Data-Driven Disaster Management Requires Data: Implementation of a Military Orthopaedic Trauma Registry

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The Military Orthopaedic Trauma Registry (MOTR) is a comprehensive joint service registry of military orthopaedic injuries. Conceived in 2006, MOTR is now operational for retrospective data entry and prospective data collection of extremity injuries sustained by U.S. service members serving in current Overseas Contingency Operations. Running in tandem with data from the United States Army Institute of Surgical Research's Joint Theater Trauma Registry (JTTR), MOTR augments the casualty data included in JTTR with additional orthopaedic specific data (i.e., the injury patterns, characteristics, treatment, and complications associated with extremity war injuries). Extremity war injuries are the major clinical burden of the current conflicts. However, the scope of the injuries in detail useful to the orthopaedic researcher has never been prospectively collected. MOTR is designed to fill that gap in extremity trauma research. As such, MOTR represents an evolutionary step in the refinement of data-driven disaster management. (Journal of Surgical Orthopaedic Advances 20(1):56–61, 2011)

Key words: orthopaedic registry, orthopaedic research, registry data, trauma registry

Following Operation Desert Shield and Operation Desert Storm, the Department of Defense (DOD) recognized the need to collect trauma data on war casualties in order to improve the processes that provide care for these casualties. The Joint Theater Trauma Registry (JTTR), conceived in 1996 for this purpose, became operational in November 2004 (1). Currently, version 3.1 is deployed to the forward theater of operations, Landstuhl Regional Medical Center in Germany, and 11 contiguous U.S. Army medical centers. It is maintained at a central repository at the United States Army Institute of Surgical Research (USAISR) as a secure shared drive application. Since inception, the JTTR has been an effective performance improvement tool, identifying over 30 systemic issues requiring policy development, research, education, evaluation of medical resource allocation, and alteration in clinical care (2, 3).

Although JTTR has a tremendous, proven track record, it is a registry designed by and for trauma surgeons. For the orthopaedic surgeon, the level of detail is too low to allow clinically useful studies. The JTTR can yield what the injury is (e.g., a left tibia fracture), but cannot characterize the injury for the orthopaedist (e.g., a left proximal third grade IIIb open tibia fracture with segmental defect) (4). As an example, a JTTR search was performed for femoral neck fracture data using ICD-9 codes resulting in 1394 potential subjects, five of whom were confirmed to actually have a femoral neck fracture (Fig. 1). This information gap is critical to the clinicians and researchers caring for warriors wounded in current Overseas Contingency Operations (OCO). Orthopaedic injuries are the most common combat injuries, consume the greatest amount of military medical resource utilization, and result in the most long-term disabilities (5–7). The optimal treatment of these warriors using today's technology and surgical techniques is unknown at this time. Therefore, an orthopaedic trauma registry could not replace JTTR but would supplement JTTR in conducting data-driven orthopaedic research and process improvement.

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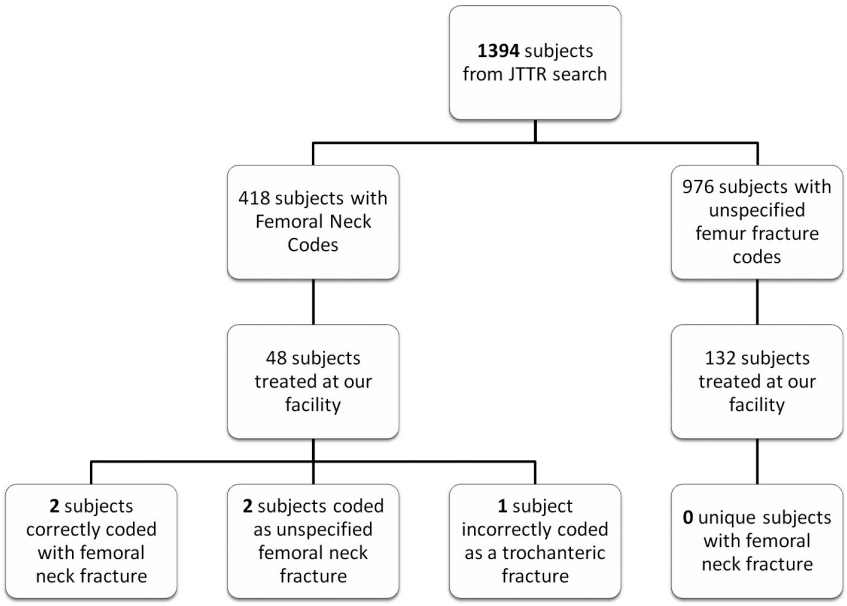

