

Surveillance of Disease and Nonbattle Injuries During US Army Operations in Afghanistan and Iraq

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ABSTRACT

Disease and nonbattle injury (DNBI) are the leading causes of morbidity during wars and military operations. However, adequate medical data were never before available to service public health centers to conduct DNBI surveillance during deployments. This article describes the process, results and lessons learned from centralized DNBI surveillance by the US Army Center for Health Promotion and Preventive Medicine, predecessor of the US Army Public Health Command, during operations in Afghanistan and Iraq (2001-2013). The surveillance relied primarily on medical evacuation records and in-theater hospitalization records. Medical evacuation rates (per 1,000 person-years) for DNBI were higher (Afghanistan: 56.7; Iraq: 40.2) than battle injury rates (Afghanistan: 12.0; Iraq: 7.7). In Afghanistan and Iraq, respectively, the leading diagnostic categories for medical evacuations were nonbattle injury (31% and 34%), battle injury (20% and 16%), and behavioral health (12% and 10%). Leading causes of medically evacuated nonbattle injuries were sports/physical training (22% and 24%), falls (23% and 26%) and military vehicle accidents (8% and 11%). This surveillance demonstrated the feasibility, utility, and benefits of centralized DNBI surveillance during military operations.

Historically, disease was the greatest threat to Soldiers' health and the leading cause of death in early American wars, including World War I. During World War II, there was a transition to a more mechanized Army. There were also significant advances in sanitary and medical control of infectious diseases.^{1,2} As a result, for the first time in history, the Army fatality rate for disease and nonbattle injury (DNBI) combined (74/10,000 Soldiers) was much lower than the rate for battle injury (209/10,000 Soldiers).³

Unlike the fatality rate, the hospitalization rate for DNBI in World War II was still much higher (669/1,000 person-years [p-years]) than the rate for battle injury (29/1,000 p-years), due primarily to disease (592/1,000 p-years).⁴ Even though DNBI and battle injury rates dropped significantly in Viet Nam and again in Operations Desert Shield and Desert Storm (the Gulf War, 1990-1991), the DNBI hospitalization rate was still higher than the battle injury rate in the Gulf War (152/1,000 p-years and 6/1,000 p-years, respectively).^{4,5} Of the DNBI hospitalizations in the Gulf War, the 2 leading diagnosis categories were acute nonbattle injury and conditions of the musculoskeletal system, accounting for 25% and 13% of hospitalizations, respectively.⁶

After 13 years of continuous military operations in Afghanistan and Iraq, the Army is rapidly transforming

from a force focused on counterinsurgency operations to a smaller force that will be more adaptable, mobile, and responsive to global threats.^{7,8} In the future, there will be an ever greater dependence on the personal medical readiness of every Soldier. In this rapidly changing operational setting, every casualty, whether from battle injury or DNBI, will impact unit and mission readiness. Even more than now, commanders will rely on near-real time DNBI surveillance to assess medical readiness of the force and identify emerging medical threats.^{1,2,9}

In past military deployments and conflicts, up to and including Operations Desert Shield and Desert Storm, the military services had no systematic, theater-wide DNBI surveillance.⁵ Reported DNBI patterns, rates, and trends were based on analysis of hospitalization records that were centrally collected after the deployments ended.⁵ The absence and importance of a systematic DNBI surveillance program were realized when there were insufficient medical and environmental surveillance data to evaluate possible causes of adverse health effects reported by veterans of the Gulf War.¹⁰

In 1993, the Joint Staff mandated medical surveillance with weekly DNBI reporting on future joint deployments.^{5,11} A theater-wide program for collecting outpatient data for DNBI surveillance was in place for deployments to Somalia (Operation Restore Hope, 1992-1993),

Haiti (Operation Uphold Democracy, 1994), and Egypt (Bright Star training exercise, 1994). But these surveillance data were incomplete and nonspecific.⁵ This same Joint Staff DNBI surveillance was still in place in October 2001 when Operation Enduring Freedom began in Afghanistan.

IMPROVEMENTS IN DNBI SURVEILLANCE DURING OPERATIONS IN AFGHANISTAN AND IRAQ

In 2003, the Deployment Health Support Directorate (Office of the Secretary of Defense) fielded the Theater Medical Information Program (TMIP), a layered force health protection data system.¹⁰ The Joint Medical Workstation (JMeWS), an element of TMIP fielded in January 2003, provided online, near real-time medical surveillance and analysis derived from patient records and DNBI reports.^{10,12} Later, TMIP added the Medical Situational Awareness in the Theater (MSAT) and Theater Medical Data Store (TMDS) web-based applications that allow both classified and unclassified access to theater medical records and other medical data.¹³⁻¹⁵ Numerous system updates contributed to improvements in the theater medical surveillance capability during the operations in Afghanistan and Iraq.¹⁵ Updates to components of the electronic health record, including AHLTA-Theater and Theater Composite Health Care System Cache, improved the capture of outpatient and inpatient medical encounters, respectively. Improvements in the theater informatics infrastructure allowed greater connectivity and access to these systems. But even with these improvements, concerns persisted about the completeness and accuracy of the in-theater DNBI surveillance capability and the medical encounters in the electronic health record.

