

Conserving the Future Force Fighting Strength

*Findings from the Army Medical
Department Transformation
Workshops, 2002*

David E. Johnson

Gary Cecchine

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David E. Johnson

Gary Cecchine

Prepared for the United States Army

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Preface

This report is one in a series that documents the Army Medical Department's process of identifying medical issues in the Army's Transformation. It contains an assessment of the three AMEDD Transformation Workshops (ATW I-III) conducted at the RAND Washington Office on 16-18 April, 27-29 August, and 5-6 November 2002. The report describes the development of issues that provided a basis for the workshops, workshop organization, the composition of the various teams and cells, objectives and issues, the scenario used, and the analysis methodology employed. Finally, the report provides results and observations.

The Commanding General, U.S. Army Medical Department Center and School sponsored this work, which was conducted jointly by RAND Arroyo Center's Manpower and Training Program and RAND Health's Center for Military Health Policy Research. RAND Arroyo Center, part of the RAND Corporation, is a federally funded research and development center sponsored by the United States Army. Comments and inquiries should be addressed to the authors.

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Contents

Preface iii

Figures ix

Tables xi

Summary xiii

Acknowledgments xxi

Glossary xxiii

CHAPTER ONE

Introduction and Background 1

Background of AMEDD Transformation Efforts 1

Toward a New AMEDD Analytical Process 2

 Redefining AMEDD Transformation Issues 3

 Medical Risk as an Analytical Foundation 3

 RAND Process to Redefine Issues 4

 Designing a New AMEDD Analytical Process 5

CHAPTER TWO

AMEDD Transformation Workshop Design 9

Organization 10

 Workshop Teams 10

 Control/Administrative Support Cell 10

Workshop Objectives and Issues 12

 Objectives 12

 Issues 13

Scenario 13

Sequence of Events	16
ATW I and II	16
ATW III	16
Methodology	16
ATW I	17
ATW II	18

CHAPTER THREE

Workshop Results	21
ATW I and II	21
Casualty Outcomes, Status of HSS Resources, and Advice to the Commander	22
Issue Resolution	24
ATW III	27

CHAPTER FOUR

Observations and Conclusions	29
Specific Workshop Observations	30
Broader Workshop Implications	31
Workshop Implications for the HSS System	31
Workshop Implications for the Army	36
Conclusion	38

APPENDIX

A. Restated AMEDD Transformation Issues	39
B. Team Members, ATW I–III	49
C. Medical Technologies Employed in ATW I–III	53
D. Casualty Determination Process	79
E. Casualty Tracking Worksheet	81
F. Step Three Worksheet	89
G. Treatment Briefs	97

Figures

- 1. AMEDD Transformation Workshop Structure 11
- 2. AMEDD Transformation Workshops Methodology..... 19

Tables

S.1. Mean Casualty Outcomes at H+8 hours xvi

 1. Mean Casualty Outcomes at H+8 hours 22

A.1. Issue Assessment Categories and Potential Scores 39

Summary

This report details the results of the Army Medical Department Transformation Workshops (ATW) held in April, August, and November 2002, and it includes a RAND Corporation assessment and discussion of the workshop results. The purpose of these workshops was to initiate an assessment of the medical risks associated with emerging Army operational concepts and the capacity of the Army Medical Department (AMEDD) to mitigate these risks. Medical risk, discussed later in this report, is defined generally as the number, severity, and fate of casualties incurred.

Background

The Army's transformation to a future force not only posits dramatically different equipment, it also envisions radically new ways of fighting. One future development of particular importance will be the employment of widely dispersed units moving rapidly around the battlefield. These operational concepts pose enormous challenges for the units that support the combat elements. In 1998, the AMEDD began an analytic effort to gain insight into the challenges for health service support (HSS) posed by emerging Army concepts.¹ Over the next few years, AMEDD conducted two games and several work-

¹ AMEDD's analytic effort has included broad aspects of HSS, to include homeland security, recruiting, retention, etc., in addition to combat HSS, which is the focus of this report.

shops to provide further insight into how it could best support the Army as it transformed.

From these various events, AMEDD derived some 250 issues, which they eventually winnowed down to 75. AMEDD then convened a Council of Colonels to assess and prioritize these issues. Researchers from RAND (the authors of this report) were asked to provide observations on the proceedings and conclusions. The RAND assessment concluded that the AMEDD process did not provide a sound basis for identifying and communicating the medical risks of these Army concepts.

The RAND researchers determined that the issues identified by the AMEDD process related to one of two policy issues: the level of medical risk posed and AMEDD's role in mitigating that risk. It reorganized the issues using AMEDD's Integrated Concept Teams as a construct, and assessed the issues against two sets of criteria. One set determined whether an issue was a true and relevant concern of AMEDD, while the other set prioritized the issues. RAND also recommended that AMEDD adopt a different analytical approach to identifying the degree of medical risk posed by a given issue.

We suggested that AMEDD adopt a scenario planning approach. This approach assumes that the dimensions of the distant future are, by their very nature, largely unknowable. Thus, scenario planning takes a broad approach to ensure that intervening destinations on the journey offer as many perspectives as possible.

In January 2002, the AMEDD Center and School (AMEDDC&S) asked RAND to design and conduct a series of workshops to begin an assessment of the medical risks associated with emerging Army operational concepts and the capacity of AMEDD initiatives to mitigate these risks. The underlying goals of the workshops were to identify gaps between HSS concepts for the future force and requirements and to assess the medical risk imposed by identified gaps.

AMEDD Transformation Workshops

RAND designed, organized, facilitated, and provided analytic support to the workshops, which were held in April, August, and November 2002.² The three workshops were each supported by subject matter experts (SMEs). Two workshops examined combat operations of a notional future force, each supported by a different HSS structure. Eight hours of simulated combat provided the context for the workshops, generating casualty data to support the analysis of the HSS structure. The simulation was developed by the Army's Training and Doctrine command and is based on a notional future force in combat operations in 2015 (TRAC-F-TC-01-006, August 2001). In this scenario, a future force Unit of Action (battalion) is employed in a brigade shaping operation in preparation for a Unit of Employment (division) main attack. The third workshop used the more robust HSS structures from the first workshop, attempting to reorganize and reallocate these HSS assets to determine if they could better address the casualty care challenges.

The workshop teams focused on three principal issues identified by AMEDD, based in part on prior RAND research:

- Where do first responders and combat medics fit in the overall future concept for combat casualty care, and what treatment capabilities (treatment technologies and skills) will medics require to support this concept?
- What theater military medical infrastructure is necessary to support future military medical operations across the spectrum of operations?
- What are the evacuation requirements to support military operations across the spectrum of operations?

² The ATWs were designed as a modified version of the RAND "Day After" gaming methodology. Their goal was to present a structured problem to a team of experts to resolve by employing AMEDD's proposed future operational concepts and resources.

At the conclusion of the workshop, each team was also asked to provide three additional items of information:

- The final disposition of the casualties at the end of the workshop.
- The status of the HSS system (i.e., the availability of medical resources and services).
- The ability of the HSS system to support continued operations.

Workshop Results

Each of the first two workshops resulted in three estimations of the outcomes for casualties generated in the scenario. Although the HSS concept used in each of these baselining workshops was different, Table S.1 shows that the outcomes were remarkably similar at the end of the simulated eight-hour battle. These results indicate that the limiting factors in the HSS concepts were probably not the different set of resources employed in the two workshops. For example, ATW I

Table S.1
Mean Casualty Outcomes at H+8 hours^a

Outcome	ATW I			ATW II		
	Mean	(SE)	%	Mean	(SE)	%
Killed in Action (KIA) ^b	15.7	(1.2)	29%	17.0	(3.1)	31%
Died of Wounds (DOW)	2.0	(1.0)	4%	3.0	(1.5)	6%
Returned to Duty (RTD)	3.7	(0.7)	7%	3.3	(0.9)	6%
Treated/held or awaiting treatment	32.7	(2.6)	60%	30.7	(1.3)	57%

SE = standard error of the mean.

^a Means are calculated from results of three teams per workshop. There were 57 total casualties generated in the scenario, but the teams did not consider three USAF pilot casualties resulting from F-15 aircraft being shot down during the simulation; percentages are therefore derived from a total casualty population, N = 54.

^b The casualty estimation provided by AMEDD indicated that 13 casualties were killed instantly. These and casualties whom the participants determined would die before reaching the battalion aid station (BAS) are included in the KIA values.

included a medic in each maneuver platoon while ATW II did not, yet this reduction made little, if any, difference in casualty outcomes.

At the completion of the workshop, each team reported on the status of the medical assets in support of the battalion effort. Generally, the medical system was operating at or near full capacity, especially surgical capabilities. Teams estimated that it could take an additional day or more to clear the surgical backlog. Although ground evacuation assets were not fully employed at H+8 because casualties were typically over sixty kilometers from surgical assets, air evacuation assets were near or at maximum capacity, reflecting the heavy reliance each team placed on these assets. It was also estimated that medical supplies and blood were either expended or in short supply. Significantly, the teams agreed that they would recommend an operational pause to the maneuver commander to enable the HSS system to treat existing casualties and to restore its capabilities.

Issue Results

Issue 1: Where do first responders and combat medics fit in the overall future concept for combat casualty care, and what treatment capabilities (treatment technologies, level of supply, and skills) will medics require to support this concept?

The assumed proficiency of first responders, especially of combat lifesavers (CLS), and the availability of advanced technologies to control bleeding were judged to be absolutely essential. The reliance on CLS and advanced technologies was intended to address two characteristics of the future force concept that make HSS challenging: dispersed unit operations and the absence of organic medics in maneuver platoons. These two characteristics resulted in a significant time lapse between injury and care by a medic; this time lag is especially problematic for bleeding casualties who must be treated quickly.

But some SMEs were skeptical that such an advanced level of CLS proficiency could be achieved and maintained. A related observation was that the role of CLS was unreasonably large, considering the pace of the battle and the high expectation of medical proficiency required. Nonetheless, suggested alternatives to this strategy that did

not include force structure changes included even greater CLS competence and the ability to provide substantial treatment during evacuation.

Issue 2: What theater military medical infrastructure is necessary to support future military medical operations across the spectrum of operations?

The teams concluded that the HSS infrastructure employed in the scenarios were generous, representing a dedication of divisional assets. Furthermore, none of these assets suffered attrition. Nevertheless, all three teams believed that this infrastructure was stretched to capacity in dealing with the casualties generated by the scenario.

Each team indicated that perfect situational awareness—based on advanced communications technologies—was a key capability because it enabled optimal allocation of medical assets. That is, knowing the location and severity of casualties in real time would allow for remote triage, resulting in the precise and appropriate allocation of both evacuation and treatment assets. Surgical capability was also critical, although many participants indicated that more was required and that this capability would be more beneficial if it were located closer to where a soldier was actually wounded.

Issue 3: What are the evacuation requirements to support military operations across the spectrum of operations?

Wide unit dispersion made air evacuation essential to facilitate an efficient, timely casualty evacuation. To this end, each team used air evacuation at or near full capacity. Furthermore, it was estimated this level of demand would continue for some time following the end of the scenario to evacuate the casualties resulting from those eight hours of action. Were these assets not available, the teams suggested that surgical capability would be needed even farther forward, perhaps even at the battalion aid station.

ATW III Results

In ATW III, team members reorganized and reallocated the more robust HSS system from ATW I in an effort to better address the combat casualties. In general, each team presented very preliminary concepts that centered on modular HSS structures designed to pro-

vide surgical capability as far forward as possible. The major observations from ATW III can be summarized in four points:

- Dispersion of units, long lines of communication (LOCs), and limited surgical capacity were the most problematic characteristics of the operations supported in the scenario.
- Timely surgical intervention is imperative. However, due to high demand, little distinction was made between the combat support hospital and the forward surgical team, resulting in a nondoctrinal use of the forward surgical team concept.
- Modular alternatives to provide far-forward surgical intervention may prove attractive with further investigation, but mobility and security are significant concerns.
- The roles of the CLS, combat arms platoon medic, and battalion aid station need to be revisited.

Conclusions

The teams agreed that the HSS systems employed during the workshops to support the transformed force had been stretched to or near their maximum capacities during the eight-hour scenario. Furthermore, this situation would affect the ability of the HSS system to support follow-on operations for some period of time, perhaps twenty-four or more hours. Reallocation of resources did not markedly improve outcomes.

The combined arms battalion in the scenario had more HSS assets available to it (i.e., all brigade assets, a combat support hospital at division, and all the aerial medical evacuation assets allocated to the division) than would normally be expected. Even in the best-case scenario of working at optimum efficiency and suffering no attrition, they were still inadequate for the task. Of further concern to workshop participants was the recognition that the operation modeled in the Army's scenario was a relatively low-intensity, secondary-effort shaping operation.

It should be noted that the specific workshop observations and the broader implications deduced from the workshops are based on the experience of three workshops focused on a single Unit of Action (UA) battalion in a single simulation depicting shaping operations. Nevertheless, given the commonality of the findings of the three separate teams during the three workshops pertaining to the HSS system, they deserve attention.

The workshops also show the importance of simulating future force concepts and the criticality of in-depth, subject matter expert analysis in assessing the outputs of any simulation. In the case of these workshops, experts in all the components of combat casualty care tracked every casualty generated by the simulation from the point of wounding to final disposition. Thus, the teams were able to articulate credible casualty outcomes and the emerging challenges that AMEDD concepts, structures, and technologies face in supporting a postulated future force Unit of Action. The team members stressed that further simulations of additional scenarios and of evolving future force concepts should continue to ensure that the AMEDD can define for the Army the medical risks involved in future force concepts and the ability of the future HSS system to mitigate those risks. Such analysis will support the design and implementation of a health service support system that is as robust as the operational system it will support.

In addition to these results, it is likely that ongoing and recent operations in Afghanistan and Iraq will influence emerging future force concepts and structures as well as related medical requirements.

Acknowledgments

We gratefully acknowledge the assistance of all the participants in the workshops for their contributions to its success. In particular, we appreciate the extraordinary efforts of Captain John Belew and Specialist Nathanael Sutton (AMEDD Center and School) for all the work they did to ensure the many administrative issues concerning the execution of the workshops were appropriately addressed.

We gratefully recognize the expertise of Walt Perry and Roger Molander, of RAND, for their significant contributions to the workshop design. We also are indebted to the RAND researchers who served as facilitators and analysts during the workshop: Richard Darilek, John Gordon, Bob Howe, Bruce Pirnie, Terri Tanielian, and Peter Wilson. Lee Hilborne deserves thanks for serving as our medical advisor, and Jerry Sollinger greatly improved this report with his thoughtful review and suggestions. Anita Duncan deserves thanks for her patience and persistence in supporting the publication of this report.

Finally, we want to express our appreciation to the RAND support staff whose generous efforts greatly facilitated a smoothly functioning workshop.

