsibility in management and administration. Embrace them. When you finish your time on active duty, it is your management experience that will set you off from the rest of the crowd of applicants. Your clinical skills will be assumed. You have come from excellent programs, and you will all be board certified. But when you apply for another position in 5,

10, or 20 years, your administrative, teaching, and research experience will set your application apart from the pack. So look for additional duties, whether it's Director of Process Improvement, JCAHO Representative, or hospital committee memberships.

Despite the fact that we are always officers, leadership will always be an option. One is not a leader merely because of rank, position, seniority or title. We have all chosen to be officers. So we must also choose, on a daily basis, to be leaders. And leadership is not necessarily something that we were trained for in college or graduate school. So we must learn. We learn by watching the great leaders around us, as much as we learn by watching "not-so-great" leaders. Become a student of leadership. Read about it. (There is no shortage of excellent books, and new ones appear all the time.) Talk about it in groups and in one-on-one "mentor" relationships. At Tripler we meet Wednesdays at lunch to discuss an article or talk about a leadership principle from a movie clip. The discussions and the things I learn from our junior officers continue to shape my understanding of leadership

Decide what your own philosophy of leadership will be so you can model it continuously, conspicuously, and consistently. Refine your philosophy over time. Test it in new situations. Become mentors yourself, and teach leadership to junior officers. I was criticized once for writing in the Senior Rater section of a Captain's OER that I thought the officer would be a general one-day. "Only a General should say that someone will be a general one day," I was told. Well, perhaps. I am not a general and very likely will never be one. But I am beginning to think that I know what a good one looks like. I know what a not-so-good one looks like. And I believe that I know what one looks like when he or she is still a captain. I am a student of leadership. We all should be.

We are all "intentional" officers. Our commissions were not by conscript. Neither were they "accidental," resulting from carelessness. We did not become "incidental" officers by miscalculation or error. And certainly we are not "transcendental" officers by some mystical alignment of the stars. We are officers on purpose. And we must be officers with a purpose. I believe that we have the greatest honor that could be offered to medical professionals. We have the opportunity to care for the most deserving of all our countrymen: American's sons and daughters. It is our duty, it is our privilege, and it is our calling.

> *"So nigh to grandeur is our dust*
> *So near to God is man When duty*
> *whispers, lo 'thou must' And youth*
> *replies, 'I can."*
>
> Ralph Waldo Emerson

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The Tactical Combat Casualty Care Transition Initiative

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The Tactical Combat Casualty Care (TCCC) project initiated by the Naval Special Warfare Command and continued by the U.S. Special Operations Command (USSOCOM) developed a new set of tactically appropriate battlefield trauma care guidelines in 1996. These guidelines were included in the Fourth Edition of the American College of Surgeons (ACS)-sponsored Pre-Hospital Life Support (PHTLS) Manual published in 1998 and revised in 2003. In addition, the guidelines are submitted to the ACS-Committee on Trauma for their review, input, and approval. Although these concepts have been widely accepted throughout the Department of Defense, ensuring that all personnel and units deploying in support of the Global War on Terrorism (GWOT) have the latest TCCC training updates and equipment continues to be a challenge. The USSOCOM and the U.S. Army Institute of Surgical Research (USAISR) have recently developed a successful model to meet this challenge called the TCCC Transition Initiative. This article outlines how this model works and its successes to date and proposes that it be considered a model for use on a wider scale in the U.S. Military.

Background of TCCC

Battlefield trauma care during combat operations presents military medical providers with challenges not encountered in most civilian pre-hospital settings. Military combat medical personnel treating casualties typically have to deal with such additional factors as harsh environments, darkness, hostile fire, long delays to casualty evacuation, very severe injuries and an ongoing tactical mission. Accounts of casualties encountered in tactical Special Operations settings highlighted the need to develop and employ trauma management strategies that ensured casualties were managed in a way that optimized both medical care and tactical response in combat scenarios.[1,2] Similar observations have been made in the civilian tactical setting.[3] Despite this fact, until the mid-90s, military trauma guidelines for battlefield trauma care mirrored the strategies used in the civilian sector, largely rigidly following Advanced Trauma Life Support (ATLS) guidelines. In 1996, a novel set of trauma management strategies appropriate to the combat setting was published.[4] These guidelines were the result of a study initiated by the Naval Special Warfare Command and continued by the USSOCOM and were collectively called "TCCC." A description of how these guidelines were developed has been published previously.[5] Some of the strategies advocated in this article were phased levels of battlefield care, more aggressive use of tourniquets to control severe extremity hemorrhage, battlefield antibiotics, intravenous vs intramuscular battlefield analgesia, hypotensive resuscitation strategies, use of small volume colloid as a resuscitation fluid, preferential use of early cricothyrotomy vs intubation for a definitive airway in maxillofacial trauma, use of intraosseous infusion devices instead of cut downs for fluid replacement, and more aggressive use of needle decompression for suspected tension pneumothoraces.

The TCCC guidelines were first adopted as the standard of care by the Naval Special Warfare community in a letter by RADM Tom Richards.[6] The Army Ranger community followed quickly by incorporating TCCC into their Ranger First Responder Course. (conversation with SFC Rob Miller, USA, retired) Since that time, TCCC guidelines have been implemented by other groups in the U.S military and allied nations.[7-10] These guidelines were included in the Fourth Edition of the American College of Surgeons-sponsored PHTLS Manual published in 1998 and thus became the first-ever set of battlefield trauma guidelines to carry the endorsement of both the ACS Committee on Trauma and the National Association of Emergency Medical Technicians.[11] They have since been adopted as a standard of care in the U.S. Army for medics and combat lifesavers and the USSOCOM.[12]

The Committee on Tactical Combat Casualty Care (COTCCC)

It was recognized from the outset that any set of medical guidelines needs to have a mechanism to ensure that they are periodically reviewed and updated. Much like the ACS Committee on Trauma, the original TCCC article called for a standing COTCCC to accomplish this function.[4] The USSOCOM funded the establishment of this Committee in 2001. The organization selected to undertake the COTCCC project was the Naval Operational Medicine Institute located in Pensacola, FL. The COTCCC is chaired by retired Navy Captain Dr Steve Giebner and met throughout the year in 2002 to accomplish the requisite update of the TCCC guidelines. The revised guidelines resulting from the COTCCC effort were published in the Second Printing of the Fifth Edition of the PHTLS Manual.[13] This committee is now sponsored by

the Navy Bureau of Medicine and Surgery, is comprised of a multidisciplinary group of medics and physicians from all services, all of whom have cared for combat casualties and is nearing completion of a second revision of the TCCC guidelines, published as the Sixth edition of the PHTLS Manual. In addition, the guidelines are submitted to the ACS-Committee on Trauma for their review, input, and approval. As much as possible, guidelines are based on data; when data is not available, then the expert opinion of the COTCCC is utilized to guide recommendations.

Present Challenges in TCCC

Special Operations units are currently heavily committed in support of the GWOT. An evaluation of the state of medical readiness to deal with combat trauma, conducted in 2004, revealed that there were still a number of challenges to be dealt with: (1) better mechanisms were needed to ensure that deploying Special Operations medics had received training in the recent updates to the TCCC guidelines before leaving for combat duty; (2) better strategies were needed to ensure that deploying Special Operations Forces (SOF) units had obtained all of the latest combat trauma medical equipment (tourniquets, antibiotics, hemostatic dressings, warming blankets, etc) recommended by the current TCCC guidelines and had adequate training in their use; (3) methods were needed to provide training in at least some basic combat trauma lifesaving skills to ALL members of deploying Special Operations units, not just medics; and (4) a mechanism needed to be established to obtain better feedback from returning combat medical personnel regarding the strengths and weaknesses of currently-recommended techniques and equipment so that appropriate changes could rapidly be implemented in future revisions of the TCCC guidelines.

These issues were presented to the USAISR and a pilot program called the TCCC Transition Initiative was developed to meet these challenges.

The TCCC Transition Initiative Model

The USSOCOM Surgeon's office in coordination with the USSOCOM Component Surgeons identifies SOF units that will be deploying in the near future (within the next 6 months). The deploying units are contacted and commanders or medical representatives asked if they would like for their units to receive the updated TCCC training and equipment for both their medics and nonmedical personnel prior to the unit's deployment into theater. Focusing on units that are deploying in the near future ensures that all deploying forces have the opportunity to be optimally prepared to deal with battlefield trauma care during their deployment. The proximity of the TCCC training to leaving for a combat environment also enhances the impact of the training and provides a second strong reason to focus the training on departing units.

Once a deploying unit has indicated that it wishes to receive the TCCC Transition Initiative training, USAISR representatives coordinate a date for a 3-day training session with the deploying units who wish to participate. They also review the combat trauma equipment currently carried by the deploying SOF unit and compare it to a list of newly-approved combat casualty equipment as recommended in the PHTLS manual in order to identify any shortfalls. USAISR procures any recommended new TCCC equipment not currently in the unit allowance list and has it delivered to the unit for the training session. A point of emphasis is that only equipment which is either new or has been recently added to recommended TCCC equipment lists is provided. It is expected that units will have combat trauma equipment items that have been standard for some time already on hand.

The 3-day training sessions are conducted at the unit's home location. It is much easier to have the two-man instructor team travel to the unit than to pay travel costs for unit personnel to travel to a remote site for training. There is no cost to the unit for the training sessions or the equipment provided. Funding is provided centrally through USSOCOM.

Upon the unit's return from deployment into theater, USAISR coordinates an after action review with the unit to document the effectiveness or shortfalls of the new techniques and equipment used in the tactical environments. This information will be fed back to the COTCCC so that medical management strategies and equipment that worked well will be retained and those that don't will be re-evaluated. The USAISR team will utilize a structured evaluation process, collate all of the user evaluations from these specific casualty reports and prepare an annual report of their findings and recommendations. The data gathering aspect of the project is a critical feature. It is exceedingly difficult to obtain clinically useful data about first responder care provided to combat casualties. A detailed account of the care rendered in the tactical setting is typically not a part of the medical record generated by the treating medical facility and the successful capture of these data would greatly enhance efforts to continue to improve the TCCC guidelines.

This project was funded in Jul 04 and the first Special Operations unit to receive the TCCC Transition Initiative training and equipment was SEAL Team Three in Sep 04. Since then, 10 battalion-sized Special Operations units (520 medics and 1,320 operators) have been trained and many more are on the schedule to be trained in the near future. Feedback from the units trained has been strongly positive to date.

TCCC Transition Initiative Training/Equipment Program

The first day of the 3-day training session is devoted to training unit medics/corpsmen on the new equipment to ensure that they are familiar with its use. A list of all of the TCCC recommended equipment is provided in Tables 1 and 2. "Train-the-trainer" sessions are also held on Day One so that unit medics/corpsmen can assist in the small-group sessions in the subsequent 2 days. The small group sessions are primarily devoted to practice and demonstration of individual skills and to discussion of the many hypothetical and real-world casualty scenarios that are presented.

Hextend - 500cc bags
Velcro IV straps
Injectable phenergan - 25 mg ampules
Sternal intraosseous device
Cefotetan 2 gm vials
Blizzard Rescue Blanket
TechTrade "Ready-Heat" Blanket

Table 1. New TCCC Equipment for Medics Provided by TCCC Transition Initiative

Combat Pill Pack
Gatifloxacin 400 mg
Tylenol 1000 mg
Celebrex 200 mg
Combat Application Tourniquet
HemCon® dressing
Nasopharyngeal airway

Table 2. New TCCC Equipment for all SOF Combatants Provided by TCCC Transition Initiative

The SOF Non-Medical Operator Training conducted on Days Two and Three is devoted to teaching the basic combat trauma lifesaving skills recommended by the PHTLS manual for ALL combatants. The training is conducted by the USAISR instructor team and includes data on how people die in ground combat, specific management guidelines for the 3 phases of care (Care Under Fire, Tactical Field Care, and CASEVAC Care), guidelines for optimal management of wounded hostile combatants, guidelines for determining the urgency for evacuation for specific types of injuries, specific casualty scenarios, and "Lessons from the Front." Assistance is obtained from the unit medics/corpsmen in the small-group practical skills sessions (tourniquets, hemostatic agents, recognition of shock on the battlefield, airway management, hypothermia prevention, splinting, antibiotics and analgesics, management of specific casualty scenarios, etc). Pre- and post-training tests are given to provide a quantitative measure of improved medical readiness.

TCCC – Success in Combat

The first published report of a successful use of TCCC in combat operations by Malish et al is in recovering a downed pilot in 1999.[7] The TCCC has been used by Special Operations units to manage combat casualties since the beginning of the GWOT. Both authors have used these concepts personally in combat casualty situations and seen them succeed. Although there are historically relatively few articles that describe the successes of specific battlefield trauma strategies in combat operations, there have been indicators of success using TCCC in the GWOT. One of the first units to engage in operations against the Taliban regime in Afghanistan used TCCC methods with great success in caring for their casualties, (conversation with Major Kevin O'Connor, U.S. Army Special Operations Command). At the Special Operations Medical Association meeting held in Dec 04, there were two presentations that described the success of TCCC principles used by Special Forces and Ranger units.[14,15] Some specific comments made by these two presenters are shown in Tables 3 and 4. Most recently, Tarpey described the implementation of TCCC by an Army unit and characterized the performance on these strategies in combat as an "overwhelming success."[16]

• Train EVERYONE in combat casualty care
• Hypotensive resuscitation and early antibiotic therapy work – use them
• Antibiotics given within one hour of injury to all U.S. casualties and zero known infections in patients
• Evacuation of U.S. casualties took 5+ hours

Table 3. 2000 Pound JDAM "Friendly Fire" Selected After Action Comments[14]

• Ranger First Responder Course is validated and vital
• Early application of tourniquets saves lives
• Tourniquets saved the life of at least 7 Rangers who lost a significant amount of blood
• Chitosan dressing worked extremely well when used
• Pulse oximeter is a great tool

Table 4. 75th Ranger Regiment – Combat Lessons Learned Selected After Action Comments[15]

As compelling as the accounts of success of TCCC in combat are the reports of combat fatalities that could have been potentially preventable by use of these guidelines. A retrospective evaluation of the 84 Special Operations fatalities in the GWOT has found that 12 of the 84 SOF fatalities were potentially preventable, largely by either improved adherence to TCCC recommendations (tourniquets, surgical airways vs intubation, hemostatic agents, needle thoracostomy, the availability of blood products in CASEVAC platforms) or faster evacuation times. (Holcomb, unpublished data) It should be noted that at least some of these casualties were treated by nonmedical first responders, either because there was no medic in the SOF element engaged or the medic had been killed earlier in the same engagement.

Conclusions and Recommendations

The TCCC Transition Initiative is now in widespread use in the Special Operations community. Variations of this program have now also been used to train deploying Marine Corps units, the 82d Airborne Division, the 10th Mountain Division, the Third Infantry Division, and the 101st Airborne Division. The TCCC Transition Initiative has proven to be a successful way to provide critical medical training to units about to depart for a combat deployment. Strengths of this approach are: (1) it provides just-in-time TCCC update and refresher training to all unit medics; (2) it provides critical trauma management skills to ALL members of the deploying unit – often the first time that nonmedical unit members have received this training; (3) it minimizes the financial and logistical impact on the unit receiving the training since it is taught at their home location; (4) it allows for rapid and uniform implementation of battlefield lessons learned; (5) it provides a venue to reinforce the critical need to wear body armor and eye armor while in theater; (6) it ensures that all deploying units that receive this training have the lifesaving TCCC equipment recommended by the current version of the guidelines; (7) it provides a framework for redeploying units to provide feedback about the performance of both the equipment and the casualty management strategies taught in TCCC; and (8) focusing on units about to deploy helps provide a strategy for selecting units that have the most immediate need for the training and ensures that the information and equipment provided will be state of the art at the time they leave for combat operations.

Implementation of TCCC updates into military medical training commands is a critical step that should parallel the TCCC Transition Initiative process and this is discussed more completely in the companion paper to this article. The TCCC Transition Initiative model will provide critical information on both techniques and technology that is essential to updating academic military curricula and combat trauma equipment lists. Transition of periodic TCCC updates will be expedited if training commands adopt the practice of updating their TCCC curricula as soon as new guidelines are published.. This practice mirrors that used in conducting courses such as ATLS and ACLS, where nationally recognized guidelines are periodically updated. This step has just been taken by the U.S. Special Operations Command and will prevent lengthy delays in curriculum revision.[13]

The TCCC Transition Initiative model has proven very successful in providing lifesaving combat trauma management skills and equipment to military units departing for deployment. The authors propose that this model be considered by U.S. military leaders for wider use in training all units that will be deploying for combat operations.

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Tactical Combat Casualty Care in Operation Iraqi Freedom

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Introduction

In the mid-1990s, the U.S. Army Special Operations Command developed a new set of guidelines concerning the treatment of casualties on the battlefield. These guidelines, called Tactical Combat Casualty Care (TCCC), have been updated since their initial proposal and have been widely practiced with excellent results throughout the Special Operations community.[1] However, there has been very little spread of the use of the TCCC guidelines into conventional units. This article reviews the use of the principles of TCCC by a mechanized infantry unit in Operation Iraqi Freedom One (OIF 1).

Background

When Task Force (TF) 1-15 Infantry (TF 1-15 IN), part of the Third Brigade Combat Team of the Third Infantry Division, deployed to Kuwait in Jan 03 in preparation for war, I was assigned by the Professional Officer Filler System (PROFIS) as their Battalion Surgeon. While the infantrymen were training over the next several months for urban combat, trench warfare, and long-range movement, our medical platoon simultaneously underwent a rigorous train-up in preparation for combat. First Lieutenant Robert (Brian) Fox, the battalion physician assistant (PA), SFC Christopher Parker, the medical platoon sergeant, our other medical noncommissioned officers (NCOs) and I concentrated on teaching our 38 enlisted medics the principles of TCCC. Briefly, TCCC breaks up battlefield medicine into three stages:

- *"Care Under Fire"* is care rendered by the medic on the battlefield while under hostile fire with an aid bag as the only equipment.

- *"Tactical Field Care"* is treatment provided once the casualty and his unit are no longer under hostile fire, with equipment limited to that carried into the field.

- *"Combat Casualty Evacuation Care" (CASEVAC)* is treatment provided once the casualty has been picked up by aircraft, vehicle, or boat.

