

Distributive Medical Management System

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Abstract. Medical readiness has become a critical concern world wide. Threats across diverse operation environments, coupled with critical voids in both medical management and medical skills has made the development of new training and management tools and operational assessment methods for first-responders a high priority across global communities. That first response role incorporates a broad array of individuals providing field-based emergency medical services. As recently observed during and after the Asian tsunami and Hurricane Katrina disaster in the United States, critical technological tools and training resources were not available to ensure that the involved first responders had pertinent information available to them to properly do their jobs. The deficiencies must be rectified in order to insure rapid response to natural and man made disasters. Tools that distribute knowledge to aid a range of first responders in evaluating a medical situation, guide them in the uniform collection and reporting of critical information and provide telemedicine clinical reach back to medical experts are essential components of today's medical preparedness. The Distributive Medical Curricula Architecture (DMCA) is designed to provide access to "just-in-time" training and streamline assessment and management of remote medical situations across military and civilian environments nationally and internationally.

Keywords: First responder, medical skills training, training management, remote treatment.

1 Introduction

Medical readiness has become a critical concern world wide. New operational threats and diverse operational environments, coupled with critical voids in medical management, skills, and scarce medical resources have made the development of new training, management tools, and operational assessment methods for first-responders a high-priority in both military and civilian communities [1]. As observed during the Asian Tsunami and Hurricane Katrina in the United States, we still need new technological tools and training resources to ensure that first responders have pertinent information available to them in a timely manner to insure rapid response to natural and man made disasters.

The United States federal, state and local governments as well as the Uniformed Services are investing untold amounts of time and money in the development of first-responder skill sets. However, this approach provides limited focus on curricula development, evaluation of work performance and sustainment training or skills based training. Prior to 9/11, there were few centralized medical controls governing the development and delivery of first-responder training or response, thus, sharing course materials and other training resources in a distributed environment was not a common occurrence. In addition, there were no operating frameworks by which agencies could jointly plan, train and share information. Existing platforms still find it difficult to share data with other platforms even when the units follow the Shareable Content Object Reference Model (SCORM) standard [2], since there is no standardized way of exchanging various course units and training resources. In addition, integration of such platforms in a distributed environment across military and civilian contexts is even more challenging and complicated.

The demand for tools and methods to strengthen remote medical management capabilities has been accelerated. Critical voids in remote operational health care management prompted the development of tools to aid global first-responders in comprehensively evaluating medical situations through a distributive, deployable, protocol-driven training system. Tools that distribute knowledge to aid a range of first-responders in comprehensively evaluating a medical situation, guide the uniform collection and reporting of critical information and provide a telemedicine clinical reach-back to medical experts are essential components of today's medical preparedness and response plans. The DMCA is designed to expand and strengthen existing capabilities by creating a dynamic, interactive, distributed architecture that takes full advantage of current best practices in information science.

Contrary to military actions which are often preemptive to a threat, the civilian or joint civilian/military response to a threat/disaster is usually in reaction to an event. In these situations first responders must have the necessary information and skills available to them to make rapid informed decisions to save human life [3]. The systems, software tools and training aids that are developed should support the learning objective, the standards, behavior and performance needed.

1.1 Goal of the Distributive Medical Curricula Architecture

The development of the DMCA follows a spiral approach and is continually being updated and upgraded in order to meet the overarching goals. The first goal is to provide an architectural foundation for users to build, publish and share internet based services. The second goal is to develop courses, scenarios, simulations and curriculum that provide skill based state-of-the-art training. In addition, DMCA will provide a platform for SCORM compliant training courses, development and delivery of skills based curriculum that is readily accessible and rapidly reconfigurable to support current and evolving requirements for rapid response for military and civilian emergency responders and medical personnel across all services. The final goal is to provide a collaborative environment that can rapidly update and reconfigure course content.

1.2 Structure and Interfaces

While designers of online learning systems have a wide variety of software tools and learning platforms at their disposal, many different vendor tools and platforms are not able to share learning resources and/or interoperate with each other. Software tools should support the learning objective, the standards, behavior and performance needed. The four most common standards are Aviation Industry Computer-based Training Committee (AICC), SCORM, IMS Global Learning Consortium, and Microsoft LRN. The DMCA supports these standards and has developed learning metadata schemes, course structures and software interfaces that provide interoperability between applications and learning resources. The DMCA enables an institution to deliver skills based training — quickly, effectively, with full tracking and reporting — in an adaptable and straightforward manner. The DMCA has the flexibility to link to any page or document across the web, providing links to external reference materials, glossaries, documents and related websites. Bookmark links allow the user to connect to any slide within a presentation and create non-linear navigation within the content. Bookmarks also provide links to external cataloged library documents.