In early 2004, the US Army Center for Health Promotion and Preventive Medicine (USACHPPM), predecessor of the US Army Public Health Command (USAPHC) developed and implemented a plan for centralized DNBI surveillance for the operations in Afghanistan and Iraq. This surveillance plan included identifying and coding causes of nonbattle injury to monitor rates and trends over time. This article describes the process used by the USACHPPM and USAPHC for centralized DNBI surveillance for operations in Afghanistan and Iraq; summarizes findings from the surveillance; and describes surveillance lessons learned.

METHODS

The Injury Prevention Program at USACHPPM identified and evaluated medical and nonmedical data systems for their potential contribution to centralized, systematic DNBI surveillance. It evaluated the data systems initially in 2004, and reevaluated them periodically as

changes and improvements were made. Using data completeness, accuracy, accessibility, timeliness, and utility as criteria, the following data systems were evaluated:

- ▶ Medical encounter data from theater accessed through MSAT and TMDS
- ▶ Standard Inpatient Data Records (SIDR) from in-theater hospitalizations provided by the Patient Administration System and Biostatistics Activity (PASBA), Office of the Surgeon General
- ▶ Medical evacuation records from the Transportation Command Regulating and Command & Control Evacuation System (TRAC2ES)
- ▶ Casualty records from the Defense Casualty Information Processing System
- ▶ Accident records from the Army Safety Management Information System

The USACHPPM concluded from this evaluation that TRAC2ES and hospitalization records were best suited for centralized surveillance. The data from TRAC2ES were complete (*all* medical evacuations from theater), accurate, accessible (through the TRAC2ES portal), timely (data entered at the time of evacuation), and useable (ie, unique personal identifiers, ICD-9-CM* diagnosis codes, and patient histories from which causes of nonbattle injury could be determined). Also considered was the fact that Soldiers requiring evacuation from theater have serious medical conditions and are a “loss” to their unit until they return to theater or are replaced. Each loss negatively affects the unit’s mission readiness related to the operational tempo and special skills of each Soldier. While hospitalization records were judged to be accurate and useable, they were not accessible until 4 to 6 months after the hospitalization occurred.

The USACHPPM evaluation of the remaining data sources (ie, theater outpatient encounters, casualty records, and accident records) determined that they should be used only as secondary data sources. Due to theater-related issues, the outpatient encounter data were incomplete and the representativeness of available data could not be determined. These encounter data were used to investigate some specific medical problems, but were not used in the centralized surveillance. Casualty and accident records were valuable in providing additional details about the causes and mechanisms of some injuries.

For rate calculations used in the surveillance, the Armed Forces Health Surveillance Center provided the denominator data (number of deployed person-months) for each month of the deployments. These data were based on the

*International Classification of Diseases, 9th Revision, Clinical Modification

Contingency Tracking System data from the Defense Manpower Data Center.

RESULTS OF CENTRALIZED DNBI SURVEILLANCE

Medical Evacuations

Overall, 20,702 Soldiers were medically evacuated from Operation Enduring Freedom (OEF: October 2001 to December 2013) and 47,647 Soldiers were evacuated from Operation Iraqi Freedom-New Dawn (OIF-OND: March 2003 to December 2011). Medical evacuation rates in OEF for disease, nonbattle injury, and battle injury were 28.6/1,000 p-years, 18.1/1,000 p-years, and 12.0/1,000 p-years, respectively. In OIF-OND, these rates were lower than in OEF (24.0/1,000 p-years, 16.3/1,000 p-years, and 7.7/1,000 p-years, respectively).

Figures 1A and 1B show the monthly rates for DNBI (blue line) and battle injury (red line) medical evacuations from OEF and OIF-OND, respectively. Monthly rates were highest during the initial phases the operations. After the initial phases, monthly DNBI rates in OEF were generally higher (range after 2002: 21/1,000 p-years to 93/1,000 p-years) than in OIF (range after 2003: 20/1,000 p-years to 70/1,000 p-years). Monthly battle injury rates in OEF were lower prior to May 2006 compared to the period June 2006 to December 2011. Battle injury rates after June 2006 in OEF followed a seasonal pattern with higher rates between April and September reflecting higher levels of hostile action during the warmer months. In OIF-OND, monthly battle injury rates were higher during the first half of the operation (March 2003 to May 2008; range: 5 to 25/1,000 p-years) compared to the period June 2008 to December 2011 (range: 0 to 5/1,000 p-years).

Figures 2A and 2B show the distribution of medical evacuations for each operation by primary diagnosis groups in the ICD-9-CM. The pattern for distribution is similar for both operations. The 2 leading diagnosis categories for OEF and OIF-OND were nonbattle injury (ie, acute injuries and injury-related musculoskeletal conditions) accounting for 31% and 34%, respectively, of medical evacuations, and battle injury, accounting for 20% and 16%, respectively, of evacuations. The next 3 leading categories for OEF and OIF-OND were behavioral health (12% and 10%, respectively), ill-defined conditions (8% and 9%, respectively), and digestive disorders (6% for both operations).

