A CHARACTERIZATION OF INJURIES AMONG ACTIVE DUTY PERSONNEL AT FORT RILEY, KANSAS

by

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Abstract

This report summarizes my experiences as a student extern at the Department of Public Health, Fort Riley, Kansas. This field experience was in partial fulfillment of the requirements of the Master of Public Health Program at Kansas State University. During the fall 2011 semester, I shadowed health department personnel, observed day-to-day operations, and assisted with various duties.

During the student externship, I also conducted research under the direction of Lieutenant Colonel Paul Benne, Chief of Public Health at Fort Riley. Research was conducted on injuries among active duty personnel at Fort Riley. Injuries in the military are the greatest threat to combat readiness and the health of active duty personnel. Injuries related to physical activities and training are the primary reason service members seek medical treatment. This results in excessive limited duty days, high medical attrition rates, and tremendous health care costs for the military. Researchers have determined several risk factors, both intrinsic and extrinsic, that are associated with increased injury incidence. The purpose of the research at Fort Riley was to determine the incidence of injuries and musculoskeletal conditions among Army active duty personnel at Fort Riley, Kansas, between April 2010 and September 2011. Variables of interest included medical diagnosis, demographic data (age, gender, race), body mass index, unit, and disposition after injury (e.g., limited duty, hospitalization, etc.). Results showed that the leading injury diagnoses were musculoskeletal in nature and included low back pain and joint pain (primarily lower extremity). Injury rates were higher at Fort Riley than those that have been reported for the military as a whole. Recommendations to decrease injury rates at Fort Riley include continued, routine surveillance of injuries; education about appropriate prevention interventions; and adherence to policies and programs that are in place to prevent injuries.

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Chapter 1 - Department of Public Health, Fort Riley, Kansas

Introduction

Fort Riley, a U.S. Army installation in Northeast Kansas, has a long and rich history. In 1853, it was established in the heart of the Flint Hills where the Smoky Hill and Republican Rivers meet. Named after Major General Bennet C. Riley, previous commander of Fort Leavenworth, Kansas, the Fort was built to help resolve conflicts between local Native Americans who lived in the area and settlers and traders who used the Santa Fe and Oregon trails (Riley County Historical Museum, n.d.).

Fort Riley is home of the 1st Infantry Division, also called the "Big Red One." Throughout the past century, soldiers from the 1st Infantry Division have fought in several major conflicts, including World Wars I and II, Vietnam, the Gulf War, Bosnia, Kosovo, Iraq, and Afghanistan. Twice during the 20th century, the 1st Infantry Division moved to Germany (from World War II to 1955, and from April 1996 to August 2006). The 1st Infantry Division at Fort Riley is composed of four brigades and many support units. The brigades include the 1st Brigade Combat Team, the 2nd Brigade Combat Team, the 4th Infantry Brigade Combat Team, and the Combat Aviation Brigade (1st Infantry Division, 2012).

Meeting the healthcare needs of soldiers and their families has always been a priority at Fort Riley. A temporary hospital was set up on post in 1854, and the first permanent hospital was opened in 1855. Population growth at the Fort led to the construction of a new hospital in the 1880s and to several additions over the following years. The threat of the Second World War prompted the construction of a second hospital, Station Hospital. The current hospital, Irwin Army Community Hospital, was opened in 1958; it was dedicated to Brigadier General Bernard John Dowling Irwin, known as "The Fighting Doctor," who won the Congressional Medal of Honor for his bravery in a conflict with the Chiracahua Native American tribe in 1861. Construction is currently underway on the new Irwin Army Community Hospital, which will replace the current hospital, and is expected to open in 2014 (Irwin Army Community Hospital, n.d.).

The Fort Riley Department of Public Health at Irwin Army Community Hospital offers several healthcare services to active duty personnel and their families, retired military personnel,

and civilian employees. The Health Department is a component of the United States Army Public Health Command (USAPHC), whose mission is:

> "To promote health and prevent disease, injury, and disability of Soldiers and military retirees, their Families, and Department of the Army civilian employees; and assure the execution of full spectrum veterinary service for Army and Department of Defense Veterinary missions" (United States Army Public Health Command, n.d.).