2 Background

The Distributed Medical Curricula Architecture (DMCA) was developed through the Office of the Secretary of Defense (OSD) Small Business Innovative Research program. During the initial investigative phase, the research uncovered a plethora of first responder training from traditional classroom instruction to online courses. However, finding and gaining access to the courses was a difficult task. The early study confirmed that there were many nonstandard and sub standard patient assessment/treatment protocols in use by first responders and that many courses needed to be revised or updated. During extensive interviews with corpsmen and medics we found discrepancies and disconnects between core training and sustainment training and that first responders had limited accessible resources. In some instances the on-line training was misleading in that it was confined to resource centers and not accessible via personal computers.

2.1 Global Treatment Protocols Via Advanced Distributed Learning

The initial approach for the program was to design and develop a distributive and deployable training module that would teach military and counterpart civilian medical personnel an approved treatment protocol for interacting with physicians and other health care professionals. There were two problem statements that we originally addressed. First, because treatment protocols are not standardized across the US military and civilian community there is an undue hardship caused to both the patient and medical personnel. Upon further investigation of medical documentation, critical incident reports, data collected from health care personnel and a search of pertinent literature, it was determined that problems relating to the lack of standardized training were most likely indicative of larger issues in terms of the organization and approach to the design of emergency responder training programs. Driving towards a single

standard, however, was not appropriate for us to undertake, given the diverse nature of the emergency responder community and their missions especially between military and civilian entities.

The second problem addressed was that medical personnel at all echelons lack formal protocol training for assessing patients and reporting patient conditions to physicians that would allow the latter to make the best possible patient diagnosis and direct the medical personnel to provide the best possible initial treatment until the patient can be transported to a medical facility. Overall, it was assumed that a lack of standards resulted in a reduction in the quality of patient care. However, there is currently a lack of patient outcome data, in both military and civilian communities, that makes the direct correlation between a training course, and a particular treatment, with a patient outcome. There has been some outcomes research but more needs to be done to document and report outcomes as they relate to remote medical treatment and operations. We very quickly learned from our surveys and interviews that while we could develop a training model that would teach certain protocols it would not be useful to the entire community. More importantly, it by no means would create standardization. The problem in the emergency response community is not that there is a lack of standards but a plethora of standards and medical personnel are trained to different protocols. Yet there are few centralized medical controls governing the development and delivery of first-responder training.

Most healthcare teaching/learning platforms, where available, are stand-alone systems. They basically provide only one service (teaching/learning) for a given set of units (courses) which are stored within a single system generally as a PowerPoint, MS Word or PDF file. Sharing course materials and other training resources in a distributed environment is not a common occurrence. Existing platforms find it difficult to share data with other platforms, even when the units follow the SCORM standard, as there is no standardized way of exchanging various course units and training resources. In addition, integration of such platforms in a distributed environment is even more challenging and complicated. In the US there are approximately 15 million full and part-time emergency responders, which include fire personnel, nurses, civilian and military law enforcement personnel, Emergency Medical Technicians (EMTs), Emergency Room Physicians, military corpsmen, medics and millions of ancillary medical personnel. These individuals basically represent the traditional front line of First Responders who must have some type of formal (and coordinated) training. This force, in turn, must integrate with community health workers in schools and offices, with public health facilities, security guards, military medics, National Guard units, and others depending on the catastrophe.

3 Distributed Medical Curricula Architecture (DMCA)

The results of the initial study confirmed the need to develop an infrastructure which facilitates the sharing and real time updating of curricula, best practices, lessons learned and outcomes. Research analysis indicated the need for an architecture that supports the development of adaptable training solutions, acts as a knowledge repository and leverages processes and products that enhance skills-based medical preparedness, as well as provide a collaborative environment to review, revise and

develop curriculum. Therefore, the second phase or spiral was based on developing a Distributed Medical Curricula Architecture (DMCA) that supports first responder readiness through training in a distributed environment and takes advantage of developing technologies to guarantee that the first responder has the information and skills necessary to make rapid informed decisions when treating casualties.

3.1 DMCA Design

The DMCA is designed to address key distance learning issues including: Discovery, Access, Integration, Interoperability and Standardization. This approach supports first responders across jurisdictions and disciplines and improves Communication, Collaboration and Coordination. Specific DMCA goals are to: solve discovery and access issues for first responders; provide a standardized method for the organization and distribution of first responder training; and create an infrastructure for measuring and tracking first responder readiness. It is anticipated that the DMCA will create a “community of practice” for the first responder training community and thereby enhance standardization of first responder training initiatives. The best initiatives will be adopted by other institutions. The DMCA will also provide the means to train to specific skills, measure and track first responder skills levels and provide the venue to develop “just in time” courses to meet urgent training needs. These critical training needs will support a variety of users that include: training solutions providers, content developers, publishers, courseware developers, instructors, students, researchers and medical planners and analysts in both military and civilian communities.