Glossary

AMEDD	Army Medical Department
AMEDDC&S	AMEDD Center and School
APOD	Aerial Port of Debarkation
ATW	AMEDD Transformation Workshop
BAS	Battalion Aid Station
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CLS	Combat Lifesaver
CRAF	Civil Reserve Air Fleet
CSH	Combat Support Hospital
DOW	Died of Wounds
FCS	Future Combat System
FST	Forward Surgical Team
H+8	H Hour + eight hours
HSS	Health Service Support
ICT	Integrated Concept Team

IDEAS	Interactive Distributed Engineering Evaluation and Analysis Simulation
KIA	Killed in Action
LOC	Line of Communication
MEDEVAC	Medical Evacuation
MIW	Multiple Internal Wounds
MRMC	[U.S. Army] Medical Research and Materiel Command
RSTA	Reconnaissance, Surveillance, and Target Acquisition
RTD	Returned to Duty
SME	Subject Matter Expert
TRAC	U.S. Army Training and Doctrine Command (TRADOC) Analysis Center
TRADOC	U.S. Army Training and Doctrine Command
UA	Unit of Action
UE	Unit of Employment
WIA	Wounded in Action

Introduction and Background

For nearly a decade, the Army has been investigating how it should transform itself for the future. The Army Medical Department (AMEDD) has been deeply engaged in an assessment of the health service support (HSS) implications of the larger Army effort and has participated in the U.S. Army Training and Doctrine Command (TRADOC) processes, including annual war games.

Background of AMEDD Transformation Efforts

In 1998, the AMEDD began its own parallel gaming process as a TRADOC franchise effort to garner insights into the challenges for HSS posed by emerging Army concepts for the future.¹ Over the next few years, the AMEDD conducted two games and several workshops to gain further insight into how it could best support the Army as it transformed. Since 1998, RAND has provided analytical support and assessments of AMEDD's efforts.² From the various AMEDD-

¹ Franchise games are efforts in the overall TRADOC gaming architecture that are designed to explore specific functional areas, e.g., special operations, information operations, etc.

² Reports in the public domain include: Gary Cecchine, David Johnson, Walter L. Perry, C. Ross Anthony, Beatrice Alexandra Golomb, Anthony C. Hearn, Lee H. Hilborne, and Jerry M. Sollinger, *Army Medical Support to the Army After Next: Issues and Insights from the Medical Technology Workshop, 1999*, Santa Monica, CA: RAND Corporation, MR-1270-A, 2001; Gary Cecchine, David E. Johnson, John R. Bondanella, J. Michael Polich, and Jerry

sponsored events, the AMEDD derived some 250 issues, which were further refined into 75 issues. From 27 February to 2 March 2001, the AMEDD convened a Council of Colonels to assess and prioritize these issues. The council identified 15 issues that it believed most important in transforming the AMEDD to meet the needs of the transformed force of the future.

Toward a New AMEDD Analytical Process

The AMEDD asked researchers from RAND to attend the Council of Colonels and to provide observations on the proceedings and conclusions. RAND provided feedback to the AMEDD on the Council of Colonels session, which contained a critique of the process and its findings. RAND identified the principal difficulties with the AMEDD approach to that point. First, the issues identified by the AMEDD through earlier gaming efforts were often, in reality, solutions to specific problems identified during the games. Second, many of the proffered solutions had obviously high technical and programmatic risks that had yet to be assessed. In short, the approach at the games was largely one of "solving" medical problems presented by Army concepts and operations. Consequently, the AMEDD events did not provide a basis for assessing and communicating the medical risks of these Army concepts. In light of the recommendation to base its transformation analysis on the concept of risk, AMEDD asked RAND to reassess the 75 issues identified in its initial process. That reassessment involved two steps. First, we developed screening criteria to determine what qualified as an issue and applied these screening criteria to the 75 issues identified by AMEDD. Second, we arranged the remaining issues by assessing them against a second, prioritizing set of criteria. These criteria sets are detailed later in this report, and the issues as restated by RAND are included in Appendix A.

M. Sollinger, *Army Medical Strategy: Issues for the Future*, Santa Monica, CA: RAND Corporation, IP-208-A, 2001.

Redefining AMEDD Transformation Issues

RAND's assessment of the issues identified by AMEDD and considered by the Council of Colonels led to a recasting and reclassification of many of the issues. Medical risk assessment was at the heart of the issue redefinition process. In a basic sense, all the issues identified by AMEDD during its transformation efforts can be summarized by two policy-level issues:

- What is the acceptable level of medical risk in future force operations?
- What is AMEDD's role in mitigating medical risk?

Medical Risk as an Analytical Foundation

Any concept of operations will involve medical risk in the form of potential casualties, and deciding on any one concept requires an implicit acceptance of some level of that risk. In the context of Army transformation as it relates to operational medicine, medical risk can be considered to be the casualties incurred (including soldiers, enemy prisoners of war, noncombatants, etc.) and their disposition.

Medical risk may also have operational and political implications. An operation may fail if the number of casualties incurred affects capability and cohesion. Political risk in this context refers to the relationship between actual casualties incurred or estimated and the decision to employ Army forces. Interestingly, a risk that is acceptable at the operational level may not be politically acceptable. Obviously, these types of risk are not mutually exclusive, nor are they inclusive of all the risks associated with Army transformation from an HSS standpoint.

It is important to determine the level of medical risk so that the AMEDD can investigate concepts to mitigate that risk as much as possible given operational and resource constraints. This is also important so that the AMEDD can employ an analytical method to define and communicate that risk clearly to decisionmakers. In the context of AMEDD support to Army transformation, the Army must estimate the total medical risk associated with its operational concepts. Army leadership must also decide and communicate what level

of medical risk is acceptable. It is then up to the AMEDD to determine mitigation methods—operational concepts and technologies—that can reduce the estimated level of risk to the acceptable level or below. If mitigation strategies do not exist or are not sufficient to result in acceptable (or better) risk, then Army leadership must be informed that the acceptable level of medical risk will be exceeded unless changes are made in either the operational concepts, the ability (resources) to develop alternative mitigation methods, or the levels of risk considered acceptable.

RAND Process to Redefine Issues

As stated above, the AMEDD asked RAND to reassess the 75 issues considered by the Council of Colonels and to recommend adjustments to the AMEDD's transformation analytical architecture. Each of the 75 AMEDD issues was examined against a set of screening criteria developed by the authors of this report to define what constitutes an issue. According to these criteria, an issue:

- Asks an important question in relevant timeframes.
- Often relates to key capabilities that enable the overall transformation concept.
- May suggest multiple paths (alternatives) to issue resolution.
- Does not presuppose a solution.
- Is specific enough to prompt analysis.
- States uncertainty.
- Requires iteration over its lifetime to discover its full dimensions and alternatives for resolution.

To present the issues in a taxonomy that supported their investigation and resolution, RAND reclassified them using AMEDD's Integrated Concept Teams (ICTs) as an organizing construct.³ Finally, the issues were further assessed against six prioritizing criteria:

³ Integrated Concept Teams (ICTs) are cross-AMEDD working groups that focus on developing AMEDD concepts and capabilities in specific domains, e.g., evacuation, combat casualty care.

- The degree of risk to the Army if the issue is not resolved.
- The degree to which the AMEDD is in control of the resolution of the issue.
- The specificity of the issue.
- Whether the future force and current force resolution of the issue may differ.⁴
- A determination of whether the issue is persistent or conditional.
- A determination of whether or not the issue is resolvable in isolation or if it is linked to another issue (AMEDD or non-AMEDD).

The restated issues that resulted from this assessment, which were validated by the AMEDD, are in Appendix A.

Designing a New AMEDD Analytical Process

At the core of our approach to designing a new analytical process for future AMEDD assessment efforts was the perception that earlier AMEDD and Army efforts were linear and discrete. The Army Transformation process appeared grounded in the assumption that the Army could postulate itself at a place in the future—depicted in the war games as concepts, capabilities, technologies, and forces—and look back to the present to determine how it should proceed to that specific future condition. In short, the Army, as depicted on one of the early Army After Next briefing slides, was attempting to “stand on a mountain in the future” and look back along the path it took to get there.⁵

Such a process, however, has significant limitations. First, it assumes one can know the correct “mountain”—a proposition that becomes increasingly problematic the more distant the future. Sec-

⁴ At the time the AMEDD workshops were held, the terms Legacy Force, Interim Force, and Objective Force were standard. These terms are no longer in use; the Legacy and Interim Forces are now considered the current force, and the Objective Force is now termed the future force. We use the current terminology in the main text of this report.

⁵ Deputy Chief of Staff for Doctrine, U.S. Army TRADOC, *AAN Overview Briefing: Army After Next—Knowledge, Speed and Power*, Fort Monro: U.S. Army TRADOC, 1999.

ond, the process is perforce linear, because the end point is assumed and the path to it is traced back to the present from that point.

Furthermore, this is a bounded process, which, when gamed, validates a specific concept rather than rigorously assessing alternatives and assumptions.

RAND suggested an alternative approach for planning for the future to the AMEDD: "scenario planning." Scenario planning "starts from the assumption that—much as we try—we simply cannot predict or control the future. We can only imagine different ways in which the future might turn, stake out a course that makes sense today, and try to be flexible and alert when the unexpected inevitably occurs."⁶ This approach assumes that the dimensions of the distant future are, by their very nature, largely unknowable. In short, one cannot know the destination before making the journey. Thus, the approach in scenario planning is broad to ensure that intervening destinations on the journey offer as many perspectives as possible. It also assumes that the best place to make a decision about where to proceed next on a journey with an ambiguous destination is from vantage points along the route that can provide better information. The importance of this approach is that it provides agility in coping with uncertainties whose dimensions will unfold only over time.

RAND recommended basing future AMEDD analytical efforts on the scenario-planning concept. Furthermore, RAND recommended that future efforts should critically examine AMEDD's concepts for medically supporting Army Transformation concepts and objectives. In particular, this effort should focus on the assessment of the critical issues adopted by the AMEDD.

Based on this research, RAND suggested that AMEDD construct an analytical architecture that was focused on issues that are of high importance to the Army, resolvable by the AMEDD, and tractable (will lend themselves to analysis). Furthermore, RAND recommended that the results from the analysis of these issues should enable the AMEDD to communicate risks, or the gaps between require-

⁶ This description of scenario planning is on the web site of the College of Marin (<http://www.marin.cc.ca.us/scenario/>, accessed 25 October 2001).

ments and capabilities, to the Army. RAND also offered that the recast issues could serve as the basis for designing games, workshops, and other forms of analysis to resolve the issues.

The results of RAND's issue redefinition process were reported to the AMEDD in memoranda and briefings by the authors of this report. At the heart of the RAND recommendations was the delineation of AMEDD's analytical challenge. We noted that an adequate assessment of the medical risk posed by future force operational concepts required the Army to delineate realistic time and patient variables in game play or simulations, as this research endeavored to do through the ATWs. AMEDD could then assess medical outcomes from these games or simulations and communicate the medical risks posed by the future force concepts and the ability of a postulated AMEDD HSS system to mitigate them.

In January 2002, the AMEDD Center and School (AMEDDC&S) asked RAND to design and conduct a series of workshops to begin an assessment of the medical risks associated with emerging Army operational concepts and the capacity of AMEDD initiatives to mitigate these risks. The remainder of this report describes the design, execution, and results of those workshops.

AMEDD Transformation Workshop Design

This chapter provides an overview of the AMEDD Transformation Workshop (ATW) design, including the structure, scenario, sequence of events, objectives, and methodology. RAND designed, organized, facilitated, and provided analytical support to the workshops.¹ Participants included subject matter experts (SMEs) from the AMEDD, TRADOC, and the TRADOC Analysis Center (TRAC) and AMEDD contractors. The purpose of the workshops was to:

- Identify gaps between AMEDD future force HSS concepts and combat casualty care requirements generated from a TRADOC-sponsored simulation.
- Isolate potential solutions and alternatives for further analysis.
- Provide AMEDD with analytical support for future programmatic decisions.
- Assess medical risks and their mitigation potential.

¹ The ATWs were designed as a modified version of the RAND “Day After” gaming methodology. Their goal was to present a structured problem to a team of experts to resolve by employing AMEDD’s proposed future operational concepts and resources. For a description of the “Day After” methodology, see R.H. Anderson and A.C. Hearn, *An Exploration of Cyberspace Security R&D Investment Strategies for DARPA: “The Day After—in Cyberspace II,”* Santa Monica, CA: RAND Corporation, MR-797-DARPA, 1996.

Organization

At the heart of the workshop organization (see Figure 1) were three teams of SMEs. Each team was designed to function as a seminar and was supported by a RAND facilitator and data collector.² A control/administrative support cell provided overall workshop direction and contained non-AMEDD-specific SMEs. Finally, the RAND project leaders, facilitators, analysts, workshop designers, and data collectors formed a postworkshop team to conduct analysis of the workshop results.

Workshop Teams

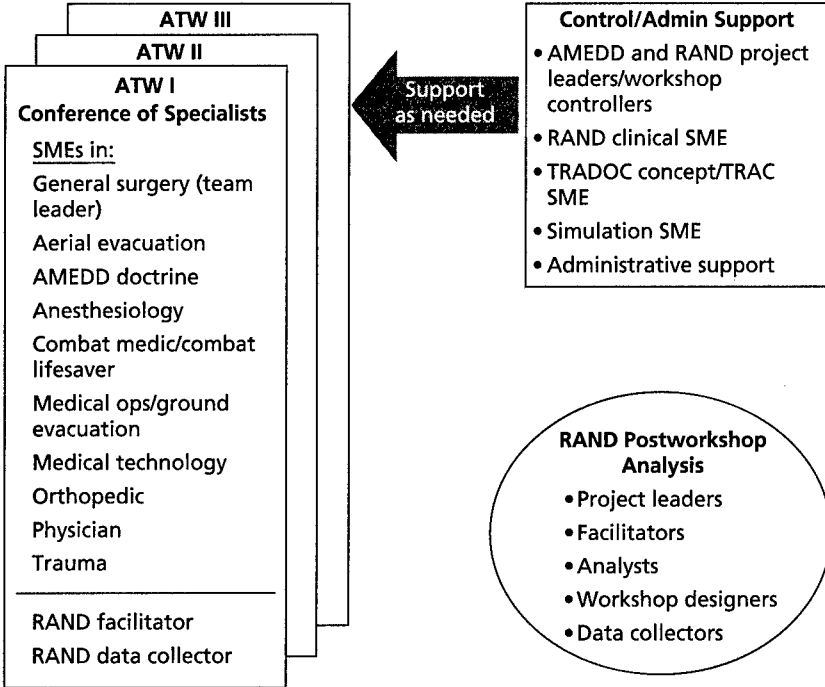
The three workshop teams each contained SMEs selected by the AMEDD. Their areas of expertise spanned the functional areas critical to an informed examination of a scenario focused on combat casualty care issues. These areas included Aerial Evacuation, AMEDD Doctrine, Medical Operations/Ground Evacuation, Anesthesiology, Combat Medic/Combat Lifesaver, Medical Technology, Orthopedics, Physician Assistant, General Surgery, and Trauma. The teams deliberated to reach a consensus on how best to solve the combat casualty care issues presented by the scenario and to resolve the issues posed for the workshop. The scenario used in the workshop was developed by TRAC and is discussed later in this report. Each team was headed by an AMEDD physician and facilitated by a senior RAND analyst. A RAND analyst also supported each team as a data collector (see Appendix B for the composition of the teams and other participants in ATW I–III).

Control/Administrative Support Cell

The control/administrative support cell was the locus for workshop direction and for extra-AMEDD subject matter expertise. Specifically,

² A seminar is defined in the *Oxford Desk Dictionary* as a “conference of specialists.” This was as intended by the designers of the workshops, in contrast to the normal TRADOC gaming methodology of having participants serve as role players.

Figure 1
AMEDD Transformation Workshop Structure



*Each conference team had the same categories of SMEs.