The staff of the Health Department fulfills this mission under the leadership of the Chief of Public Health, Lieutenant Colonel Paul Benne. The Health Department is comprised of four sections: public health nursing, occupational health, environmental health, and industrial hygiene. Veterinary Services is also a part of USAPHC and works closely with the Health Department.

Fort Riley Department of Public Health Field Experience

During the fall 2011 semester, I shadowed Health Department and Veterinary Services personnel, observed day-to-day operations, and assisted with various duties. This experience was in partial fulfillment of the requirements of the Master of Public Health Program at Kansas State University. I also conducted research on injuries among active duty personnel at Fort Riley. The following sections highlight experiences from my field experience and Chapters 2 and 3 detail my research.

Public Health Nursing

The Public Health Nursing section is staffed by Registered Nurses, a Nurse Practitioner, a physician, and administrative staff. The staff members of this section promote the health and safety of people of all ages at Fort Riley, and their responsibilities include Child and Youth Services health inspections, health education, disease surveillance, and immunization administration.

Each month, the Public Health Nurse inspects the Child Development Centers on post. I accompanied him on one visit to the Whitside Child Development Center (CDC) and assisted with the inspection procedures. Each CDC offers care for children ages six weeks to five years. Each child is placed in a classroom with children of various ages to provide an environment where the children can learn from each other. The CDC is accredited by the National Association for the Education of Young Children (NAEYC) and is certified by the Department of the Army

(AR 608-10). The Public Health Nurse inspects each classroom in the CDC to ensure that it is safe for the children. In classrooms with children who have allergies, there must be a notebook that includes a page for each child with allergies and a sign on the wall alerting staff of which children have allergies. The RN makes sure the notebook and sign include the child's name, picture, and list of allergies to ensure that staff members are aware of the children's allergies. He observes that hand washing stations are available and equipped with soap and paper towels, that diaper changing stations are clean, that toys are age appropriate, and that food is properly and safely stored and still within the "best by" date.

Another major component of all activities in the Nursing section is health education with an emphasis on prevention. Staff members screen and educate clients on prevention of sexually transmitted diseases, tuberculosis, smoking cessation, and other relevant health topics. Once a week, one of the Registered Nurses (RN) sets up a table at the commissary (grocery store) and conducts wellness screenings for customers who are interested in learning more about their health. I accompanied him during one of his trips to the commissary. The RN assesses blood pressure, body mass index (BMI), and blood glucose and cholesterol levels, and reviews the results with the customer. If any of the assessments are abnormal, he recommends that the customer make an appointment with his or her physician for follow up.

During my time with the Nursing section, there was a possible gastrointestinal (GI) illness outbreak. Several soldiers from one unit visited a health clinic on post during a two day period with signs and symptoms of GI illness (i.e., nausea, vomiting, diarrhea, fever, and chills). The clinic provided a list to one of the public health RNs with names, telephone numbers, unit, signs/symptoms, and diagnoses of the soldiers who had been to the clinic during the time period of the possible outbreak. To assist with the investigation, I attempted to call each soldier on the list who had presented to the clinic with symptoms of GI illness. I inquired about what symptoms were experienced, when symptoms began and ended, if the soldier had been in contact with anyone else who had been ill, where and what the soldier had eaten, and any other potential exposures to the illness. After speaking with several soldiers and collaborating with the RN, it was determined that the soldiers had no risk factors in common with each other; in other words, none of them had eaten the same foods or had been in contact with anyone who had been ill. It was concluded that this was not a true outbreak of GI illness, but random incidents.