FIGURE 1 In order to capture one cohort of patients with femoral neck fractures, a JTTR search of ICD-9 codes for fractures of the femoral neck (820.0–9) and fractures of unspecified area of femur (821.0–11) was performed. This search yielded 1394 potential subjects: 418 with femoral neck codes and 976 with unspecified femur fracture codes. A total of 180 subjects were treated at this facility and had radiographs available for review. After all radiographs were reviewed, five of these 180 subjects had a confirmed femoral neck fracture. Two of these were coded with the correct ICD-9 code specific to the femoral neck, two were coded as unspecified fracture about the femoral neck, and one subject was coded incorrectly as a trochanteric fracture. The remaining subjects' radiographs reveal fractures at other sites about the femur ($n = 34$) and fractures of the acetabulum ($n = 4$); no lower extremity radiographs were ordered in four subjects, and one subject had an unfractured femur. The JTTR search for all femur fractures did not add any subjects to the femoral neck fracture cohort. Two subjects in this group had a femoral neck fracture confirmed by radiographs, but these two subjects were already counted due to double coding in the femoral neck fracture group.

History

In 2005, following a tour of Walter Reed Army Medical Center by a military orthopaedic surgeon and the American Academy of Orthopaedic Surgeons (AAOS) president, collaboration between the AAOS and the military orthopaedics leadership bore the Extremity War Injury (EWI) Symposium effort. The inaugural EWI: State of the Art and Future Directives, cosponsored by AAOS, the Orthopaedic Trauma Association (OTA), and the Society of Military Orthopaedic Surgeons (SOMOS), paired military and civilian orthopedic surgeons with leading experts in musculoskeletal trauma and research to define the current knowledge of extremity war injuries (8). This EWI met in 2006. In concluding EWI I, participants enumerated future research priorities, the first being the implementation of a data collection system. This was supported by the U.S. Army Surgeon General.

The 2007 Extremity War Injuries Symposium II: Development of Clinical Treatment Principles focused on establishing treatment guidelines for four critical war surgery topics: prehospital management of extremity wounds, initial debridement guidelines, initial fracture and soft tissue stabilization guidelines, and wound management during patient transport and evacuation (9). These priority topics established the need for evidence- based medicine and justification for educational programs designed to reach both the military and civilian surgeon. Leading extremity trauma researchers at the USAISR and OTA had long recognized the potential of a joint service orthopaedic registry's ability to provide the longitudinal patient data required to query specific questions in support of evidence-based practice. While the need for improved data collection system gained priority in EWI I, EWI II defined the need for orthopaedics-specific war injury data. Out of this need, the Military Orthopaedic Trauma Registry (MOTR) was born.

Getting Started

Following EWI II, the custodians of JTTR were asked to launch a preliminary MOTR module from within the existing registry. The JTTR staff began work on a Microsoft Access platform-based interim module, incorporating the capability and content specific to orthopaedics, and troubleshooting user-friendly data entry. A research nurse with a background in orthopaedics provided the clinical background to assure that the module was medically accurate and clinically relevant. A health