RAND MG103-1

it had representatives from TRADOC, TRAC, and the modeling and simulation contractor who answered questions and provided inputs to the workshop about future force concepts and capabilities and about the scenario used for the workshop. Finally, RAND provided a clinical SME (physician) for the cell to serve as a medical advisor to the RAND project leaders.

Workshop Objectives and Issues

Objectives

In the aggregate, the overarching goal of the ATW series was to develop a sound analytic process that would enable the AMEDD to identify capability gaps for the Army that clarify medical risk and identify mitigation strategies. Accordingly, the workshops were designed to address the following three objectives:

- Design an analytical architecture to evaluate HSS concepts through an assessment of recast AMEDD issues.
- Identify gaps between Army and AMEDD concepts and capabilities and HSS requirements derived from future force operational simulations.
- Begin to identify and assess alternative HSS concepts.

ATW I and II were “baselining workshops” that began the process of assessing a limited set of AMEDD issues, which will be discussed later. They used the results of a TRADOC-sponsored future force Unit of Action (UA) (battalion) simulation, and casualty data derived from that simulation by the AMEDD, to assess the adequacy of the AMEDD future force HSS system designed to support the future force.³ HSS individuals, organizations, and capabilities were assumed throughout the workshop to operate optimally, i.e., they were assumed to always perform to standard and were not degraded by combat action or other means.

In short, the objective of ATW I and II was to assess the ability of the postulated future force HSS systems, performing in “best case” modes, to support a future force UA (battalion) operation.

In ATW III, team members used the resources of the HSS system from ATW I as a pool of resources for team members to orga-

³ See Appendix D for the process used to estimate numbers and types of casualties.

nize, allocate, and position as they saw fit to better address the combat casualty care challenges posed by the scenario.

Issues

The workshop teams focused on addressing three principal issues identified by AMEDD, based in part on prior RAND research:

- Where do first responders and combat medics fit in the overall future concept for combat casualty care, and what treatment capabilities (treatment technologies and skills) will medics require to support this concept?
- What theater military medical infrastructure is necessary to support future military medical operations across the spectrum of operations?
- What are the evacuation requirements to support military operations across the spectrum of operations?

At the conclusion of the workshop, each team was also asked to provide three additional items of information.

- What was the final disposition of the casualties at the end of the workshop?
- What was the status of the HSS system (i.e., the availability of medical resources and services)?
- What advice would they give the operational commander about the ability of the HSS system to support continued operations?

Scenario

ATW I–III examined the operations of a notional future force in combat operations in 2015, as detailed in the TRADOC/TRAC report entitled *Objective Force Concept Operation: A Notional Combat Battalion Engagement* (TRAC-F-TC-01-006, August 2001). In this scenario, a Unit of Action (battalion) is employed as the main effort in a brigade shaping operation in preparation for a Unit of Employ-

ment (division) main attack. The simulation covers eight hours of operations.

Several important conditions were fixed in the workshop to establish a baseline/optimal case:⁴

- The theater had a 44-bed Combat Support Hospital (CSH) located at an aerial port of debarkation (APOD).⁵
- The theater had matured for 12 days.
- The brigade assessed had a Field Surgical Team (FST), a Forward Support Medical Company, and a Forward Support MEDEVAC Team (3 UH-60L helicopters).
- The UA (battalion) in ATW I had two evacuation vehicles per company-sized maneuver unit (including RSTA) and three treatment/evacuation vehicles (all based on the Future Combat System or FCS). In ATW II, the UA (battalion) had one evacuation vehicle per company-sized maneuver unit (including RSTA), and two treatment vehicles (all FCS-based).
- None of the medical assets were degraded during the operation, e.g., no medics became casualties, no helicopters were shot down, and C4ISR systems worked perfectly.
- There were no restrictions on medical materiel (Class VIII).
- Twenty-one technologies deemed technologically feasible and due to be fielded by 2015 by the U.S. Army Medical Research and Materiel Command (MRMC) were employed by the teams (Appendix C).
- Time of wounding, 8-digit grid coordinates, Patient Condition Codes, and associated Treatment Briefs were provided to the teams for all casualties.⁶

⁴ The medical force structure, provided for the workshop by AMEDD, is based on AMEDD's input to the Army Transformation effort, specifically a proposed Brigade Support Medical Company structure to the Unit of Action, as of April 2002.

⁵ This capability was deployed because of an assessment by the Armed Forces Medical Intelligence Center (AFMIC) that sufficient host nation medical support would not be available in the theater by 2015 to meet U.S. requirements.

⁶ Deployable Medical System (DEPMEDS) Patient Condition Codes describe a disease or injury. Treatment briefs provide an overview of the required medical treatment for each

The TRADOC simulation had a number of limitations. Specifically, a limited number of “entities,” or weapon systems/platforms could be modeled. Consequently, not all the systems that would have been deployed by the future force UA battalion or higher units were portrayed in the simulation. Within the UA battalion, this included approximately a company-sized element and also logistics vehicles. The effect this limitation had on the workshop was that it potentially lowered the number of overall casualties, because the population at risk was reduced by the entity limitation. Simply put, the simulation could not attack platforms that were not in the model. In turn, this potentially reduced the demand on the HSS system portrayed in the workshops.

The scenario also presented another issue in that the UA battalion employed when the scenario was developed contained six combined arms companies and a reconnaissance, surveillance, and target acquisition (RSTA) troop. Subsequent to the simulation based on the scenario, the UA battalion structure has evolved, e.g., from six combined arms companies and a RSTA squadron to three combined arms companies and a RSTA squadron. Furthermore, it is highly likely that the structure of future force units will continue to change as concepts and technologies mature. Consequently, the approach taken by the workshop designers was to allocate the appropriate HSS system resources to the future force units in the simulation. From the perspective of casualty generation, the structure of the UA battalion was not significant. The TRADOC representatives at the workshops confirmed that the number of entities employed in the geography portrayed in the scenario conformed to future force combined arms company and RSTA squadron concepts. Thus, the number of entities attacked in the simulation, and the attendant casualties, was deemed realistic within the context of future force operations.

specific case. These materials were provided by AMEDD for the workshops and are included at Appendix G.

Sequence of Events

ATW I and II

ATW I and II took place over three-day periods (16–18 April 2002 and 27–29 August 2002) per the following schedule:

Day 1:

- Introductory briefings given in plenary session.
- Team organization meeting in team rooms and deliberations on the first six hours of the eight-hour operation.

Day 2:

- Instructions update given in plenary session.
- Deliberations on the final two hours of the operation.

Day 3:

- Teams finalized deliberations, completed the Casualty Tracking Worksheet (Appendix E), and prepared the Step 3 Worksheet (Appendix F).
- Teams briefed findings in plenary session.

ATW III

ATW III was conducted 5–6 November 2002.

Day 1:

- Development of HSS concepts using ATW I resources.

Day 2:

- Teams continued development of HSS concepts.
- Teams briefed results in plenary session.

Methodology

Each of the teams in ATW I and II addressed the same problem: how to employ the deployed HSS system to provide combat casualty care for the future force UA battalion modeled in the scenario. The objec-

tive for each set of team members was to apply their collective expertise to determine the likely outcome for each casualty by providing the decisions they would make on how to treat each casualty. The RAND facilitator and the team leader guided their teams in reaching a consensus solution for each casualty. Each team was given a Casualty Tracking Worksheet that detailed:

- The type of weapon that caused the casualty.
- The type of vehicle the casualty was in when wounded, or if the casualty was dismounted.
- The time the casualty was wounded (H + minutes).
- A casualty number (for tracking).
- A specific location for each casualty.
- The wound type and standard for treatment (Patient Condition Code and Treatment Briefs).⁷

Furthermore, each team was provided the location of medical evacuation and treatment resources relative to the casualty (provided by TRADOC and TRAC SMEs in ATW I; provided from simulation data in ATW II). Movement speeds were specified as dismounted personnel, 3 kilometers per hour (kph); ground evacuation vehicles, 25 kph; and aerial evacuation (UH-60L), 120 kph (no aerial evacuation was permitted forward of the company headquarters due to the surface-to-air missile threat). In addition to the HSS concept of operations provided by AMEDDC&S, the following additional conditions were specified at each echelon of the HSS system in the area of operations for workshop purposes:

ATW I

- **Combat Arms Platoon:** no organic medical capability⁸ other than highly trained combat lifesavers (CLS), but a medic from

⁷ A copy of this worksheet is at Appendix E.

⁸ An organic capability is one that normally resides in and deploys with a unit.

the assets at the Combined Arms Company is placed in each combat arms platoon.

- **Combined Arms Company/RSTA Squadron:** no organic medical capability, but generally has 2 evacuation vehicles with 3 medics each attached from the UA (battalion).
- **UA (Battalion Headquarters):** 14 organic evacuation vehicles task organized as follows: 12 attached to maneuver companies (2 per company); 2 attached to RSTA troop; 3 treatment vehicles stay at battalion headquarters for aid stations.
- **Brigade Headquarters (did not change locations throughout the workshop):** medical company with a FST (general guideline: 30 resuscitative surgeries in 72 hours); medical company with 20 minimal care beds; aerial evacuation provided by a forward support MEDEVAC team (3 UH-60L helicopters).
- **Division Headquarters (located at an APOD; did not change location throughout the workshop):** 44-bed CSH (general guideline: 30 resuscitative surgeries in 72 hours); medical company: 24 intensive care unit beds and 20 intermediate care ward beds.

ATW II

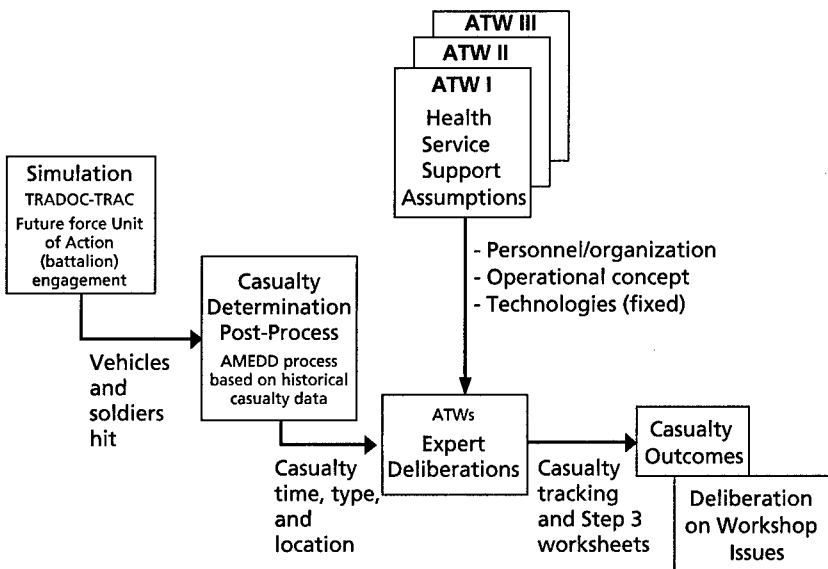
- **Combat Arms Platoon:** nothing organic other than highly trained combat lifesavers (CLS)—no medics attached to the platoons.
- **Combined Arms Company/RSTA:** 1 Future Combat System Medical Evacuation (FCS-MED-E) vehicle in direct support.
- **Battalion Headquarters:** Two Future Combat System Medical Treatment (FCS-MED-T) vehicles at battalion headquarters.
- **Brigade Headquarters (did not change locations throughout the workshop):** medical company with a FST (general guideline: 30 resuscitative surgeries in 72 hours); medical company with 20 minimal care beds; aerial evacuation provided by a forward support MEDEVAC team (3 UH-60L helicopters).
- **Division Headquarters (located at an APOD; did not change location throughout the workshop):** 44-bed CSH (general

guideline: 30 resuscitative surgeries in 72 hours); medical company with 24 intensive care unit beds and 20 intermediate care ward beds.

In ATW I and II, the teams considered each individual casualty as it moved through the HSS system, deliberating on what type of treatment and evacuation was required and what could be provided, considering the assets available in the scenario. The teams annotated their actions, results, and observations in the appropriate columns of the Casualty Tracking Worksheet. The next chapter of this report details the findings of the workshop teams. Again, during ATW III, teams deliberated on how the more robust resources from ATW I might be better utilized to resolve the combat casualty care challenges presented by the scenario.

The methodology for the workshops is depicted in Figure 2.

Figure 2
AMEDD Transformation Workshops Methodology



Workshop Results

ATW I and II

At the conclusion of each of the first two workshops, teams were asked to answer three questions:

- What was the final disposition of the casualties at the end of the workshop?
- What was the status of the HSS system at the end of the workshop?
- What advice would the teams give the operational commander concerning the ability of the HSS system to support continued operations?

Additionally, each team completed a Casualty Tracking Worksheet and Step Three Worksheet, which recorded their consensus views concerning the three workshop issues.¹ Samples of the worksheets are included in Appendixes E and F. The teams also briefed their Step Three Worksheet results at the plenary session, addressing the three workshop issues:

¹ The workshop design was based on RAND's "Day After" gaming methodology, which comprises three steps. The first two steps are future-scenario based. Step Three requires participants to discuss a set of questions or issues from their perspective in the present.

- Where do first responders and combat medics fit in the overall future concept for combat casualty care, and what treatment capabilities (treatment technologies and skills) will medics require to support this concept?
- What theater military medical infrastructure is necessary to support future military medical operations across the spectrum of operations?
- What are the evacuation requirements to support military operations across the spectrum of operations?

Casualty Outcomes, Status of HSS Resources, and Advice to the Commander

What was the final disposition of casualties at the end of the workshops? The workshops resulted in three estimations of the outcomes for casualties generated in the scenario. Although the HSS concept used in each baselining workshop was different, Table 1 shows that the outcomes were remarkably similar. These outcomes indicate that the limiting factors in the HSS concepts most likely

Table 1
Mean Casualty Outcomes at H+8 hours^a

Outcome	ATW I			ATW II		
	Mean	(SE)	%	Mean	(SE)	%
Killed in Action (KIA) ^b	15.7	(1.2)	29%	17.0	(3.1)	31%
Died of Wounds (DOW)	2.0	(1.0)	4%	3.0	(1.5)	6%
Returned to Duty (RTD)	3.7	(0.7)	7%	3.3	(0.9)	6%
Treated/held or awaiting treatment	32.7	(2.6)	60%	30.7	(1.3)	57%

SE = standard error of the mean.

^a Means are calculated from results of three teams per workshop. There were 57 total casualties generated in the scenario, but the teams did not consider 3 USAF pilot casualties resulting from F-15 aircraft being shot down during the simulation; percentages are therefore derived from a total casualty population, N = 54.

^b The casualty estimation provided by AMEDD indicated that 13 casualties were killed instantly. These and casualties whom the participants determined would die before reaching the battalion aid station (BAS) are included in the KIA values.

were not the different levels of resources between ATW I and II. For example, ATW I included a medic in each maneuver platoon while ATW II did not, yet this reduction made little, if any, difference in casualty outcomes.

It is important to note that the results shown in Table 1 do not indicate the final disposition of those casualties who were awaiting treatment or being held following treatment (e.g., for evacuation) at H+8. After H+8, the number of Died of Wounds (DOW) casualties can either remain the same or increase. Most workshop participants expected that the DOW rate would increase. Our assessment is that this assumption is probably valid, given that the operating room assets had reached capacity, which implies that casualties would have to wait longer for necessary surgical intervention.