Another responsibility of the Nursing section is to administer vaccinations to adults and children at Fort Riley. During the fall, influenza vaccines are given to children who receive care at the CDCs on post. I accompanied one RN to an influenza immunization clinic at a CDC and observed the process of screening and vaccinating. Before children can receive a vaccine, letters are sent to the parents to obtain permission to vaccinate the children. A questionnaire is sent with the letter to determine if the child has any medical conditions that would prevent him or her from receiving a vaccine. Children over the age of six months are eligible to receive the influenza vaccine if they pass the screening criteria. At the immunization clinic, the RN and an administrator review the screening forms to determine if the criteria have been met. If these criteria are met, the child is then accompanied by a caregiver or parent who verifies the child's identity, and the RN ensures that the "five rights" of medication administration are followed (right person, right vaccine, right dose, right route of administration, and right time) before proceeding with the vaccination.

Apple Day

On September 24, 2011, Fort Riley held its 11th annual Apple Day Festival. Each year the event showcases various organizations on post, and there are many activities for the entire family to enjoy. The Health Department set up two tents; at one tent, personnel provided public health information and education, and at the other tent, staff offered influenza vaccines for soldiers and their family members. Those who wished to receive a vaccine filled out a screening form that asked a series of health-related questions and then entered their personal information into a computer. Each person was then screened by a health care professional (either a physician or nurse practitioner) who determined if he or she was eligible for the influenza vaccine and which type of vaccine (intranasal or intramuscular). After being screened by a health care provider, the person proceeded to the vaccination area where an RN administered the vaccine. I assisted with the operations of the influenza vaccine tent by ensuring forms were filled out correctly and by helping people enter their information into the computer.

Environmental Health

The personnel in the Environmental Health (EH) section are responsible for ensuring a safe environment that promotes the health and well-being of everyone who visits, works, and lives at Fort Riley. The staff accomplishes this through food service and CDC sanitation and

inspections, water quality surveillance, vector surveillance, and hospital waste management monitoring.

Ensuring the cleanliness and safety of food preparation areas is one responsibility of the EH section. Staff members monthly inspect dining facilities (DFACs) and CDCs and assign a letter grade to each facility based on several factors associated with food safety and cleanliness. The goal is to guarantee that food is stored at proper temperatures and is labeled with the date it was opened or prepared, food containers are stored properly, food preparation tools are cleaned, trash containers are properly covered, and food preparation staff handles food appropriately. I accompanied EH staff and assisted with several inspections and reviewed food safety codes and inspection procedures.

In addition to the above mentioned duties, EH staff routinely samples water sources at Fort Riley. These sources include wells, indoor faucets, and swimming pools. On two separate occasions, I accompanied one member of the EH staff on a water sampling trip. He collected water from a faucet in two buildings and one swimming pool. He showed me how to test chorine and pH levels and then allowed me to perform the test. He also showed me how to conduct a membrane filtration test; this tests the water for coliform bacteria (e.g., E. *coli*). Five dishes are used in the test; two are negative controls, one is a positive control, and two are for the water sample. The negative controls test sterile water and the positive control tests E. *coli* that has been grown in a test tube. These tests are run to ensure that the media are functioning properly. All collected samples from these water sampling trips were negative.

Another responsibility of the EH staff is the monitoring of mosquito types and levels on post and keeping those levels at an acceptable amount. One of the EH staff members routinely monitors traps at several locations on post; each Monday from May through September, he turns on the traps and returns to them Tuesdays through Fridays to collect and transport the mosquitoes back to the lab in the health department. He then examines them under a microscope to determine what species of mosquitoes have been trapped. I had the opportunity to examine mosquitoes after one outing and was taught how to distinguish females from males, and mosquitoes from other types of insects that had been caught in the traps. One interesting fact I learned was that *Anopheles* mosquitoes are indigenous to the United States. The females of this species are carriers of the parasite that causes malaria. Because malaria has been eradicated from

North America, I had falsely believed that this species did not exist in the United States. I was surprised when I observed several female *Anopheles* mosquitoes under the microscope!

Industrial Hygiene

The Industrial Hygiene (IH) staff works to reduce the risk associated with various hazards encountered in the workplace. Responsibilities include assessing ventilation in buildings, measuring noise exposure, ensuring air quality in buildings, reducing risk of radiation exposure, and conducting ergonomic assessments. The staff works with Army staff and civilian employees all across Fort Riley to ensure that they have safe working environments that promote good health and productivity.