The training of medics by the battalion surgeon and PA, together with the medical NCOs, is probably the most important job assigned to these professionals. However, it is frequently overlooked or not done well. This is particularly true for health care providers who normally work in hospitals and are assigned as PROFIS health care providers just prior to deployment. Despite the inherent difficulties, assigned health care providers have to make the training of medics their first priority. Health care providers who normally work in hospital settings will need to make a concerted effort in their training to get out of the Advanced Trauma Life Support (ATLS) mindset and into one based around battlefield medicine, with its completely different scenarios. Intense daily training is the best way to accomplish this.

Health care providers assigned to Level I positions, such as a Battalion Aid Station (BAS), have a particularly important role to play since up to 90% of combat deaths occur on the battlefield before a casualty ever reaches a medical treatment facility.[2] Hemorrhage from wounds remains the number one cause of mortality, accounting for 50% of all deaths.[3] In Vietnam, 50% of combat deaths were due to wounds with uncontrolled bleeding, with about 11% of these in sites accessible by first aid treatment.[3,4] Ryan et al assert that approximately one-third of all killed in action (KIA) could potentially be salvageable and point to data from Oman in 1973 and Panama in 1989 in which the stationing of emergency medicine physicians at casualty collection points close to the point of wounding resulted in lower KIA rates than in previous conflicts.[5-7]

With this in mind, we undertook to train our medics and ourselves in the precepts of TCCC with the goal of lowering battlefield morbidity and mortality. We concentrated first and foremost on the importance of stopping hemorrhage promptly and efficiently with the use of tourniquets. We also reviewed again and again various battlefield procedures such as needle decompression of tension pneumothorax, nasopharyngeal airway insertion, and cricothyrotomy. The medics worked on starting intravenous (IVs) in all kinds of conditions, including in the dark with night vision goggles.

Emphasis was placed on the simple recognition and treatment of common battlefield injuries. For instance, medics were trained to recognize shock by assessing pulses and mental status, rather than with blood pressure cuffs and stethoscopes which have little use on the battlefield. The principles of hypotensive resuscitation were reviewed, as well as in what

situations the judicious use of IV fluids was appropriate. We avoided teaching procedures like endotracheal intubation and CPR which are of little use to frontline medics in combat.

Each of the medics, alone and in teams, was run through repeated reality-based combat scenarios featuring other Soldiers acting as casualties with the types of wounds likely to be encountered on the battlefield. The medics learned to quickly triage casualties first, then going through the actual steps involved in their treatment. Again and again they were made to demonstrate the actual steps involved in each medical procedure. In addition, we talked through various scenarios, especially those encountered by medics in Mogadishu in 1993. Given the likelihood of impending war at that time, it was not difficult to get 100% effort from the medics in their training. By the time our unit moved north, we had reviewed these techniques and scenarios with our medics so many times that recognition and treatment, at times, simply involved muscle memory, which is important in the stress of combat.

Overview of the Battle

On 21 Mar 03, TF 1-15 IN attacked across the Kuwaiti border into Iraq as part of the Third Infantry Division assault. Over the next 25 days of continuous combat operations, the TF covered over 800 kilometers of open desert and urban terrain and fought in eight major engagements for two Brigade Combat Teams. Major battles were fought at Nasiriyah, Tallil Airbase, as Samawah, and in Baghdad. The TF conducted the first major attack across the Euphrates River and was the Army's main effort in destroying the Republican Guard Medina Division and securing the southern approaches into Baghdad.

Casualties

Over these 25 days, TF 1-15 IN sustained 32 wounded in action and 0 KIA or died from wounds. Friendly casualties with penetrating wounds broke down as follows:

Injury Location	Number of Casualties
Extremity	23
Thorax	0
Head/Neck	2
Pelvis	0
Abdomen	2

Table. Anatomical Distribution of Penetrating Wounds Sustained by TF 1-15 IN Soldiers in OIF 1, 21 Mar 04-14 Apr 04

In addition, two Soldiers were treated for blast injuries and three Soldiers for motor vehicle accidents. As in previous conflicts, approximately 70% of our casualties with penetrating wounds involved the extremities.[8] Body Armor obviously played an important role in limiting significant truncal injuries. Though our sample is very small, our lethality from war wounds was 0%, going along with the decreasing lethality seen in Iraq and Afghanistan as compared to previous wars. As of 16 Nov 04, lethality from war wounds in Iraq and Afghanistan was approximately 10%, as compared to 30% in World War II and 24% in Vietnam.[9]

We treated a significant number of Iraqi casualties over this time as well, though accurate records are not available. In contrast to U.S. casualties, the majority of wounded Iraqis – who did not have body armor – sustained multiple serious injuries of the trunk and extremities. Often these wounds were as a result of fire from weapons with heavy firepower, such as the 25 mm gun on the Bradley Fighting Vehicle. Their morbidity and mortality were thus significantly higher, though again, good statistics are not available.

Lessons Learned – Care Under Fire

The first lesson learned concerned the importance of additional firepower provided by medics, proving that the best medicine on any battlefield is fire superiority. On numerous occasions, TF 1-15 IN medics were subject to both direct and indirect fire and confronted uniformed and nonuniformed enemy combatants. Particularly upon movement into southern Baghdad, our medics played an important role in engaging and destroying enemy fighters prior to treating casualties.

Tourniquets played a decisive role in quickly and effectively stopping hemorrhage under fire and keeping a number of Soldiers with serious extremity wounds involving arterial bleeding alive until they could eventually undergo emergent surgery at the Forward Surgical Team (FST). Medics under fire, based on their training, had a very low threshold for applying tourniquets to extremity wounds with heavy bleeding and, therefore, a significant number of our casualties received them. Given the intense conditions under which our medics treated casualties, it would have been absolutely impossible for them to have attempted to hold pressure over wounds while continuing to fight and treat other wounded. All of our medics carried with them at all times an improvised tourniquet designed from tying together two cravats by 1LT Fox, our PA, and this tourniquet stood up well in battle.

Once Soldiers were seen by a PA or physician at the BAS, in most cases within an hour, they would be reevaluated. In some cases, when appropriate, the tourniquets were removed and replaced with pressure dressings and in others,

particularly amputations, they were left on. In the majority of these cases, these Soldiers received treatment at an FST within several hours. Though long-range follow-up on these wounded Soldiers is not available, evidence that is available suggests that long-term complications due to the use of these tourniquets have been minimal. As for pressure dressings, the combination of Kerlex bandages with Ace wraps supplied effective pressure.

Though we had trained our medics on the use of the hemostatic agent QuickClot, in only one instance did one of our medics have occasion to use it – in a gunshot wound to the thigh involving heavy bleeding from the femoral artery in which the medic was unable to apply sufficient force with an improvised tourniquet to completely stop the bleeding, and was able to do so by pouring QuickClot into the wound. The medic poured the QuickClot into the wound carefully, and as a result, there was no damage to surrounding skin, as sometimes happens with this product. We cannot report on hemostatic dressings as we were not issued them.

Lessons Learned – Tactical Field Care and CASEVAC

Our treatment rendered in the arenas of Tactical Field Care and CASEVAC also bore out many of the TCCC principles. Upon our initial entry into the southern outskirts of Baghdad, the situation developed into a mass casualty scenario, with 10 U.S. casualties, dozens of seriously wounded Iraqi Soldiers, and seven injured Iraqi civilians. As the lead element in the battle, we waited over 12 hours for the FST to advance and set up, and were forced to care for the casualties on our own in the interim, while the battle was ongoing and evacuation was impossible. Before this occurred, we were already low on supplies since we had not been resupplied since fighting had begun 2 weeks prior. As a result, we were forced to seriously partition supplies.

None of our friendly casualties had wounds which affected the airway and thus there was no need for extensive airway interventions among our own casualties. Many Iraqi casualties with sucking chest wounds were treated with Asherman chest seals with good results. Some have reported that they do not adhere well under battlefield conditions, but we did not have that problem despite temperatures around 95^{0}F. A number of the Iraqi casualties with thorax injuries developed increasing respiratory difficulty. As we had trained our medics to treat a penetrating thorax injury with increasing respiratory difficulty as tension pneumothorax, these casualties received needle decompression. Again, we do not have good evidence on their outcomes, but a number did survive until treated much later at the FST. A portable pulse oximeter is an indispensable tool in caring for casualties with these types of injuries.

We adhered throughout to the principles of hypotensive resuscitation, using IV fluids only when appropriate. Casualties not in shock were encouraged to take fluids orally. Those casualties in shock received 1000 cc of Hespan, the colloid available to us. It was very effective in resuscitating casualties without complications noted. Given our low supplies and little room to transport everything throughout the length of Iraq, we found colloids to be a better choice of fluid for resuscitation.

We did use crystalloids for dehydrated casualties, and in some cases, both types of fluid. One of our first serious casualties was a young scout with a large fragmentation wound to the back of the leg involving the peroneal nerve and rapid bleeding from the popliteal artery. The medic on scene rapidly stopped the bleeding and saved his life with a tourniquet, but he had lost enough blood by the time he arrived at the BAS that he was in grade IV hypovolemic shock. He was initially resuscitated with 1000 cc of Hespan. Because he remained tachycardic and hypotensive, and there was no danger of "busting the clot" since a tourniquet remained in place, he received another 2 liters of normal saline while awaiting air evacuation to the FST. He received blood immediately upon landing at the FST and then quickly went into surgery. He survived and kept his leg with only some residual peroneal nerve deficits.

As for analgesia, our experiences confirmed the traditional wisdom that Soldiers in battle with serious wounds often experience very little or no pain in the immediate hours after the injury, particularly if the battle is continuing. Soldiers who could continue to fight received Tylenol and those who could not were given IV morphine, all without noted complications.

We gave antibiotics to all of our casualties with open wounds, even relatively minor fragmentation wounds. None of our casualties developed wound infections. We could not obtain the exact antibiotics recommended in the TCCC guidelines, but found suitable alternatives. Soldiers who could take oral medicines received Levofloxacin, which was convenient due to its once daily dosing. Those wounded who could not take medicines orally received IV Cefazolin for extremity wounds and IV Ceftriaxone for abdominal injuries.

Finally, the quick evacuation of casualties was of prime importance. When air evacuation was available, we were very aggressive in ensuring it arrived rapidly. When not available, wounded Soldiers need to be rapidly evacuated by ground to FSTs, even if the battle is ongoing and conditions are difficult. We were fortunate in often having FSTs stationed fairly short distances away, but our ambulance drivers often demonstrated real heroism in evacuating casualties despite repeatedly being fired upon. Our goal in treating any casualty was to quickly make any needed potentially lifesaving interventions, and then to arrange for evacuation as rapidly as possible.

Recommendations for the Future

Our experiences suggest a number of recommendations for future practice. First, the Army Medical Department (AMEDD) needs to continue to make an effort to rapidly disseminate and organize training on the TCCC guidelines. These guidelines have proven to be lifesaving and their widespread dissemination should be first priority. There is no good reason why wounded Soldiers are continuing to die on the battlefield from extremity bleeding.

Combat Lifesaver training needs to be overhauled as well, away from an emphasis on the application of first aid dressings and starting IVs, and toward the principles of TCCC, especially stopping hemorrhage on the battlefield with tourniquets and perhaps new technologies in the future.

The AMEDD should make the development and distribution of effective tourniquets top priority. All Soldiers should go into battle with a tourniquet on their web gear which is lightweight, easy to use, and capable of being applied with one hand. And all Soldiers should be trained on its application.

Experience has also shown that best results are obtained when PAs and physicians are deployed far forward on the battlefield. The first minutes after wounding are critical and treatment on the scene by an advanced health care provider can be lifesaving. Furthermore, the AMEDD should continue to support and fund research into technologies which can be effective on the battlefield, in particular, items such as hemostatic dressings, various types of tourniquets, and methods of hypotensive resuscitation that have important ramifications for Level I care.

Army health care providers who normally work in hospitals or clinics and are assigned to combat units as part of the PROFIS system should realize that they need to get away from the ATLS mindset and adopt a battlefield-focused approach. At Level I, this means following the TCCC guidelines. And it's the duty of physicians and PAs to ensure that their medics undergo rigorous, intensive training in these principles prior to going into battle.

Conclusion

The adoption and implementation of the principles of TCCC by the medical platoon of TF 1-15 IN in OIF 1 resulted in overwhelming success. Over 25 days of continuous combat with 32 friendly casualties, many of them serious, we had 0 KIAs and 0 died from wounds, while simultaneously caring for a significant number of Iraqi civilian and military casualties. This success should serve as a model for other conventional combat units throughout the Army involved in Level 1 treatment. The principles of TCCC are well-researched and proven effective and should be the foundation for the treatment of battlefield casualties.

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Battlefield Tourniquets: Modern Combat Lifesavers

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The use of tourniquets for control of battlefield hemorrhage is a practice many centuries old. Despite the controversies surrounding their use in civilian trauma, tourniquets remain necessary treatment for severe extremity hemorrhage from combat injuries. The increased military operational tempo in recent years and the frequency and severity of the resultant combat extremity trauma has led the United States Army Medical Department to focus on two objectives regarding battlefield tourniquets:

- Improving tourniquet use doctrine and training to maximize the potential lifesaving benefits of tourniquet use, especially during active combat.

- Identification of an effective, simple-to-use, field-compatible tourniquet for issue to all Soldiers.

The U.S. Army Medical Research and Materiel Command (USAMRMC) and the U.S. Army Institute of Surgical Research (USAISR), have played active roles in the Army-wide efforts to meet the above goals. This overview and the articles that follow present an overview of the iterative development of the USAISRs recent efforts to improve battlefield tourniquets and their use.

Tourniquet use in extremity trauma is controversial, and in civilian emergency medicine, the fear of tourniquet-related complications has all but eliminated the use of these devices as anything but an absolute last resort. Yet, the Israeli Defense Force (IDF) has for years advocated the liberal use of tourniquets, as have members of the Special Operations Forces community.[1-3] The concerns of those who advocate the tourniquet only as an option of last resort stem from the perception that the application of a tourniquet dooms the injured limb to amputation. The routine use of tourniquets in the operating room as well as U.S. military experience during World War II (WWII) and published Israeli military experiences refute this line of thinking. A large body of clinical and animal research into the safety of operating room tourniquet use has been performed, and pneumatic tourniquet use is now considered safe for up to 2 hours during surgery.[4] Following WWII, Wolff et al reported tourniquet applications of 4-6 hours without any apparent deleterious effects.[5] In Israel, Lakstein et al reported over 90 cases of tourniquet application in the IDF and found complications only after 150 minutes, none of which resulted in the loss of the injured limb.[1]

These and other reports of the successful and uncomplicated use of battlefield tourniquets led the USAISR, in 2003, to draft a new set of tourniquet use guidelines, incorporating the use of the devices as a standard, first-line battlefield hemorrhage control measure. The recommended doctrinal changes regarding tourniquet use have now been adopted into the Tactical Combat Casualty Care curriculum and issued as a supplement to the Soldiers' manual of common tasks. Instead of focusing on tourniquets as battlefield hemorrhage control measures of last resort, the new guidelines liberalize the criteria for the application of a tourniquet. In the case of a severe, bleeding extremity wound, a tourniquet is now considered first-line therapy while the casualty is under active fire. Re-evaluation of the casualty's condition and the continued need for the tourniquet is made by combat medics or other medical personnel when the situation is more secure. In already secure situations without ongoing combat, a tourniquet is used if the application of a pressure dressing or hemostatic bandage has failed to control the hemorrhage.

In the mid-1990s, the U.S. Armed Forces, led by CAPT Frank Butler and the Special Operations community, identified the need for an effective, easy-to-use, field-compatible tourniquet device.[6] The strap and buckle item in the inventory at that time, which had been issued since WW II, was found to be ineffective. Collaboration between USAMRMC and the U.S. Army Special Operations Command began in 1998 to discern the attributes of an ideal device and to begin the process of identifying, testing, and fielding a new tourniquet. Testing conducted in 2000-2001 at USAISR identified a device now known as the one-handed tourniquet (OHT) as an improved device over the available options, and recommendations were made to field this item. Feedback from Soldiers using the OHT led to an initiative from USAISR, in 2003, to identify an improved device. Using criteria developed by a multi-disciplinary military/civilian consensus panel, a call to industry was placed to provide candidate tourniquets for laboratory and field testing.[7] A number of devices were tested in the summer and fall of 2004, and in March of 2005. The Office of the U.S.

Army Surgeon General announced the pending issue of the approved individual Soldier tourniquet for fielding as a component of the individual first aid kit, to be carried by all Soldiers Army-wide.

The importance of tourniquet use in the effective treatment of severe battlefield extremity hemorrhage is clear. This changing doctrine represents a significant departure from the historical military aversion to the use of tourniquets. Together, the new doctrine and devices will undoubtedly lead to Soldiers' lives saved in ongoing and future conflicts.

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Laboratory Evaluation of the U.S. Army One-Handed Tourniquet

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***Objective**: To provide a physiological assessment of the U.S. Army one-handed tourniquet (OHT). **Methods**: An OHT was self-applied to maximum tolerable tightness to the proximal arm or thigh under different conditions and positions by 26 subjects and presence of blood flow was assessed using Doppler ultrasound or occlusion plethysmography. **Results**: Doppler sound was eliminated at the radial artery in all subjects with OHT application, but was not stopped at the popliteal or dorsalis pedis arteries of any subjects. The OHT reduced forearm blood flow by 79%, but only decreased leg blood flow by ~50% regardless of condition and position applied to the thigh. **Conclusions**: (1) the OHT appears to effectively minimize blood flow in the arm, but not in the lower extremities and(2) clinical assessment of blood flow disappearance by Doppler may underestimate the magnitude of actual blood flow to the limb.*

Introduction

It is estimated that 7 out of 100 combat deaths would be preventable with properly applied tourniquets.[1,2] Until recently, the only tourniquets available to the Soldier were the standard strap and buckle tourniquet (NSN 6515-00-383-0565) and the improvised tourniquet (windlass [stick] and cravat). The former has been recognized as ineffective since World War II, and the latter takes excessive time to apply.[3] The need for a rapidly deployable military tourniquet has been articulated for half a century, and recently it has been recommended that top priority be given to the development of an improved tourniquet capable of reliably stopping arterial bleeding, as well as rapid self-application with one hand.[4,5]

There is a need for an inexpensive, safe, and low volume/weight tourniquet in the military that is effective in controlling blood loss in extremity wounds.[5,6] Specific design characteristics were developed based on unpublished experimental data and input from user community representatives at the U.S. Army Medical Department and U.S. Special Operations Command. It was recognized that in meeting the desired physical tourniquet characteristics a trade-off may be necessary in that smaller, narrower tourniquets require greater circumferential pressures for arterial occlusion and may be associated with an increased risk of tourniquet related injury.[7-9] As a result, a OHT (NSN 6515-01-504-0827) has been designed, produced, and added to the U.S. Army inventory that meets expense (approx $8 U.S. per unit), volume, and weight criteria (Figure 1). In addition, the nylon and plastic material used to manufacture the OHT provides a long shelf life. This tourniquet system was specifically designed to be self-applied rapidly and easily with one hand in the event of a wound to an upper extremity that left only one hand available for tourniquet application. However, the OHT has not been tested to determine its efficacy in the occlusion of arterial blood flow when applied to either arms or legs of human subjects. Therefore, we conducted a series of experiments designed to test the effectiveness of the OHT in occluding arterial blood flow in both the upper and lower extremities. The purpose of the present investigation was to test the hypotheses that: (1) self application of the OHT to the proximal thigh or proximal arm will stop blood flow to the respective limbs; (2) if one OHT does not stop blood flow, the application of a second OHT will; and (3) when saturated with fluid, reduction in blood flow to the leg with self application of the OHT to the distal thigh will be as effective as the application of a dry OHT.