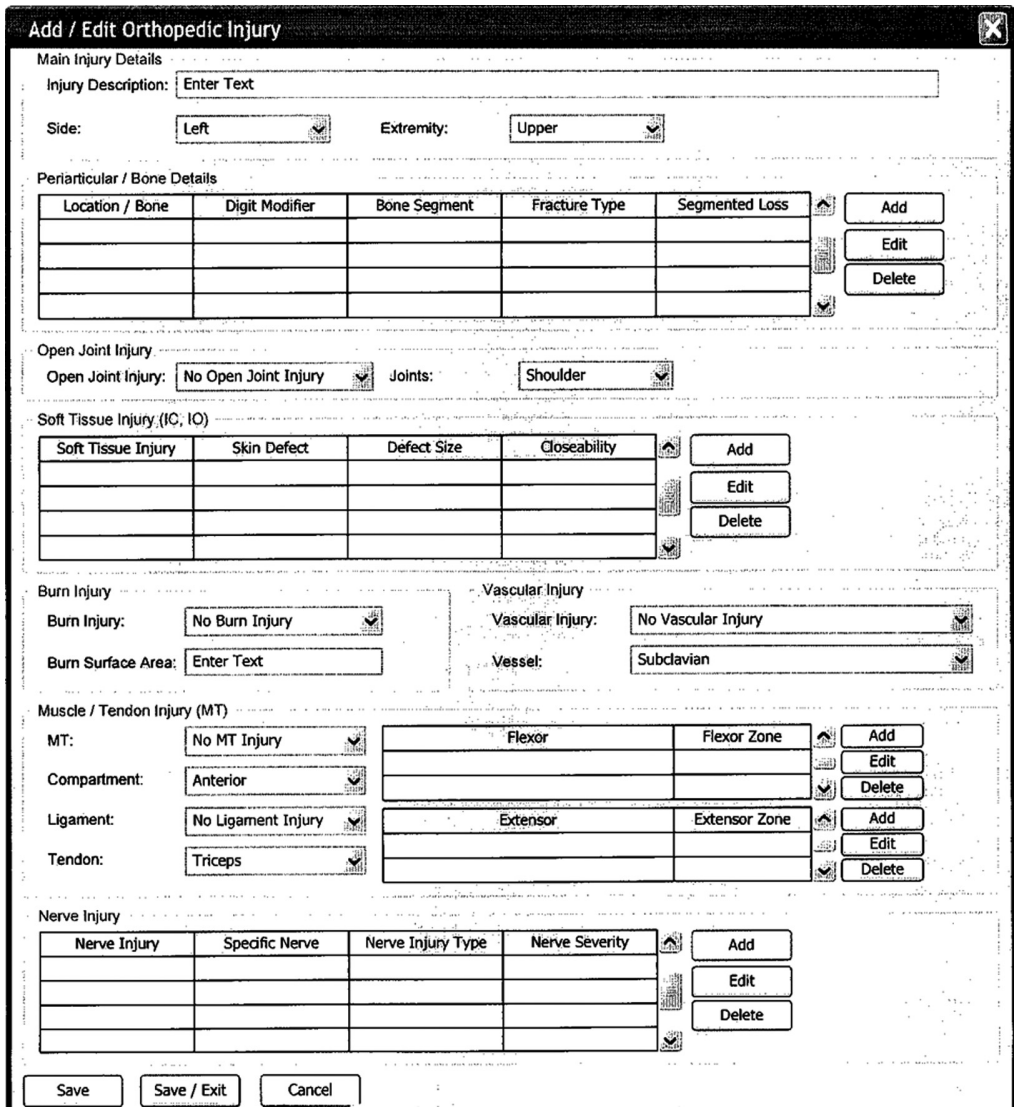

FIGURE 2 Interim MOTR module screen where injury characteristics are entered. Each entry has either a drop-down menu or free text options. Entering information at most points also provides a link to another screen for more detailed data entry.

information management specialist was enlisted to ensure a valid flow of the module data points and that the various incorporated medical coding systems matched the data entry options. In 2008, the Military Extremity Trauma, Amputation, and Limb Salvage (METALS) project, another DOD-funded research effort, contributed its data dictionary, a set of metadata that contains definitions and data elements, for use in the MOTR interim template (10). By EWI IV in 2009, a military orthopaedic surgeon was assigned as custodian for the MOTR effort and the decision was made to mobilize MOTR separate from METALS.

Data entry into the interim module began in late 2009. While MOTR was linked to JTTR for certain demographic data and some injury characteristics such as Injury Severity Scores and ICD-9 codes, completion of the orthopaedics-specific data elements and quality control (QC) checks involved 55 steps and an average of 6 hours per patient record. The MOTR custodian, data abstractors, and research nurses built a template for the orthopaedics-specific information to include fracture characterizations (AO/OTA classification), orthopaedic procedure information along the evacuation chain, definitive treatment information by CPT code, and complications (Figs. 2 and 3). All treatments and procedures are captured in chronological order by treatment facility and/or echelon of care. Complications associated with the procedure (e.g., compartment syndrome, nerve injury, infection) are captured. Based on injury severity and the evacuation