Figures 3A and 3B show the annual percentage of all medical evacuations for each of the 6 leading diagnosis groups from Figures 2a and 2b. Evacuations for nonbattle injury fluctuated in both operations. The percentage of battle injury evacuations in OEF increased starting in

2006, whereas the battle injury percentage in OIF-OND was increasing from 2003 to 2007 and then dropped from 2008 to 2013. For both operations, the percentage of evacuations for behavioral health increased beginning in 2007, peaking at 18% in OEF (2012) and 21% in OIF-OND (2010).

Figure 4 shows the leading causes of nonbattle injuries that required medical evacuation, as determined from the patient history in TRAC2ES records. The leading causes of nonbattle injury were similar for both operations, though the rank order of the causes differed by operation. Sports and physical training accounted for 24% and 22% of nonbattle injury evacuations in OIF-OND and OEF, respectively. Falls and near-falls accounted for 23% of evacuations in OIF-OND and 26% in OEF. Military motor vehicle accidents accounted for 11% and 8% of nonbattle injury evacuation in OIF-OND and OEF, respectively.

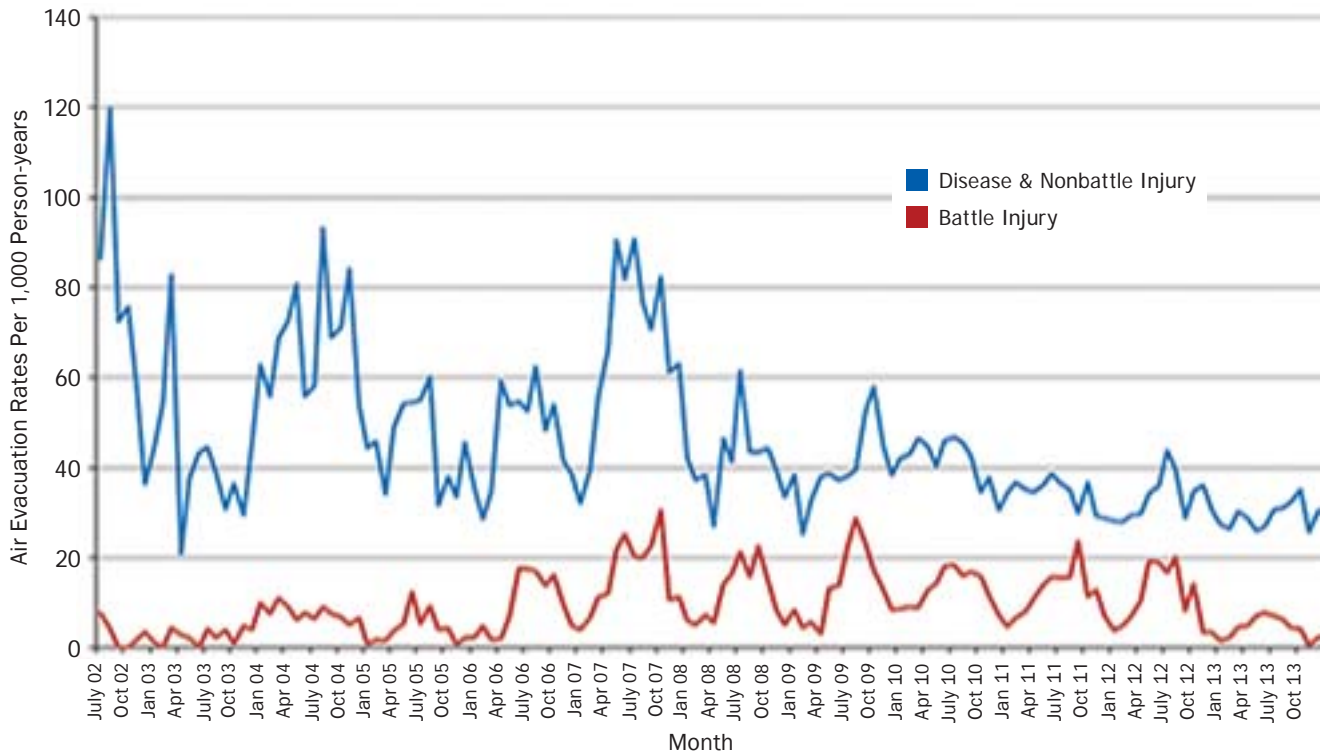
In-theater Hospitalizations

Overall, there were 12,251 hospitalizations in OEF and 23,299 hospitalizations in OIF-OND. Hospitalization rates for disease, nonbattle injury, and battle injury in OEF were 16.1/1,000 p-years, 6.2/1,000 p-years, and 12.3/1,000 p-years, respectively. In OIF-OND, hospitalization rates for disease and nonbattle injury (26.3/1,000 p-years and 8.8/1,000 p-years, respectively), were higher than in OEF, but the rate for battle injury (9.1/1,000 p-years) was lower.