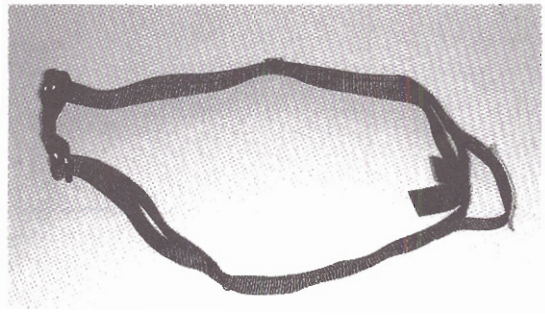

Fig 1. The OHT is slipped over the limb. The handle is pulled, causing the excess strap to pass between the D-rings and the tourniquet to be tightened.

Methods

Subjects. All procedures and protocols were reviewed and approved by the Institutional Review Board at the Brooke

Army Medical Center. After being informed of all procedures and risks, 26 healthy, normotensive, nonsmoking men and women (age range: 18-35 years) gave their written consent to serve as subjects in one of two experiments. Eleven subjects (6 males) participated in the initial experiment (Experiment 1), and 15 additional subjects (11 males) participated in second experiment (Experiment 2). Different subjects were used for the two experiments to minimize exposure time and the number of times the OHT was applied to any single subject. Prior to each experiment, height, weight, thigh and calf circumference, and baseline blood pressure and heart rate were measured in each subject. Demographic data of the subjects are presented in Table 1. After changing into medical scrubs designed to provide access to the arms and legs and completing an exposure period of 20 min in the supine position, each subject's baseline blood flow (Doppler ultrasound or occlusion plethysmography) was assessed on the limb targeted for OHT application. The OHT was self-applied to maximum tolerable tightness for each evaluation. Immediately after blood flow was reassessed during OHT application, the OHT was loosened to minimize discomfort to the subject.

	Experiment 1 (N = 11)	Experiment 2 (N = 15)
Age, yr	22 ± 1	23 ± 1
Height, cm	174 ± 3	176 ± 2
Weight, kg	74.4 ± 3.1	82.5 ± 2.8
Blood Pressure, mmHg		
Systolic	112 ± 4	117 ± 3
Diastolic	61 ± 3	64 ± 3
Mean	78 ± 3	82 ± 3
Heart Rate, bpm	68 ± 2	67 ± 3
Circumference, cm		
Arm	30.5 ± 0.9	32.5 ± 0.6
Distal Thigh	N/A	45.8 ± 0.8
Proximal Thigh	60.2 ± 1.4	59.8 ± 1.0

Table 1.

Experiment 1. While the subjects were supine, the dorsalis pedis, popliteal, and radial arteries were located by auscultation and marked. At these points, Doppler ultrasound was used qualitatively to assess the effectiveness of the OHT in stopping blood flow distal to the tourniquet. Two OHTs were placed 4 cm and 7 cm distal of the inguinal notch. Initially, the subject tightened the most proximal OHT on the thigh. The presence or absence of sound (pulsatile blood flow) at the dorsalis pedis and popliteal arteries was determined (Figure 2A). Subsequently, the subject tightened the distal OHT and assessment for presence or absence of sound was repeated. Following the experimental conditions for tourniquet application to the leg, the effectiveness of the OHT in stopping sound at the radial artery was assessed by application of the OHT around the proximal arm 5 mm distal of the deltoid insertion (Figure 2B).

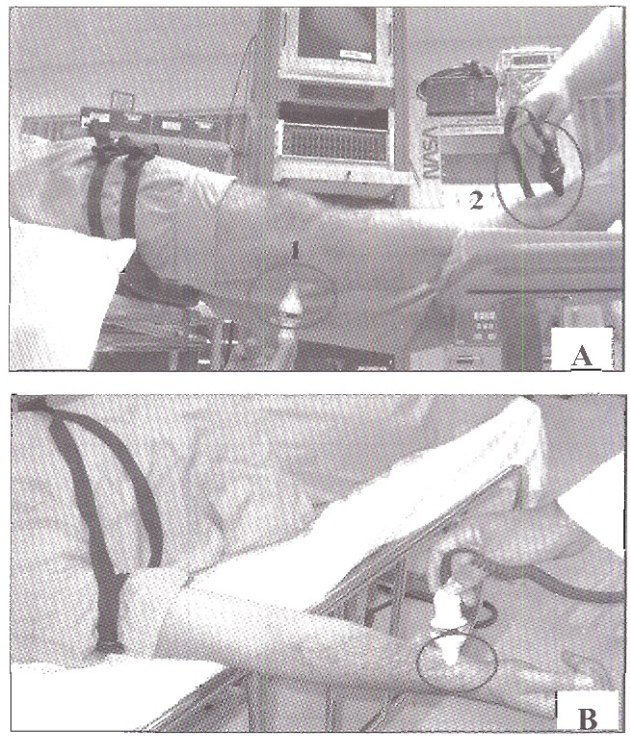

Fig 2. Placement of Doppler ultrasound sensors are shown at the popliteal artery (photo A, circle #1), dorsalis pedis artery (photo A, circle #2), and radial artery (photo B, circle). OHT placement on the thigh and arm is also shown.

Experiment 2. Venous occlusion plethysmography was used to assess the effectiveness of the OHT in reducing or stopping blood flow to the leg and arm. The use of a Whitney strain gauge for quantitative blood flow measurements in limbs is a well-documented procedure.[10-12] A dual loop mercury-in-silastic strain gauge was placed around the calf or forearm at the point of maximum circumference (Figure 3). Venous outflow from the distal limb was prevented by the placement of a cuff around the thigh or arm just above the knee or elbow using an occlusion pressure of 60 mmHg. An ankle or wrist cuff was inflated to a pressure of 250 mmHg for 1 min prior to the occlusion of venous outflow in order to isolate the circulation from the foot and hand, respectively. Venous occlusion was initiated for 10 s followed by the cuff's release for 10 s for 6 sequential occlusions. The relative change in strain gauge length over 10 s was quantified as a volume of blood per unit time. The use of the thigh or arm cuff was not needed to occlude venous blood flow when the tourniquet was applied. Blood flow was determined by the change in leg or forearm volume per unit time during the initial minute after the application of the tourniquet (Figure 4).

Fig 3. Placement of mercury-in-silastic (Whitney) strain gauge around the calf is shown with OHT placement on the proximal thigh.

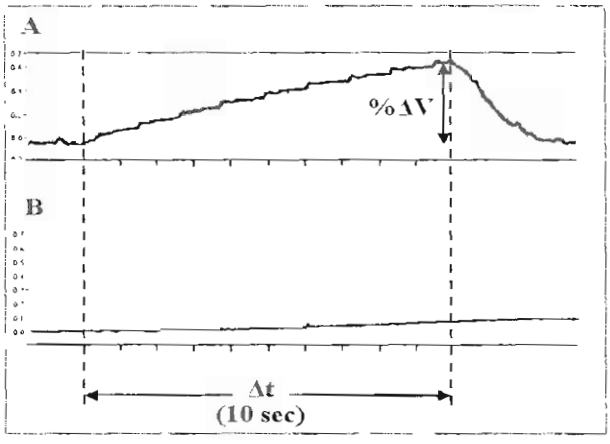

Fig 4 Plethysmographic record from the arm of a subject demonstrating a typical recording of the increase in strain gauge circumference (%ΔV) over a 10-second time interval (Δt) with (top panel A) and without (bottom panel B) application of the OHT. Blood flow is calculated by the ratio ΔV /Δt.

To test the effectiveness of the OHT in reducing blood flow to the limbs under varying conditions, the OHT was placed on the distal thigh (dry and saturated with water), proximal thigh (one and two OHTs applied), and proximal arm. The order in which OHT condition (wet or dry) and number of OHTs applied (one or two) was counterbalanced. The OHT was positioned 6 cm proximal of the patella, 4 and 7 cm distal of the inguinal notch, and 5 mm distal of the deltoid insertion for the distal thigh, proximal thigh, and proximal arm positions, respectively.

Data Analysis. Paired *t*-tests were used to compare limb blood flow values. Bonferroni correction was used to adjust the alpha level of 0.05 because of multiple comparisons. No statistical analysis was performed on the Doppler data because of the lack of variance (100% success or failure rates).

Results

Subjects. As a group, the subjects were normotensive active military personnel. Their demographic data are presented in Table 1. The circumference of location for placement of the OHT on the proximal thigh was approximately twice the circumference of location for placement of the OHT on the arm.

Experiment 1. The number of trials per application of the OHT that resulted in the absence of Doppler sound (blood flow) at the radial, dorsalis pedis, and popliteal arteries is presented in Table 2. The OHT was successful in stopping Doppler sound at the radial artery in all 11 subjects when applied to the proximal arm. In contrast, the OHT failed to eliminate Doppler sound at the popliteal or dorsalis pedis arteries in any of the 11 subjects when either one or two OHTs were applied to the proximal thigh.

	Dorsalis Pedis	Popliteal	Radial
1 OHT Proximal Thigh	0/11	0/11	N/A
2 OHT Distal Thigh	0/11	0/11	N/A
OHT Arm	N/A	N/A	11/11

Table 2. OHT Success Rate Using Doppler Auscultation at Different Arterial Locations

Experiment 2. The relative (%Δ) reductions in blood flow resulting from OHT application to the leg and arm are presented in Figures 5 and 6. When applied to the proximal arm, the OHT reduced blood flow from 2.9 ± 0.2 $ml \cdot dl^{-1} \cdot min^{-1}$ at baseline to 0.6 ± 0.1 $ml \cdot dl^{-1} \cdot min^{-1}$ following OHT application (t = 10.69, $P<0.0001$). When applied to the proximal thigh, the OHT

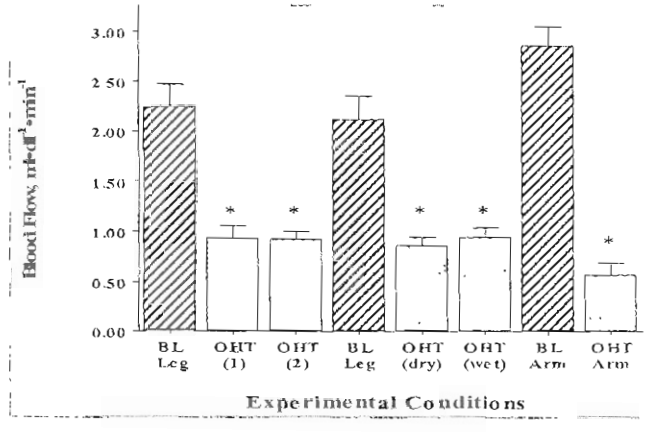

Fig 5. Mean (± SE) blood flow data during baseline conditions for the leg and arm (lined bars) and during applications of the OHT (dotted bars) under conditions of a single OHT applied on the proximal thigh (1), two OHTs applied on the proximal thigh (2), a dry OHT applied on the distal thigh (dry), and a wet OHT applied on the distal thigh (wet), and an OHT applied on the proximal arm (arm). Asteric indicates P<0.0003 compared to the corresponding baseline condition.

reduced blood flow from 2.2 ± 0.2 ml•dl^{-1}•min^{-1} at baseline to 0.9 ± 0.1 ml•dl^{-1}•min^{-1} following application of either one or two OHT (t >5.73, P< 0.0001). Finally, baseline blood flow was reduced from 2.1 ± 0.2 ml•dl^{-1}•min^{-1} at baseline to 0.9 ± 0.1 ml•dl^{-1}•min^{-1} (t = 5.87, P<0.0001) when a dry OHT was applied to the distal thigh compared to 1.0 ± 0.1 ml•dl^{-1}•min^{-1} (t = 4.72, P< 0.0003) when a wet OHT was applied to the distal thigh.

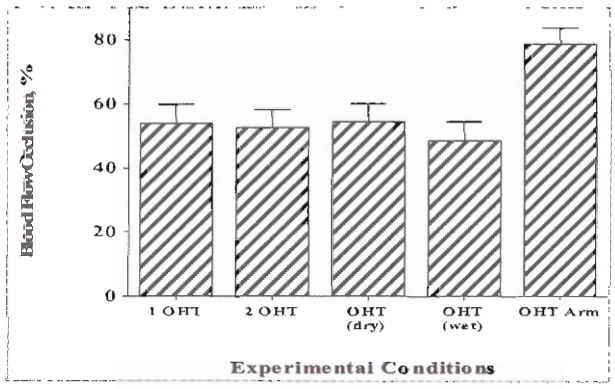

Fig 6. Mean (± SE) percent of blood flow occluded following applications of the OHT under conditions of a single OHT applied on the proximal thigh (1), two OHTs applied on the proximal thigh (2), a dry OHT applied on the distal thigh (dry), and a wet OHT applied on the distal thigh (wet), and an OHT applied on the proximal arm (arm).

Relationships Between Limb Circumference and Blood Flow Occlusion. In general, smaller average limb circumference of the upper extremity was related to a greater relative reduction in blood flow during application of the OHT as indicated by average blood flow reductions of 79% in the arm and 49%-55% in the leg. This corresponded to average arm and proximal thigh circumferences of 32.5 and 59.8 cm, respectively. However, correlation coefficients (r^2) calculated from individual limb circumferences and relative (%Δ) reductions in blood flow were 0.064 for the arm and 0.218 for the leg.

Discussion

OHT Application to the Arm. The primary objective of any tourniquet is to occlude arterial blood flow. Previous evaluation of possible tourniquets for combat far-forward settings established the criteria that a tourniquet must occlude detectable (Doppler) blood flow in at least 75% of the subjects in order for the device to be considered successful.[6] The specific requirement for a tourniquet that can be self-applied with one hand may be important for application to an upper extremity wound when the hand of the injured limb is not functional. From this standpoint, OHT application to the upper extremity appears to meet the criteria for a relatively effective approach of occluding blood flow in the arm. This notion was supported by the results from our study that demonstrated that 100% of our subjects were able to arrest detectable blood flow with OHT application to the proximal arm as determined by Doppler auscultation. The absence of Doppler sound with OHT application to the proximal arm corresponded to ~80% reduction in average forearm blood flow. This 80% reduction in blood flow to the distal arm could be of great significance in the event of an upper extremity injury. Since a 50% loss of a total blood volume of ~6 liters (~3 liters) is acutely life-threatening, we could expect a Soldier that has an arterial arm injury that loses 100 ml of blood per minute to "bleed out" in ~30 min in the absence of tourniquet application.[13] If the normal blood loss from such a wound could be reduced by 80% as indicated by the results of the present investigation, the amount of time required to reach a 50% blood volume loss (bleed out) would be increased by 120 min. Thus, OHT application to a major arterial wound to the arm could be expected to "buy" as much as two additional hours for the Soldier to receive the definitive care that could save his or her life. This could be the worst-case scenario because the reduced blood flow might allow spontaneous coagulation or effective control with hemostatic dressings to stop blood loss completely.

OHT Application to the Leg. In contrast to the arm, OHT application to the leg failed to stop detectable blood flow (Doppler auscultation) when applied to the thigh in any of the subjects. The presence of Doppler sound with OHT application to the thigh corresponded to a reduction in average leg blood flow of only ~50%. Although the blood flow to one leg is approximately 0.3 L/min at rest, bleeding from a severe wound can be exacerbated in a Soldier engaged in combat (during mild physical activity) when blood flow in the leg can be increased by 5- to 10-fold[14] Therefore, depending on the physical activity required during combat conditions, a wounded Soldier with a severe hemorrhage wound and blood flow of 1.0 to 1.5 liters/min in the leg may "bleed out" (lose 3 liters of blood) in as few as 2 minutes. The results of this investigation indicate that immediate application of the OHT may perhaps double this time. Under this scenario, it is unlikely that the additional 2 minutes would result in a lifesaving measure.

A recent panel of experts has questioned the specific requirement for a tourniquet that can be self-applied to a bleeding arm wound with the uninjured hand.[15] The panel was concerned that the design requirement for one-handed operation may be incompatible technically with the ability to occlude arterial flow in the lower limb adequately. This is because the pressure required to occlude blood flow in a limb increases exponentially with the circumference of that limb.[7,9,16] Thus, the lower limb requires much greater tourniquet pressure to occlude blood flow than does the upper limb. However, the vast majority of the battlefield wounds requiring tourniquet application occur in the lower limb where both hands should be available for tourniquet application.[17] Inasmuch, it is much more important that a battlefield tourniquet is first able to occlude

arterial flow in the lower extremity.[3] In an earlier survey, Calkins et al identified two strap-type tourniquets that did provide satisfactory arterial occlusion; both employed a ratchet device with a 1.75" strap.[6] However, neither was compatible with one-handed operation.

It is likely that the relatively narrow width (1") of the OHT was a primary contributor to its inability to stop leg blood flow effectively. Previous investigators have demonstrated clearly an inverse relationship between tourniquet width and minimum pressure required to occlude arterial blood flow.[7-9] That is, as the width of the tourniquet decreases, the pressure required to occlude arterial blood flow increases exponentially. Furthermore, as introduced previously, the pressure required to occlude blood flow in a limb increases exponentially with the circumference of that limb.[7,9,16] Thus, it was not unexpected that the OHT was more effective in occluding blood flow in the arm, which is approximately half the circumference of the leg. However, there existed great variability in blood flow occlusion within the same limb (for example, arm) across subjects, suggesting that factors other than limb circumference *per se* contributed (for example, subject strength, subject intolerance to discomfort, and tissue composition).