What was the status of the HSS system at the end of the workshop? At the completion of the workshop, each team reported on the status of the medical assets in support of the battalion effort. Generally, the medical system was at or near capacity, including and especially surgical capabilities. In ATW I, one team estimated that these assets were at full capacity, with seven casualties still awaiting surgery. Furthermore, this team estimated that an additional 31 hours of surgery were required after H+8. In ATW II, one team estimated that 20 casualties awaited surgery, for a total of approximately 50 additional surgical hours after H+8. This team also estimated that two soldiers would lose limbs due to the surgical delay and warned that the estimate of 50 additional surgical hours does not anticipate the needs of patients who may require additional surgeries.

Importantly, these estimations of surgical capacity included both the CSH and FST, and the teams asserted that the FST would not be able to relocate until surgeries were completed or patients were stabilized and evacuated. It is probable that this limitation could affect future operations by severely limiting mobility, assuming that the FST is not intended to be left behind by maneuvering units.

While ground evacuation assets were not fully utilized at H+8, air evacuation assets were near or at maximum capacity, reflecting the heavy reliance each team placed on these assets. It was also estimated

that medical supplies and blood were either exhausted or in short supply.

What advice would the teams give the operational commander about the ability of the HSS system to support continued operations? Although the workshop scenarios were designed based on optimal HSS capabilities and conditions (albeit within a constrained HSS structure), each team indicated that the casualties resulting from operations to H+8 had saturated the system in both workshops. They agreed that they would recommend an operational pause to the maneuver commander to enable the HSS system to treat existing casualties and to replenish its capabilities.

Issue Resolution

As mentioned previously, the workshops were designed around RAND's "Day After" gaming methodology. The third and final step of this methodology asked each team to address the workshop issues retrospectively, i.e., given what they now know about outcomes, what would they suggest? Accordingly, each team conducted a guided discussion that focused on each of the workshop issues in the context of the workshop scenario, critical factors that contributed to the outcomes of the workshop, and the implications for the AMEDD and the Army if these critical factors were not present.

Where do first responders and combat medics fit in the overall future concept for combat casualty care, and what treatment capabilities (treatment technologies, level of supply, and skills) will medics require to support this concept? The assumed proficiency of first responders, especially of combat lifesavers (CLS), and the availability of advanced technologies to control hemorrhage were judged essential by each of the teams. In ATW II, this capability was made even more crucial by the lack of combat medics in the maneuver platoons. One team in that workshop estimated that 46 percent of combat deaths incurred during the scenario may have been preventable had a medic been closer to the casualty (assuming rapid subsequent evacuation).

Some participants were skeptical, however, that such an advanced level of CLS proficiency could be achieved and maintained. A

related observation was that the role of CLS was unreasonably large, considering the pace of the battle and the high expectation of medical proficiency required. Nonetheless, suggested alternatives to this strategy that did not include force structure changes required even greater increased CLS competence and/or the ability to provide substantial treatment during evacuation.

The idea of relying on CLS and advanced technologies was intended to address two characteristics of the future force concept that make HSS challenging. The combination of dispersed unit operations and the absence of medics organic to maneuver platoons resulted in a significant amount of time between injury and care by a medic. As hemorrhage was postulated as the most significant presentation of battle injuries, the posited technologies were critical, and it was essential that they be applied as soon after wounding as possible. These technologies included hemostatic agents, fibrin bandages, advanced tourniquets, and advanced intravenous fluids. One team in ATW I estimated that had the CLS not been as proficient at applying these technologies as was assumed, the total mortality rate (KIA + DOW) would have risen from their estimate of 33 percent to 59 percent. Another team made a similar estimate during ATW II, adding that limb loss would increase from 6 percent to 15 percent of casualties.

What theater military medical infrastructure is necessary to support future military medical operations across the spectrum of operations? The teams concluded that the HSS infrastructure employed in the ATW I scenario was generous, including 14 ground treatment/evacuation vehicles, 3 air ambulances, an FST, and a CSH, all dedicated to the battalion engaged in the scenario. This infrastructure represents a dedication of divisional assets, and it was further assumed that none of these assets would be lost. Nevertheless, all three teams believed that this infrastructure was stretched to capacity in dealing with the casualties generated by the scenario. The HSS infrastructure employed in ATW II was reduced in comparison to ATW I, but it still represented a very high dedication of divisional assets to support the battalion in the scenario (see the section "Methodology" in Chapter Two). Similarly, this infrastructure was stretched to capacity.

Each team indicated that perfect situational awareness—based on advanced communications technologies—was a key capability because it enabled optimal medical regulating. That is, knowing the location and severity of casualties in real time would allow for remote triage, resulting in the precise and appropriate allocation of assets. Surgical capability was also critical, although many participants indicated that more was required and that this capability would be more beneficial if it were located closer to the point of wounding. A more forward surgical capability would reduce evacuation times. Again, the dispersion of the future force and the absence of medics in the maneuver platoons were cited as significant challenges. One team in ATW I estimated that total mortality would rise from 33 percent to 41 percent if surgery were not available within 3 hours, and to 57 percent if unavailable in 8 hours. This estimate assumed the presence of highly proficient CLS as well as the availability of advanced medical technologies throughout the HSS system. The teams raised some concern about whether the concept for medical resupply would be adequate, but the workshop was not designed to investigate this issue in full detail.

What are the evacuation requirements to support military operations across the spectrum of operations? Air evacuation was essential to meet the casualty evacuation demands of the scenario. This need was dictated by the dispersion of units. As noted earlier, the workshop design assumed that three UH-60Ls were focused on the UA battalion portrayed in the simulation, could move as far forward as the company area, and would not be affected by enemy action.

Air evacuation was utilized by each of the teams at or near full capacity during the scenario, and it was estimated that it would continue to be needed at maximum capacity for some time following H+8 to evacuate the casualties occurring in those eight hours of action. Were these assets not available, the teams suggested that surgical capability would be needed even farther forward, perhaps even at the battalion aid station.

Little in the way of enroute care was assumed during the workshop, although one team suggested this approach as a way to amelio-

rate the shortfalls in medical infrastructure and evacuation assets. However, this team qualified its suggestion with the observation that this care would have to be more substantial than providing oxygen and fluids; they suggested that the telemedicine (monitoring) technologies posited during the workshop would be of limited utility without the ability to intervene substantially.

The throughput of casualties during the scenario overwhelmed the HSS system. As one team pointed out, there was simply no place to put all the casualties, given the surgical/bed capacities and evacuation assets allotted. Although the teams unanimously recommended additional, farther-forward surgical capabilities, one team leader reminded participants during the ATW II plenary session that an FST is doctrinally intended to stabilize patients for evacuation. The number of patients requiring such resuscitative surgery is generally low—10 to 15 percent. If evacuation assets capable of evacuating out of the theater could be placed close to farther-forward resuscitative surgical capabilities, surgical assets in the rear of the theater (CSH) might not be as critical. This concept could indicate a tradeoff of “footprint” between UE and UA medical assets that deserves further investigation. It should be noted, however, that such a concept would redistribute this footprint along the deployment sequence, likely requiring more medical assets earlier. This could occur via either contingency deployment or prepositioning (in this scenario, the theater was assumed to be mature, allowing the presence of the CSH).

ATW III

In ATW III, team members used the more robust HSS system from ATW I as a pool of resources for team members to organize, allocate, and position as they saw fit to better address the combat casualty care challenges posed by the scenario. Teams presented key points of their discussions at a plenary session that was characterized by discussion and refinement of what the teams considered to be critical issues arising from ATW I and II. In general, each team presented very preliminary concepts that centered on modular HSS structures designed

to provide surgical capability as far forward as possible. However, none of the concepts were sufficiently mature to warrant their presentation here as possible solutions; the presentations were intended to foster discussion and generate observations. Further, none of the teams suggested that a solution could be found using the HSS assets from ATW I that would significantly improve casualty outcomes. The four major observations from ATW III can be summarized as follows:

1. Dispersion of units, long LOCs, and limited surgical capacity were the most problematic characteristics of the operations in the scenario.
2. Timely surgical intervention is imperative. However, little distinction was made between the CSH and the FST due to demand, representing a contravention of the doctrinal concept of the FST as a capability that stabilizes a relatively small (approximately 15 percent) proportion of patients for further evacuation.
3. Modular alternatives to provide far-forward surgical intervention may prove attractive with further investigation, but mobility and security are significant concerns in the context of this scenario.
4. The roles of the CLS, maneuver platoon medic, and battalion aid station (BAS) need to be revisited.

These topics are discussed further in Chapter Four of this report.

Observations and Conclusions

The three teams agreed that the HSS systems employed during ATW I–II had been stretched to or near their maximum capacities during the eight-hour operation portrayed in the scenario. Furthermore, this situation would affect the ability of the HSS system to support follow-on operations, perhaps for 24 or more hours. Efforts to reallocate ATW I resources in ATW III to achieve better results did not significantly improve outcomes.

The fact that the HSS assets available to the future force UA battalion in this scenario (i.e., all brigade assets, a CSH at division, and all the aerial medical evacuation assets allocated to the division) were probably more than what would reasonably be expected suggests that the HSS systems portrayed in these three workshops, even in optimized and undegraded states, were inadequate. Of further concern to workshop participants was the recognition that the operation modeled in the TRAC scenario was a secondary effort shaping operation that one might expect to be of lower intensity than, for example, a deliberate frontal engagement.

The remainder of this chapter includes our observations and discussion. Our observations fall into two categories: specific medical observations and the broader implications deduced from the three workshops. These observations are based on the experience of three workshops focused on a single UA battalion in a single simulation depicting shaping operations. Nevertheless, given the commonality of

the findings of the three separate teams during the three workshops regarding the HSS system, they deserve attention.

Specific Workshop Observations

- The HSS structure and capabilities employed in the workshops were more robust than a future force UA battalion in a shaping operation could reasonably expect, particularly given the assumptions built into these three workshops that optimized for a “best case” capability. Nevertheless, in all three workshops the HSS system was stretched beyond capacity during eight hours of relatively low-intensity shaping operations.
- Workshop participants believed that the HSS system portrayed in the three workshops would require a pause to clear the battlefield, replenish itself, and deal with patient backlog before it could adequately support continued combat operations. This is particularly important, because the battalion in the scenario used for the workshops, per emerging UA operational concepts, was expected to move immediately into the next phase of operations. The phase investigated during the workshops was a stand-off and shaping operation culminating at the very end in a dismounted attack. The unit was then going into an urban fight, where it is likely that there would be more intense combat and higher casualty rates. Workshop participants believed that there would have been significant medical risk associated with such a course of action, given the state of the HSS system at the end of the shaping operation.
- The potential implications arising from the fact that the HSS system, particularly the surgical capabilities of a brigade FST and a CSH (at division), were essentially saturated by the shaping—not direct combat—operations of a single UA battalion are critical. One can fairly assume that the sister UA battalions of the modeled UA battalion in the UA brigade would also be engaged at some level and generating casualties from their own

ranks. These would be casualties that the same brigade FST, division CSH, and aerial medical evacuation platforms would be required to collect, evacuate, and treat. Furthermore, one can also assume that the remainder of the UE division is conducting simultaneous operations, per current future force operational concepts, and generating further casualties that would have to be treated at the same division CSH. Given the backlog generated by the modeled UA battalion at the division CSH, it is likely that any further surgical demand would only exacerbate this backlog. Accordingly, there is a significant risk that the died of wounds (DOW) rate would increase.

Broader Workshop Implications

The broader workshop implications will be discussed in two categories: workshop implications for the HSS system, and workshop implications for the Army.

Workshop Implications for the HSS System

Combat lifesaver competencies. A significant aspect of emerging future force operational concepts is the dispersed nature of UA forces. Given the envisioned capabilities of future force weapon systems, coupled with the quality of situational awareness, units will be able to control much larger areas of terrain. Additionally, individual systems will be much more dispersed on the battlefield than now—routinely by as much as three to four kilometers. Thus, when a manned vehicle was hit by enemy fire that produced casualties, that vehicle was largely isolated from the other vehicles in the unit. Furthermore, these vehicles and their casualties were (in the simulation) left behind as the remainder of the unit continued to move rapidly toward its objectives.

The dispersion of vehicles in this scenario placed a premium on the skills of combat lifesavers (CLS) and their ability to employ the advanced medical technologies used in the workshops to care for casualties until they could be evacuated. This was particularly impor-

tant because combat medics were frequently unable to get to casualties in a timely manner, either because of the distance to the casualty or because they were already treating a casualty.

In the view of the teams, the CLS skills employed in the workshops greatly exceed what is expected of a CLS today and in reality approach what is expected of a combat medic. For example, in the workshops, CLS applied dressings and tourniquets, cleared airways, managed fractures, applied needle decompression, and administered many of the 21 advanced technologies incorporated in the workshops. From the perspective of casualty outcomes during ATW I and ATW II, these extraordinarily competent CLS were critical to the effectiveness of the HSS system. This is reflected in the estimates of some of the teams on what the effect of less-competent CLS would have been on casualty outcomes. During ATW I, one team estimated that total mortality (killed in action and died of wounds) would increase from 33 percent to 59 percent. In ATW II—when platoons did not have combat medics—this estimate rose from 32 percent to 61 percent. Finally, in ATW II one team believed that absent highly competent CLS, limb loss would have increased from 6 percent to 15 percent. In short, highly competent CLS were critical to the performance of the HSS system in ATW I–III.

The role and importance of the CLS raises several issues that need further analysis. First, there was broad consensus that the initial and ongoing sustainment training of CLS need to be thoroughly assessed to determine feasibility, considering the proficiency levels demanded by the workshops. In short, is it possible to train a future soldier to be both an infantryman and a highly competent CLS and to maintain both skill sets over time? Second, performing as a CLS will be a secondary role for UA combat arms soldiers, just as it is now. Consequently, there will be an inherent tension in combat for the CLS between providing combat casualty care or fighting. In these workshops the CLS provided care and thus made a significant contribution to favorable casualty outcomes. On the other hand, the workshops did not assess the impact of these CLS being taken away from their combat duties.

Role of the platoon combat medic. The workshop teams concluded that the shaping operation portrayed in this scenario—with its highly dispersed, fast-moving maneuver—called into question the role of the platoon combat medic.

The principal issue was the proximity of the platoon medic to casualties. Even though the location and type of injury for each casualty was provided during the workshops, if the casualty was not in the same vehicle as the medic, the distance to the casualty was generally at least a kilometer. Consequently, it was not feasible for the medic to move by foot to the casualty. This created a dilemma that was recognized, but not solved, by workshop participants. To move the medic to the casualty, the FCS vehicle carrying the medic would have to be diverted from the mission. Such a decision would degrade platoon combat capability. In the workshops, this dilemma was largely solved, as noted above, by investing the unit CLS with extraordinary competence and capabilities, principally in the form of advanced medical technologies. The best assistance the medic could potentially provide in these cases was remote advice to the CLS.

All this is not to imply that the platoon combat medic could or did not make a difference. One team estimated that if a combat medic had been able to provide immediate care to each casualty, total mortality would have decreased by 46 percent. Furthermore, the combat medic will clearly be more effective in dismounted combat when casualties are not so widely dispersed.

The teams also noted that future force medics will also play a significant role in other dimensions of force health protection. As they are today, they will be involved in training CLS and other soldiers, performing on-site and remote triage during battle, dealing with disease nonbattle injuries (DNBI), and myriad other readiness-related duties that have traditionally required combat medics. What these workshops did point out, however, was the immense difficulty that combat medics will have in providing immediate response in highly dispersed, fast-moving combat operations.