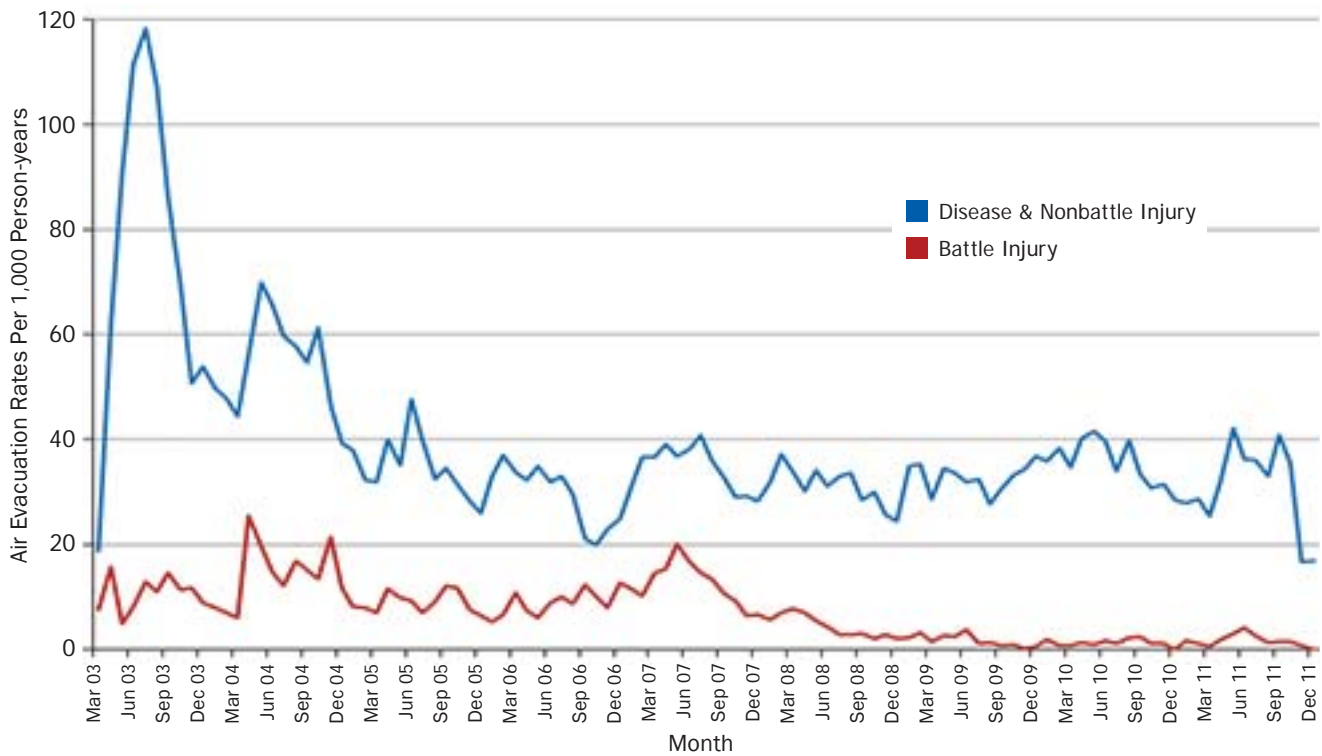
The distribution of primary diagnosis groups for in-theater hospitalizations differed from the distribution for medical evacuations. For OEF and OIF-OND, the 4 leading diagnosis groups for hospitalizations were battle injury (36% and 21%, respectively), nonbattle injury (18% and 19%, respectively), digestive disorders (11% and 15%, respectively) and ill-defined conditions (10% for both operations). Whereas behavioral health ranked third for medical evacuations in both operations (18% to 21%), it ranked eighth for OEF hospitalizations (3.0%) and sixth for OIF-OND hospitalizations (6%).

The distribution of causes of nonbattle injuries hospitalized in-theater also differed from the distribution for nonbattle injuries that were medically evacuated. The 2 leading causes of nonbattle injury hospitalizations for OEF and OIF-OND were military vehicles (21% for both operations) and falls (21% and 15%, respectively). Inhalation or ingestion of toxic substances (intentional injuries) ranked fourth for OEF (11%) and third for OIF-OND (13%). Sports and physical training ranked fifth for hospitalizations but was the leading category for nonbattle injury medical evacuations.