Based on the relationship between tourniquet width and occlusion pressure, described above, it might seem that the ineffectiveness of the OHT could be addressed by increasing the width of the strap. However, wider straps cause more friction through the D-rings and, consequently, prohibit pressure development in the tourniquet (unpublished observation). Also, as width increases, so does the amount of tissue that must be compressed increases, greatly increasing the effort required to produce tension.[18] Taken together, these two factors likely would further reduce the effectiveness of the OHT. It is theoretically possible to attain adequate occlusion pressure using a one inch wide tourniquet augmented with a mechanism that provides a mechanical advantage, such as a ratchet system. However, such a system could produce significant tissue damage. A wider tourniquet employing a mechanism other than that used in the OHT should be pursued in future development of an improved tourniquet for combat use.

Relationship Between Doppler Sounds and Blood Flow

The use of presence of sound obtained from Doppler ultrasound placed on arteries is a common method used by physicians to determine blood flow in extremities. With the use of occlusion plethysmography, a more sensitive technique, we demonstrated that a minimum of ~20% of baseline blood flow can be present in the absence of Doppler sound. Since the presence of sound obtained from Doppler auscultation relies on the presence of pulses, our results may reflect a pressure generated by OHT application that eliminates pulsatile blood flow but allows nonpulsatile flow. Our observations provide evidence that Doppler auscultation may overestimate the effectiveness of a clinical procedure designed to occlude blood flow (for example, a tourniquet) and underestimate the actual amount of blood flow present.

A recent panel of experts has questioned the specific requirement for a tourniquet that can be self-applied to a bleeding arm wound with the uninjured hand.[15] The panel was concerned that the design requirement for one-handed operation may be incompatible technically with the ability to occlude arterial flow in the lower limb adequately. The lower limb requires much greater tourniquet pressure to occlude blood flow than does the upper limb due to differences in limb circumference. However, the vast majority of the battlefield wounds requiring tourniquet application occur in the lower limb where both hands should be available for tourniquet application[17] Inasmuch, it is much more important that a battlefield tourniquet is first able to occlude arterial flow in the lower extremity.[3] In an earlier survey, Calkins et al identified two strap-type tourniquets that provided satisfactory arterial occlusion when self applied by subjects provided with distal pulse feedback; both employed a ratchet device with a 1.50" strap.[6] However, neither was compatible with one-handed operation.

Conclusion

There is an urgent need for an effective tactical tourniquet that can be rapidly self- or buddy-applied by the Soldier under fire. The current Army OHT represents a step towards satisfying that need. Although effective when applied to the arm, the inability of the OHT to occlude arterial blood flow in the lower extremity, when tightened to a pain threshold, emphasizes the need for continued development of tourniquet systems that can meet weight and cube requirements without sacrificing effectiveness and safety. We suggest that the need for one-handed application, while desirable, be secondary to effective arterial occlusion. Future designs for battlefield tourniquets must balance the need to meet size and weight requirements with established principles of tourniquet design.

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Laboratory Evaluation of Battlefield Tourniquets in Human Volunteers

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Objective: *To determine effectiveness of currently available commercial off-the-shelf (COTS) tourniquets in human volunteers when self-applied.* ***Methods****: Seven tourniquets were initially tested for efficacy (elimination of distal Doppler sound) in volunteer human subject's legs (Experiment I; n=18). Those found to be effective in ≥ 80% of subjects in Experiment I were then tested for effectiveness in the upper extremity (Experiment II; n=12).* ***Results:*** *Experiment I: Three of the seven tourniquets tested on the thigh were effective in 100% of the subjects tested; a fourth was effective in 88%. Experiment II: Three of the four successful tourniquets from Experiment I were also 100% effective in eliminating the distal pulse when applied to the arm. Reasons for tourniquet failure in either experiment included: mechanical limitations (design or construction), circumferential pain, and/or skin pinching pain.* ***Conclusion:*** *The Emergency Military Tourniquet™ (Delfi Medical Innovations, Inc); the Combat Application Tourniquet (Phil Durango LLC); and the Special Operations Force Tactical Tourniquet (Tactical Medical Solutions LLC) were all found to be 100% effective in occluding distal arterial Doppler sound on both the arm and leg when self-applied by volunteer human subjects.*

Introduction

Uncontrollable hemorrhage accounts for almost 50% of combat fatalities and up to 80% of civilian trauma fatalities within the U.S.[1,2] Standard field dressings and direct pressure for hemorrhage control have been shown to be inadequate in previous combat patients. Hemorrhage control has been a priority for the Department of Defense Combat Care Research Program for the last 10 years and research has recently focused on the development of various dressings for compressible areas, the use of systemic agents to control hemorrhage and improved tourniquets to help reduce mortality from exsanguinations.[3,4] The majority of combat wounds continue to occur in the extremities, and it has been estimated that 7 out of 100 battlefield deaths might have been prevented with a properly applied tourniquet.[5,6] The need for a rapidly deployable and effective tourniquet has been identified for at least a half century.[7] Recent combat experience has again advocated that "high priority" be given to the development of an improved, field-expedient tourniquet capable of reliably stopping arterial bleeding as well as having the ability for rapid self-application.[8,9]

The military has used several tourniquets in the past to include the standard strap and buckle tourniquet (National Stock Number [NSN] 6515-00-383-0565), the cravat and cotton strap tourniquet (NSN 6515-00-383-0565) and the one-handed tourniquet (OHT) (NSN 6515-01-504-0827). However, studies have demonstrated limitations with these devices. The strap and buckle tourniquet was recognized as ineffective as early as World War II and the cravat and cotton strap tourniquet has difficulties in self-application.[9,10] Also, a recent evaluation of the OHT found the tourniquet was unable to stop detectable blood flow (Doppler auscultation) when applied to the thigh in all subjects tested (n = 11) regardless of tourniquet location or thigh position.[11]

Because of the above stated limitations of the tourniquets currently in military use, the U.S. Army Institute of Surgical Research (USAISR) decided to test other currently available COTS tourniquets for effectiveness. The availability of potential COTS items for testing was determined by an informal internet search for trauma tourniquets as well as reports from military medical personnel involved in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) on the use of commercial products currently used in combat. Appropriate functional parameters, design criteria, cost, weight, size, effectiveness and testing procedures were based on previous literature and recommendations from an expert panel that convened at the 2003 Advanced Technology Applications for Combat Casualty Care Conference.[11,12] The consensus of this committee resulted in a Request For Information (RFI) document which requested letters of intent from parties interested in producing tourniquets for testing. The RFI was posted in Federal Business Opportunities website (**www.fedbizopps.gov**). Nine companies responded to the RFI

and were asked to provide 10 samples of their tourniquets for testing in human subjects at the USAISR. This article reports the results of testing these tourniquets in human volunteers.

Methods

Study Setting. This study was performed at the USAISR facility at Fort Sam Houston, TX. Established in 1943, the USAISR currently employs over 250 military and civilian personnel to provide requirements-driven combat casualty care research, medical solutions, and product development and testing.

Subjects. Approval for this study was obtained from the Brooke Army Medical Center Institutional Review Board. After being informed of all procedures and risks, 20 healthy, normotensive men and women age 23-47 years gave written consent to serve as subjects. Eighteen of the subjects participated in Experiment I (16 male, 2 female). Twelve subjects participated in Experiment II (10 male, 2 female). Ten of the subjects in Experiment II had also participated in Experiment I.

Tourniquets. Nine different tourniquet models were submitted to the USAISR for consideration to be tested. Tourniquet size, weight, and design features are summarized in Table 1. The candidates were as follows: Combat Application Tourniquet (CAT-Phil Durango, LCC) (Figure 1); Self-Applied Tourniquet System (SATS-Marketing Tactics, LLC) (Figure 2); Mechanical Advantage Tourniquet (MAT-Bio Cybernetics International) (Figure 3); Special Operations Forces Tactical Tourniquet (SOFTT-Tactical Medical Solutions, LLC) (Figure 4); OHT (H-dyne-Hemodyne Inc.) (Figure 5); Last Resort Tourniquet (LRT-Hammerhead, LLC) (Figure 6); Emergency Military Tourniquet (EMT-Delfi Mecial Innovations Inc) (Figure 7); London Bridge Tourniquet (LBT-London Bridge Trading Company, LTD); K^2 Tactical Tourniquet (K^2 -HGWV, LLC). Of the nine tourniquets received for testing, six are currently commercially available (CAT, SATS, SOFTT, LRT, EMT, LBT) and three are advanced prototypes (MAT, OHT, K^2) intended for eventual commercial marketing. Strap type tourniquets do not require approval from the U.S. Food and Drug Administration (FDA) as a medical device. The pneumatic EMT has been previously tested in humans and does have FDA approval.[13] Two tourniquets, LBT and K^2, failed to meet weight and/or size requirements established in the RFI and were excluded from further evaluation. A one-inch minimum strap width requirement was established for the safety of the subjects based on the principles that the pressure required to occlude blood flow is inversely proportional to tourniquet width, and the severity of tourniquet injury is directly proportional to tourniquet pressure.[14-16]

Study Design. This was a prospective observational study performed on 20 healthy human volunteers. Two separate experiments were conducted. The first experiment, Experiment I, tested tourniquet success at the level of the proximal femur. The second experiment, Experiment II, tested tourniquet success at the level of the proximal humerus. Both experiments

Tourniquet	Wt (g)	LxWxH (cm)	Strap Width (cm)	Mechanical Augmentation
CAT	59	266	3.8	Windlass (tensions strap within an outer sleeve)
SATS	136	448	3.8	Cam (tightens via cantilever system)
MAT	145	912	3.8	Block and Tackle (multiple pulleys within rigid outer frame)
SOFTT	160	746	3.7	Windlass (directly tensions strap)
H-dyne	174	692	2.8	Elastic (4 parallel elastic "bungee" cords)
LRT	183	410	5.1	Ratchet (similar to cargo strap)
EMT	215	491	9.1	Pneumatic (similar to blood pressure cuff)
LBT	260[b]	401	2.4[a]	Ratchet (similar to cargo strap)
K^2	990[b]	4,597	3.8	Clamp (modified wood clamp)

Abbreviations: CAT- Combat Application Tourniquet (Phil Durango, LCC); SATS – Self-Applied Tourniquet System (Marketing Tactics, LLC); MAT – Mechanical Advantage Tourniquet (Bio Cybernetics International), SOFTT – special operation forces tactical tourniquet (Tactical Medical Solutions, LLC); H-dyne – One-Handed Tourniquet (Hemodyne Inc.): LRT - Last Resort Tourniquet (Hammerhead, LLC); EMT – Emergency Military Tourniquet (Delfi Mecial Innovations Inc.); LBT – London Bridge Tourniquet (London Bridge Trading Company, LTD); K^2 - K^2 Tactical Tourniquet (HGWV, LLC).

Notes: Mechanical Augmentation refers to the method employed by each tourniquet to gain mechanical advantage in the tightening process.
a < 2.54 cm (device not tested) b > 250 g (devices not tested)

Table 1. Physical Characteristics of Candidate Tourniquets

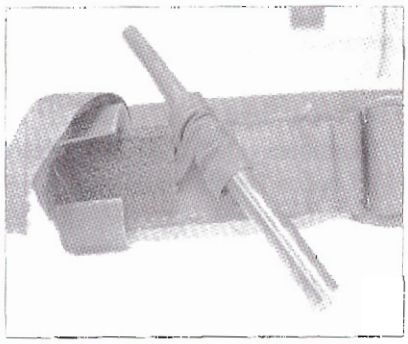

Fig 1. CAT. The rod acts as a windlass, tightening the inner strap within the outer sleeve with each turn. The strap on the left secures the windlass when the tourniquet is fully tightened.

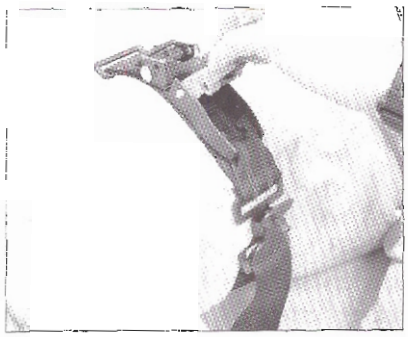

Fig 2. SATS. The cam system used in this tourniquet provided too little excursion to reliably and effectively occlude blood flow.

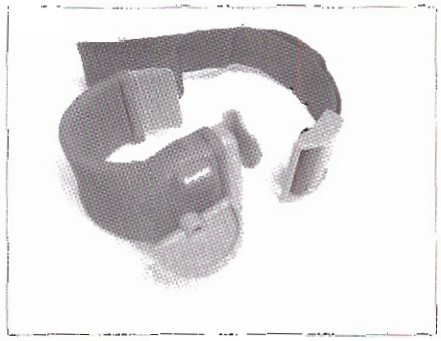

Fig 3. MAT. This device malfunctioned on some trials and severely pinched the skin. At the time of this writing, both issues have been addressed by the manufacturer.

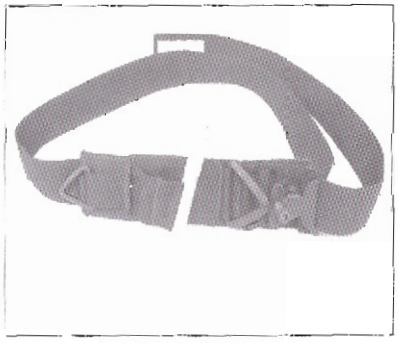

Fig 4. The SOFTT. The silver rod acts as a windlass, tightening the entire strap. The triangular pieces secure the windlass when the tourniquet is fully tightened.

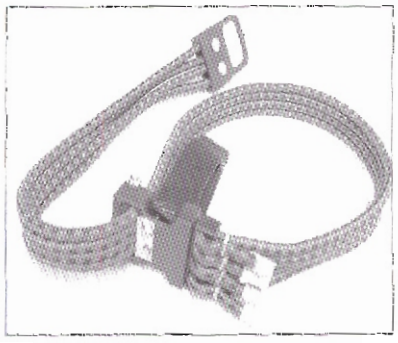

Fig 5. The OHT by Hemodyne. Tension is created by pulling the free end through the metal jaw. This tightens but also narrows the four elastic cords. The silver plate acts to prevent the cords from slipping, but makes it very difficult to release the device.

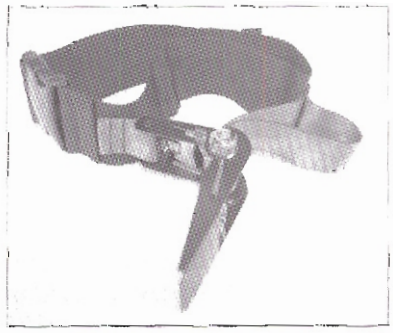

Fig 6. The LRT. The metal portion (similar to a cargo strap) contains a cam-and-ratchet device to tighten the outer strap. This device malfunctioned in some trials.

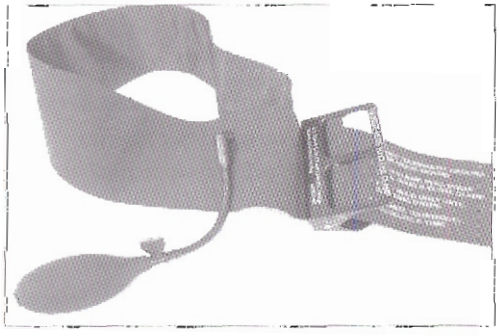

Fig 7. The EMT. The strap is wide and secured by the clamp to the right. The bladder within the strap is inflated with the bulb to tighten the device.

were conducted with the subjects wearing surgical "scrubs" of identical fabric composition. Prior to the experiment, each subject's height, weight, and limb circumference (Experiment I mid-thigh; Experiment II mid-upper arm) was measured and recorded. In addition, the subject's blood pressure and heart rate were measured and recorded. Baseline subject data are presented in Table 2.

All tourniquets were tested in a single session with each subject. Each tourniquet was assigned a number, and this number was used in conjunction with a random number generator to produce the order of testing for each subject. The primary endpoint of both experiments was the elimination of arterial blood flow by auscultation of the popliteal (Experiment I) or radial (Experiment II) artery by Doppler ultrasound (Imexdop CT+, Nicolet Vascular Inc). The Doppler provided the investigators and subjects with continuous auditory feedback during the tightening of each tourniquet. Prior to testing each tourniquet, subjects were instructed on how to properly apply each device according to the instructions provided by the individual manufacturers. During the experiments, subjects applied and tightened their own tourniquets, and were instructed to continue tightening the

	Experiment I – Leg (n = 18)		Experiment II - Arm (n = 12)	
	Mean ± SD	Range	Mean ± SD	Range
Age (yrs)	35.3 ± 7.3	23-47	35.5 ± 7.9	22-47
Weight (Kg)	83.4 ± 10.7	65-103	85.5 ± 13.9	65-103
Height (cm)	177 ± 7	163-188	178 ± 8	163-191
Limb Circumference (cm)	59.5 ± 4.6	51.5-67.5	34.0 ± 4.2	28.5-42.5
Heart Rate (beats/min)	65 ± 9	42-80	62 ± 7	50-72
Blood Pressure (mmHg)				
Systolic	122 ± 7	100-130	119 ± 6	110-128
Diastolic	75 ± 9	58-90	79 ± 4	70-88

Note: Subject data for male and female subjects is combined: Experiment I - 2 female, 16 male; Experiment II - 2 female, 10 male. The thigh circumferences of the 2 females fell into the 50th percentile for U.S. male Soldiers. The overall range of thigh circumferences was 51.5-67.5 cm, corresponding respectively to the 95th and 5th percentiles of U.S. male soldiers with 7/18 above the 80 percentile. (10).

Table 2. Baseline Characteristics of Subjects

tourniquet until either the audible signal ceased or the pain from the tourniquet became intolerable. If the subject successfully occluded blood flow, the tourniquet was slowly released to confirm re-establishment of Doppler signal and ensure that loss of signal was due to the tourniquet and not movement of the ultrasound probe. Subjects were aided by the experimenter to ensure proper and uniform placement prior to tightening each tourniquet.

In some cases, tourniquets broke or malfunctioned during a test. In these cases, the event was documented and the subject was asked to repeat the test with a new, identical tourniquet. Immediately upon release of every tourniquet, subjects rated their maximal pain (circumferential and pinching) produced during tourniquet application using the Numeric Rating Scale (NRS).[17] Separate pain scores were differentiated and documented for diffuse, circumferential pain from the tourniquet strap and localized pinching from one or more tourniquet components.