Role of the battalion aid station. The BAS played a limited role in the workshops. It, like the combat medics, was a victim of the dispersion of the battlefield and the ever-increasing length of the lines of

communication in this particular scenario. Participants generally elected to evacuate casualties via air directly to either the FST or the CSH.

This does not imply that the BAS will not play an important role in the HSS system of the future, only that its utility in the highly dispersed, fast-moving operation in the workshop scenario was limited. Like the medic, the BAS will be critical to the HSS system during less dispersed but more casualty-prone operations (e.g., military operations on urban terrain, or MOUT). In these situations, some participants believed that the BAS could serve as a casualty collection point or as the location for the FST. Additionally, the BAS will be important in the overall force health protection effort before, during, and after combat as a locus for maneuver unit medical readiness, DNBI treatment and prevention, field sanitation, sick call, medical training, and medical regulation.

Medical technology. During these workshops the utility of advanced medical technologies was not specifically addressed as an analytical issue. Instead, the MRMC provided 21 technologies (see Appendix C) for the workshops that it affirmed would be fully fielded and will perform to stated expectations by 2015. Workshop participants employed the technologies as specified by MRMC. Nevertheless, although the performance of medical technologies was not a stated issue, participants did note several technologies that they believed were critical to combat casualty care during the workshops.

Two critical factors, as frequently noted in this report, made the combat casualty care effort particularly challenging: battlefield dispersion and the distance to surgical capability at the FST or the CSH. Perhaps the most important technology in the workshops for dealing with the dispersion factor was the Warfighter Physiological Status Monitor (WPSM). The WPSM provided immediate location and injury-type data for all casualties. This information was invaluable in the medical regulation effort, particularly in allocating the aerial evacuation assets. The distance factor for urgent casualties was primarily alleviated by the application of a number of advanced hemostatic agents, which prevented fatal hemorrhage while severely wounded casualties were enroute to treatment at the FST or CSH.

It was the sense among many of the participants that the WPSM and the advanced hemostatic technologies were of such importance that their development should be accelerated as much as possible, perhaps at the expense of fielding some of the other medical technologies used in the workshops.

Aerial medical evacuation. On the highly dispersed battlefield portrayed during the workshops, aerial medical evacuation made the difference between life and death for many casualties. Furthermore, its criticality became more pronounced as the battle progressed, because the distance from point of wounding to the FST steadily increased. At the end of the workshop (H+8), casualties were typically over 60 kilometers from the FST and approximately 80 kilometers from the CSH. Ground evacuation of casualties requiring surgery was simply not a viable option. Again, however, it should be noted that the three UH-60L helicopters used to support this UA battalion were all that were available to the UA brigade and would probably have been supporting other battalions as well.

Surgical capacity. The main limiting factor in dealing with the casualties in the workshops was surgical capacity. Quite simply, casualties backed up at the FST and CSH awaiting surgery. Again, as with medical evacuation, one could assume that the remainder of the brigade and the division in the scenario would be engaged in operations and suffering casualties. Thus, the surgical capacity at the FST at the brigade and the CSH at the division, which were overwhelmed by a single UA battalion's casualties over eight hours, would clearly have difficulty dealing with more casualties.

Additionally, the FST was not able to displace forward as the battle progressed, because it was in a mass casualty mode throughout the duration of the simulation. Thus, the time from wounding to operating table gradually increased for casualties as the battle moved progressively further from the FST location. This additional time increased mortality and morbidity among casualties. During ATW II, one team estimated that total mortality increased from 33 percent to 41 percent if surgery was not available within three hours, and from 33 percent to 57 percent if not available within six hours.

These observations indicate a need to conduct further simulations of future force operations that portray casualties in different scenarios to provide a clearer sense of the level of medical risk—and the medical resources required to mitigate that risk to an acceptable level.

Workshop Implications for the Army

Several issues arose during the workshops that are beyond the scope of the AMEDD to address independently. They truly are Army issues. Again, as with the medical implications of the workshops, these Army issues are a result of observations tied to a specific scenario and simulation.

Lines of communication and rear area security. As the battle portrayed in this scenario progressed, the lines of communication steadily increased and were left largely unsecured as maneuver units pressed on to their objectives. From the perspective of the HSS system, this created a situation in which ground medical evacuation vehicles moved independently around the battlefield to casualty locations, casualty collection points, aerial medical evacuation landing zones, etc. This movement was across a battlefield that was neither cleared nor secured. Team members believed this would be particularly problematic given the fact that many of the casualties were caused by paramilitary forces. Since the UA was not securing the battlefield as it moved rapidly through it, it is reasonable to assume that some of these paramilitary forces survived and would remain a threat in what essentially became the rear area—both to ground and aerial evacuation platforms. This is a situation not dissimilar to the challenges faced by coalition forces during Operation Iraqi Freedom in securing lines of communication behind combat forces rapidly moving toward Baghdad.

As noted earlier, the workshops did not allow attrition of any of the components of the HSS system, in order to portray its capabilities in a “best case” condition. Therefore, the impact of operating in an insecure rear area was not assessed. Nevertheless, given the ubiquitous nature of the paramilitary forces, it would be reasonable to assume that elements of the HSS system would be attacked, particularly if

they moved around the battlefield as single entities. Loss of medical personnel or platforms could only worsen medical outcomes.

The issue for the Army is: How will ground and air lines of communication and rear areas be secured in the wake of rapidly advancing future force combat units?

Unit morale, cohesion, and combat effectiveness on a dispersed battlefield. The shaping operation examined in this workshop took place on a highly dispersed battlefield through which UA forces rapidly advanced to their objectives. As combat units rapidly advanced, disabled vehicles and their crews were left behind. Again, the growing rear area in which these vehicles and crews found themselves was not secure, and one could assume the crews were still liable to attack from paramilitary forces.

Team members believed that the nature of the scenario's battlefield—highly dispersed and not secure—would create problems in the realms of morale, cohesion, and combat effectiveness in a number of ways. First, as already discussed, getting a combat medic to a casualty location was frequently not feasible, and casualties often only received primary care from a CLS. This situation is in contrast to the historic expectation of American soldiers and their leaders: when they call for a medic, one will appear to render aid. Second, given the dispersion of the battlefield and the distance between casualties, medical evacuation platforms, and treatment locations, the elapsed time between wounding and evacuation was generally longer than the Army has come to expect.

Team members believed that the frustration of the twin expectations that a medic will quickly come to a casualty's aid and that the wounded person will if necessary be rapidly evacuated to the appropriate level of care could negatively affect morale, cohesion, and combat effectiveness. Furthermore, the possibility of being "abandoned" on a battlefield that has not been secured would only complicate these human factors issues. These are areas of future force operations that need investigation.

Conclusion

The three AMEDD Transformation Workshops provided valuable insights into the ability of AMEDD's envisioned future force HSS system to support a future force operation. Although the results and insights gleaned from ATW I-III are unique to a specific scenario and simulation, they do point to the potential medical challenges posed in supporting rapid future force operations on a highly dispersed battlefield.

The workshops also show the importance of simulating future force concepts and the criticality of in-depth, subject matter expert analysis in assessing the outputs of any simulation. In the case of these workshops, every casualty generated by the simulation was tracked from the point of wounding to ultimate disposition within a future force division HSS system by experts in all the components of combat casualty care. Thus, the teams were able to articulate credible casualty outcomes and the challenges facing emerging AMEDD concepts, structures, and technologies in supporting a postulated future force unit of action. The team members stressed that further simulations of additional scenarios and of evolving future force concepts should continue to ensure that the AMEDD can articulate to the Army the medical risks involved in future force concepts and the ability of the future HSS system to mitigate those risks to a level acceptable to the Army. Such analysis will support the design and implementation of a health service support system that is as robust as the operational system it will support.

In addition to these results, it is likely that ongoing and recent operations in Afghanistan and Iraq will influence emerging future force concepts and structures as well as related medical requirements.

Restated AMEDD Transformation Issues

This appendix presents the entire set of issues from all of AMEDD's Integrated Concept Teams (ICTs).¹ As such, not all of the issues listed, such as Homeland Security, were relevant to the scenario of ATW I–III, but are included here for completeness. Each matrix provides a subjective assessment of the issue in six categories. Table A.1 describes the assessment categories.²

Table A.1
Issue Assessment Categories and Potential Scores

Category	Potential Scores
Risk to the Army if the issue is not resolved	High, Medium, Low (H, M, L)
The degree to which AMEDD can control the resolution of the issue	H, M, L
The specificity of the issue	H, M, L
The phase of Army Transformation to which the issue is relevant	Objective Force (O), Interim Force (I), Legacy Force (L), or all (A)
Persistence of the issue	Persistent (P), Conditional (C)
Whether or not the issue is linked to others	Yes (Y), No (N)

¹ The AMEDD uses Integrated Concept Teams to develop and investigate issues within specific functional areas. We used the ICT construct to organize the issues in this appendix. These ICTs include: Command, Control, Communications, Computers, Intelligence (C4I); Casualty Care; Medical Evacuation; Medical Force Protection; Medical Logistics; and Homeland Security. Some issues are not readily assignable to an ICT; others can be assigned to two or more ICTs ("Meta-ICT Issues").

² As mentioned in the main text of this report, the terms Objective Force, Interim Force, and Legacy Force are no longer in use. However, in these appendixes we retain them as they were used for the AMEDD workshops.

Shading is used in the matrices to give some sense of how the issues should be addressed by the AMEDD. Although all the issues are important, the intent was to identify those that have the highest priority for addressing early in an analytical process. The prioritization is based on two key criteria: the importance of the issue to the Army, and whether or not AMEDD could solve the issue. The shading code for the matrices follows.

	A critical issue whose parameters must be provided to the AMEDD by the Army (AMEDD not in control, but the issue fundamentally drives AMEDD requirements)
	Issues that are "gameable" and of high priority
	Issues that are "gameable" but may not be of high priority. May be resolvable in the context of a high-priority issue
	Issues that may be better resolved by analytical means other than gaming
	Issues that are important but that are not so urgent as to be included in first series of workshops

The issue matrices, grouped by ICT, appear on the next seven pages.

C4I ICT Issues

Issue	Risk to Army if Not Resolved	AMEDD in Control	Specificity	Phase of Transformation	Persistent or Conditional	Linked to Another Issue
1: What alternative organizational and C2 arrangements are viable options to execute the military medical mission in future operations?	M	M	L	O	P	Y
2: What are the future bandwidth requirements to support military medical operations and how much bandwidth will be available for military medical operations at different points along the spectrum of operations?	M	L	H	ALL	P	Y
3: What processes and technologies are needed to deal with the high volume of information anticipated in future military operations? Note: This issue assumes a "super leader" without raising alternatives, e.g., artificial intelligence that might ease the information management demands on leaders.	M	L	L	ALL	P	Y

C4I ICT Issues

Issue	Risk to Army if Not Resolved	AMEDD in Control	Specificity	Phase of Transformation	Persistent or Conditional	Linked to Another Issue
5: What organizational and staff arrangements best provide adequate medical advice to operational commanders and planners?	M	L	H	ALL	P	Y

C4I ICT Issues						
Issue	Risk to Army if Not Resolved	AMEDD in Control	Specificity	Phase of Transformation	Persistent or Conditional	Linked to Another Issue
RAND: How will AMEDD mitigate the problems of integrating U.S. and Coalition C4ISR capabilities?	M	L	L	ALL	C	Y

Casualty Care ICT Issues						
Issue	Risk to Army if Not Resolved	AMEDD in Control	Specificity	Phase of Transformation	Persistent or Conditional	Linked to Another Issue
1: Where do the first responders and combat medics fit in the overall future concept for combat casualty care and what treatment capabilities (treatment technologies and skills) will medics require to support this concept?	H	H	H	O	P	Y
3: What theater military medical infrastructure is necessary to support future military operations across the spectrum of operations?	H	M	H	ALL	P	Y

Casualty Care ICT Issues

Issue	Risk to Army if Not Resolved	AMEDD in Control	Specificity	Phase of Transformation	Persistent or Conditional	Linked to Another Issue
4: What are the casualty rates and injury types anticipated during Objective Force operations (particularly early entry operations and decisive operations) and what are their medical implications?	H	L	H	ALL	P	Y
5: What degree of modularity do medical organizations need to effectively support military operations (across the spectrum of operations; for legacy, interim, and objective forces or mixes of these forces)? Question: Is the only viable medical organizational alternative modularity?	L	H	H	ALL	P	Y

Medical Evacuation ICT Issues

Issue	Risk to Army if Not Resolved	AMEDD in Control	Specificity	Phase of Transformation	Persistent or Conditional	Linked to Another Issue
1: Is joint medical doctrine for evacuation planning adequate for future operations?	H	M	M	ALL	P	Y
2: What are the evacuation requirements to support military operations across the spectrum of operations?	H	M	L	O	P	Y
3: What are the AMEDD's platform requirements to support the transformed force and on which of these platforms will telemedicine (and other technologies, e.g., enroute care) be advantageous?	H	M	L	O	P	Y

Medical Logistics ICT Issues

Issue	Risk to Army if Not Resolved	AMEDD in Control	Specificity	Phase of Transformation	Persistent or Conditional	Linked to Another Issue
1: What are the medical logistics concepts and capabilities required to support future Army concepts of operation?	M	H	M	O	P	Y
2: How will contractors be used to support military (particularly medical) operations in the future and at different points along the spectrum of operations?	M	L	L	ALL	C	Y
3: How will the AMEDD manage medical materiel storage to support operations across the spectrum?	M	H	M	ALL	P	Y

Homeland Security ICT Issues

Issue	Risk to Army if Not Resolved	AMEDD in Control	Specificity	Phase of Transformation	Persistent or Conditional	Linked to Another Issue
1: What are the military medicine requirements in support of homeland security?	H	M	L	ALL	P	Y
2: What is the concept to detect BW attacks on the homeland, to isolate these attacks, and to protect and/or treat individuals affected by these attacks?	H	L	L	ALL	P	Y
RAND: What is the AMEDD responsibility to develop chemical and biological defense technologies to support the homeland defense mission?	M	M	H	ALL	P	Y

*Homeland security might require a separate gaming effort because the lack of data and understanding of emerging national relationships/doctrine

Unassigned ICT Issues

Issue	Risk to Army if Not Resolved	AMEDD in Control	Specificity	Phase of Transformation	Persistent or Conditional	Linked to Another Issue
RAND: What are the medical considerations of MOUT that will affect operational plans?	H	M	H	ALL	C	Y
RAND: What are the requirements to protect military medical facilities across the spectrum of operations?	H	L	H	ALL	C	Y

Meta-ICT Issues

Issue	Risk to Army if Not Resolved	AMEDD in Control	Specificity	Phase of Transformation	Persistent or Conditional	Linked to Another Issue
1: What doctrinal changes (medical) are necessary to support evolving U.S. Army operational doctrine?	H	M	L	O	P	Y
2: What changes to joint medical doctrine are needed to integrate service/coalition/host nation/NGO capabilities to support the medical requirements of future military operations and what will be the roles of each across the spectrum of operations and in various combinations of the future force (legacy, interim, and objective)?	M	L	M	ALL	C	Y
4: What capabilities will the AMEDD require to support the transformed force and is there a significant role for "teletreatment"?	H	M	L	O	P	Y