I accompanied one industrial hygienist to visit the Combat Aviation Brigade in order to conduct ventilation assessments and assess noise exposure. When soldiers weld or conduct activities that produce fumes, it is important that the room in which they are working has proper ventilation. Noise exposure is of great concern because soldiers must have excellent hearing to help ensure safety when they are deployed to a combat zone. Army regulations mandate that soldiers are not to be exposed to more than 85 decibels over the course of eight hours. A sample of soldiers was chosen to wear dosimeters for eight hours. A dosimeter measures the amount of noise to which the person is exposed. After the eight hours, the industrial hygienist returned to collect the dosimeters and measure the noise level to which each soldier was exposed. If the noise level exceeds 85 decibels, actions are taken to reduce the noise level.

IH is also responsible for ensuring good indoor air quality for buildings on post. One of these responsibilities involves control of mold in buildings. I had the opportunity to investigate a potential mold problem in an office building on post. The supervisor at the building had contacted IH to report that she was concerned about the air quality in the working environment. IH sent a survey to the workers in this building asking them to identify the symptoms they had experienced and how long they had experienced them. Several people who worked in this building had complaints of seasonal allergy symptoms (e.g., coughing, sneezing, itchy and watery eyes, headaches, ear infections, etc.) that had lasted for weeks or months. Many of these people claimed their symptoms cleared once they left the building. The air conditioning system had malfunctioned several months earlier, but had been repaired. However, in one office, a worker had found mold on the back of pictures hanging on the wall. After this discovery, many

of the workers were convinced that mold was the reason for their symptoms. I accompanied one industrial hygienist to the building to collect both an indoor and outdoor air sample to test for mold. The results showed that the indoor mold level was much less than the outdoor level. I had the opportunity to independently interview several of the workers to clarify the symptoms they had experienced and I explained to them the results of the mold sampling. The cause of the symptoms was not determined during my time at the Health Department. Even though the workers had not received closure about the cause of their symptoms at that time, they were grateful that someone had taken the time to investigate further. I learned that even if a solution cannot be readily offered, sometimes empathy and listening can help to mitigate a perceived problem.

Occupational Health

The Occupational Health (OH) section of the Health Department is responsible for identifying and decreasing risks of injury and illness related to certain civilian and Army occupations at Fort Riley. The staff accomplishes this through medical surveillance examinations and screenings. They conduct yearly hearing and vision evaluations for primarily civilians, firefighters, and law enforcement personnel. Pregnant soldiers are referred to OH, which follows them throughout their pregnancies and makes recommendations about decreasing workload. Another responsibility of OH is to promote injury prevention and control in the workplace. Staff reviews proper techniques and positioning for specific job responsibilities and determines if personnel require special ergonomic equipment to properly perform their job duties. OH is responsible for ensuring that all work-related immunizations are up-to-date. They also conduct worksite evaluations to assess noise level, determine if employees are wearing proper ear and eye equipment, and decide what personal protective equipment may be needed (e.g., eyewear, footwear, or ear protection).

Army Hearing Program

The Army Hearing Program works closely with OH to ensure hearing safety among Army personnel. The goal of the Army Hearing Program is to decrease the risk of hearing loss among Army personnel through education, reduction of exposure to noise hazards, and development of policies. These personnel are exposed to high levels of noise for prolonged lengths of time; noise exposure comes primarily from weapons and machinery. Hearing

screenings are done on every soldier upon entering the Army and then annually to assess for any hearing loss. Education courses are routinely conducted to teach soldiers about the importance of protecting their hearing. Hearing protection (i.e. ear plugs) is provided to all soldiers.

I reviewed relevant regulations that govern the Hearing Program at Fort Riley and also had the opportunity to go to one of the firing ranges on post with the audiologist, who checked for the use of hearing protection among the soldiers at the range. The audiologist inspected each soldier for hearing protection and ensured that it had been inserted into the ear canal appropriately. If the ear protection was inserted incorrectly, she instructed the soldier on how to properly use it.