3.2 Architecture

The DMCA architecture is an extensible, agile architecture built on current best practices in software engineering and information management. The DMCA is based on Web Services architecture. The use of Web Services is expanding rapidly as the need for application-to-application communication and interoperability grows. Web Services fundamentally do not represent a new concept but a new approach to an old problem – that of enabling disparate applications to talk to one another. This architecture is already a proven force in e-business and the information technology and tele-communications industries. While other training technologies have been proposed and successfully implemented, albeit sporadically, to improve integration in the training community, they do not address the full scope of the problems facing the first-responder community. The DMCA is not meant to replace these previous efforts but to expand on existing capabilities by creating a dynamic, interactive, distributed platform.

3.3 DMCA Key Features and Capabilities

The DMCA will provide a distributed environment across multiple platforms and organizational settings as shown in Figure 1. Depending on the user’s needs and their access privileges, the DMCA will allow retrieving or publishing information or resources in a web service framework. Some of the key features include:

- Access to various medical web services that facilitate medical decisions
- Access to key medical procedures and protocols that support first responders

- Access to DMCA's knowledge repositories
- Access to general medical educational resources
- Provide trusted infrastructure for publishers to publish their treatment protocols, tools, and curricula
- Access to just-in-time medical curricula and critical information
- Provide metadata searching across multiple organizations
- Trusted information search and retrieval capabilities
- Exchange reusable learning and teaching resources
- Access to updated products and clinical decision making tools.

The DMCA provides a framework for collaboration allowing curriculum developers to independently create, catalog and share their training materials with others. The framework will simplify the process of discovery, comparison and evaluation for the users of the materials while not requiring conformity to a single training mode or technology. The DMCA will also act as a knowledge repository and clearinghouse

for the data and training curriculum with easy access for all interested parties. Our intent is to provide a platform that will have a significant impact on the first-responder community. Through the Web Services capability, DMCA will provide (a) a publishing model to support the coordinated & collaborative development of medical education and training materials, (b) a consumer model for first-responders to search, discover, and "bind" to medical educational and training materials, and (c) a transaction model to support application-to-application communication (e.g., billing processes, database queries and transactions). It is important to note that the DMCA is not necessarily serving the specific educational content to the student, but rather acting as a broker or intermediary between parties, i.e., in this case, the student and the author. Students come to the DMCA looking for educational content, and the DMCA then connects the student with the desired content. After such a connection is established, the role of the DMCA is largely secondary.

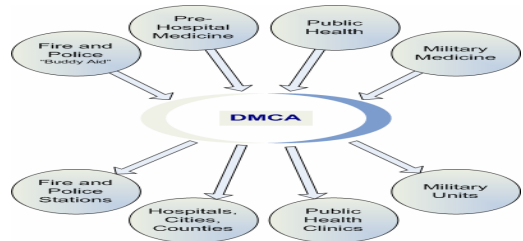


Fig. 1. The DMCA Collaborative Environment

3.4 Demonstrating the DMCA: Integration with Raven Wedge

Based on the technical development and supporting content and organizational research for the DMCA we were prepared to integrate the DMCA with a major first responder exercise in the summer of 2005. The selected exercise, Raven Wedge, was a joint Maryland National Guard (MDNG) exercise scheduled for August 2005. The Maryland Air National Guard was to demonstrate the capabilities of an EMEDS unit for Homeland Security requirements. The Maryland Army National Guard was to demonstrate supporting medical and logistic capabilities necessary for EMEDS units to function in a dirty environment (biological agent). The Public Health Service supported both groups. The Federal Emergency Management Agency (FEMA) [4] Region 3 Raven Wedge exercise was held at Camp Fretterd, Maryland. It was the first

time the 300 participants, primarily from Air National Guard, Army National Guard and Public Health Service had the opportunity to participate in pre and post skills based training geared to the specific exercise.

The scientific and technical development of the DMCA for Raven Wedge followed specific design and planning efforts.