Team Members, ATW I-III

ATW I Team Members

Subject Matter Area	Team 1	Team 2	Team 3
Aerial Evacuation	COL David Heintz	LTC William Layden	LTC Bryant Harp
AMEDD Doctrine	LTC Richard Dabbs	LTC Bernard Hebron	LTC Brian Shaw
Medical Ops/ Ground Evacuation	MAJ Chris Richards	MAJ Bruce Shahbaz	MAJ Thomas Berry
Anesthesiology	COL John Chiles	COL Denver Perkins	COL Stephen Janny
Combat Medic	SGM Eduardo Benavides	SFC Michael Haynes	SFC Louis Gholston
Medical Technology	COL Robert Vandre	LTC Beau Freund	Dr. Tommy Morris
Orthopedics	LTC Paul Dougherty	COL John Uhorchak	COL James Malcolm
Physician Assistant	MAJ Jerald Wells	CPT Peter Bulley	MAJ Michael Summers
Team Leader/ General Surgery	LTC Brian Lein	LTC Stephen Flarherty	LTC Kim Marley
Trauma	COL David Burris		LTC Tom Knuth
RAND Facilitator	Mr. Peter Wilson	Mr. John Gordon	Dr. Richard Darilek
RAND Data Collector	Ms. Terri Tanielian	Mr. Robert Howe	Dr. Bruce Pirnie

Other ATW I Participants

Colonel Harrison Hassell: Control Cell (workshop control, AMEDD C&S)

Colonel David Nolan: Control Cell (workshop control, AMEDD C&S)

Colonel Raj Gupta: Control Cell (medical technology SME, MRMC)

Dr. David Johnson: Control Cell (workshop control, RAND)

Dr. Gary Cecchine: Control Cell (workshop control, RAND)

Dr. Lee Hilborne: Control Cell (RAND clinical practices SME)

Captain Daniel Maroney: Control Cell

Mr. Harry Birch: Control Cell (simulation SME)

Lieutenant Colonel John Lockey: Control Cell (Objective Force SME, TRADOC)

Dr. Mike Ingram: Control Cell (simulation SME, TRAC)

Captain John Belew: Control Cell (workshop support, AMEDD C&S)

Specialist Nathanael Sutton: Control Cell (workshop support, AMEDD C&S)

ATW II Team Members

Subject Matter Area	Team 1	Team 2	Team 3
Aerial Evacuation	COL David Heintz	LTC William Layden	LTC Bryant Harp
AMEDD Doctrine	LTC Richard Dabbs	LTC Bernard Hebron	LTC Brian Shaw
Medical Ops/ Ground Evacuation	MAJ Chris Richards	MAJ Bruce Shahbaz	MAJ Keith Rigdon
Anesthesiology	COL John Chiles	COL Denver Perkins	COL Stephen Janny
Combat Medic	SGM Eduardo Benavides	SFC Michael Haynes	SFC Louis Gholston
Medical Technology	COL Robert Vandre	LTC Beau Freund	Dr. Tommy Morris
Orthopedics		COL John Uhorchak	MAJ Bradly Nelson
Physician Assistant	MAJ Jerald Wells	CPT Peter Bulley	MAJ Michael Summers
Team Leader/ General Surgery	LTC Brian Lein	LTC Stephen Flarherty	LTC Kim Marley
Trauma	COL David Burris	LTC David Cancelada	LTC(P) Tom Knuth/ LTC Jim Goth
Unit of Action	Mr. Rick Pena	Ms. Gladys Garcia/ LTC Mel Washington	
RAND Facilitator	Ms. Terri Tanielian	Mr. John Gordon	Dr. Richard Darilek
RAND Data Collector		Mr. Robert Howe	Dr. Bruce Pirnie

Other ATW II Participants

Colonel Harrison Hassell: Control Cell (workshop control, AMEDD C&S)

Colonel Raj Gupta: Control Cell (medical technology SME, MRMC)

Dr. David Johnson: Control Cell (workshop control, RAND)

Dr. Gary Cecchine: Control Cell (workshop control, RAND)

Mr. Harry Birch: Control Cell (simulation SME)

Captain John Belew: Control Cell (workshop support, AMEDD C&S)

Specialist Nathanael Sutton: Control Cell (workshop support, AMEDD C&S)

ATW III Team Members

Subject Matter Area	Team 1	Team 2	Team 3
Aerial Evacuation	COL David Heintz	LTC William Layden	
AMEDD Doctrine	LTC Richard Dabbs	LTC Bernard Hebron	LTC Brian Shaw
Medical Ops/ Ground Evacuation	MAJ Chris Richards	MAJ Bruce Shahbaz	MAJ Bob Cornes
Anesthesiology	COL John Chiles	COL Denver Perkins	COL Stephen Janny
Combat Medic	SGM Eduardo Benavides	SFC Michael Haynes	SFC Louis Gholston
Medical Technology	COL Robert Vandre	LTC Beau Freund	Dr. Tommy Morris
Orthopedics		COL John Uhorchak	MAJ Bradly Nelson
Physician Assistant	MAJ Jerald Wells	CPT Peter Bulley	MAJ Michael Summers
Team Leader/ General Surgery	LTC Brian Lein	LTC Stephen Flaherty	LTC Kim Marley
Trauma	COL David Burris	LTC David Cancelada	COL Tom Knuth
Unit of Action	Mr. Rick Pena	Ms. Gladys Garcia	LTC Mel Washington
RAND Facilitator	Mr. Peter Wilson	Mr. John Gordon	Dr. Richard Darilek
RAND Data Collector	Ms. Terri Tanielian	Mr. Robert Howe	Dr. Bruce Pirnie

Other ATW III Participants

Colonel Harrison Hassell: Control Cell (workshop control, AMEDD C&S)

Colonel Raj Gupta: Control Cell (medical technology SME, MRMC)

Dr. David Johnson: Control Cell (workshop control, RAND)

Dr. Gary Cecchine: Control Cell (workshop control, RAND)

Dr. Lee Hilborne: Control Cell (RAND clinical practices SME)

Mr. Harry Birch: Control Cell (simulation SME)

Captain John Belew: Control Cell (workshop support, AMEDD C&S)

Specialist Nathanael Sutton: Control Cell (workshop support, AMEDD C&S)

Medical Technologies Employed in ATW I-III

The following advanced medical technologies were deemed by MRMC to be feasible and due to be fielded by 2015. They were available for use by team members during the workshops. Descriptions for each of these technologies, as provided by MRMC, follow.

1. Warfighter Physiological Status Monitor (WPSM)
2. Universal Red Blood Cells for Severe Hemorrhage
3. Universal Freeze-Dried Plasma
4. Spray-on Protective Bandage
5. Machine-Language Translation
6. Liquid Tourniquet
7. Lightweight Extremity Splint
8. IV Hemostatic Drug
9. Intracavitary Hemostatic Agent
10. Enzymatic Wound Debridement
11. Battlefield Medical Information System Telemedicine
12. Advanced Resuscitation Fluid
13. Advanced Hemostatic Dressing
14. Warrior Medic (Biocorder)
15. Hemoglobin-Based Oxygen Carrier
16. Field Therapy Utility Pack for Laser Eye Injury
17. Digital Information and Communications System
18. Transportable Automated Life Support System
19. Teleconsultation/Teledermatology

20. High-Intensity Focused Ultrasound

21. Forward-Deployable Digital Medical Treatment Facility

1. Warfighter Physiological Status Monitor

Summary: Networked array of physiological sensors embedded in the Objective Force Warrior (OFW) suit and transparent to the soldier. Data management algorithms in the soldier computer deduce near-real-time physiological data from the sensors to information useful to medics and commanders.

Capabilities and indications for use: Monitoring capability includes remote triage (determination of life signs, blood pressure, respiratory function, neurological status, ballistic wounding alert) and force health protection monitoring (thermal stress risk, hydration state, sleep status, mental alertness status, metabolic status/energy reserve, altitude adaptation, and potential exposure to toxic chemicals and materials on the battlefield).

User(s): Every soldier equipped with the OFW suit.

First fielding date: FY11.

Distribution: Monitoring capability in every OFW suit.

Training: No training required. Complex physiological data will be reduced to easy-to-understand information for medics and commanders about the physiological status of individual soldiers and units.

Cube and weight: Sensors will add about a pound to the OFW suit.

Cost: MRMC medical research will provide the sensor specifications and data management algorithms. The OFW suit developer will develop or purchase the sensors and include the data management algorithms in the soldier computer.

2. Universal Red Blood Cells for Severe Hemorrhage

Summary: The product is non-type-specific red blood cells for battlefield blood replacement.

Capabilities and indications for use: The successful product will eliminate the need for blood typing, reduce logistics footprint, and can be used in a far-forward environment to improve organ oxygenation in severe hemorrhage and to stabilize combat casualties in scenarios of delayed evacuation.

User(s): Physician assistant, surgeon.

First fielding date: 2015.

Distribution: 10 units at battalion aid station PA. 50 per FST.

Training: Training in proper indications for use and in intravenous access and administration.

Cube and weight: 0.75 pound per 250 ml unit with administration set and packaging.

Cost: \$150 per unit.

3. Universal Freeze-Dried Plasma

Summary: The product is freeze-dried plasma that is not type-specific and is packaged for rapid reconstitution and administration on the battlefield by the combat medic or the physician assistant.

Capabilities and indications for use: The product is freeze-dried (lyophilized) plasma that is not type-specific and is packaged for rapid reconstitution and administration on the battlefield for control of hemorrhage. The product can be carried without significantly adding to the medic's battlefield load and when reconstituted and administered will provide functional activity similar to native plasma. The product will eliminate the need for blood typing, will reduce logistical footprint, and can be used in a far-forward environment for casualty resuscitation.

User(s): Combat medic, physician assistant, surgeon.

First fielding date: 2012.

Distribution: 4 units per combat medic and PA, 50 units per FST.

Training: Training in indications for use; training in intravenous access and administration.

Cube and weight: Each unit will come as prepackaged intravenous bag (with IV setup) with 2 compartments, one containing freeze-dried plasma, the other sterile water for injection. The two compartments must be joined and mixed for use. Each package will be 250 ml and weigh 0.75 pound. No maintenance is required.

Cost: \$50/unit.

4. Spray-on Protective Bandage

Summary: A spray-on, self-sanitizing, flexible bandage that will reduce or eliminate blood and fluid loss; will reduce or eliminate pain associated with motion; and will protect wounds from environmental contamination.

Capabilities and indications for use: The spray-on bandage may be self- or buddy-applied and will enhance wound stabilization for 2 or more days after injury. The bandage will be applicable to large and small wounds and will be self-sanitizing (antimicrobial) and capable of reducing or stopping blood and fluid losses (including compressible hemorrhage and amputation stumps after minimal tourniquet control); reducing or eliminating pain during motion; and protecting wounds from environmental contamination. May be used in conjunction with enzymatic/chemical debridement.

User(s): Combat lifesaver, combat medic; PA; surgeon.

First fielding date: 2010.

Distribution: One tube per soldier. One tube covers wounds up to 50 percent of total body surface.

Training: Minimal training required; will be applied directly to wound surface.

Cube and weight: Final form not established. Attempts are being made to deliver dressing as a powder that will use wound liquid (blood, serum) to polymerize on wound surface.

Cost: \$50 per unit.

5. Machine Language Translation

Summary: The goal of the machine language translation project is to build and deliver a 2-way machine voice translation system on a small, rugged, handheld computer/Personal Digital Assistant (PDA).

Capabilities and indications for use: Machine language translation uses computers to translate free speech from one language into another: for example Spanish into Ukrainian. A handheld computer with this technology will enable deployed medical personnel to communicate/interact with and provide immediate care to non-English-speaking patients (e.g., during humanitarian assistance operations, unconventional operations, etc.). This device will also enhance the situational awareness of military personnel, and improve the speed and precision in coalition/ally collaboration (and decisionmaking) via automated translanguing access to Command, Control, Communications, Computers and Intelligence (C4I).

User(s): Combat warfighter, medical personnel (medics, physician's assistant, and physicians) and other military personnel that may interact with an indigenous population (e.g., chaplains, military police, civil affairs).

First fielding date: In one year (July 2003).

Distribution: The device can be tested in the Operation Enduring Freedom with the civil affairs units, medical personnel, etc.

Training: The military personnel need to be trained on the system and the system needs to be trained to their voice.

Cube and weight: Height: 5.3 in; width: 3.3 in; depth: 0.62 in; weight: 6.7 oz, recognizer board: 9 oz.

Cost: \$1,800 for each unit; the cost includes the cost for the rugged PDA and also the rugged recognizer speech board.

6. Liquid Tourniquet

Summary: A lightweight polymerizing gel that will be used for compressible hemorrhage or amputation. If tourniquet is required to stop extremity bleeding, it will only be applied for the time necessary for placement of gel into/onto the wound surface and gel polymerization (less than 15 minutes). Expected to result in much greater survival and function of muscle and tissue currently lost by long-term placement (greater than 2 hours) of current tourniquet system. Will allow stabilization of wounds for several days under battle conditions.

Capabilities and indications for use: Will allow compressible hemorrhage to be buddy- or self-treated. Gel will be applied directly to wound and compressed by field dressing or by temporary use of standard one-handed tourniquet with placement of gel on stump and removal of tourniquet. Material will provide several days of wound stabilization and protection from environmental contamination.

User(s): Soldier, combat medic, PA, FST. Will be packaged as component of and distributed with field dressing and one-handed tourniquet.

First fielding date: 2010.

Distribution: One per current field dressing and tourniquet.

Training: Hands-on training will be required.

Cube and weight: Device will be less than 0.25 pound; one use disposable.

Cost: \$10 for field dressing and \$50 for tourniquet per use.

7. Lightweight Extremity Splint

Summary: The lightweight extremity splint will allow soldiers with immobilized and nondisplaced fractures to continue their mission and soldiers with serious open fractures to be stabilized and unit transportable for several days under battle conditions.

Capabilities and indications for use: The splint will be fabricated from new, lightweight material(s) and will be deployable far forward in the battle area. The field medic or "buddies" on the battlefield or medical officers at the forward surgical team, or equivalent, will use it for open fractures and external fixation splints. The lightweight extremity splint will enable the soldier with a single upper extremity fracture to remain functional, perhaps even operating an individual weapon until evacuation. A war fighter with a lower extremity fracture will be able to ambulate with crutches and perhaps one other person instead of requiring a stretcher and 2 or more stretcher bearers. In both cases, the functional capabilities of a team with an extremity fracture will be improved.

User(s): Buddy care, combat lifesaver, combat medic, PA, surgeon.

First fielding date: 2010.

Distribution: One arm and one leg splint per 10 soldiers.

Training: Hands-on training will be required. Device will be a balloon sleeve with a pressure limiting valve and self-contained flexible air pump.

Cube and weight: Device will be less than 0.25 pound; one use disposable.

Cost: \$100/set (one leg/one arm).

8. IV Hemostatic Drug

Summary: An IV agent that will safely enhance the ability of the combat casualty with hemorrhage to form natural clots and stop hemorrhage on the battlefield.

Capabilities and indications for use: The hemostatic drug is an IV agent that will safely enhance the ability of the combat casualty to form natural clots and stop hemorrhage on the battlefield. The agent will effectively treat casualties who have experienced serious hemorrhage.

User(s): Combat medic, physician assistant, surgeon.

First fielding date: 2010.

Distribution: 2 doses per medic and PA, 20 per FST.

Training: Users must be trained in proper indications for use, i.e., uncontrolled, especially, noncompressible hemorrhage.