Experiment I. Seven tourniquets met the criteria to be tested in the leg. With the subject seated and the leg extended, the site of maximal popliteal Doppler signal at the level of the knee was located and marked. The subject positioned the tourniquet around their proximal thigh and secured it in place using both hands. The experimenter then re-established a Doppler signal, and the subject tightened the tourniquet. Subjects alternated between right and left legs, with 5 minutes between each test. The initial leg was alternated between each session (for example, subject 1 applied the first tourniquet to the right leg, subject 2, to the left). Tourniquets were required to occlude arterial flow in 15 of the 18 (83%) subjects to be considered successful and be tested in the arm.

Experiment II. With the subject seated and the non-dominant arm extended, the site of maximal radial arterial signal at the level of the wrist was located by Doppler auscultation and marked. Following instruction, the subject applied the tourniquet using their dominant hand. All other procedures were the same as those outlined in Experiment I.

Data Analysis. Data from the subject's NRS was analyzed using a Cochran-Mantel-Haenszel chi-square test. Significance was set at $P < 0.05$. Descriptive statistics used to describe Tourniquets were judged effective if they were successful in occluding arterial flow in $\geq$ 80% of subjects.

Results

Experiment I. The results of Experiment I are shown in Table 3. The CAT, EMT, and SOFTT were effective in all subjects. The MAT was effective in 88% (14/16) of the subjects

tested. The remaining three tourniquets all fell below the 80% level of acceptance. Causes of failure included intolerable pain, either circumferential or pinching; failure of the tourniquet to maintain tension (slipping); or the inability of the subject to generate the requisite tension to occlude flow (physical limitation). There were a total of seven mechanical failures, occurring in two of the devices tested: four MAT tourniquets and three LRT tourniquets. In these cases, the trial was repeated with a replacement tourniquet, and breakage is not reflected in the effectiveness data. Pain scores were only analyzed for tourniquets that met the acceptance level based on the elimination of Doppler pulse: the MAT, EMT, CAT, and SOFTT. The EMT resulted in significantly less circumferential pain than the other three effective tourniquets ($P < 0.05$). There was significantly less pinching in both the EMT and CAT compared to the remaining two devices ($P<0.05$).

Experiment II. The results of Experiment II are shown in Table 4. Three tourniquets were effective in all subjects tested. A fourth, the MAT, was effective in 75% (9/12). The failure of the MAT was due in all cases to intolerable pinching pain. The MAT produced significantly greater pinching pain than the other tourniquets ($P<0.05$).

	CAT	SOFTT	EMT	MAT
Percent Effective	100	100	100	75
Number Effective	12/12	12/12	12/12	9/12[a]

Note: a. Failure in all cases was due to intolerable pinching pain.

Table 4. Results of Experiment II

Discussion

Tourniquet Use. The use of tourniquets for hemorrhage control on the battlefield has a long history and their use can be traced as far as 1674 when the French Surgeon, Etienne J. Morel, introduced the stick, or windlass, to the common compression bandage.[18] French Army surgeon Jean Louis Petit, a French surgeon, is credited with inventing a screw tourniquet to control bleeding in 1718 which was still in use through the American Civil War.[18,19] Troops in the American Civil War were issued individual tourniquets for hemorrhage control on the battlefield. Tourniquet use on today's battlefield is common practice and is advocated by U.S. military experts and Soldiers.[5,6,8,20,21] Current military doctrine dictates the use of a tourniquet as first-line therapy for all "life-threatening" extremity hemorrhage in the first stage of Tactical Casualty Combat Care, that portion of care which occurs while the casualty is under active fire.[8,21,22]

The use of tourniquets to save lives in tactical and combat situations is a well documented phenomenon.[5,8,19] The tactical and combat environments possess unique challenges and other risks to pre-hospital providers and patients not inherently present in the usual urban, civilian setting. Applying a tourniquet in these environments clearly outweighs the risks. Although rare, there are also environmental and situational considerations that may necessitate the need for the civilian provider to resort to use of a tourniquet for hemorrhage control. Despite widespread use of tourniquets in the combat pre-hospital setting, the use of tourniquets in civilian and humanitarian emergency medicine remains a source of controversy.[23-26] Much of this controversy stems from concerns that tourniquets may be used inappropriately or even modified, in either case, potentially causing more harm to the injured limb than benefit to the patient. Civilian Emergency Medical Technician curriculum and textbooks allow the use of tourniquets only as a "last resort" for hemorrhage control if all

	CAT	SOFTT	EMT	MAT	LRT	SATS	H-Dyne
Percent Effective	100	100	100	88	67	44	22
Number Effective	18/18	18/18	18/18	14/16[a]	12/18	8/18	4/18
Number of Failures							
Circumferential Pain	n/a	n/a	n/a	1	2	2	4
Pinch Pain	n/a	n/a	n/a	1	1	0	0
Slipping	n/a	n/a	n/a	0	3	0	5
Physical limitation	n/a	n/a	n/a	0	0	8	5

Notes: a. N=16 due to failure to replace and retest two devices following mechanical failures

Table 3. Results of Experiment I

other methods have failed to control bleeding.[22,27] However, that same civilian literature mentioned earlier does recognize the "need for" and advocates for appropriate use of tourniquets in the right environments and medical situations.

Tourniquet Design. The primary endpoint in this study was for the complete occlusion of distal arterial blood flow by Doppler detection. Military experts consider any tourniquet that fails to occlude distal arterial flow to be unacceptable.[10,12] A tourniquet tight enough to occlude venous but not arterial flow may exacerbate hemorrhage from injured arteries and cause significant injury to underlying and distal tissues. In addition, an inadequate tourniquet may cause significant bleeding from damaged soft tissues distal to the device by allowing continued arterial flow to these tissues with occlusion of venous return to the circulation.[28] Fewer than half of the COTS tourniquets evaluated in this study effectively eliminated distal arterial blood flow in >80% of tested subjects. This has significant implications in the potential use of commercially available but ineffective devices to control life-threatening hemorrhage.

The term "tourniquet" is derived from the French word *tourner* meaning "to turn." This derivation implies what is seen clinically and was seen in this study: that in order for a tourniquet to be effective, it must employ some type of mechanical advantage to occlude blood flow. The use of mechanical advantage allows the tourniquet strap to overcome the barrier of soft tissue between the skin and the proximal vessel and provide compression to the deep tissues. This is especially important in the lower extremity, both because the majority (68%) of combat injuries requiring a tourniquet occur there, and because the pressure required to occlude blood flow increases exponentially with limb circumference.[14,19,29,30] All of the devices that we tested employed some type of mechanical advantage, however, only those devices employing a windlass (CAT, SOFTT), a block-and-tackle system (MAT), or pneumatic compression (EMT) were able to occlude flow in the lower extremity of more than 80% of subjects.

An additional consideration in tourniquet design is the width of the strap. For pneumatic tourniquets, it has been shown that a wider tourniquet allows for occlusion of blood flow at lower pressure, thus helping to minimize the potential for damage to underlying tissues. Animal studies have demonstrated that there is a direct relationship between nerve injury and tourniquet pressure and the majority of nervous complications following tourniquet use during extremity surgery can be attributed to the accidental over-inflation of the tourniquet.[15,31,32] In the present study, intolerable pain was one criterion for failure. The use of pain as a criterion for success could be argued as an unfair test of a tourniquet's effectiveness in a life-threatening situation, in which pain is a secondary concern to hemorrhage control. However, the extent of tourniquet pain induced by a given device is likely related to the potential for compression injury to the underlying nerves, thus self-limitation with intolerable pain acts as an indirect screen for the tissue compression and subsequent damage caused by the tourniquet. The EMT produced significantly less circumferential pain in both the leg and the arm than the other effective devices. Combined with the established relationship between tourniquet width and effective occlusion pressure, it is reasonable to assume that the elimination of Doppler pulse with this device occurred at a lower pressure than the other tourniquets tested.[14]

It is important to note that increasing the width of a strap type tourniquet increases the amount of tissue that must be compressed, greatly increasing the effort required to produce tension. Additionally, as the width of a strap increases and tension is applied, it tends to bow, transmitting relatively more pressure to the center than to the edges, and effectively reducing the functional width.[13] The optimal width of a strap type tourniquet remains to be determined.

Limitations

This study has several limitations worthy of discussion. A limited number of companies responded to our request for participation, thus there are likely one or more available effective tourniquets that were not included in our testing. The corollary to this is that it is conceivable that there are some other currently available tourniquets that are ineffective. In order to ensure subject safety, we had to modify the H-Dyne tourniquet from the original manufacturer's design and remove a serrated metal plate that was meant to secure the device to prevent slippage. With this plate in place, expeditious removal of the device was impossible and it was considered to be unsafe. This modification did not substantively alter the results of the study, however, as even if all slippage failures were counted as successes, the success rate in the lower extremity was only 50%.

It is important to note that we made no attempt to simulate field conditions. Potential interactions with field clothing, challenging environmental conditions, and user education in tourniquet use remain to be evaluated. Next, use of Doppler auscultation as an end point does not represent 100% distal arterial occlusion. Wenke et al found that as much as 20% of blood flow can occur despite loss of Doppler signal.[11] Finally, the use of pain as an end point may have mislabeled some tourniquets as "failures," realizing that subject human protection was more important than overcoming this possible limitation.

Conclusion

Tourniquets for combat use have received significant

interest from field health care providers as well as Soldiers and leaders in all branches of the U.S. military. As a result, the fielding of effective, safe, simple, and field-expedient tourniquets has been identified as a high priority by Department of Defense medical commands. In this study, the EMT (Delfi Medical Innovations, Inc), the Combat Application Tourniquet (C-A-T) (Phil Durango LLC), and the Special Operations Force Tactical Tourniquet (Tactical Medical Solutions LLC) were found to be 100% effective in occluding distal arterial blood flow based on Doppler auscultation on both upper and lower extremities in the laboratory environment.

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The Chitosan-Based Hemostatic Dressing: Experience in Current Combat Operations

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Background: *Hemorrhage remains a leading cause of death in both civilian and military trauma patients. The HemCon® chitosan-based hemostatic dressing is a U.S. Food and Drug Administration (FDA) approved bandage for hemorrhage control. Previous animal data have shown the HemCon® dressing to reduce hemorrhage and improve survival. The purpose of this case series is to report the hemostatic efficacy of the dressing in combat casualties.* ***Methods:*** *A request for case information on use of HemCon® dressings in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) was sent to combat medics, physicians, and physician assistants.* ***Results:*** *Forty-eight uses of the HemCon® dressing were reported and reviewed by two U.S. Army emergency medicine physicians. Four of the 48 cases were determined duplicative resulting in a total of 44 combat uses. Dressings were utilized externally on the chest and abdomen in 19 cases, on extremities in 23 cases, and on neck or facial wounds in 2 cases. Dressings were appropriately utilized after gauze failed 66% of the time. In 42 (95%) of the cases, the use of the HemCon® dressing resulted in a cessation or marked improvement in hemostasis. Dressings were reported to be most useful in areas where a tourniquet could not be applied to control bleeding. The dressings were reported to be most difficult to use in extremity injuries where they could not be placed easily onto or into the wounds. No complications were reported.* ***Conclusion:*** *The HemCon® dressing appears to be an effective hemostatic agent for combat casualties.*

Introduction

Uncontrollable hemorrhage accounts for almost 50% of combat fatalities and up to 80% of civilian trauma fatalities within the U.S.[1,2] Standard field dressings and direct pressure for hemorrhage control have been shown to be inadequate in previous combat patients. Therefore, hemorrhage control has been a priority for the U.S. Army Department of Defense Combat Casualty Care Research Program for the last 10 years. Research has focused on the development of various dressings for compressible areas, improved tourniquets, tourniquet guidelines, and the use of systemic agents (rFVIIa) to control hemorrhage and reduce mortality from exsanguination.[3,4]

A number of hemostatic agents and bandages have undergone animal studies to compare hemorrhage control, morbidity and mortality with some success.[3,5-10] Also, there have been reported success in two recent human studies for hemorrhage control with these agents.[11,12] King et al reported that a new dressing, the Modified Rapid Deployment Hemostat, successfully stopped bleeding in nine out of 10 patients with high grade liver injuries who failed conventional hemorrhage control therapies.[11] The results of these studies suggests pre-hospital use of some new hemostatic agents may decrease mortality related to hypovolemia and have led to recommended use in the Pre-Hospital Trauma Life Support textbook.[13]

Currently, military medical personnel are using two of the new hemostatic products in combat operations to include Quickclot and the HemCon® chitosan-based dressing, with reported success. This study describes the use of the HemCon® dressing in current combat operations by military medical personnel for external hemorrhage control.

Materials and Methods

This study describes the results from clinical practice in hemorrhage control in a combat zone. In 2003, just prior to the start of OIF, the HemCon® dressing was approved by the U.S. FDA and 2,500 were distributed to U.S. Special Operations Military medical personnel. Initial distribution was to forward deployed medics and was followed by a more general distribution to physicians and physician assistants located in both Iraq and Afghanistan as more bandages became available. Over 40,000 dressings have now been distributed. Providers were instructed to utilize the dressings in cases where other standard techniques had failed or if they thought there was a high likelihood of failure with standard techniques. Instruction and training on use of the bandage was based largely on review of the packet insert by all providers.

In Nov 03, in an effort to discern any issues related to usage of these dressings, those forward deployed medical personnel

who initially received HemCon® dressings, were contacted by the authors on use and performance of the dressing (Table 1). Initially, six successful cases were reported. A second larger scale request was put out in early 2004 requesting information on hemorrhage control success and failure for the HemCon® dressing. This request resulted in another 38 cases reported. Due to security reasons and combat situations, most of these cases were based on verbal reports of HemCon® dressing usage and success.

1. Anatomical area of injury
   Extremities Trunk/Abdomen Groin Head/Neck

2. Type of bleeding
   Arterial Venous/mixed Unknown

3. Other hemostatic measures attempted first?
   Gauze Pressure dressings Other_____

4. Was the HemCon® dressing applied before other measures?
   Yes No
   Comment_____

5. Was the HemCon® dressing effective in hemorrhage control?
   Complete Partial None
   Comments_____

Table 1. HemCon® Dressing Data Collection Sheet

The authors received approval to conduct a retrospective review of these cases from the institutional review board at Brooke Army Medical Center, Fort Sam Houston, TX.

Results

A total of 48 cases of HemCon® dressing use was collected over a 1-year period and reviewed by two U.S. Army emergency physicians. Four cases were determined to be duplicate reports of HemCon® dressing experience. Thus, a total of 44 unique cases are described. No adverse effects or complications were noted with dressing use. The anatomical distribution of the HemCon® dressing use in combat patients is summarized in Table 2. The majority, 52%, of dressings were applied to wounds located on patient's extremities while 43% were applied to wounds located on the chest (trunk) and abdomen. The remaining two uses of the HemCon® dressing consisted of a face and a neck wound. Bleeding was from a predominantly venous source in 14 cases, arterial source in four cases, and unknown in 26 cases (Table 3). The dressings were applied in the pre-hospital setting by medics. No dressings were used in a body cavity.

Extremity	23
Chest/Abdomen/Groin/Buttock	19
Head/Neck	2

Table 2. Anatomical Location of Injury

Arterial	4
Venous/Mixed	14
Unknown	26

Table 3. Probable Source of Bleeding

In 29 (66%) of the cases, the HemCon® dressings were used after failure of traditional dressings such as gauze Kerlex® and pressure dressings such as an ace wrap. In the remaining 15 cases, it was unclear if any methods had been tried prior to HemCon® application. In 42 (95%) of the cases reported, the use of the HemCon® dressing resulted in complete cessation or marked improvement in bleeding. One unsuccessful case described attempted dressing use on an extensive face wound that had persistent bleeding from areas where the dressing could not cover. However, where the dressing was able to be applied, hemostasis was achieved. The other unsuccessful case involved use of the HemCon® dressing on a foot laceration from broken glass. The dressing initially was ineffective because the bandage could not be applied effectively onto the small wound. However, when the dressing was then torn into small pieces and placed into the laceration, hemostasis was attained.

Discussion

The two hemostatic agents used currently in combat operations are QuickClot and the HemCon® dressing. QuickClot, which has been used in combat operations since 2002, is an FDA-approved product that uses zeolite granules for hemorrhage control and has demonstrated potential in animal models.[6,8,9] QuickClot was also reported to be successful in a human case of severe hemorrhage from multiple gunshot wounds.[12] The granules were applied to three external wounds which resulted in cessation of bleeding from these sites. However, a potential side effect of the granules is the production of an exothermic reaction in the wound, which potentially could cause collateral organ and tissue damage.[7,8]

The HemCon® dressing is an FDA-approved hemostatic agent currently used in the combat environment for the external temporary control of severely bleeding wounds, and also has demonstrated potential based on animal work.[9,10,14] Chitosan is a biodegradable, nontoxic, complex carbohydrate derived from chitin (poly β [1 to 40]-N-acetyl D-glucosamine), a naturally occurring substance. Chitosan is the deacetylated form of chitin. The generic term chitosan generally is applied when the extent of deacetylation is above 70% and the generic term chitin is used when the extent of deacetylation is insignificant, or below

20%. In the form of an acid salt, chitosan demonstrates mucoadhesive activity.[15] This makes it an ideal candidate for a hemostatic agent. A variety of forms of chitosans have been used to enhance hemostasis in animal studies involving bleeding from esophageal varices, arterial catheter puncture sites, peritoneal abrasions, or similar experimental insults [16-21]

The HemCon® dressing is a freeze-dried chitosan-based dressing designed to optimize the mucoadhesive surface density and structural integrity of chitosan at the site of injury. The current version of this dressing is sold commercially as a 10 cm x 10 cm x ~2 mm thick square dressing with nonabsorbable backing, and is packaged in a vacuum sealed aluminum pouch (figure). The prototype version of this dressing significantly reduced blood loss and resuscitation fluid use, and improved hemostasis and survival in an experimental model of severe hepatic injury and hemorrhage in swine.[10] In a subsequent study that employed the commercial version of the dressing, the HemCon® dressing controlled bleeding in five of seven attempts in an experimental model that included transection of the femoral artery and vein in pigs.[9] The authors of the latter study noted that the dressing resulted in "superb hemorrhage control" in five instances but failed completely in two others, raising issues with dressing-to-dressing variability. There is evidence suggesting that the HemCon® dressing may act by enhancing platelet function and by incorporating red blood cells into the clot that forms at the site of the wound.[17,22] However, it currently appears that the hemostatic effects of the HemCon® dressing are due principally to its mucoadhesive properties.[10]

Fig. HemCon® chitosan-based hemostatic dressing courtesy of HemCon, Inc.