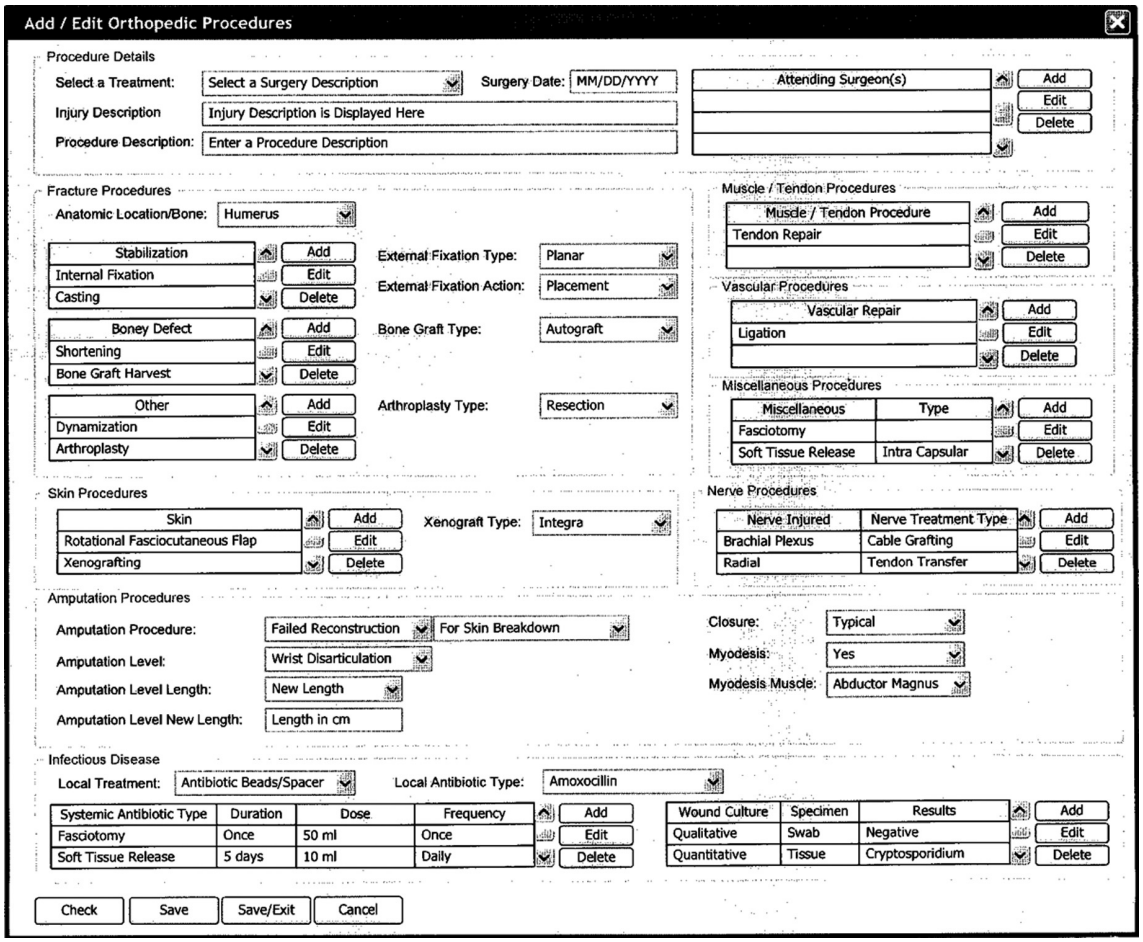

FIGURE 3 Interim MOTR module screen where injury treatments are entered.

chain, the MOTR-specific process can total 25 screens for each injury.

Making It Work

The preliminary data abstraction process illuminated two key elements necessary to develop a successful new registry: adequate funds and an adequate data source.

An adequate budget is required to implement a successful trauma registry. Initially, JTTR staff was "loaned" to MOTR as an additional duty to their existing JTTR responsibilities. Time constraints prohibited timely progress on the development of the interim MOTR module. As of October 1, 2009, there were 40,531 casualties in Operations Enduring and Iraqi Freedom with 16,842 not returning to duty — 13,509 of these casualties sustained at least one extremity injury requiring input into MOTR (11). Based on data from the interim module, one record input to MOTR required 6 man-hours. Assuming a 5-day work week for 50 weeks per year, one abstractor could input 250 warrior records into MOTR per year. This would require 55 full-time equivalent (FTE) years to complete the records up to October 1, 2009. With 14 full-time abstractors, this would require 4 FTE years. The start-up costs (i.e., computer terminals, furniture, and salaries) are estimated at $2.4 million.