Cube and weight: 20 ml syringe per dose.

Cost: \$500 per dose.

9. Intracavitary Hemostatic Agent

Summary: The intracavitary hemostatic agent will be provided in foam, gel, or liquid form that can be introduced into a body cavity via a large-bore needle (without surgery) to slow or stop internal hemorrhage.

Capabilities and indications for use: In the far-forward environment, the intracavitary hemostatic agent will be especially useful to stop internal bleeding.

User(s): Combat medic, PA, surgeon.

First fielding date: 2015.

Distribution: 2 doses per combat medic, 5 per PA, 20 per FST.

Training: Training in proper indications and techniques for use.

Cube and weight: 50 ml per dose, preloaded syringe; 4 oz per dose including packaging.

Cost: \$400/dose.

10. Enzymatic Wound Debridement

Summary: A spray-on, self-limited enzymatic/chemical and analgesic debridement system for chemical and burn injuries prior to covering with a spray-on bandage.

Capabilities and indications for use: The spray-on enzymatic/chemical debridement system may be self- or buddy-applied and will enhance wound cleaning and stabilization for 2 or more days after injury. Debridement will be applicable to large and small wounds and may be used before application of or, perhaps, integrated with the spray-on bandage.

User(s): Soldier, combat lifesaver, combat medic; physician assistant; surgeon.

First fielding date: 2010.

Distribution: 50 ml tube per soldier and stored at first PA level.

Training: Minimal training requirement. Debridement will be self-limiting.

Cube and weight: 50 ml; flexible tube; less than 0.1 pound.

Cost: \$10 per tube.

11. Battlefield Medical Information System Telemedicine (BMIST)

Summary: BMIST is a wireless hand-held assistant designed to record the essential elements of a medical history and physical examination and then provide the medical analysis and decision support for first responders. It uses a wireless, flexible, and scalable personal data assistant that can be used by military health care providers at all levels of care from the foxhole to the medical center. It is the ideal tool to meet the military objective of providing useful medical informatics and telemedicine support for first responders across the spectrum of the military health care operations and continuum of support levels of care.

Capabilities and indications for use: BMIST enables first responders (and other health care staff) to quickly and accurately capture, integrate, transmit, and display data from medical histories/physical examinations, medical reference libraries, diagnostic and treatment decision aids, medical sustainment training, and medical mission planning using a wireless, hand-held assistant. To meet the needs of first responders with varying levels of expertise and experience, BMIST will support a user interface that includes help windows and decision rationale. BMIST will also provide the flexibility to adapt to evolving medical procedures and protocols, as well as to accommodate additional or new medical databases and mission requirements. When adequate communications are available, BMIST will support real-time "teleconsultation" between the first responder and expert medical staff (e.g., physician) residing in different locations.

User(s): Combat lifesaver, combat medic, PA, battalion/brigade surgeon.

First fielding date: Summer 2002 (initial prototype field tests).

Distribution: One per combat infantry medic.

Training: Minimal (estimated under 1 hour for untrained users, the interface is user friendly and is an intuitive part of their business process).

Cube and weight: The Pocket PC Platform is 5.3 in by 3.3 in by 6.2 in, 6.7 oz; BMIST is software.

Cost: Hand-held commercial \$500 per unit, software undetermined (estimate under \$100 per license if commercialized).

12. Advanced Resuscitation Fluid

Summary: A resuscitation fluid that sustains wounded soldiers and preserves organ integrity and function even in the face of small-volume fluid resuscitation and hypotension.

Capabilities and indications for use: The advanced resuscitation fluid will require less fluid to maintain critical levels of blood pressure and tissue perfusion. It will reduce the mortality and late morbidity associated with trauma and serious blood loss by reducing vascular injury and immune system activation caused by decreased blood perfusion and oxygen radical generation during tissue reoxygenation. The fluid will be well suited for small-volume resuscitation for trauma and blood loss with delayed evacuation for up to 72 hours.

User(s): Combat medic, PA, and surgeon.

First fielding date: 2015.

Distribution: 6 units of this resuscitation fluid will be distributed to each medic in the Objective Force for far-forward resuscitation, 10 units to each battalion aid station, and 20 units to each FST.

Training: The advanced resuscitation fluid will be used as current resuscitation fluids so no additional training will be required.

Cube and weight: 500 cc bags weighing 0.5 kg, including packaging and administration set.

Cost: \$50/500 ml unit.

13. Advanced Hemostatic Dressing

Summary: The advanced hemostatic dressing will stop lethal severe arterial or large venous hemorrhage within 2 minutes. In the far-forward environment, this will be most useful for compressible hemorrhage.

Capabilities and indications for use: The advanced hemostatic dressing will stop lethal severe arterial or large venous hemorrhage within 2 minutes. It may be applied externally or internally. It will be used in the far-forward environment, especially for compressible (external) hemorrhage, and in the FST.

User(s): Soldier, buddy aid, combat lifesaver, combat medic, PA, surgeon.

First fielding date: 2007.

Distribution: One per soldier, 5 per combat medic and PA, 20 per FST.

Training: Hands-on training for all users.

Cube and weight: 0.25 pound per dressing, size of current bandage. No maintenance requirement.

Cost: \$100 per dressing.

14. Warrior Medic ("Biocorder")

Summary: A hand-held device used by combat medics to detect or collect and analyze physiological and metabolic information in combat casualties. The sensors and other capabilities of the Biocorder will interface with physiologic sensors that are part of the WPSM and will provide supplementary physiological data for use by the combat medic for casualty management. Results of analysis are displayed as well as the recommended actions to be taken by the medic.

Capabilities and indications for use: The Biocorder provides the combat medic with the capability to collect casualty data and provides assistance and guidance to the medic for best casualty management. The Biocorder will enhance casualty management far forward on the battlefield by providing real-time physiological and vital signs information to the medic. Return to duty of minor casualties will be accelerated. Evacuation demand will be reduced and/or more accurately targeted to appropriate casualties. The Biocorder will be capable of communicating with the physiological sensors to be worn by the soldier (WPSM). The Biocorder will monitor and log ECG, cardiac output, blood pressure, peripheral resistance, heart rate, respiratory rate, oxygen saturation, body temperature, acoustic heart and lung sounds and blood chemistries. The Biocorder will be equipped to drive miniature IV infusion pumps based on blood pressure for both resuscitation and drug infusion.

User(s): Combat medic, PA, surgeon, nurses.

First fielding date: 2015.

Distribution: One per combat medic, 3 per FST, 10 per holding company, 1 per ambulance, 50 per CSH.

Training: Physicians and nurses, combat medic (2 hrs), unit-level maintenance (2 hrs), depot-level maintenance (5 hrs).

Cube and weight: Hand held 6 in by 6 in by 2 in (.04 cu ft) weighing < 1 pound.

Cost: 5,000 units * \$2,000/unit = \$10M.

15. Hemoglobin-Based Oxygen Carrier (HBOC)

Summary: The hemoglobin-based oxygen carrier will provide a temperature-stable alternative to red blood cells.

Capabilities and indications for use: The hemoglobin-based oxygen carrier will provide an alternative to red blood cells that can be deployed far forward. The product will remain stable and functional in a wide range of ambient temperature conditions and can be rapidly administered to provide replacement of oxygen-carrying capacity in casualties who have experienced significant blood loss on the battlefield. The product will effectively stabilize patients with severe blood loss during extended evacuation delay.

User(s): Combat medic, PA, surgeon.

First fielding date: 2007.

Distribution: 4 units per combat medic and PA, 50 per FST.

Training: Training in indications for use and in intravenous access and administration.

Cube and weight: Each unit with administration set is 0.75 pound with packaging.

Cost: \$400/unit.

16. Field Therapy Utility Pack for Laser Eye Injury

Summary: Field therapy utility pack containing a diagnostic card and therapeutics that can be easily administered by a combat medic immediately after injury to prevent secondary retinal degeneration and vision loss.

Capabilities and indications for use: Provides diagnostic tools for rapidly assessing injury severity, retinal location, and presence of hemorrhage. Provides treatments that can curtail degenerative processes and conserve vision.

User(s): Combat medic.

First fielding date: FY09.

Distribution: One kit per combat medic.

Training: Combat medic requires training to use diagnostic tools and administer therapeutic agents.

Cube and weight: about 1 pound.

Cost: unknown.

17. Digital Information and Communications System

Summary: The goal of the digital information and communications system is to create and support a medical global information grid that will extend far forward into a combat zone.

Capabilities and indications for use: The digital information and communications system consists of two major components: the Special Medical Augmentation Response Team for Medical Command, Control, Communications and Telemedicine (SMART MC3T) package and Warfighter Information Network–Proof of Concept (WIN-POC). SMART MC3T package will enable soldiers to establish medical communications (e.g., self-sufficient Internet and telephony coverage) capability in remote areas where communication infrastructure is unavailable or not functional. This capability will enable support to deployed specialty teams (e.g., trauma/critical care, stress management) and provide on-scene commanders with a real-time “reach-back” capability to medical specialists and/or commanders. This global information grid will be extended by WIN-POC, which is a mobile, powerful communications node mounted on a field vehicle. WIN-POC will provide seamless, broadband communications from forward-deployed areas to Theater and National Military Command Headquarters and Military Health System Medical Centers worldwide. It will function as a platform for multiuser broadband medical command-and-control communications and telemedicine connectivity. The entire system provides a seamless, modular, expandable, and secure manner in which to rapidly acquire, transfer, and display critical medical and logistical information in a battlefield (or other operational) environment.

User(s): Combat medic, nurse, PA, battalion/brigade surgeon, medical support personnel, and other medical commanders.

First fielding date: November 1999–October 2000, initial acquisition and integration of digital communication systems; October 2000–November 2001, Technology Integration testing and evaluation at AMEDDEX 2000, TX and Joint Readiness Training Center (JRTC) Advanced Warfighter Experiment (AWE), Fort Polk, LA; November 2001–October 2008, identify, acquire, and integrate

wireless technologies to facilitate improvement of the quality of care provided by AMEDD MTOE organizations to forward deployed military personnel.

Distribution: Forward-deployed medical units for the SMART MC3-T; CSHs for BRSS; and brigade support areas for the WIN-POC.

Training: 5 days training for the SMART MC3-T; 2 weeks to 30 days for the BRSS; 3 months to 1 year for the WIN-T.

Cube and weight: 76 pounds, 6 cubes for the complete set (for SMART MC3T).

Cost: SMART MC3T: \$385K FY02, \$269K FY03-06; WIN-POC: \$300K FY02, \$350K FY03-2006; BRSS: \$150K per unit; WIN-T: approximately \$1.1M each vehicle.

18. Transportable Automated Life Support System (TALSS)

Summary: A portable, self-contained, lightweight (<40 pounds), protected environment for one casualty, capable of providing sustained monitoring and automated life support for combat casualties for up to 72 hours on the battlefield.

Capabilities and indications for use: The TALSS provides automation of life support functions, providing computer-driven closed-loop control of ventilation, fluid, drug, and oxygen administration. The system optimizes the patient's treatment, while minimizing resource utilization. The automated capability of the TALSS is a force multiplier for the small FST staff and for the combat medic staffing the ambulance by freeing them to care for other casualties once they have stabilized a seriously injured casualty. The system will also provide data-logging and telecommunication capability to facilitate record keeping and to enable real-time communication of patient data to the receiving hospital for assistance with monitoring and decisionmaking from a remote location. The TALSS will provide increased and improved holding capability at the FST as well as extended critical-care capability within the ground ambulance platform by providing automated life support for the critically injured awaiting and during evacuation.

User(s): PA, surgeon, combat medics (91W), nurses (91C).

First fielding date: 2015.

Distribution: 4 per FST, 10 per holding company, 10 per ambulance company, 30 per CSH.

Training: Medical personnel (1 hr), unit-level maintenance personnel (2 hrs), depot-level maintenance (24 hrs).

Cube and weight: 40 pounds, 5 cu ft., 4 cu ft. resupply bag.

Cost: 500 units * \$100K each = \$50M.

19. Teleconsultation/Teledermatology

Summary: Teleconsultation is the application of information and telecommunications technologies to facilitate delivery of medical treatment across all barriers. Teledermatology is a proven, clinically-focused teleconsultation system designed to enable dermatology interactions between various parties located anywhere in the world.

Capabilities and indications for use: Dermatology is one of the most frequently performed telemedicine consultations within (and outside of) the Army. Currently, initial teledermatology prototypes have been deployed at 4 Army medical centers and over 60 Defense Department clinics worldwide. An advanced or "next generation" system will facilitate secure, more efficient, real-time and/or store and forward distance consultation and treatment. A more portable teledermatology system will better serve highly mobile, dispersed forces engaged in a variety of operations (e.g., humanitarian assistance, unconventional warfare), thereby facilitating force readiness and effectiveness, and in general, promote (force) health protection.

User(s): Combat medic, nurse, PA, battalion/brigade surgeon, dermatologist (specialty).

First fielding date: April 1999.

Distribution: 4 Army medical centers and over 60 Defense Department clinics worldwide.

Training: User training on software application and digital camera photography is provided onsite by a local trainer.

Cube and weight: COTS/GOTS software installed on COTS CPU with current browser capability and digital camera.

Cost: Workstation: ~\$4,000 (includes one workstation, one digital camera and software). Server: ~\$12,000 (includes one server and software).

20. High-Intensity Focused Ultrasound

Summary: The high-intensity focused ultrasound device will provide cauterization of both internal and external bleeding structures without damaging overlying tissues. The device will feature a computerized Doppler guidance system designed to locate and focus on hemorrhaging structures.

Capabilities and indications for use: The high-intensity focused ultrasound device functions by focusing ultrasonic waves to cause cauterization of bleeding structures without damaging overlying or surrounding tissues. The hand-held device features a computerized Doppler guidance system designed to locate and focus on hemorrhaging structures. In the far-forward environment, the device will have the capability to successfully manage both external and internal bleeding.

User(s): PA, surgeon.

First fielding date: 2012.

Distribution: One per battalion aid station, 2 per FST.

Training: Proper indications and techniques for use.

Cube and weight: 1 cubic foot per unit, 15 pounds per unit.

Cost: \$50,000 per unit.

21. Forward Deployable Digital Medical Treatment Facility (FDDMTF)

Summary: The FDDMTF will provide a lightweight, wireless, digitized forward surgical capability that can be deployed across a range of military operations.

Capabilities and indications for use: The FDDMTF supports Army Transformation by reducing weight and cube, airframe requirements, providing essential care in theater, and reach-back capabilities. Utilizing a 10–25 bed Air Force EMEDS with digitized enhancements as the prototype “core,” the FDDMTF provides a lightweight, wireless, digitized forward surgical capability that can be rapidly deployed to (medically) support a range of military operations. The FDDMTF provides 24-hour sick call and emergency medical care plus the following capabilities: medical command and control, preventive medicine, trauma resuscitation and stabilization, limited general and orthopedic surgery, critical care, primary care, and limited ancillary care to a population at risk of 2,000 to 3,000.

User(s): Combat medic, nurse, PA, battalion/brigade surgeon, and various medical support personnel.

First fielding date: 2004.

Distribution: One per Stryker Brigade Combat Team.

Training: Training required for shelter establishment, operation of the communications enhancements, and the use of wireless, digitized medical equipment. The combat medic program coupled with upgrades in the biomedical maintenance course would provide the soldiers with the necessary clinical background to function effectively in the facility.