SETTING THE STAGE



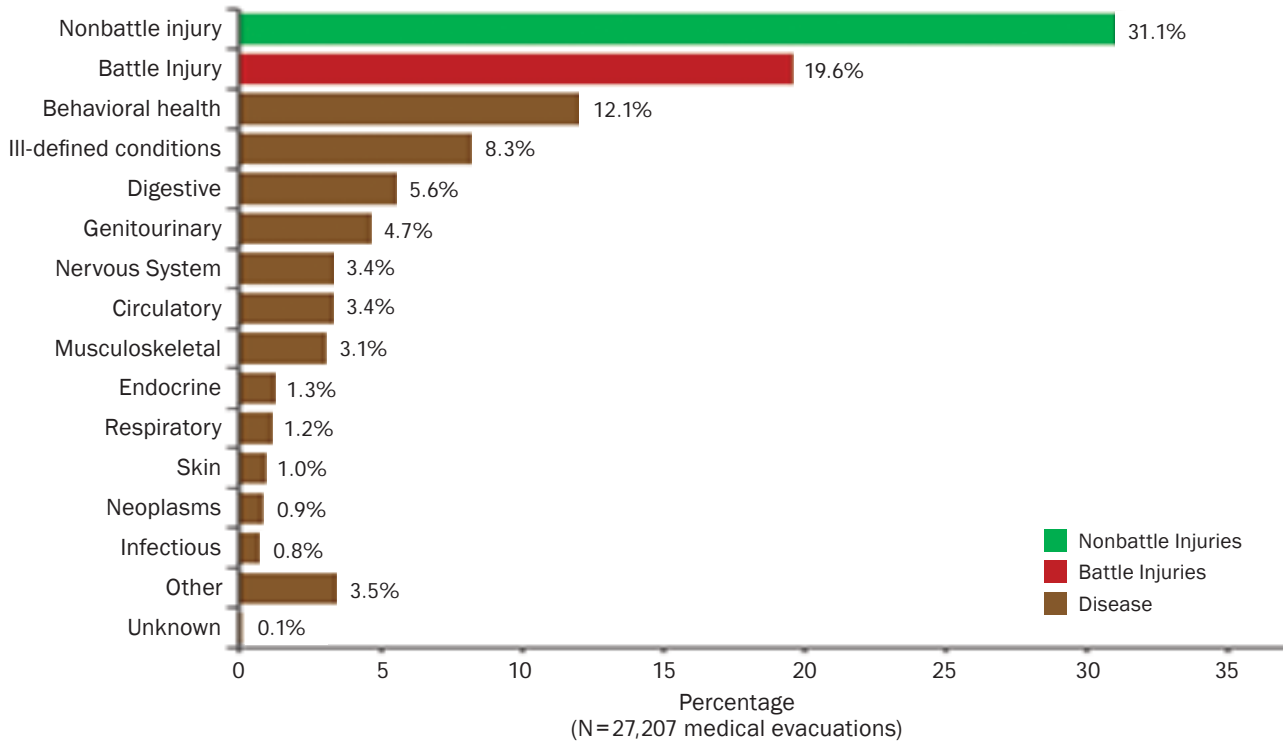
1A. Operation Enduring Freedom (July 2002 - October 2013).



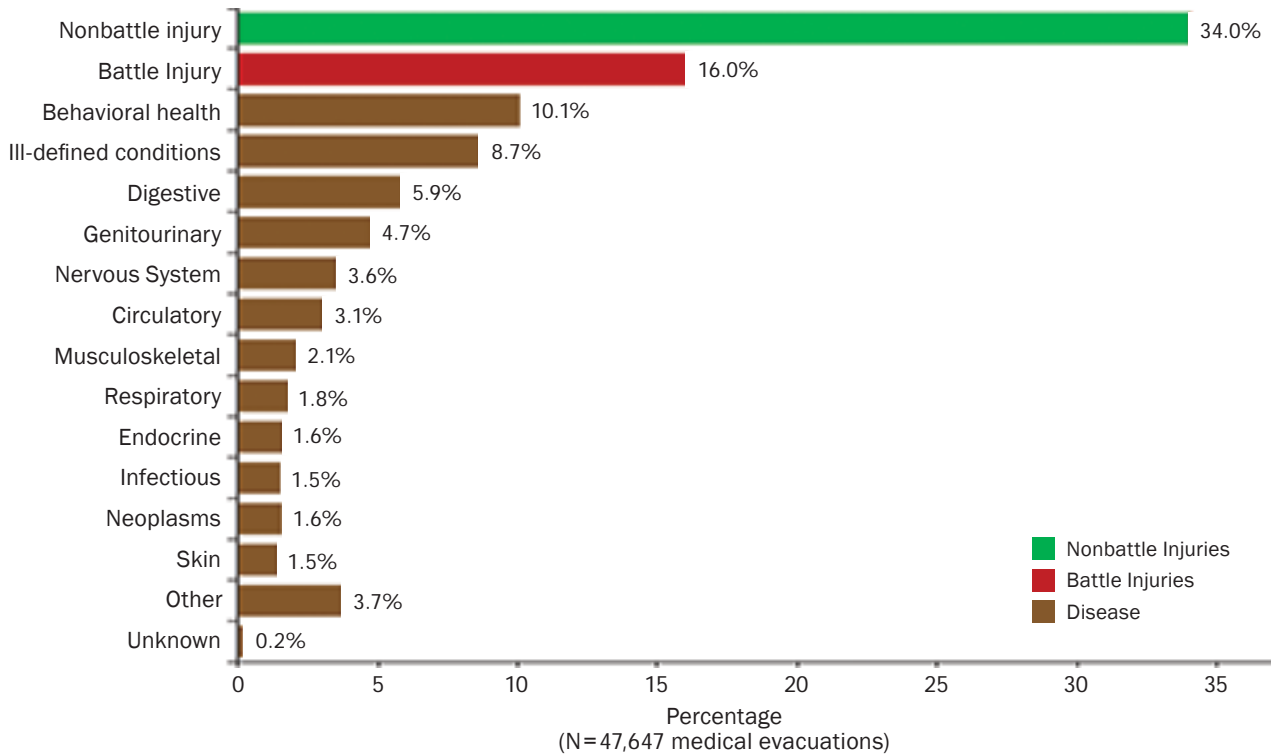
1B. Operation Iraqi Freedom - New Dawn (March 2003 - December 2011).