The success of a registry is also contingent on an adequate data pool. The initial abstractions illustrated how the paucity of quality documentation significantly limits the quality of the data input — thus compromising the registry's objectives. In response to similar obstacles, the JTTR issued a clinical practice guideline in December 2008 suggesting a standardized trauma flow sheet. This flow sheet included required fields of the patient history, physical, and decision-making process to be documented by the trauma team leader. Similarly, MOTR developed a documentation template for the treating orthopaedic surgeon in theater (4).

At this time, MOTR is focused on U.S. service members. Any U.S. service member who is identified in JTTR with at least one extremity injury is eligible for MOTR inclusion. JTTR has deployed research nurses in combat theater to initiate the JTTR data entry. This far-forward

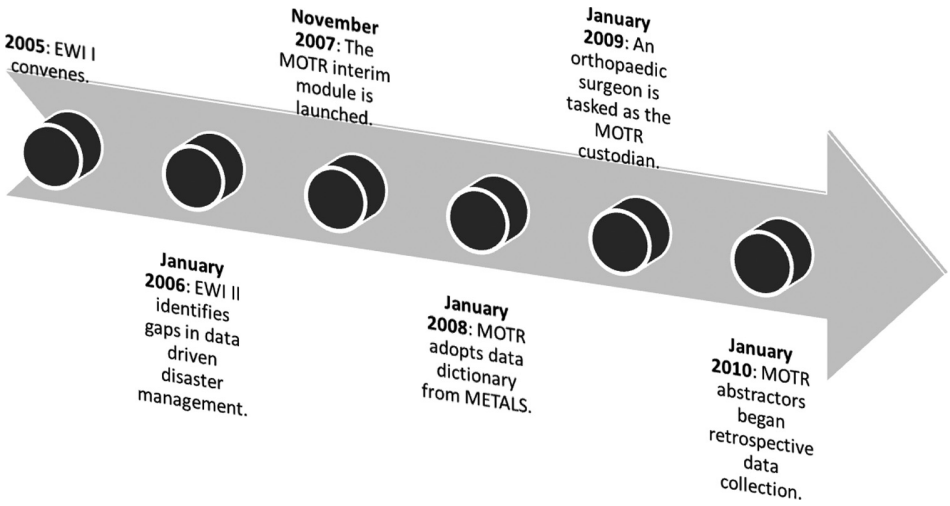

FIGURE 4 MOTR development began in 2006 and more than 4 years later the project is operational for retrospective data collection.

approach allows as complete of a capture as possible. Furthermore, the simultaneous development of JTTR and MOTR as web-based applications minimizes the risk of transcription errors because data can be entered near real time. Since MOTR patients are pulled from the JTTR, MOTR should have the same data capture rate as JTTR. Thus, MOTR also serves as a quality control mechanism for JTTR. MOTR has built in logic control checks for each required field for every patient record. This assures that a record cannot be marked "complete" unless these fields are entered. Data entry on coding and classification will only be performed by personnel trained appropriately. MOTR, as with JTTR, will abide by all required personal information protection guidelines such as HIPAA. Requests for research for MOTR content will be conducted under an institution review board (IRB) approved protocol and after review and approval of the MOTR custodian.

MOTR became fully mission capable in January 2010 (Fig. 4). Demographic data, basic injury data, and some orthopaedic injury data are pulled from JTTR. Chart abstraction elaborates on the injury by including a free text injury description followed by data elements for periarticular detail, soft tissue status, and presence of concomitant burn, vascular, muscle, tendon, and nerve injuries. Fracture detail includes bone segment, articular data if necessary, segmental loss data, and AO/OTA fracture classification. Concomitant injury data include anatomical location and details of severity. An orthopaedic procedures section is included that will contain information on where, when, and how each injury was treated. An orthopaedic complication section is also present that allows selection of multiple complications present per injury during the treatment course. The strength of the data as a whole will be the injury specifics relevant to an orthopaedic surgeon and the longitudinal follow-up as the patient progresses through each echelon of care.