- Member of the team attended planning meetings for the Raven Wedge Exercise from January-August, 2005. At the January meeting we presented the DMCA concept and reviewed initial outline of content with exercise planners, developed draft template for content and established points of contact with subject matter experts. Throughout the next seven months content was added and any problems were discussed at the meetings. In July we opened a site for use by Raven Wedge participants. In addition to “at home” internet access, participants had the opportunity to use the system while on campus during the exercise – the distance learning center at Camp Fretterd was made available. We also completed audio recording of the Chemical and Biological Defense Primer (CBDP). It was implemented as part of the “just in time” training for select Raven Wedge participants. During July we completed final testing of prototype (and Raven Wedge material) using multiple hardware platforms and multiple web browsers.

The DMCA functionality was reviewed with Raven Wedge leadership. Content development for targeted training – especially medical response to a radiological dispersal device (RDD) was completed. Discussions about the variety and formatting of materials to be offered for Raven Wedge (so that we had a good cross section and covered all the necessary learning objectives) were held. We cataloged the materials based on skill categories. Different genre of training materials, as well as varying the type and length of materials to be offered were selected so that the planned scenario was fully covered. Scenario and training materials for Raven Wedge were sent to Laerdal and METI. They participated in the live exercise and played key roles in the field exercise. We played a key role in selecting the courses and instructors for the classroom training to be held the week prior to the three day exercise.

- Selected team members met with senior leadership at the Uniformed Services University of the Health Sciences (USUHS) on the DMCA in support of Raven Wedge demonstration. The administration was fully supportive and authorized subject matter expert (SME) time in support of the effort. The USUHS provided subject matter expertise and collaborative funding for pre-exercise training and post-exercise analysis.

Selected content materials were integrated into a pilot version of the DMCA. These materials included training and evaluation tools for a variety of first responders (EMTs, doctors, nurses, support personnel, etc.). The DMCA was used to distribute pre-exercise training materials to a select group of the first responders participating in Raven Wedge. Pre- and post exercise tests were administered using the DMCA. During Raven Wedge, responder performance was evaluated and after the exercise the DMCA was used to administer post-exercise evaluations and to study the retention of exercise specific training. Raven Wedge was a unique opportunity to test and demonstrate the DMCA and was ideal for our purposes as it was designed to provide a variety of first responders with a wide range of medical skill levels. It was also

fortuitous for many of the participants worked together weeks later in New Orleans on the Katrina relief effort.

4 DMCA Enhancement

The program received continuing developmental funds through an SBIR enhancement effort with matched funding provided by OSD for efforts that integrate the DMCA with other government agencies' programs. Funds were received for a joint project with the Uniformed Services University of Health Sciences (USUHS) [5], Online Preparedness Education Program (OPEP). Both benefit from a jointly funded effort that furthers the development of medical distance learning technologies and OPEP content development for medical personnel and the general public.

4.1 USUHS Online Preparedness Education Program

OPEP is a multidisciplinary, interactive, tiered activity that awards a certificate of completion and continuing education credits. The program provides discipline-specific content for EMT/Paramedics, nurses, physicians, hospital administrators, and emergency managers. The curriculum is designed to assist providers in: recognizing that a WMD event has occurred; managing the medical consequences of an incident; obtaining and utilizing the appropriate resources from internal and external sources; preparing and responding in collaboration with other professions and disciplines; utilizing an incident management system; protecting providers and facilities; and understanding the hierarchical response system. The tiered program consists of a family of activities including: a quick reference a.k.a. "Field Guide" providing rapid access to key management guidelines; a general library of information regarding all aspects of threat agents, cross-cutting issues; and certificated on-line interactive courses. The major tasks for the DMCA enhancement are provided in Table 1.

4.2 DMCA Technical System

DMCA is an online training and tracking system that can utilize almost any kind of educational content, from individual PDF documents to standard web sites to SCORM formatted courses. It can also provide registration and tracking for offline training events and courses. This makes DMCA more flexible than standard LMS systems which typically support content formatted either in SCORM or possibly a proprietary format. The flexibility of DMCA results from its modular design. The main module manages a database of available learning content, including how to access each content type. The database also contains student information and tracks the content they have viewed, and the training results they have achieved. The main module itself does not contain functionality to display the learning content. It only stores information on how the student can be directed to the content, and provides functionality to the other modules to report back the students' progress and scores.

Additional modules manage the student display of SCORM content, displaying and tracking the student's performance in quizzes and exams, and other content available to the students. When students complete the content provided by the additional modules, the modules typically report students' progress and scores back to the main

module. If a remote module (such as a third party web site) does not provide feedback on students' progress and completion status, the content is marked completed the first time the student launches it. Naturally only non-scored content like slideshow presentations or PDF documents are suitable to be accessed in this manner.