Cube and weight: 50,000 square feet, on 26–30 463L pallets (13K forklift). Figures based equipment minus transportation assets

Cost: \$1.9M.

Casualty Determination Process

The process by which the numbers and types of casualties used in the workshop were determined by AMEDD is described below.

Assigning Deployable Medical System (DEPMEDS) Patient Condition (PC) Codes to Casualties from Blue System Kills

The Interactive Distributed Engineering Evaluation and Analysis Simulation (IDEEAS) model employed in the study by TRADOC Analysis Center at Fort Leavenworth produced a list of all Blue entities attrited by Red fires. In the simulation, each Blue entity is represented as a three-dimensional object with XYZ coordinates. Ordnance fired by both Blue and Red platforms is modeled as a distinct entity, and the trajectory of the ordnance depends on the characteristics of the ordnance and prevailing environmental conditions. Based on the ordnance type, vector, XYZ coordinates of the hit location, and Blue vehicle characteristics, the hit was assigned one of five battle damage types: Catastrophic Kill, Mobility Damage, Firepower Damage, Mobility Kill/Firepower Damage, and Crew Kill.¹

Casualty generation and injury severity were assigned based on the Blue entity type (enclosed vehicles with crew or passengers; towed

¹ "Crew Kill" is defined as disabling dismounted personnel operating a towed vehicle such as a howitzer or mortar. A Crew Kill occurs when the minimum number of personnel required to operate the towed vehicle are disabled or killed.

vehicles serviced by dismounted crewmembers; or dismounted infantry) and Battle Damage Assessment. Estimates for casualties used in the workshop were determined by AMEDD using input from the TRADOC simulation in combination with estimates from historical references. The TRADOC simulation provided the kind of object hit and the type and severity of damage sustained. For example, a "catastrophic and combined firepower/mobility kill" of an enclosed vehicle yields a 0.20 probability that a crewmember becomes KIA and 0.50 of becoming WIA. A "catastrophic kill" of a dismounted crewmember yields a 1.0 probability of KIA.

For those vehicle crewmembers WIA, British WWII data² are used as a basis to assign roughly 40 percent with fractures (to include amputations), 25 percent with burns, 20 percent with penetrating wounds with soft tissue/visceral injuries, and 15 percent with both burns and penetrating injuries. Those wounded with fractures are further estimated to experience either amputation of extremities or blunt trauma from mine blast, based on Soviet experience in Afghanistan.³ For those with burns, Israeli data from combat in 1982⁴ are used to assign severity of burns (<10%: 51 percent; 10%–40%: 31 percent; and >40%: 18 percent). Finally, again from Soviet experience, penetrating wounds are further assumed to cause visceral organ damage in about half of the cases, the majority of the remainder soft tissue injury only, with some experiencing wounds at multiple sites.

The overall outcome of this casualty estimation effort was a broad variety of wound types that one could reasonably expect to be used as a basis for assessing the HSS system. They are listed in their entirety in Appendix G.

² H.B. Wright and R.D. Harkness, *A Survey of Casualties Amongst Armored Units in North West Europe: Survey of Casualties in Tank Crew—21 Army Group, Jan 1946*. Medical Research Council Team, Document 1862.

³ E.A. Nachaev et al., *Mine Blast Trauma: Experience from the War in Afghanistan*. St. Petersburg: Russian Ministry of Public Health and Medical Industry, 1995.

⁴ E. Dolev, "Medical Service in the Lebanon War, 1982: An Overview." *Israeli Journal of Medical Science*, Vol. 20, pp. 297–299, April 1984.

Casualty Tracking Worksheet

The next six pages contain the Casualty Tracking Worksheet provided to the workshop teams. The worksheet contains 25 columns. The data in the first six columns were given to the teams. The table shows the first sixteen columns of the worksheet in order to present each of the casualties; the headings for the nine remaining columns appear at the bottom of the sixth page.

Evac Time										
Time Awaiting Evac										
Identity of Evacuation Assets Committed										
(Unique) Medical Technologies Used at Med Platoon										
Time Awaiting Treatment at Med Platoon										
Evac Time										
Time Awaiting Evac										
Identity of Evac Asset Committed (ground)										
Medical Supplies Used by Medic										
Time to First Response by Medic										
Wound Type (Treatment Brief Code)	KIA	87	175	KIA	69	137	127	KIA	153	151
Location	7833			7893			2982	8307		
	7383			7365			7717	7728		
Casualty Number	1	2	3	4	5	6	7	8	9	10
Time Wound Occurred H+min	1.0			2.2			7.7	23.9		
Vehicle Type or Dismount	FCS-FAVLB HHC Mnvr Spt Plt			FCS-FAVLB HHC Mnvr Spt Plt			F15	FCS-FRV HHC RSTA1		
Red Weapon	SNAPPER (AT-1)			SNAPPER (AT-1)			GRISOM (SA-19)	SNAPPER (AT-1)		

Evac Time											
Time Awaiting Evac											
Identity of Evacuation Assets Committed											
(Unique) Medical Technologies Used at Med Platoon											
Time Awaiting Treatment at Med Platoon											
Evac Time											
Time Awaiting Evac											
Identity of Evac Asset Committed (ground)											
Medical Supplies Used by Medic											
Time to First Response by Medic											
Wound Type (Treatment Brief Code)	KIA	131	124	KIA	180	183	120	38	50	49	41
Location	8684			9542			3126	1871	0095	0427	0434
	8082			6863			8092	9530	7613	6571	6585
Casualty Number	11	12	13	14	15	16	17	18	19	20	21
Time Wound Occurred H+min	40.6			86.0			89.8	90.9	95.2	160.7	160.8
Vehicle Type or Dismount	FCS-FRV HHC RSTA2			FCS-FRV HHC RSTA4			F15	F15	2A33_152M FCS-FRV HHC RSTA6	2A64_152M FCS-F15V BCo M_GUN	2A64_152M FCS-F15V BCo 3d CAP
Red Weapon	SNAPPER (AT-1)			SNAPPER (AT-1)			GRISOM (SA-19)	GRISOM (SA-19)	2A33_152M FCS-FRV HHC M_GUN	2A64_152M FCS-F15V BCo M_GUN	2A64_152M FCS-F15V BCo 3d CAP

Evac Time				
Time Awaiting Evac				
Identity of Evacuation Assets Committed				
(Unique) Medical Technologies Used at Med Platoon				
Time Awaiting Treatment at Med Platoon				
Evac Time				
Time Awaiting Evac				
Identity of Evac Asset Committed (ground)				
Medical Supplies Used by Medic				
Time to First Response by Medic				
Wound Type (Treatment Brief Code)		KIA	KIA	131
Location		1755		88
	8944			
Casualty Number	54	55	56	57
Time Wound Occurred H+min	462.5			
Vehicle Type or Dismount	FCS-F1V Eco 1st CAP			
Red Weapon	SPANDREL (AT-5)			

Prognosis and Comments	
Treatment Time at CSH	
Time Awaiting Treatment at CSH	
Evac Time	
Time Awaiting Evac	
Identity of Evacuation Assets Committed	
(Unique) Medical Technologies Used at Med Company/FST	
Treatment Time at Medical Company/ FST	
Time Awaiting Treatment at Medical Company/FST	

Step Three Worksheet

The following pages contain the Step Three Worksheet used by the teams to address the workshop issues.

Step Three

HOW TO PROCEED

1. In Step Three the task of the group, now back in the present, is to reflect on the experiences of the first two steps in the exercise and discuss how best to communicate the lessons learned therein to the Army Transformation community.
2. A draft set of issues to be addressed is presented: First Responders and Combat Medics, Military Medical Infrastructure, and Intra-Theater Medical Evacuation.
3. The group leader will begin the discussion for each of the issues presented by asking members of the group to give their individual perspectives on the issue and those shortfalls manifest in the first two steps in the workshop.
4. Discussion of individual issues should focus on:
 - The contribution of first responders and combat medics in the context of the workshop scenario,
 - The critical factors that contributed to the overall success of the medical mission, and
 - The implications for the Army medical community and the Army itself if these factors were not present.
5. Over the course of this discussion (or subsequently), the facilitator will elicit recommendations on other issues manifest in the exercise that group members believe warrant a comparable level of attention from the Army Transformation community.
6. The group leader will attempt to find a consensus on recommendations on individual issues and priorities and summarize the group's deliberations, individual recommendations, and any thoughts on overall strategy for communicating on these matters to the Army leadership in the Step Three plenary session.

First Responders and Combat Medics

Where do first responders and combat medics fit in the overall future concept for combat casualty care and what treatment capabilities (treatment technologies, level of supply, and skills) will medics require to support this concept?

What was the contribution of first responders and combat medics in the context of the workshop scenario?

What factors (technologies, competencies, resources, etc.) enabled your group to reach the result it did?

Which of these (technologies, competencies, resources, etc.) were most critical and why?

What alternative HSS actions could be taken if one or more of these factors is not present?

What components of the Army's operational concept (if any) make HSS support problematic?

Military Medical Infrastructure

What theater military medical infrastructure is necessary to support future military medical operations across the spectrum of operations?

What was the contribution of the proposed military medical infrastructure in the context of the workshop scenario?

What infrastructure factors (technologies, competencies, resources, etc.) enabled your group to reach the result it did?

Which of these (technologies, competencies, resources, etc.) were most critical and why?

What alternative HSS actions could be taken if one or more of these factors is not present?

What components of the Army's operational concept (if any) make HSS support problematic?

Medical Evacuation

What are the evacuation requirements to support military operations across the spectrum of operations?

What was the contribution of the proposed medical evacuation system in the context of the workshop scenario?

What evacuation factors (technologies, competencies, resources, etc.) enabled your group to reach the result it did?

Which of these (technologies, competencies, resources, etc.) were most critical and why?

What alternative HSS actions could be taken if one or more of these factors is not present?

What components of the Army's operational concept (if any) make HSS support problematic?

Other Issues And Observations

1.

2.

3. _____

Treatment Briefs

The following list summarizes the treatment briefs that described the casualties included in the simulation and workshops. They are arranged by the number code of the treatment brief used in the workshop, as shown in the casualty tracking worksheet (Appendix E).

Treatment Brief Code	Wound Description
003	Cerebral contusion, closed, with/without nondepressed linear skull fracture, severe - loss of consciousness greater than 24 hours, with focal neurological deficit.
017	Wound, face, jaws, and neck, open, lacerated with associated fractures, excluding spinal fractures, severe - with airway obstruction.
018	Wound, face, jaws, and neck, open, lacerated with associated fractures, excluding spinal fractures, moderate - without airway obstruction, eyelid and eyeball laceration with retained intraocular foreign body.
019	Wound, face and neck, open, lacerated, contused without fractures, severe - with airway obstructions and/or major vessel involvement.
037	Burn, thermal, partial thickness, head and neck, greater than 5% but less than 10% of total body area and/or eye involvement.
038	Burn, thermal, partial thickness, head and neck, less than 5% of total body area and no eye involvement.
041	Fracture, clavicle, closed, all cases.

Treatment Brief Code	Wound Description
042	Wound, shoulder girdle, open, with bone injury, severe - joint involvement.
044	Fracture, humerus, closed, upper shaft, all cases.
049	Fracture, shaft radius and ulna, closed, severe - shafts of bones.
050	Fracture, radius and ulna, closed, moderate - Colles fracture.
052	Wound, forearm, open, lacerated, penetrating, without bone, nerve or vascular injury, moderate - not requiring major debridement.
054	Wound, forearm, open, lacerated, penetrating, with fracture and with nerve and vascular injury, forearm salvageable.
055	Fracture, hand or fingers, closed, severe - requiring open reduction.
059	Wound, hand, open, lacerated, contused, crushed, with fracture(s), all cases - involving fractures of carpals and/or metacarpals.
069	Amputation, hand, traumatic, complete, all cases.
075	Burn, thermal, superficial, upper extremities, greater than 10% but less than 20% of total body area involved.
079	Burn, thermal, full thickness, upper extremities or partial thickness hand, greater than 10% but less than 20% of total body area involved.
082	Fracture, rib(s), closed, moderate.
087	Wound, thorax (anterior or posterior), open, penetrating, with associated rib fractures and pneumothorax, acute, severe respiratory distress.
088	Wound, thorax (anterior or posterior), open, penetrating, with associated rib fractures and pneumothorax, moderate respiratory distress.
101	Wound, abdominal cavity, open, with lacerating, penetrating, perforating wound to the large bowel.
104	Wound, abdominal cavity, open, with penetrating, perforating abdominal wound with lacerated liver.
114	Wound, abdomen, open, with pelvic fracture and penetrating, perforating wounds to multiple pelvic structures (male or female).

Treatment Brief Code	Wound Description
115	Wound, abdomen, open, with pelvic fracture and penetrating, perforating wounds to pelvic colon only (male or female).
120	Fracture, closed, femur, shaft, all cases.
124	Wound, thigh, open, lacerated, penetrating, perforating, with fracture and nerve/vascular injury, limb salvageable.
125	Wound, knee, open, lacerated, penetrating, perforating, with joint space penetration, shattered knee.
127	Fracture, closed, tibia and fibula, shaft, all cases.
128	Wound, lower leg, open, lacerated, penetrating, perforating, without fractures, requiring major debridement.
129	Wound, lower leg, open, lacerated, penetrating, perforating, without fractures, not requiring major debridement.
131	Wound, lower leg, open, lacerated, penetrating, perforating, with fracture and nerve/vascular damage, limb salvageable.
132	Fracture, ankle/foot, closed, displaced, requiring reduction.
136	Wound, ankle, foot, toes, open, penetrating, perforating, with fractures and nerve/vascular injury, limb not salvageable.
137	Wound, ankle/foot, toes, open, penetrating, perforating, with fractures and nerve/vascular injury, limb salvageable.
151	Burn, thermal, superficial, lower extremity and genitalia, greater than 15% but less than 30% of total body area involved.
152	Burn, thermal, partial thickness, lower extremities and genitalia, greater than 30% but less than 40% of total body area involved.
153	Burn, thermal, partial thickness, lower extremity and genitalia, greater than 15% but less than 30% of total body area involved.
154	Burn, thermal, full thickness, lower extremities and genitalia, greater than 30% but less than 40% of total body area involved.
165	MIW (multiple internal wound) brain and lower limbs requiring bilateral above knee amputations.
171	MIW chest with pneumohemothorax and limbs with fracture and vascular injury.

Treatment Brief Code	Wound Description
175	MIW abdomen and limbs with penetrating, perforating wound of colon and open fracture and neurovascular wound of salvageable lower limb.
180	MIW abdomen and lower limbs, with fracture and nerve injury, with penetrating wound of spleen, with full thickness burns to greater than 20% of TBSA.
183	MIW chest with pneumohemothorax, soft tissue injury to upper limbs, and abdomen, with wound of colon.

The Army is in the process of transforming itself and is developing new operational concepts and technologies to enable this transformation. The Army Medical Department (AMEDD) has been deeply involved in the overall Army transformation effort since its inception, and it has identified operational medicine issues whose resolution will be critical to its ability to support the Army of the future. The purpose of this research was to develop a method to assess these issues and further investigate a subset of them. RAND Arroyo Center designed and conducted a series of workshops in which AMEDD experts determined likely outcomes for individual casualties resulting from an Army simulation of its future force. It was concluded that in this particular simulation, the structure and concepts postulated for the evacuation and treatment of future force combat casualties were overwhelmed by eight hours of relatively low-intensity combat.

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