Summary

The successful implementation of a trauma registry takes considerable time, funding, and personnel resources. The implementation of the MOTR registry as a module of the USAISR's JTTR required consistent communication between the medical, allied clinical, and technical staff and took nearly 4 years to create. It requires an estimated annual operating budget of $2.5 million. Lessons learned include the following (in order of importance and implementation):

1. Clearly define and articulate the goals of the registry. Explain how the new registry adds to the body of knowledge not collected elsewhere.
2. Establish a diverse but dedicated staff. The project leader should be experienced in the clinical discipline targeted for the registry. The abstractors should have a clinical background to ensure that data captured is clinically relevant. Information technology staffs are necessary to ensure that data capture plan is feasible. All should work together as a cohesive team, especially in the development phase of the project.
3. Define the crucial elements of data collection. If the data collected are available in another registry or data repository, there is no need for the registry. If the new registry is an expansion of the previously collected data, look for opportunities to share data in an automated fashion in order to save time and resources.
4. Clearly establish the timeline for project completion based on input from every member of the staff. The clinicians will underestimate the time requirement for

the abstraction process. The abstractors will need clinical input to decipher the clinical notes. The clinicians and abstractors will underestimate the time requirement for the IT staff to build and test the database. The development of the proposed interface will be dependent on completion of the database fields. The interface and the database will need to be tested and debugged. The clinicians will then request changes to the interim module. All will underestimate the time requirement of the contracting process.

5. Establish the budget in phases. Budget for concept development, contracting, and operational expenses separately. The time, staff, and infrastructure necessary to support the conceptual model will differ from the interim module. The final cost to support the final product, based on the project timeline, will be vastly different.

Orthopaedic specific trauma registries, while costly and intensive to implement, are crucial pieces to formulating data-driven orthopaedic managements during times of war. However, data-driven disaster management is not unique to the military. MOTR provides an unprecedented opportunity for comprehensive orthopaedic injury and treatment data collection that will benefit future orthopaedic surgeons responding to individual trauma patients and large natural disaster medical needs.

References

1. Glenn, M. A., Martin, K. D., Monzon, D., et al. Implementation of a combat casualty trauma registry. J. Trauma Nurs. 15(4):181–184, 2008.
2. Holcomb, J. B. *MEDCOM Memo: Collection of Trauma Registry Performance Improvement Data from All Level IV and V MTF's into the Joint Theater Trauma Registry*, May 10, 2007.
3. Eastridge, B. J., Jenkins, D., Flaherty, S., et al. Trauma system development in a theater of war: experiences from Operation Iraqi Freedom and Operation Enduring Freedom. J. Trauma 61(6): 1366–1373, 2006.
4. Pollock, G. S. *MEDCOM Memo: Collection of Injury Data for Specialty Services Into the Joint Theater Trauma Registry (JTTR)*, Aug. 28, 2007.
5. Owens, B. D., Kragh, J. F., Wenke, J. C., et al. Combat wound in Operation Iraqi Freedom and Operation Enduring Freedom. J. Trauma 64(2):295–299, 2008.
6. Masini, B. D., Waterman, S. M., Wenke, J. C., et al. Resource utilization and disability outcome assessment of combat casualties from Operation Iraqi Freedom and Operation Enduring Freedom. J. Orthop. Trauma 23(4):261–266, 2009.
7. Cross, J. D., Ficke, J. R., Hsu, J. R., et al. Battlefield orthopaedic injuries cause the majority of long term disabilities. J. Am. Acad. Orthop. Surg., in press.
8. Pollak, A. N., Calhoun, J. H. Extremity war injuries: state of the art and future directions. J. Am. Acad. Orthop. Surg. 14:S212–S214, 2006.
9. Ficke, J. R., Pollak, A. N. Extremity war injuries: development of clinical treatment principles. J. Am. Acad. Orthop. Surg. 15: 590–595, 2007.
10. Pollak, A. N., Ficke, J. R. Extremity war injuries: challenges in definitive reconstruction. J. Am. Acad. Orthop. Surg. 16:628–634, 2008.
11. Defense Manpower Data Center — Data, Analysis and Programs Division. *Global War on Terrorism: Casualties by Military Service Component — Active, Guard and Reserve.* http://siadapp.dmdc.osd.mil/personnel/CASUALTY/gwot_component.pdf. Accessed Oct. 15, 2009.