Veterinary Services

The mission statement of Veterinary Services at Fort Riley is to "provide high quality, economical animal medicine, to protect the public health, and to provide support in zoonotic disease prevention to the Fort Riley community" (1st Infantry Division, 2009). Veterinarians provide services for animals cared for by the Army (such as working dogs and horses) and those privately owned by Army personnel, retirees, and family members. Veterinary Services is also responsible for ensuring the quality and safety of food that is available at facilities on post, including the commissary, commercial food processing facilities, DFACs, and CDCs.

During my time with Veterinary Services, I observed the veterinarian in her assessments of several privately owned pets. During each encounter, the veterinarian emphasized to the owner the importance of prevention of diseases, such as rabies and parasites, through routine vaccinations and testing.

I also observed and assisted with inspections of food items and food facilities at Fort Riley. I learned about the regulations regarding inspections of meals ready to eat (MREs) and then was able to inspect an MRE. Visual inspection as well as sampling the product for flavor and texture were conducted to ensure the quality of the product. At the commissary, food is inspected upon receipt and while it is available for sale. I assisted with an inspection at the commissary and observed that food was still within the "best by" date and that cans did not have dents in the seams or edges. I also inspected the deli area for cleanliness and ensured that the staff observed proper food handling guidelines.

Reflection

I was surprised at the diversity of the responsibilities of the staff at the Fort Riley Department of Public Health. My exposure to public health outside of the classroom setting prior to this field experience has consisted of public health nursing, health education, and disease surveillance. Because of my background in nursing, I have focused more on immunizations, infectious disease surveillance, and prevention of widespread public health conditions such as diabetes and obesity. My perspective of public health has broadened and I now see the important role that public health professionals have in monitoring indoor air quality, protecting the hearing of Army personnel, and protecting food supplies, along with many other responsibilities of ensuring the health and safety of this population.

This experience provided me with the opportunity to further understand and apply the knowledge and skills I have learned during my time in the MPH Program at Kansas State University. Concepts about risk from epidemiology and environmental health were applied by the industrial hygiene staff when assessing noise risk and conducting noise surveys among active duty personnel. Epidemiologic and statistical principles were used in disease surveillance in the public health nursing section. The concepts of how behavior relates to health outcomes were used in much of the education that is conducted throughout the Health Department; this education focuses on modifying negative behaviors and reinforcing positive behaviors in order to promote the health and well-being their clients. This experience greatly enhanced my education and I am grateful to the Health Department staff for the opportunity to learn from them.

Chapter 2 - A Characterization of Injuries Among Active Duty Personnel in the United States Army

Introduction

Physical activity is an important part of a healthy lifestyle. There are many benefits of physical activity, as those who engage in regular physical activity may be less likely to die prematurely and may have a reduced risk of developing cardiovascular disease, type 2 diabetes, obesity, anxiety, depression, and colon cancer; furthermore, having a high level of physical fitness may be protective against development of injuries (Kesaniemi, 2000; Cowan et al., 2003).

For active duty personnel in the military, physical training is an essential component of their job duties because many military positions "require a higher level of physical exertion and fitness than most civilian occupations" (Cowan et al., 2003, p. 197). Active duty personnel must achieve and preserve a high level of physical readiness so that they can be prepared to enter into combat at any time (Cowan et al., 2003; Reynolds et al, 2009). Physical training occurs in schools and units. Cowan and colleagues (2003) report that "training in schools is oriented toward rapidly increasing the physical strength and endurance of personnel, while training in units is oriented toward maintaining the level of fitness appropriate for the type of unit" (p. 197). Various units require different levels of physical fitness for personnel; combat arms units (e.g., infantry units) usually require a greater level of physical fitness than combat support units (Cowan et al., 2003).