Table 1. DMCA Enhancement Tasks

Upgrade of User Testing and Survey Tools	<p>The testing and survey tools upgrade includes the development of an improved web interface for quiz authoring and editing; a downloadable, stand-alone JAVA based quiz editor; support of multiple choice /multiple answer questions; and implementation of question shuffling and random question selection options. The improved testing of the new survey tools will:</p> <ul style="list-style-type: none"> - Provide enhanced web based support for assessing student performance by providing a platform for the development, delivery and management of online tests and surveys. - Provide expanded question type/function for multiple choice/multiple answer (Multiple-choice questions provide opportunity to offer feedback that gives basis for correct answer). - Implement question shuffling and random question selection permitting the generation of skill based tests for self-administered proficiency testing - Allow instructors, designers and publishers to work off-line.
Upgrade of Learning Management System	A general upgrade of the Learning Management System (LMS) supports both USUHS and the wider OSD community needs in distance learning applications. LMS functionality would be improved to enable additional (more detailed) book marking as well as user "time tracking" to provide information about the length of time users spend on each page.
Enhanced Communication	<p>Enhanced communications include:</p> <ul style="list-style-type: none"> - Email notifications for the user on pending or expired certificates; new course offerings (filtered by user profile), and "Current Events" postings. <p>Enhanced communications for the administrator/institution would include:</p> <ul style="list-style-type: none"> - expanded course statistics, user feedback (by course), survey results, and certification/documentation requests.
Creation of 'Current Events' Portal	The integration of a "Current Events" portal as part of the USUSH WMD Distance Learning homepage includes the ability to publish information from other related sites and permit filtering of information by user profile. The "current events" section would include a link checking tool to identify "broken" or "dead" links on the website. "Current Events" links for external and internal events will be filtered based on profiles of the individual user. This task will include the creation of a publishing interface for current events.
Upgrade of Administration Interface	The administrative interface is being enhanced for more general use and will include tools for developing and deploying user survey tools and item analysis features for question responses (applicable to user tests and user surveys).
Content Development Support	Content development is guided by CDHAM (USUHS) and will focus on Chemical Agents. Funding will support the development of Field Guide(s), Library References and an On-line Course addressing Chemical Agents as weapons of mass destruction and will parallel the current materials focusing on radiological weapons.
System Support and Maintenance	System Support and Maintenance includes 24/7 Internet user access, network hardware maintenance, system backup and archiving, server administration, minor software updates and "bug fixes" and direct support of USUHS WMD Distance Learning administrators and content developers

Currently DMCA utilizes two special purpose standalone modules that directly interface with the main module (Fig 2). One is a SCORM compliant LMS (Learning Management System) that displays any SCORM compatible content to the students. The other is a quiz server that displays and tracks the students' performance in quizzes and exams the standalone modules provide simple web service interface to allow the main module to register existing students in the module database.

The web interface also provides a method for the main module to pass authenticated students to specific content in the other modules. The standalone modules provide simple web service interface to allow the main module to register

existing students in the module database. The web interface also provides a method for the main module to pass authenticated students to specific content in the other modules without requiring an additional authentication step. The main module in turn provides a method for the other modules to report content completion status and scores back to the main tracking database. For tracking completion and scores of offline training, the main module contains forms for the teachers to enter student progress and scores. Currently, DMCA supports student, registrar, and system administrator roles. Registrar users can view the students' training results and progress. System administrators are responsible for maintaining the global configuration data for the system. In the future the role of teacher/publisher is planned to be added. Teacher/publishers would be allowed to publish online or offline training content to the DMCA web site, and in case of offline content, they would be allowed to enter student scores into the system.

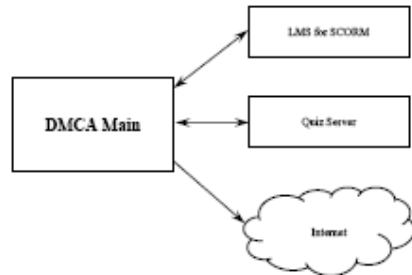


Fig. 2. DMCA format

5 Conclusion

There are a broad range of stakeholders and first-responder groups across military and civilian organizations that share a common problem – lack of medical readiness. The DMCA is one part of the solution that would provide a technical architecture with end-to-end solutions for training out emergency responders as well as providing an intelligent knowledge repository. An easily accessible repository could be leveraged and mined across multidisciplinary domains by medical planners, analysts and researchers. The DMCA could also facilitate the development, sharing, and real-time updating of curricula, best practices, lessons learned and outcomes.

Although building the DMCA presents challenges, the utility and capability to assist in educating and training our emergency response personnel is well worth the endeavor. Standards for procedures, skills development, performance measures, interagency interaction and funding are the biggest challenges. DMCA is currently working on these issues as an integral part of future development.

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