In this case series, the medical providers felt the bandages were most beneficial in cases where a tourniquet could not be utilized due to the proximity of the injuries (groin, axilla) or inability to otherwise apply a tourniquet such as a neck or face wound. Also, in one case, the bandage was utilized successfully on a leg wound in lieu of a tourniquet to allow the injured Soldier to return briefly to an ongoing combat operation.

The bandage was felt to be of less utility in small extremity injuries where standard treatment alone would be effective. It was reported that the HemCon® dressing may have been utilized "overzealously" in 12 extremity cases. In these injuries, the supervising physicians who eventually received these casualties felt that gauze dressings alone may have been as effective as the $100 bandage. Due to the stiffness of the bandage, it was also found to be more difficult to apply in small extremity wounds.

The need for hemorrhage control is not limited to combat medicine. Uncontrolled hemorrhage accounts for up to 80% of early civilian trauma deaths. The ideal hemostatic dressing would require little training; be nonperishable, durable, flexible and inexpensive; adhere to the wound only; pose no direct risk of disease; not induce a tissue reaction; and effectively control hemorrhage from arterial, venous, and soft tissue bleeding. As described in this small case series and in animal studies, the HemCon® dressing seems to meet many of these requirements.[9,10,14] Although we did not evaluate efficacy beyond initial use of the dressing, there were no reports of adverse effects with bandage use. This is the first case series to document "real-world" use and efficacy of the HemCon® chitosan-based hemostatic dressing for external hemorrhage on human patients.

This study is retrospective and observational by design and thus has several limitations. Data were collected and based on verbal and written accounts of HemCon® dressing use, rather than complete patient records due to security reasons and combat situations. Thus, selection and recall bias may affect the results reported. Also, because this study focused only on acute hemorrhage control, the long-term follow-up was absent. While no adverse outcome reports have arisen, it is possible that hemostatic failure occurred after the initial application as well as other possible complications from bandage use such as infection, delayed wound healing, and increased scaring.

In conclusion, the HemCon® chitosan-based hemostatic dressing appeared to be an effective adjunct for the control of external hemorrhage in this case series of combat injuries. No other adjuncts were required to control bleeding in 95% of the reported cases. Further human prospective controlled studies are warranted.

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Can We Provide Level III Damage Control Surgical Procedures at a Level II Facility?

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Introduction

Most experienced combat surgeons who have been involved in multiple damage control laparotomies and extremity amputations will tell you that wounded arrive to a surgical facility in one of three prognostic states. The first group of patients are the least injured and will do well without immediate care or even survive a prolonged duration before a surgical procedure and require minimal blood product support (approximately 100% survival). The second group is the massively injured patient with multiple large tissue defects and destruction that will not survive under any circumstances, despite any imaginable intervention available at this time in history (0% survival). The third group are those that arrive in Class IV shock, cold, coagulopathic and acidotic with a wounding pattern that is amendable to immediate surgical hemostasis (ligation of vessels and packing of wounds). These casualties will die unless maximal efforts are made at blood product replacement and patient warming. These patients often require 10-50 units of Packed Red Blood Cells (PRBCs), Factor VIIa (rFVIIa), and fresh whole blood to survive in the first 24 hours. This third group of patients currently are candidates for damage control surgical procedures at our Level IIb facilities.[1] Damage control surgery in civilian trauma centers is based on the U.S. Navy term used to describe "the capacity of a ship to absorb damage and maintain mission integrity."[2]

Translating this idea to surgery of severely injured trauma patients evolved into a three phase process; (1) an initial "damage control" abbreviated laparotomy to stop all hemorrhage and gastrointestinal tract soilage; (2) Intensive care unit (ICU) resuscitation and rewarming; and (3) return to the operating room (OR) for definitive treatment of all injuries when maximally stabilized.[3] While the civilian paradigm utilizes a damage control "trilogy," the deployed military damage control paradigm has the additional challenges of a tactical evacuation to a surgical facility and then a helicopter evacuation in the middle of the ICU resuscitation and possibly a global evacuation to Germany or the continental United States before or after the definitive operation. The goals for resuscitation in civilian trauma center ICU before transfer to OR are stated as a temperature >36^{0}C, Base deficit >-5, normal lactate, Prothrombin time (PT) <15 seconds, Partial thromboplastin time (PTT) <35 seconds, platelets >50,000, FiO_2 of <0.50.[4] Optimally, these same goals for resuscitation should apply to Level IIb facilities prior to helicopter evacuation to the next echelon of care. One could make the argument that these goals for resuscitation are of even more importance to deployed military damage control as the physiologically challenging helicopter evacuation provides minimal opportunities for in-flight monitoring and continued resuscitation. Due to logistical limitations in an austere environment, the OR/ICU resuscitation phase of damage control currently represents the greatest challenge to currently deployed FSTs.

This article will evaluate the differences in the surgical capabilities of the Level IIb facility (FST) compared to a Level III facility Combat Surgical Hospital (CSH) and elucidate the small yet significant changes that can be made to give the Level IIb facilities the capability to rewarm and adequately resuscitate damage control patients. These changes need to be made and still retain the unique mobility of the FST. While the CSH has many capabilities (for example, Dental, CT scanners, etc) not directly involved with damage control, we will concentrate only on the "surgical slice" from emergency room (ER) to

	LEVEL IIB	LEVEL III
Chest Tubes	+	+
X-Ray	-	+
Surgical Airway	+	+
Ventilations	+	++
CRNA	+	+
Anesthesiologist	-	+
MEDIC	+	+
Nurse	+	++
PRBCs	+	+++
Pneumatic Tourniquets	-	+
Ultrasound	+	+
ProPaq® Monitor	+	+

Table 1. ER Capabilities

postoperative monitoring and will evaluate the feasibility of providing Level III damage control at the Level IIb facilities. Increasing the survival rate of patients undergoing damage control procedures may represent the only way to significantly decrease the died of wounds rate of combat wounded arriving alive to facilities with surgical capability in current and in any near future conflicts.

The following tables (see Table 1, page 62) will compare current capabilities of Level IIb and Level III facilities.

	Level IIB	Level III
Overhead Lighting	+	++
Headlamps	+	++
Buchwalter Retractor	-	+
Balfour Retractor	+	+
Laparotomy Pads	+	+++
GIA Staplers	+	+++
Central Line	+	+
Arterial Line	+/-	+
Vascular Instruments	+	++
Vascular Shunts	+	+
External Fixators	+	++

Table 2. Operating Room

	Level IIB	Level III
Swann-Ganz	-	-
Central Venous Pressure	+/-	+
Echocardiography	-	+
Vital Signs/EKG	+	+
Urine Output	+	+
Chest X-ray	-	+
Bronchoscopy	-	+
POSTOP LABS:		
Base Deficit (ISTAT®)	+/-	+
Lactic Acid (ISTAT ®)	+/-	+/-
Hematocrit (ISTAT®)	+/-	+
Electrolytes (ISTAT®)	+/-	+
Platelets	-	+
PT/PTT (ISTAT®)	+/-	+
Thromboelastography	-	+/-

Table 3. Recovery Room—Postoperative Monitoring

	Level IIB	Level III
Room Temp	+/-	++
Thermal Head Cap	+	+
Baer Hugger®	+/-	+
Fluid Warmer	+/-	+
Ventilation Warmer	-	+/-
CAVR	-	+/-

Table 4. Patient Warming

	Level IIB	Level III
PRBCs	+	+++
Whole Blood	+/-	+++
Fresh Frozen Plasma	-	+++
Platelets	-	-
Cryoperecipitate	-	++
Factor VIIa	+/-	++

Table 5. Blood Component Availability Comparison

	Level IIB	Level III
General Surgeons	3	3-7
Vascular	+/-	+/-
Thoracic	+/-	1
Orthopedic	1	2-4
Neurosurgeon	-	+/-
Urology	-	1
ENT	-	-
OMFS	-	1-2

Table 6. Surgical Personnel Comparison

	Level IIB	Level III
Emergency Room	+	+
Operating Room	+	++
Postoperative Care	+	++
Hypothermia Prevention	+/-	++
Blood & Blood Products	+/-	+++

Table 7. Overview Level IIB Versus Level III = Comparison of Capabilities

Discussion

Emergency Room. The combat wounded who arrive straight from the field or from a Level I facility are initially evaluated in the civilian equivalent area of a trauma bay. The capabilities for treating trauma patients at these two facilities are very similar (Table 1). Following the lead of civilian trauma centers using "hypotensive resuscitation" blood product transfusions in the ER are limited.[5] The only blood products available for initial resuscitation at both Level IIb and Level III are uncrossed matched PRBCs. The minority of Level IIb facilities have a fluid warmer/rapid infusion system (for example, Level One® or Belmont®). While the Level III facilities have the capability to perform a chest X-ray, if a patient arrives at a Level II facility with the question of a pneumothorax this entity can be made irrelevant by the placement of bilateral chest tubes. Unstable blunt trauma patients can be evaluated by abdominal ultrasound at both facilities (for example, Sonosite®). Overall, the care and resuscitation of the damage control casualty in the trauma bay at current Level IIb and Level III should be considered equivalent.

Operating Room. The majority of damage control procedures are performed by two general surgeons at both facilities. The major differences in the operating theatres is the inability to control temperature at Level IIb, limited critical supplies, and blood products. While overhead lighting at the Level IIb facilities is limited, the availability of excellent headlamps can make the difference in operative lighting negligible during the majority of damage control procedures. A standard operating table with the addition of a Buchwalter retractor at Level III can be negated with the use of medic and OR tech hand held retraction. The quantity of laparotomy pads and GIA staplers often are a concern at Level IIb facilities and are more available at Level III facilities (Table 2).

Overall, general surgeons skilled in trauma care can technically perform damage control surgical procedures in current Level IIb facilities as can be performed in Level III facilities.

Postostoperative Care. The postoperative monitoring of patients in the ICU setting is based mainly on vital signs, urine output, hematocrit and ISTAT® base deficit (lactate cartridges are available from the ISTAT® manufacturer but were not used routinely in Operation Iraqi Freedom [OIF] -1 or OIF-2). Many Level IIb facilities have the laboratory values from an ISTAT and this is also used frequently at the Level III facilities. The PT and the PTT are determined at the Level III laboratory and are not available for Level IIb surgeons. While arterial line monitoring and central venous pressure monitoring are available at both the majority of Level IIb facilities and Level III facilities, Swann – Ganz catheters are not and would be of little help in but possibly a few older patients with clinical confusion regarding resuscitation. The limited number of nurses available to a Level II facility would of course limit the number of postoperative patients that could be monitored.

Overall, the equipment capabilities of Level IIb and Level III are very similar for monitoring an individual postoperative damage control patient (Table 3).

Blood/Blood Products. Level IIb facilities have at least 20 units of PRBCs but no other blood products available (Table 4). In the authors experience, a single damage control patient has required up to 50 units of blood and blood products within the first 24 hours during OIF-2 and survived. Patients in civilian trauma centers undergoing the initial damage control operations have massive blood and blood product transfusion requirements with one recent study documenting an average of 11.2 units of PRBCs, 3.5 units of Fresh Frozen Plasma (FFP) and 4.9 units of platelets.[6] These civilian transfusion requirements documented to increase to 20.4 units of PRBCs, 5.4 units of FFP, and 7.7 units of platelets transfused for patients described as the "maximum injury subset."[7] Eastridge et al in a review of all patients undergoing a damage control operation during OIF documented an average transfusion requirement of 8.6 units of PRBCs and 0.64 units of whole blood in the first 24 hours for an estimated intraoperative blood loss of 2,384 ccs.[8] Sebesta, et al documented an average transfusion requirement of 12 units of PRBCs, seven units of FFP and 2.5 units of whole blood in 92 patients undergoing damage control laparotomy at the 31st CSH in OIF during 2004.[9] Obviously, one to two damage control patients will deplete the entire PRBC supply at a FST and will have no ability to transfuse clotting factors or platelets to these hypothermic and coagulopathic patients.

Many FSTs have the ability to draw whole blood but the donor pool is usually very limited and finite. Furthermore, few FSTs have the capability to blood type potential donors. Level III facilities can provide FFP, whole blood drives, cryoprecipitate, unlimited PRBCs by air transport and large on site storage. The Level IIb facilities only method of replacing blood coagulation factors and platelets is to transfuse whole blood which can be very challenging, especially without cross matching and in the face of multiple patients. Factor VIIa, a medication that helps reverse the coagulopathy of trauma, is available at Level III facilities and at some Level IIb facilities.

Thermoregulation. The methods of patient rewarming at the Level III facilities is the use of warm intravenous fluids and blood via a Belmont® or Level One® fluid warmer, Baer Hugger® heating blanket, and warm ambient room temperature. Level IIb facilities have mixed capabilities (this needs to be universal by MTOE) with some having the fluid warmers and Baer Huggers®. The ambient room temperature is

not a problem in the summer months in Southwest Asia but, during the winter months, room temperature regulation is varied and needs to be universal. The assurance of the universal mandatory acquisition of Baer Huggers®, fluid warmers, and room temperature control at the Level IIb facilities will make patient warming essentially equivalent to the capabilities at the level III (Table 5).

Bottom Line

Blood and blood product transfusions coupled with hypothermia are the "Achilles' heel" of providing optimal damage control surgery at the Level IIb facility (Table 6).

Employment of FSTs

Focused improvements in the capabilities of FSTs ability to optimally perform damage control surgery is extremely important because during the maneuver phase of a conflict only they can move with the Brigade Combat Teams. Their austere nature is what makes the FST able to maneuver. This same austerity is what makes it of limited use when compared to the expanded capabilities of the CSH, when they become available. This becomes especially obvious when receiving multiple casualties. Due to their inherent limitations, FSTs should be replaced by the robust CSH and the FSTs should redeploy as soon as the maneuver phase is completed.

Future Solutions

This analysis leads one to the striking conclusion that the only areas of significant difference between the Level IIb capabilities and the Level III capability to perform optimal damage control in the first 24 hours (when looking only at the "surgical slice" and a single patient) is the blood and blood product transfusion capability and patient rewarming methods. The other areas of concern can be improved by immediate acquisition of equipment and supplies.

A potential solution to the blood product deficiency of the Level IIb facilities is to think of the FST as a modular component with a Blood team modular unit. A "Blood Augmentation Unit (BAU)" could be created with greater refrigeration capacity with significant increases in the PRBCs storage and, with the addition of a freezer, could provide FFP and Cryoprecipitate. This unit would provide cross matching and would handle whole blood acquisition locally. The BAU would be a two member team with all refrigeration and freezers attached to a wheeled platform (for example, HUMMV). A system could be devised where helicopter transport would provide further resupply with blood and blood products from a fixed facility (for example, PRBCs, whole blood, FFP, cryo from a CSH). Furthering the modular concept, one or two BAUs could collocate with one or two FSTs to provide a significant increase in both surgical and resuscitation capability (FST BAU) over current isolated FSTs. This concept has been operationally validated by the 274th FST in Operation Enduring Freedom.

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Global War on Terrorism: Assessment, Treatment, and Evacuation of Burn Trauma Casualties

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Not since military operations in Vietnam has the U.S. military medical system experienced the number and severity of burn trauma casualties now attributed to military operations in Iraq and Afghanistan. During the early phases of U.S. military operations in the Global War on Terrorism (GWOT), most of the burn injuries were related to handling fuel and munitions. Subsequently, burns and associated injuries from improvised explosive devices (IEDs) have become more prevalent (Figure 1).

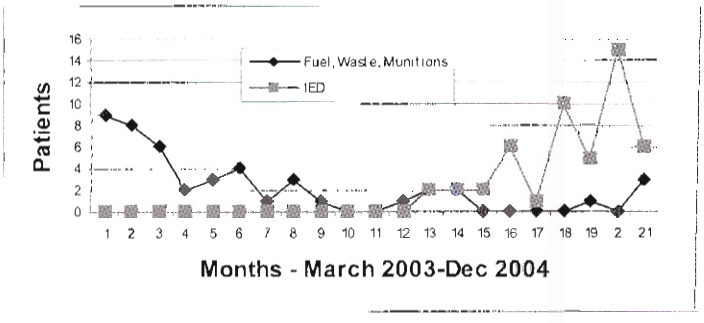

Fig 1. Etiology of evacuated burn injury.

The devastation related to both man-packed and vehicle-borne IEDs has resulted in significant traumatic injuries to thousands of coalition forces. Most evacuated casualties come from Iraq and the majority of these from the field hospitals in Baghdad. Military surgeons continue to treat multisystem trauma on a daily basis. Among the most common combat injuries seen are extremity wounds, including fragment injuries and burn wounds related to flame from explosive devices.

Through both research and clinical care, The U.S. Army Institute of Surgical Research (USAISR) focuses much of its combat-related research and clinical care efforts on treating the battlefield casualty. The USAISR is the military's only facility that combines an American College of Surgeon Level 1 trauma center with an American Burn Association verified burn center. Surgeons assigned to the trauma division of the USAISR are actively involved in all aspects of burn and trauma care, beginning with the early assessment and treatment of burn trauma casualties in Level III facilities such as those deployed in Baghdad, continuing through the evacuation system, and finally completing treatment at the USAISR. During the period from Mar 03 through Dec 04, the USAISR Burn Center admitted 210 U.S. and coalition casualties who sustained burn trauma injuries related to Operation Enduring Freedom and Operation Iraqi Freedom (OIF). Most (95%) were from OIF. The majority of the patients received burn and blast injuries with fragment wounds related to both vehicle-borne and IEDs, suicide bombings, and mortar attacks.

After the arrival of a seriously burned casualty at a Level III military facility such as the Combat Support Hospital (CSH), the goal is to stabilize, treat, and transport the severely burned casualty back to the USAISR Burn Center as soon as possible following the time of injury. This requires a strong team approach. Current U.S. Air Force air evacuation capability often allows for patients to be transferred from Iraq, to Germany, and on to CONUS within 96 hours following wounding.

Burn care in the combat zone demands a strategy of rapid assessment, airway protection, and appropriate intravascular resuscitation while avoiding excessive fluid administration and the possibility of the devastating complications associated with high-volume crystalloid resuscitation.[1] Urine output must be carefully monitored as a guide to the success of resuscitation.