Figure 1. Monthly rates (per 1,000 person-months) for medical evacuation of battle injuries and disease/nonbattle injuries for Operation Enduring Freedom (1A) and Operation Iraqi Freedom - New Dawn (1B).

THE ARMY MEDICAL DEPARTMENT JOURNAL



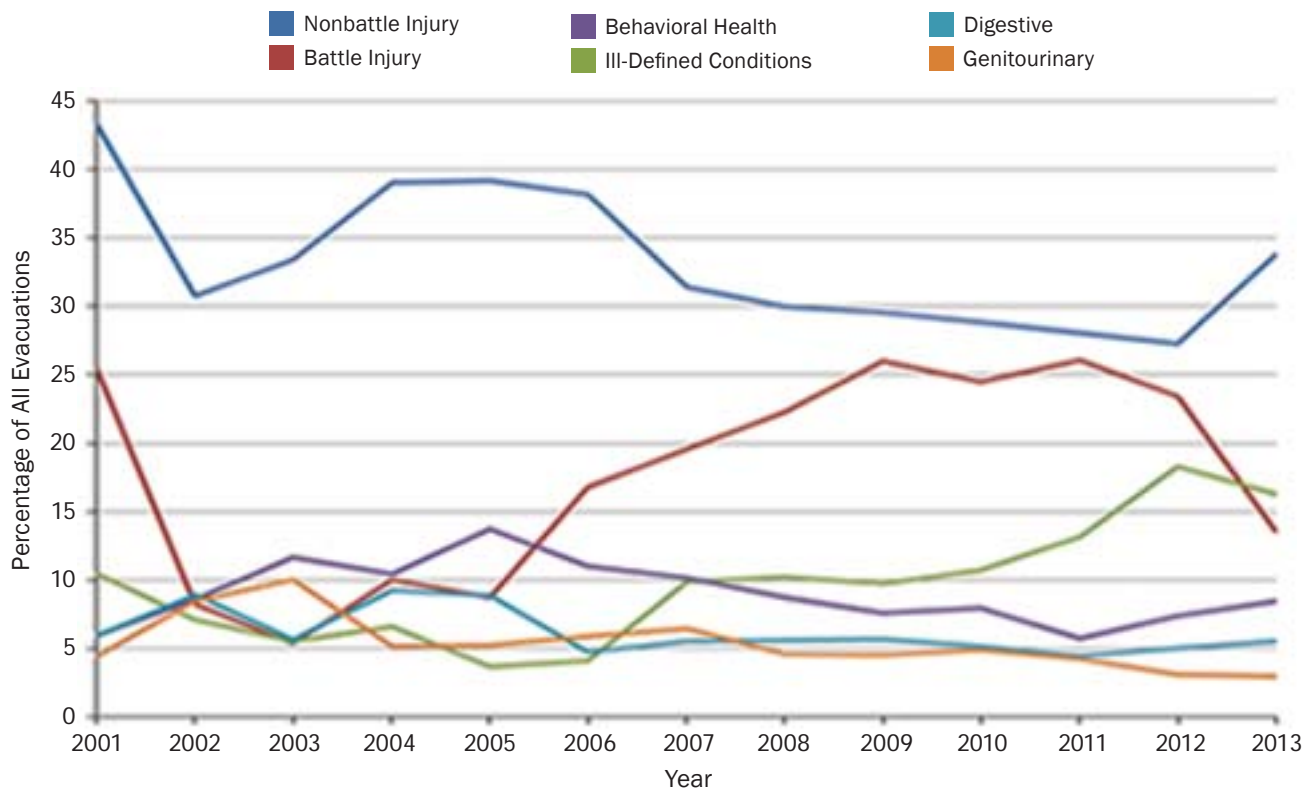
2A. Operation Enduring Freedom (2001 - 2013).