Although physical activity has many benefits, injuries commonly result from the military's rigorous physical training regimen. Injuries are the greatest threat to military readiness and the health of active duty personnel, and injuries related to physical activities and training are the primary reason active duty personnel seek medical treatment (Bullock et al., 2010; Cowan et al., 2003; Jones et al., 2010). Every year, approximately 50% of active duty personnel military-wide sustain a musculoskeletal injury. About 25% of those sustain a second injury (Jones et al., 2010). Approximately 25% of men and 50% of women develop an injury during basic training (Bullock et al., 2010). Musculoskeletal injuries are the number one cause of disabilities in the military. In the Army, active duty personnel are three times as likely to experience a disability caused by a musculoskeletal injury than from a mental disorder, the second leading cause of disability. For every fatality related to unintentional injuries in the U.S. military, there are 33

injury hospitalizations and approximately 4,000 outpatient encounters (this includes emergency department and all other outpatient clinic encounters) (Jones et al, 2010). Injuries in the military result in two million sick call visits, 25 million limited duty days (LDD), high medical attrition rates, and tremendous health care costs (Jones & Hansen, 1996; Cowan et al., 2003; Reynolds et al., 2009). Musculoskeletal conditions have resulted in over $340 million in disability costs annually, comprising approximately one-third of all disability costs for the military (Jones et al., 1999, p. 9-9).

While some injuries may result from a single traumatic event, many musculoskeletal injuries are caused by repeated less-traumatic events (overuse injuries). Several training activities have been credited with causing the most injuries among active duty personnel. According to Major Timothy Cass, Chief of Physical Therapy at Fort Riley, Kansas, activities such as road marches with heavy ruck sacks and long distance running have contributed to many overuse injuries (personal communication, September 29, 2011). These activities often "involve overtraining, overexertion, repetitive movements and activities, forceful actions, vibratory forces, extreme joint positions, and prolonged static postures" (Hauret et al., 2010, p. S65). These actions may not only cause new injuries, but may worsen existing injuries or cause past injuries to return (Hauret et al., 2010). Training for all active duty personnel generally involves strength training exercises, running, and other repetitive aerobic exercises. Other types of training activities in which active duty personnel participate vary according to the type of unit. Infantry and combat artillery soldiers must carry heavy equipment for long distances, and those involved in construction engineering must repair heavy machinery which involves "pushing, pulling, and lifting" heavy equipment (Reynolds et al., 2009).

Injuries Defined

The Department of Defense (DoD) Military Injury Prevention Priorities Working Group (DMIPPWG) has defined injuries as "intentional or unintentional damage to the body resulting from acute or over exposure to thermal, mechanical, electrical, or chemical energy or from the absence of such essentials as heat or oxygen" and excludes "casualties as the direct result of hostile action sustained in combat" (Defense Safety Oversight Council [DSOC], 2006, p. 3). These injuries include acute injuries as well as certain chronic musculoskeletal conditions usually associated with training-related injuries in the military. They have been categorized

using the International Classification of Diseases (ICD-9-CM) codes 710-739 for musculoskeletal disorders and codes 800-999 for acute injuries (Hauret et al., 2010; Lopez, 2002).

Barell Injury Diagnosis Matrix

The Barell Injury Diagnosis Matrix is routinely used to classify injuries by type of injury and body region. This matrix includes acute injuries from ICD-9-CM codes 800 to 999, but does not include musculoskeletal disorders commonly associated with physical training (codes 710-739). To obtain an accurate assessment of injuries including musculoskeletal disorders, a modified Barell Matrix was developed and includes selected codes from ICD-9-CM codes 710-739. Injuries are grouped by type of injury (columns) and by body region (rows) (Hauret et al., 2010; Jones et al., 2010). Appendix A presents the Barell Injury Diagnosis Matrix. This matrix was obtained from the Centers for Disease Control and Prevention website (www.cdc.gov). The modified Barell Matrix is located in Appendix B and was adapted from Hauret et al. (2010).

Injuries Among Active Duty Personnel, Department of Defense

According to Jones and colleagues (2010), injuries were the primary reason U.S. active duty personnel sought medical attention in 2006; injuries affected one million active duty personnel and resulted in more than 1.95 million medical encounters (clinic visits, emergency room visits, and hospitalizations). There were over 1,600 medical encounters per 1,000 person-years due to injuries; for the Army, the rate was approximately 2,200 medical encounters per 1,000 person-years and was the highest compared to each of the services of the DoD (Figure 2.1). When rates of injury hospitalizations are compared with the U.S. population, the findings are similar. In 2006, the rate of hospitalizations for only acute traumatic injuries was 584 per 100,000 among military personnel and was 676 among the U.S. population (Jones et al, 2010).