Patients demonstrating signs or symptoms such as singed eyebrows or nasal hairs, soot in the mouth or nose, or difficulty breathing or voice change which suggest smoke inhalation often require intubation for airway protection and mechanical

ventilatory support. Most patients seen at the CSH in Baghdad with more than 20% total body surface area Total Body Surface Area (TBSA), full or partial thickness burn, are subsequently intubated to protect the airway. Burn patients presenting to the CSH also routinely receive placement of a central venous catheter to facilitate access and fluid resuscitation. Lactated Ringer's solution is administered as part of the initial fluid resuscitation, generally using 2-4 cc/kg/percent burn as a guide for the first 24 hours of volume. Larger intravenous fluid volume resuscitation is most often seen in patients with greater percentage TBSA burns who require mechanical ventilation.[2] The following case involving a young Soldier who sustained injuries common to the current battlefield in Iraq illustrates the direct involvement of USAISR surgeons in continuity of care and rapid system of evacuation used to expedite their care.

The patient was a 21-year-old active duty Army Specialist who sustained blast and burn injuries related to a car bombing (a vehicle-borne IED), which destroyed the vehicle in which he was traveling and killed two of his fellow Soldiers. He sustained deep partial and full thickness burn injuries to his face, bilateral upper and lower extremities, and to parts of his torso involving approximately 30% TBSA. He also complained of pain in his left leg related to the blast injury. He was initially treated by a military corpsman near the scene of injury and was rapidly evacuated to the 31st CSH headquartered in Baghdad.

Presenting with symptoms of dyspnea and exhibiting carbonaceous material in his nares and mouth, the patient was intubated shortly after arrival for concern of inhalation injury and was placed on a ventilator. The endotracheal tube was secured to his teeth with a wire suture as insurance against tube dislodgement during subsequent evacuation. A Foley catheter was placed shortly after arrival in the emergency treatment area and urine output was carefully monitored on a hourly basis. Urine output can serve as an invaluable tool to help guide the amount and rate of infusion of resuscitation fluids. The careful monitoring and infusion of intravenous lactated Ringer's solution is critical in order to avoid complications of overzealous resuscitation (compartment syndromes).

Primary and secondary trauma surveys revealed multiple injuries including perforation of bilateral tympanic membranes, and multiple soft tissue lacerations and open wounds, in addition to his burn wounds. Many casualties are injured while traveling in a moving vehicle and need evaluation for blunt injury as well as possible penetration by fragments. In this case, a CT scan of the abdomen revealed no findings to raise suspicions of intra-abdominal injury. Plain radiographs confirmed the suspicion of a minimally displaced femur fracture. The patient was wheeled directly to the operating room for debridement of all burn and soft tissue wounds and treatment of his associated injuries, including placement of an external fixation device for the femur fracture.

During the resuscitative and perioperative phases of his care, the patient received approximately 5 liters of crystalloid and four units of fresh whole blood. Circumferential burn wounds of the extremities swell and are prone to the devastating effects of compartment syndrome as the subcutaneous tissues are constrained by the restrictive eschar. For this reason, escharotomies of the burned extremities were performed in the operating room to guard against development of compartment syndrome.

Postoperatively, the patient was brought to a designated room in the intensive care unit of the CSH where the ambient room temperature was controlled to warm the patient who, like the majority of burn trauma patients, was in jeopardy of hypothermia due to his loss of thermoregulation related to the burn wounds. All intravenous fluids were warmed via commercial warmers.

The patient remained at the CSH for approximately 6 more hours awaiting the next available air evacuation mission to Ramstein AFB. The Theatre Patient Medical Regulating Center (TPMRC) was contacted soon after the patient arrived at the CSH and a Patient Movement Request was initiated. A Registered Nurse from the Intensive Care Unit (ICU) of the CSH provided care and monitoring for the patient during the helicopter flight from the CSH in Baghdad to the airfield at Balad. An Air Force Critical Care Air Transport Team (CCATT) was designated to care for the patient upon arrival at the Balad airfield. At Balad, the patient was examined by CCATT personnel and accepted for transfer on to Landstuhl Regional Medical Center (LRMC), Germany, under the care of the CCATT critical care physician, flight nurse, and respiratory technician.

Now, approximately 12 hours after wounding, the patient was loaded onto a C-141 aircraft and flown for approximately 5.4 hours to Germany, arriving at Ramstein AFB. During flight, the CCATT crew continued to closely monitor vital signs and respiratory status and ensure adequate sedation and pain control. The patient remained stable during flight and upon arrival at Ramstein Airbase he was transported by ambulance bus to LRMC and admitted to the ICU.

Utilizing the recently established U.S. Army Medical Command Electronic Telehealth Medical Consultation system (**burntrauma.consult@us.army.mil**), vital information regarding the patient was transmitted from the CSH in Baghdad to surgeons at the USAISR Burn Center in San Antonio, TX.[3] Timely transmittal of this information allowed for the rapid mobilization and deployment of the U.S. Army Burn Flight

Team, a component of the MEDCOM Special Medical Augmentation Response Team for Burns, based at Fort Sam Houston, TX. The 5-member team consists of a General Surgeon (61J), Critical Care Registered Nurse (66H8A), License Vocational Nurse (91WM6), Respiratory Therapist (91V), and Operations NCO (91W/). The team and their equipment were able to fly to Germany via commercial aircraft and arrive at LRMC shortly after the patient arrived in the ICU.

Casualties are transported to the Burn Center by USAF CCATT crews or Army Burn Flight Teams, and occasionally both. Current evacuation policies generally support urgent or priority transport for burn casualties based upon the severity of injuries. The decision to utilize the Burn Flight Team is based upon criteria similar to that outlined by the American Burn Association for burn center admission and includes the severity of burn injury, presence of inhalation injury, and other associated injuries.[4]

Upon arrival in the LRMC ICU, the patient was assessed by the Burn Flight Team in anticipation of further evacuation and treatment. As he remained intubated, bronchoscopy was performed by the ISR surgeon to reevaluate the severity of inhalation injury. Confirming the presence of lung injury, ventilatory support was changed from a traditional transport ventilator to a Volumetric Diffusive Respirator (VDR) transport ventilator. The VDR is utilized by the Burn Center staff due to its effectiveness in supporting patients with inhalation type injury.[5] By utilizing the Burn Flight Team, advanced burn center level care is initiated in Germany, frequently within 24 hours of injury.

Physical examination revealed the patient's burn wounds to be largely full thickness in nature and involved approximately 30% TBSA. There are a number of options for dressing burn wounds prior to flight. Each dressing technique has both advantages and disadvantages, yet the primary goals for any burn dressing are to maintain cleanliness of the wound, while providing an effective topical antimicrobial dressing and minimize hypothermia due to moist dressings. The selected dressing is ultimately determined by the burn team following a detailed examination of all wounds.

All extremity pulses were carefully assessed and escharotomy sites examined. Any abnormalities noted on pulse exam or concern for tissue ischemia would have led to further investigation, to include measurement of compartment pressures. Any concern for compartment syndrome would mandate decompressive fasciotomies of the affected extremities (Figure 2).

Once the providers of the Burn Flight Team assess their patients, coordination is made with TPMRC staff in Europe for the flight back to Texas. Coordination is also performed with the Validating Flight Surgeon to ensure the patient is prepared for transport and that any adjustments in the flight plan, such as pressure restrictions, are taken into consideration. Approximately 10 hours after his arrival at LRMC, the patient and six other casualties were prepared for transport to the Burn Center, this time by the Army's critical care air transport team embodied as the U.S. Army Burn Flight Team. He was again taken to the Ramstein airbase, loaded onboard a C-17 and prepared for his flight to San Antonio, TX (Figure 3).

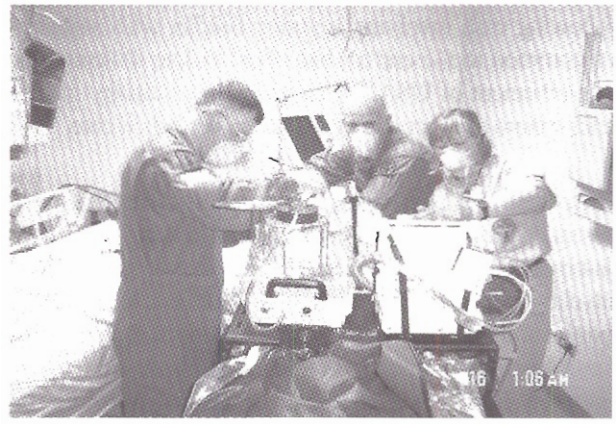

Fig 2. Burn Flight Team prepares patient for movement.

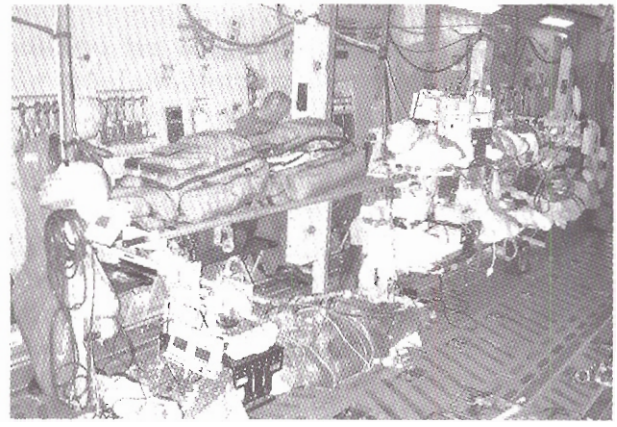

Fig 3. Patients on C-17 ready for transport.

During the 12.5-hour-long flight, the patient was continuously monitored and reassessed for any changes in hemodynamic stability or pulmonary status. Interval arterial blood gas measurements were obtained to ensure proper ventilator settings during the flight. The previously placed nasogastric tube was drained intermittently and otherwise vented. Urine output was carefully measured and intravenous fluid rates adjusted accordingly. The patient's core temperature was monitored for evidence of fever or hypothermia. Vasoactive medications were also titrated based on hemodynamic changes noted during the flight.

Upon arrival in San Antonio, the patient was transported by ambulance to Brooke Army Medical Center and the USAISR Army Burn Center. The Soldier was admitted directly to the Burn ICU, a 12-bed critical care unit dedicated to the care of burn patients. Almost immediately following his arrival, he underwent a complete dressing change to allow for reinspection, mapping, and cleansing of all wounds. Flexible bronchoscopy was again performed to assess the severity of previously diagnosed inhalation injury, perform directed pulmonary toilet, and obtain bronchioalveolar lavage specimens for cultures. The central venous catheter and arterial catheters were replaced to decrease the risk of line infection. Radiographs of the chest and abdomen are performed to confirm positioning of all tubes and lines.

Consultation with the Orthopedic Surgery, Ophthalmology, and Otolaryngology services was obtained soon after the patient's arrival at Brooke Army Medical Center. Each of these specialty teams provided immediate input and recommendations for treatment based upon injuries identified. In this case, it was determined that the external fixation device provided effective stabilization for the fracture and was left in place.

The morning following his arrival at the Burn Center (72 hours post-injury), the patient was taken to the operating room for further debridement of all wounds, followed by excision and grafting of all deep partial and full thickness burn wounds. Once dressed in the operating suite, these wounds remained covered for approximately 72 hours before detailed examination to access engraftment. During the course of the next several weeks the patient underwent daily wound care and intensive rehabilitation therapy for both his burn wounds and orthopedic injury. He was able to depart for home on convalescent leave approximately 7 weeks following injury.

The journey of this patient through the evacuation channel serves to illustrate the very effective system used to rapidly assess, treat, and transport critically injured burn trauma patients from the theatre of operations, such as we presently experience in the GWOT, back to definitive care at the military's burn center. The well orchestrated process of communication and evacuation provides unprecedented rapidity of movement of casualties to the U.S. Army Burn Center while providing state of the art critical care.

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Physical Fitness/Morbidity of Conscripts in the Estonian Defence Forces

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Background

According to the Defence Forces Service Act, the members of the Estonian Defence Forces are divided in active service into: conscripts, regular members of the Defence Forces, and reservists participating in training exercises.[1]

A conscript is a person liable to service in the Defence Forces who is called up to perform the conscript service obligation. Conscripts serve in the armed forces, in the navy or at the borders of the Republic of Estonia, as well as in active compulsory service considered equal to military service.

Army priorities focus on rapid reaction capability, mobile defence capability, host nation support and territorial defence structure for support. The Army is composed of the Army Staff, training centers, and a number of operational units (active and reserve). The training centers include four infantry training centers, one combat support-training center (engineer, artillery and air defence) and the Peace Operations Center.

The Constitution of the Republic of Estonia foresees compulsory military service in the Defence Forces of all physically and mentally healthy male citizens. The duration of the compulsory military service is 8 or 11 months. According to the military rank, conscripts are divided into Soldiers and junior noncommissioned officers (NCO). In the compulsory military service, conscripts acquire basic knowledge necessary for them to act as specialists in wartime military units.

All conscripts begin their service with Soldier's basic course (SBC). The duration of this course is 12 weeks. During this time, conscripts acquire the main skills of a single fighter, and learn about arms, orientation, and first aid. Conscripts also acquire skills for forest camps, knowledge about the basics of tactics, behaviour in the Defence Forces, and legislation. The level of basic knowledge is checked with a theoretical and practical Soldier's exam. The next step in the career of conscripts is the Soldier's specialty basic course – 6 weeks. This course provides knowledge and skills necessary for such specialists as riflemen, machine gunners, anti-tank grenade launchers, drivers, paramedics, etc. The length of the course depends on the complexity of the specialty. The specialty training terminates with a 3-week combat pair course where conscripts train the performance of combat tasks as members of combat pairs. Those conscripts who select the 11-month service option take longer specialty courses. This applies to conscripts who graduate from the junior NCO course or reserve officer course, pass signals or IT training, or serve on the ships of the Navy. Conscription to the compulsory military service is conducted on the territorial principle. Conscripts originating from one area study together in one unit. When sent to the reserve, they make up one reserve unit led by commanders who have been trained during the compulsory service and who come from the same unit. After the compulsory military service, reservists are called up for reserve training every 5 years.

According to the Defence Forces' Physical Fitness Prescript (2000), every commander has to control the physical fitness of his subordinates at the beginning and by the end of the SBC and after that, every 3 months.

The Physical Fitness Control Test (PFCT) is a three-event physical performance test used to assess Soldier's physical ability. Muscular endurance of the upper body and abdomen is measured by the number of correctly performed push-ups and sit-ups in a 2-minutes period for each event. Cardiorespiratory endurance is measured by running 3200 meters. Raw scores are converted to a point scale based on a scoring table for each event. The maximum score for each event is 100 points. A total score of at least 190 points assures passing the PFCT. The paramount score for three events is 300 points. The PFCT is adjusted for age and gender.

Introduction

To carry out duties on state defence, a Soldier has to be able to handle complex weapons of military arsenal and be ready to face physical and emotional overwork, with good physical and mental health being the pre-requisites for overcoming these difficulties. Therefore, being healthy and improving physical fitness is one of the main goals of the training and life style of the Defence Forces. The Estonian Defence Force is not an exception in this matter. The medical check-up before joining the military is a guarantee that recruits with evident symptoms of illness do not become members of the Defence Forces. The previous research in Estonia has shown that the physical development, physical ability, and state of health have not

always been up to the expected standard.[2] The main reason for this has been the low physical activity of the conscripts during their school and free time, irregular and unbalanced eating habits, smoking, consumption of alcohol, and narcotics. Thus, on entering the service, the conscripts are not equally healthy and trained and, although the training is the same for all of them, the state of health during the service can change differently.

During the conscript service, the new environment, regulated daily routine, deprivation from the family, increased emotional and physical tension – all have its impact. These factors may cause stress and health disorders in the adolescents, whose stamina was not good before the service; on the other hand, they may have a mobilizing and refreshing effect. During the service, the Soldiers can fall ill or become injured. In the annual statement of illness of the medical services of the Defence Forces the injuries, dental-and oral cavity diseases, and respiratory diseases take precedence.[3] According to the 1999 report of the Garrison hospital of the Estonian Defence Forces, 43% of the diseases requiring hospital treatment were respiratory diseases, exceeding muscular and connective tissue diseases (10%), and digestive diseases (9%). Mental and behavioral disorders (6%) and injuries and toxications (6%) were of lower frequency.

Research Material and Methods

The persons to be investigated were 568 conscripts between the age of 18 to 27, the average age being 22.4 ± 4.7 who served in one of the training centers, in particular, the Single Guard Battalion (Tallinn). The data was collected, retrospectively, after the conscript service during the year 2001 from the medical records kept in the archives of the Defense Department concerning anthropometry and morbidity records, and also from the database of the sport instructor concerning physical fitness of the conscripts.

The anthropometric data about the body weight and stature of the conscripts were used on their recruitment and in the last month of their service. The physical fitness was assessed at the beginning of the service and on the basis of the PFCT that took place in the last month of their service during which the conscripts had to do push-ups and sit-ups within 2 minutes, and a 3200 m run. To keep morbidity records, a point system was used, where every visit to the infirmary of the battalion or hospital and every day spent in the hospital gave one point. So, as to the contents, every point corresponded to one sick day when the conscript, due to some health problem, did not participate in training. The sick days were separately summed up per each conscript on the first and second half of the service.

Physical Development of Conscripts During the Service

The weight of the conscripts was between 54 to 100 kg and height 163 to 205 cm. The weight increased during the service by 3.7 and height 0.7 cm on average. According to the body mass index (BMI), there were 18% of those who were underweight (BMI less than 20) at the beginning of the service and 6% in the end (Table 1). There were 1.4% of obese conscripts (BMI over 30) at the beginning and none in the end. The number of overweight conscripts (BMI from 25 to 30) increased from 12% to 15% by the end of the service.

During the service, the level of BMI of the 21% of the conscripts decreased (4% on average), of 75% it increased (6% on average) and of 4% it remained the same. On Figure 1, the conscripts are divided into deciles, according to the change of BMI. The BMI of the decile of conscripts who had lost weight the most was 25.8 at the beginning of the service and of the decile gaining the most of weight- 20.4. By the end of the service, the BMI of both extreme groups was essentially the same- 23.9 and 23.6 respectively.