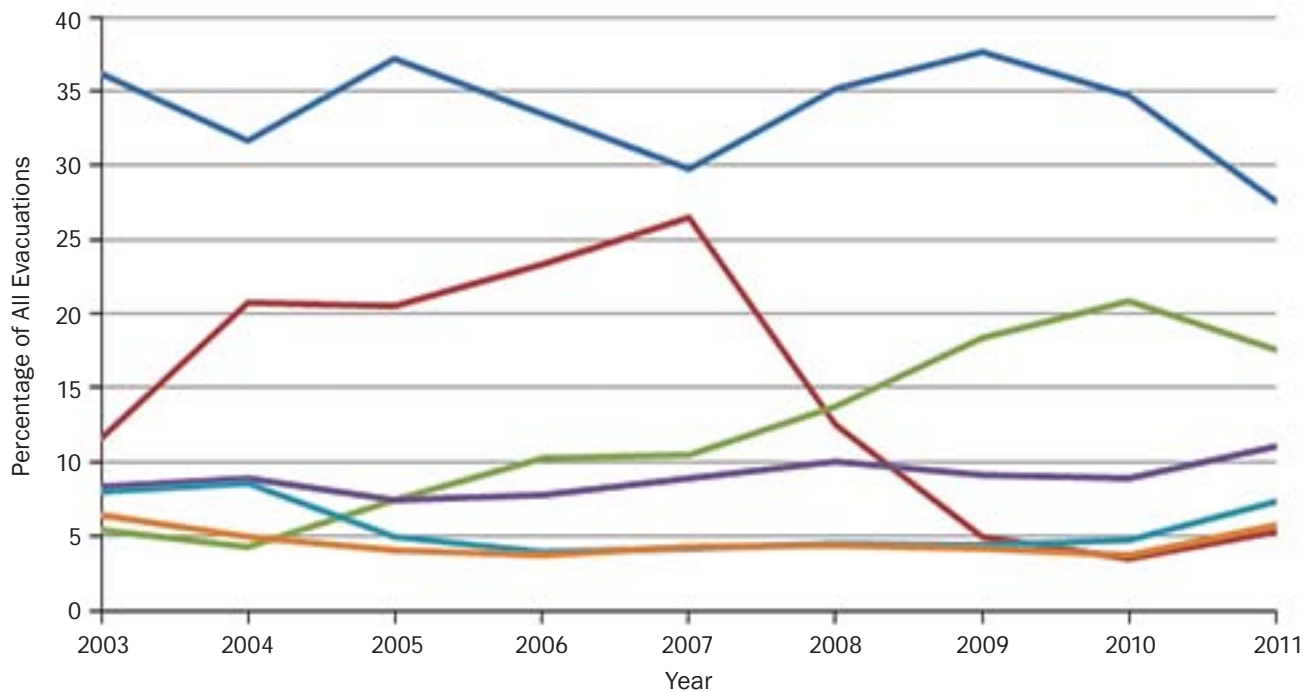
2B. Operation Iraqi Freedom - New Dawn (2003 - 2011).

Figure 2. Distribution of primary diagnosis categories for US Army medical evacuations from Operation Enduring Freedom (2A) and Operation Iraqi Freedom - New Dawn (2B).

SETTING THE STAGE



3A. Operation Enduring Freedom (2001 - 2013).



3B. Operation Iraqi Freedom - New Dawn (2003 - 2011).

Figure 3. Percentages of US Army medical evacuations for the leading primary diagnosis categories from Operation Enduring Freedom (3A) and Operation Iraqi Freedom - New Dawn (3B).

COMMENT

The USACHPPM/USAPHC conducted centralized DNBI surveillance during the operations in Afghanistan and Iraq. This surveillance used medical evacuation and in-theater hospitalization records as primary data sources. A unique component of the surveillance was coding causes of nonbattle injuries based on the narrative patient history in TRAC2ES records. This surveillance demonstrated the feasibility and utility of identifying causes of nonbattle injury from medical evacuation and hospitalization records.

Operation Enduring Freedom and OIF-OND were the first Army operations of this scale in which data were available to conduct centralized DNBI surveillance during the operations. This surveillance provided an additional means of monitoring health of the force and identifying emerging medical threats. As for nonbattle injuries, this surveillance helped to focus attention on potentially preventable causes of injury such as falls from tactical vehicles, rollover tactical vehicle accidents, and injuries from sports and physical training.

Distributions for the primary diagnosis groups for medical evacuations were similar for both operations. The 3 leading diagnosis groups were nonbattle injury, battle injury, and behavioral health. The leading diagnosis groups for in-theater hospitalizations were also similar for both operations (ie, battle injury, nonbattle injury, and digestive), but the rank order and proportion for the leading diagnosis groups were different for hospitalizations compared to medical evacuations. In-theater medical capabilities and individual prognosis likely influenced these differences.

LESSONS LEARNED FROM DNBI SURVEILLANCE IN AFGHANISTAN AND IRAQ

As the Army transforms to a smaller, yet more adaptable, mobile, and responsive force, senior leaders and commanders will have a greater expectation for near real-time DNBI surveillance to accurately assess the medical readiness of the force and identify emerging medical threats.^{1,2,9} Lessons learned from surveillance during OEF and OIF-OND should guide efforts in the Department of Defense and Army as they work toward a more robust and informative DNBI surveillance for the future. Lessons learned from this surveillance follow:

- Central DNBI surveillance was achieved using medical evacuation (TRAC2ES) and in-theater hospitalization (SIDR-PASBA) records.