Hauret and colleagues (2010) reported that in 2006, there were 743,547 musculoskeletal injuries among non-deployed, active duty personnel across all services of the DoD. The rate of musculoskeletal injuries was 628 per 1,000 person-years. The most common injuries in the military are overuse injuries, and most often affect the lower extremities and the lumbar region of the back (Amoroso & Canham, 1999; Cowan et al., 2003). Eighty-two percent of all injuries were due to inflammation and pain (overuse injuries). Vertebral column (40%) and lower extremity (39%) injuries made up most of the musculoskeletal injuries; 14% of the injuries were

located in the upper extremities. Jones and colleagues (2010) reported that the rate of medical encounters for lower-extremity overuse injuries was 900 per 1,000 person-years; the Army had the highest rates of lower-extremity musculoskeletal injuries at 1,200 per 1,000 person-years, and the Navy had the lowest rates at approximately 1,100 per 1,000 person-years (Figure 2.2).

Risk Factors Associated with Musculoskeletal Injuries

Researchers have identified several risk factors associated with musculoskeletal injuries among active duty personnel. These factors are either intrinsic (an individual characteristic) or extrinsic (an outside factor influencing an individual). Intrinsic risk factors include: age (oldest and youngest personnel), female gender, anatomy (leg and foot structure and stature), lower level of fitness, higher body mass index (BMI), and smoking cigarettes (Cowan et al., 2003; Armed Forces Health Surveillance Center, 2009; & Itskoviz et al., 2011). Extrinsic risk factors include: time spent in physical training, type and intensity of training, shoe type, training surface (Cowan et al., 2003), and season (summer) (Knapik et al., 2001; Jones et al., 2008).

Prevention

Over the past decade, military leaders have taken several steps to reduce the number of injuries among active duty personnel and to prevent injuries from occurring. In 2003, in response to high number of injuries, Secretary of Defense Donald Rumsfeld issued a directive to military leaders to reduce the number of injuries among active duty personnel by 50%. At that time, the Defense Safety Oversight Council (DSOC) was formed to oversee injury prevention efforts (Bullock et al., 2010; DSOC, 2006). Several task forces were established under the DSOC, including the Military Training Task Force (MTTF), which created the DoD Military Injury Prevention Priorities Working Group (DMIPPWG) in 2004. This working group was formed to "evaluate military physical training injury prevention programs, policies, and research for recommendations to reduce physical training-related injuries during and after initial military training within the four U.S. military services" (Bullock et al., 2010, p. S157). They used a methodological approach to assessing the problem of injuries in the U.S. military and evaluating injury prevention programs. Their assessment was based on the public health approach and involved five steps: determining the magnitude of the problem, defining the causes of injuries, evaluating current prevention interventions, implementing programs and policies focused on injury prevention, and monitoring the effectiveness of new interventions (DSOC, 2006).

Based on their research, this working group made five recommendations for strategies to prevent the incidence of injuries throughout the military. These recommendations are as follows:

1. Prevent overtraining;
2. Perform more exercises that develop body movement skills during physical training;
3. Wear mouthguards during high-risk activities;
4. Wear semi-rigid ankle braces during high-risk activities; and
5. Consume nutritional supplements to restore energy balance within one hour after performing high-intensity activity.