During the service, the number of underweight conscripts and of those who had signs of overweight decreased and the number of conscripts with normal body weight increased. At

BMI	At the beginning of the conscript service	By the end of the conscript service	The Estonian citizens of the same age group in 2000
Under 19.9	18.6%	5.8%	22.2%
20.0...24.9	68.3%	79.2%	71.3%
25.0...29.9	11.8%	14.9%	5.6%
Over 30	1.4%	0%	0.9%

Table 1. The BMI of Conscripts Compared to the Estonian Citizens of the Same Age Group

the same time, the negative feature of the physical development of conscripts is the increase of overweight conscripts by the end of the service, which implies that their physical training load was inadequate and/or indicates the need to reconsider the menu of the servicemen in the second half of their service.

Development of Physical Fitness of Conscripts During the Service

We assessed every event of the PFCT – push-ups, sit-ups, and a 3200m run according to the100 point system used in the U.S. Army.[4] We considered the result which was under 60 points for each event unsatisfactory, more than 60 points satisfactory, over 90 points good performance and 100 points excellent performance. Thus, for three events, the maximum number of points could be 300. The total number of points which remained under 180 was considered unsatisfactory, over 180 points satisfactory, over 290 points good, and 300 points or maximum result was considered an excellent performance.

On recruitment, 41% of the conscripts did not achieve satisfactory outcome in the total of three events (Table 2). At the end of the service, 8% of the conscripts received unsatisfactory outcome and the number of conscripts who had achieved good or excellent results, had increased substantially. At the same time, by the end of the service, the average number of push-ups had increased from 50 to 71, the average number of sit-ups had increased from 47 to 57, and the time for running 3200 m had decreased from 15 min 24 sec to 14 min 43 sec.

According to the dynamics of the total number of points of the PFCT, the conscripts have been divided into deciles (Figure 2). Even 77% of conscripts managed to raise the total number of points by 50% on average. The decile with most increases to the total sum had only 97 points at the beginning and 229 points on average by the end of the service.

However, the total number of points achieved during the physical performance test at the end of the service declined by

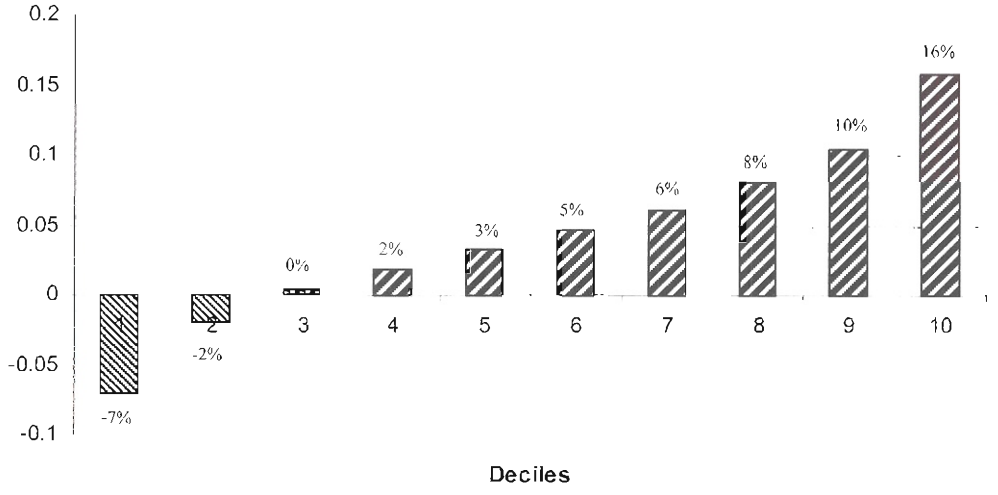

Fig 1. The change of the conscripts' BMI during the service.

The total number of points	At the beginning of the conscript service	By the end of the conscript service	USA Soldiers
Unsatisfactory (under 180)	41.6%	8.1%	22.2%
Satisfactory (over 180)	58.4%	91.9%	77.8%
Good (over 290)	3.7%	8.1%	0.6%
Excellent (300)	1.7%	5.4%	0

Table 2. The Distribution of Estonian Conscripts According to the Total Number of Points Achieved in the PFCT in Comparison with USA Soldiers

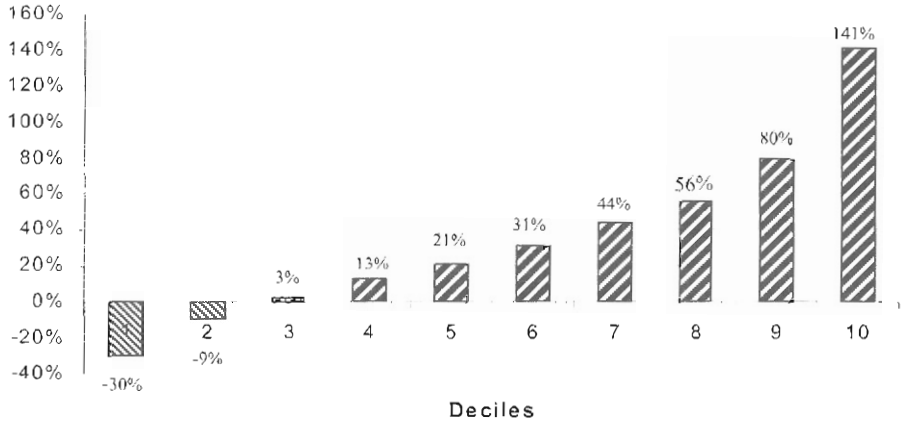

Fig 2. The dynamics of the conscripts' total number of points of the PFCT during the Conscript Service.

22%. The average total number of points of the conscripts' decile who lost the most in the PFCT had decreased from 235 points to 165. The possible reason for that could be the more frequent illness of conscripts of the first decile and/or the increase of their BMI during the service, although the available data did not prove this hypothesis.

Morbidity of the Conscripts During the Service

To keep the morbidity records, a point system was used where every visit to the battalion's infirmary or hospital and every day spent in the hospital gave one point, in spite of the reason of the visit. The collected number of points therefore depict, besides the more trivial health problems, the duration of more serious cases that needed hospital treatment. As the number of visits to the hospital decreased during the service, the points collected during the first and second half of the service were differentiated.

During the second half of the service, the number of visits to the battalion's infirmary as well as the number of sick days decreased almost by half in all deciles (Figure 3). In the first half of the service, all the conscripts visited the infirmary at least once but in the second half, 15% of the conscripts did not need any medical aid. During the whole service, 1/3 of the conscripts needed hospital treatment, and one tenth of the conscripts who needed treatment the most, were hospitalized 27 days on average in the first half of their service and 19 days in the second half of their service.

Correlations between BMI, Physical Fitness/Morbidity

Next, we explained the correlation between BMI, physical fitness, and morbidity. To identify the correlation between those features, which were distributed according to normal distribution, we calculated the Pearson's correlation coefficient (rp), and in other cases, Spearman's correlation coefficient (rs). The most significant correlations between the features are brought out in Table 3.

The most significant correlations were the following:

- BMI is negatively correlated to the total number of points of three events of the PFCT (rp – 0.17), the total number of points of those who were overweight was smaller, especially on the account of the running result.

- BMI is positively correlated to the total number of the sick days, both what concerns the visits to the infirmary (rs 0.33), as well as concerning the total number of hospital days (rs 0.31).

- From the indicators of the PFCT, the sit-up event is negatively correlated to the total number of sick days (rp- 0.19), in other words – the more sit-ups a conscript can do at the beginning of the service, the less he or she becomes ill during the service.

Dividing the conscripts into deciles according to the total number of points of the PFCT made at the beginning of the service and correlating it to the frequency of becoming ill, it turned out that becoming ill by the weakest conscripts during the service does not practically change- 11.4 sick days in the first half and 11.7 in the second half. On the contrary, the frequency of illness by the strongest conscripts in the second half of the service had reduced nearly 2 times compared to the first half of the service – from 10.1 sick days to 5.4.

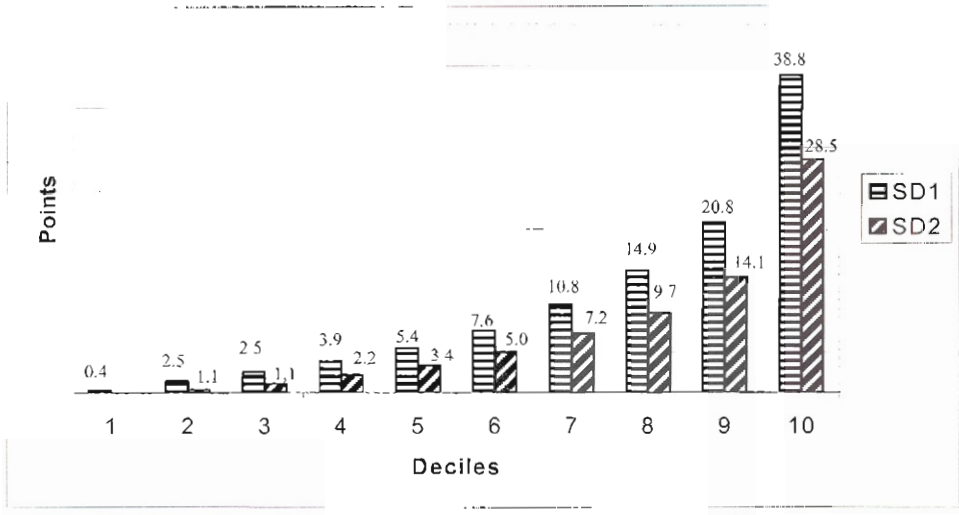

Fig 3. The total number of conscripts' sick days during the first half and second half of the service.

	SD 1	SD 2	BMI 1	BMI 1	BMI 2	BMI 2	F1	F2	P 2	S 1	S 2
BMI 1	0.309	-0.077	1	1							
BMI 2	0.334	-0.108	0.775	0.822	1	1					
F 2	0.169	-0.076	0.023	-0.119	0.068	-0.131	0.42	1			
R 2	0.178	0.008	0.017	-0.172	0.077	-0.171	0.314	0.804			
P1	0.149	-0.202	0.022	0.007	0.08	0.009	0.832	0.356	0.17	1	
P2	0.18	-0.147	0.024	-0.023	0.063	-0.065	0.427	0.773	0.52	0.512	1
I1	0.846	0.221	0.34	0.07	0.337	0.117	-0.087	-0.159	-0.156	-0.116	-0.108
H 1	0 873	0.155	0.315	-0.038	0.326	-0.011	-0 055	-0.03	-0.078	-0.066	-0.07
HD1	0 888	0.117	0.311	-0.007	0.325	0.007	-0 034	-0.013	-0.072	-0.07	-0.061
IH 1	0.907	0.235	0.338	0.059	0.347	0 109	-0.077	-0.129	-0.141	-0.108	-0.1
I 2	0.501	0.641	0.243	-0.029	0.245	-0.005	-0.151	-0.01	0	-0.151	-0.075
H 2	0.524	0.762	0.301	-0 058	0.292	-0.127	-0.134	-0.026	-0.069	-0.138	-0.1
HD2	0.516	0.883	0.302	-0.085	0.292	-0.14	-0.167	-0.123	-0.115	-0.196	-0.17
IH 2	0.526	0.743	0.25	-0 035	0.257	-0.022	-0.152	-0.001	-0.004	-0.156	-0.078
	rs	*rp*	*Rs*	*rp*	*rs*	*rp*	*rp*	*rp*	*rp*	*rp*	*rp*

Abbreviations:

SD1 – the total number of the sick days during the first half of the service
SD2 – the total number of the sick days during the second half of the service
BMI 1 – the body mass index in the beginning of the service
BMI 2 - the body mass index by the end of the service
F1 – the total number of points of the PFCT in the beginning of the service
F2 – the total number of points of the PFCT by the end of the service
P1 – the number of push-ups in the beginning of the service
P2 – the number of push-ups by the end of the service
S1 – the number of sit-ups in the beginning of the service
S2 – the number of sit-ups by the end of the service
R1 – the time of 3200m run in the beginning of the service
R2 – the time of 3200m run by the end of the service
I1 – the number of the visits to the infirmary during the first half of the service
I2 – the number of the visits to the infirmary during the second half of the service
H1 - the number of the visits to the hospital during the first half of the service
H2 – the number of the visits to the hospital during the second half of the service
HD1 – the number of sick days in the hospital during the first half of the service
HD2 – the number of sick days in the hospital during the second half of the service
IH1 – the total number of the visits to the infirmary and hospital during the first half of the service
IH2 – the total number of the visits to the infirmary and hospital during the second half of the service

Table 3. The Correlation Between Main Features

The AMEDD Regiment

When medical Soldiers pin on the AMEDD Regiment Distinctive Unit Insignia, they make certain commitments:

A commitment to maintaining the standards of excellence set in the past.

A commitment to fellow Soldiers in providing the best medical care.

A commitment to the emerging medical technology.

A commitment to the unity that exists between the corps and the Army Medical Department specialties.

For additional information concerning membership in the AMEDD Regiment, contact: Mr. Ron Still, AMEDD Regimental Office, DSN 471-8455, Commercial (210) 221-8455, FAX DSN 471-8697, or Commercial (210) 221-8697.

WRITING AND SUBMITTING ARTICLES FOR THE AMEDD JOURNAL

The AMEDD Journal is published quarterly to expand knowledge of domestic and international military medical issues and technological advances; promote collaborative partnerships among Services, components, Corps, and specialties; convey clinical and health service support information; and provide a peer-reviewed high quality print medium to encourage dialogues concerning health care initiatives.

Submit manuscripts with the following guidelines:

1. Manuscripts will be reviewed by the Journal's Editorial Board and, if appropriate, forwarded to the appropriate Subject Matter Expert for further assessment.

2. It may be necessary to revise the format of a manuscript in order to conform to established page composition guidelines.

3. Articles should be submitted in disk form (preferably Microsoft Word on 3.5" disk) accompanied by two copies of the manuscript. Journal format requires four double-spaced typewritten pages to complete one page of two-column text. Ideally, manuscripts should be no longer than ***20 to 24 double-spaced pages****. Exceptions will be considered on a case-by-case basis.*

4. The American Medical Association Manual of Style should be followed in preparation of text and references. Abbreviations should be limited as much as possible. A list identifying abbreviations and acronyms ***must*** *be included with the manuscript or materials will be returned to the author.*

5. Photos submitted with manuscripts can be black and white or color. Color is recommended for best print reproduction quality. Space limitations allow no more than eight photos per manuscript. Photo prints are preferred, but we will accept electronic graphic (i.e., BMP, JPG, or GIF) and photo files in Microsoft Word or PowerPoint. Avoid excessive use of color and shading. Please do not send photos embedded in PowerPoint. Slides, negatives, or X-ray copies will not be published. To avoid possible confusion, the top of photos should be marked on the reverse and their position within the article should be clearly indicated in the manuscript. Photo captions should be taped to the back of photos or submitted on a separate sheet.

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7. Drugs should be listed by their generic designations. Trade names, enclosed in brackets, can follow.

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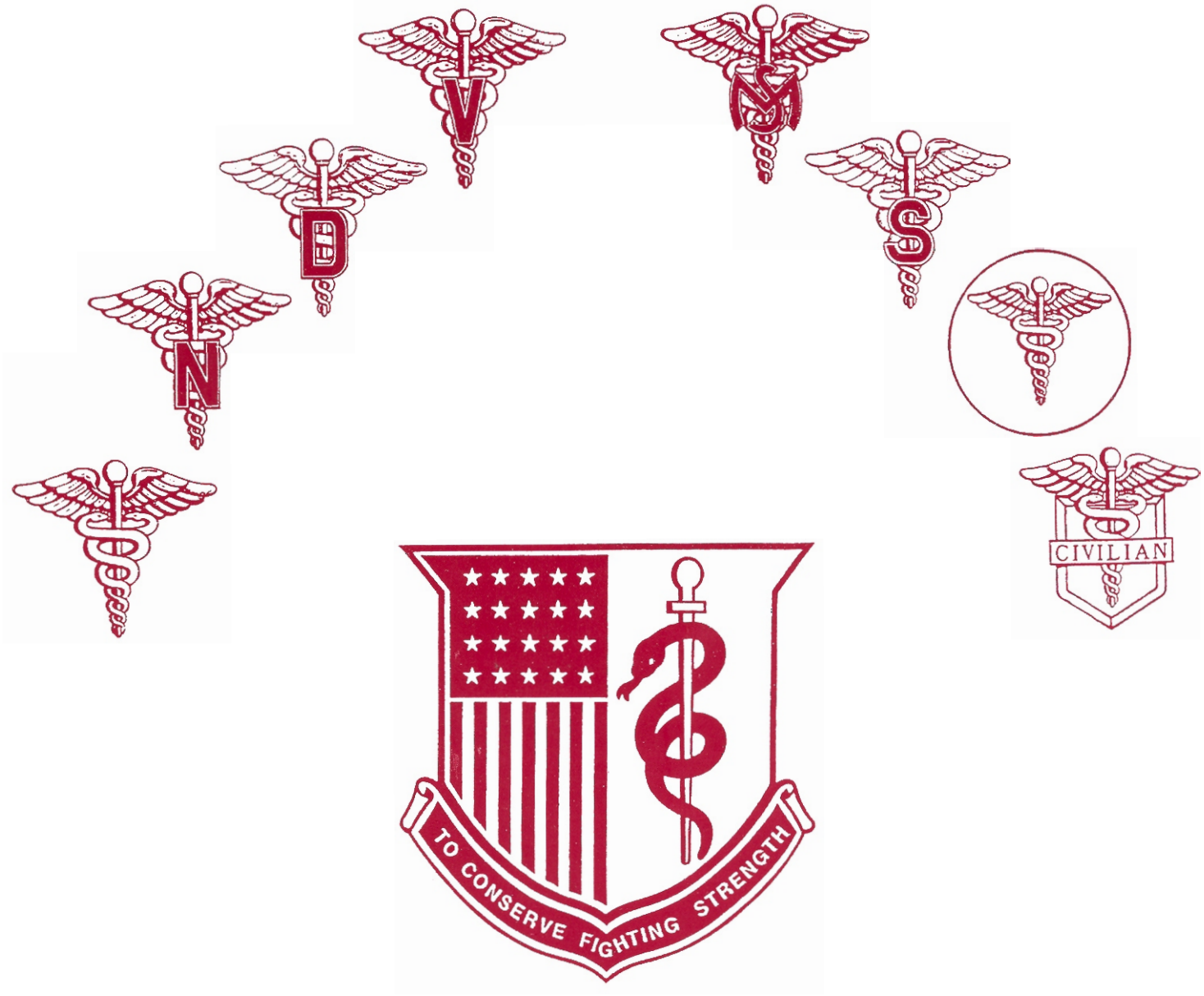

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