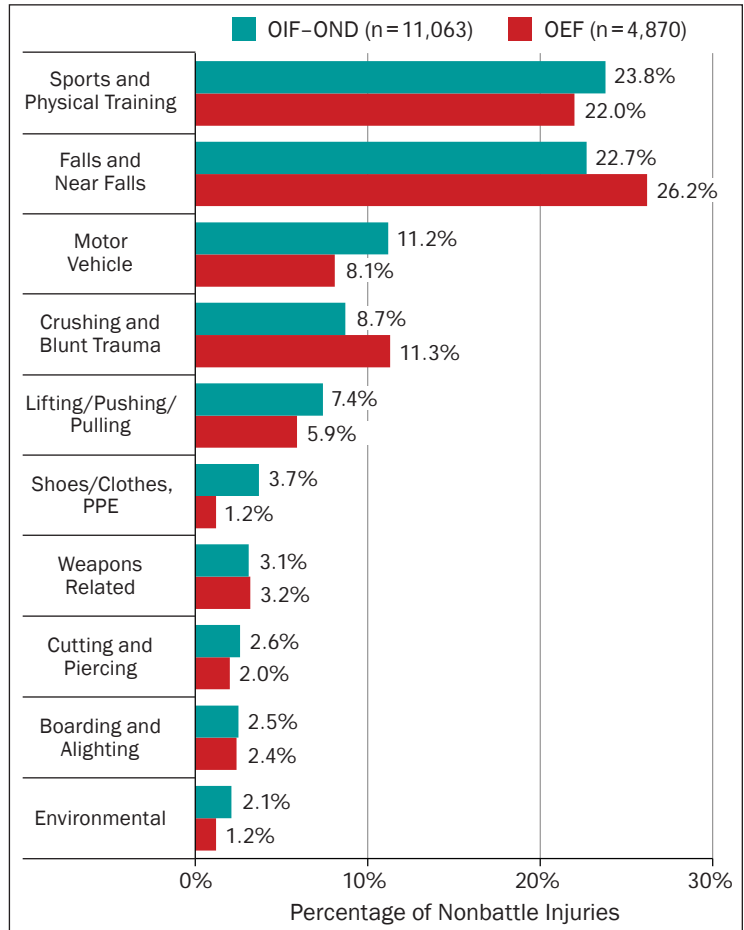


Figure 4. Causes of US Army nonbattle injuries requiring medical evacuations from Operation Enduring Freedom (OEF), 2001-2013, and Operation Iraqi Freedom - New Dawn (OIF-OND), 2003-2011.

- Utility of MSAT for centralized DNBI surveillance was limited because it could only be accessed on the classified network. As such, MSAT data could not be analyzed or linked to other medical and non-medical surveillance data that reside on unclassified systems.
- Air evacuation records from TRAC2ES were used to identify and code causes of nonbattle injury. In-theater SIDR hospitalization records from PASBA included coded causes of injury.
- The deployment outpatient encounter data in MSAT did not have coded causes of injury. Currently, injury cause coding in the electronic health record by medical providers is not mandatory in the electronic health records. As a result, causes of injury are unknown for injuries treated at levels I and II where the majority of injured Soldiers receive medical care. Finding a solution to this important shortfall in the health record should be a priority.
- Nonbattle injury was the leading diagnostic category of medical evacuations in both operations,

followed by battle injury. Of in-theater hospitalizations, battle injury was the leading category, followed by nonbattle injury. These data show that injuries are a leading medical problem during deployments and affect unit and mission readiness.

- Leading causes of nonbattle injury during deployments were the same as leading causes among Soldiers in garrison. Whether in garrison or on deployment, the 3 leading causes of injury for hospitalized nonbattle injuries are motor vehicle accidents, falls, and sports/physical training.¹⁶ The leading cause of air evacuated nonbattle injuries was sports/physical training, which is also the leading cause of injuries among Soldiers in garrison.^{17,18}

CENTRAL AND IN-THEATER DNBI SURVEILLANCE ISSUES RELATED TO DOCTRINE, ORGANIZATION, TRAINING, MATERIEL, LEADERSHIP & EDUCATION, PERSONNEL, AND FACILITIES

Doctrine

- ♦ Policy and directives should include the requirement for entering medical care in the electronic medical record at all levels of medical care in theater. Despite improvements during OEF and OIF-OND, no outpatient medical encounters were entered in the electronic medical record during the most recent operation in Africa (Operation United Assistance, 2014-2015).
- ♦ Consideration should be given to allow greater access to deployment medical encounter and population data from MSAT on unclassified systems to support military public health centers in medical surveillance and force health protection work.

Training

- ♦ Active and reserve component medical units should receive predeployment training on the medical information technology systems they will use in theater (for example, Medical Communications for Combat Casualty Care [MC4] and JMeWS).

Facilities

- ♦ In-theater support for JMeWS/MSAT/MC4 systems is essential for data flow throughout the enterprise to those with a need-to-know. Reliable in-theater and central DNBI surveillance at all levels of care can only be achieved when the medical encounter data are complete and representative of the deployed population.

Leadership & Education

- ♦ Given the magnitude of the injury problem for the Army, senior medical and safety leaders should support mandatory cause-coding of injuries in the electronic health record.

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