The DMIPPWG found that excessive distance running is a primary contributor to overtraining, which results in more injuries, decreased physical performance, loss of motivation among personnel, exhaustion, and high attrition. They recommend decreasing the number of long distance runs and performing shorter distance runs of higher intensity (e.g., interval training) and also conducting "lower intensity, task-specific, dynamic activities to warm-up prior to more intense physical training" (DSOC, 2006, p. I-3). Incorporating more time in training for developing skills in "agility, posture, stability, flexibility, balance, speed, power, reactive ability, and coordination" (DSOC, p. I-4) was recommended by the working group. They determined that personnel who spent more time on these activities spent less time running long distances, therefore were at decreased risk of lower extremity overuse injuries. They also found that exercises of this nature were representative of movements that are commonly performed in combat. The working group recommended the use of mouthguards during high-risk activities based on evidence that this reduces the number of injuries to the face and mouth. Activities associated with injuries of this nature include combatives, obstacle courses, rifle and bayonet training, and many sports activities. They also recommended that personnel who had incurred previous ankle injuries, as well as other personnel, should wear ankle braces during high-risk activities such as parachute operations, obstacle courses and sports, based on evidence that this will help to prevent re-injury. Personnel should consume protein and carbohydrate supplements as well as electrolyte drinks within one hour after long and strenuous physical activities such as running, road marches, and hiking to reduce the risk of hot weather injuries (e.g., dehydration) and muscle injuries (DSOC, 2006).

The DMIPPWG also stressed the need for military leadership at all levels to be educated about injury prevention and to enforce injury prevention policies and programs. "Education is

the first step in disseminating evidence-based interventions that can be implemented at the unit level and is the first component of any successful program that reduces injuries" (DSOC, p. I-7). If military leadership at all levels is educated about the causes of injuries and interventions that reduce the incidence of injuries, and if they support and enforce policies and programs to reduce injuries, then there is greater likelihood that the incidence of injuries among personnel will decrease (DSOC, 2006).

Figure 2.1 Injury medical encounter rates, active duty DoD and Services, 2006

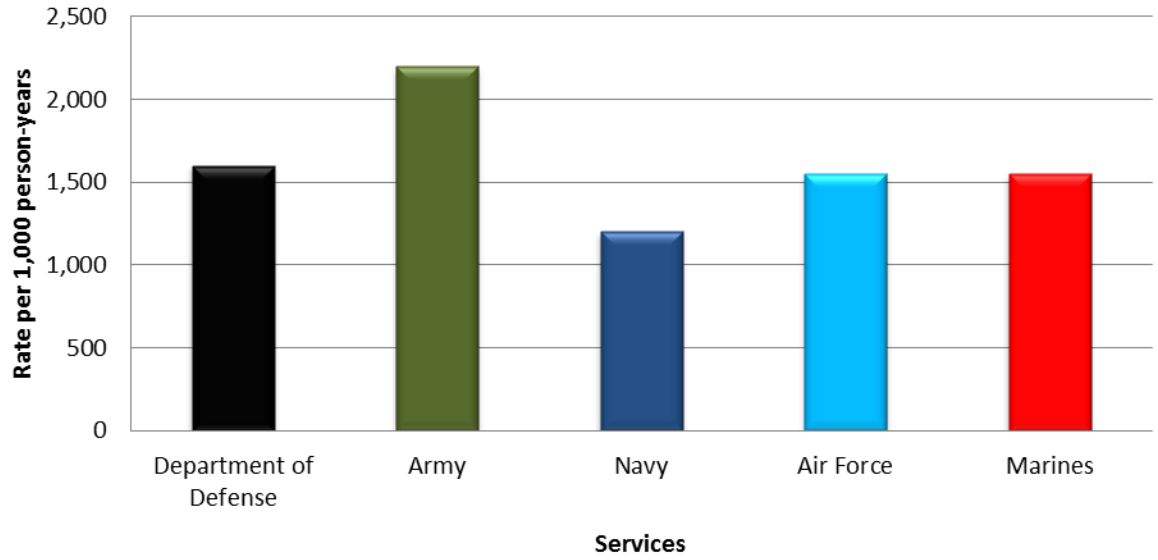


Chart adapted from Jones, et al. (2010). Medical surveillance of injuries in the U.S. Military: Descriptive epidemiology and recommendations for improvement. *American Journal of Preventive Medicine, 38*(1S): S42-S60.

Figure 2.2 Lower extremity overuse injury medical encounter rates, active duty DoD and Services, 2006

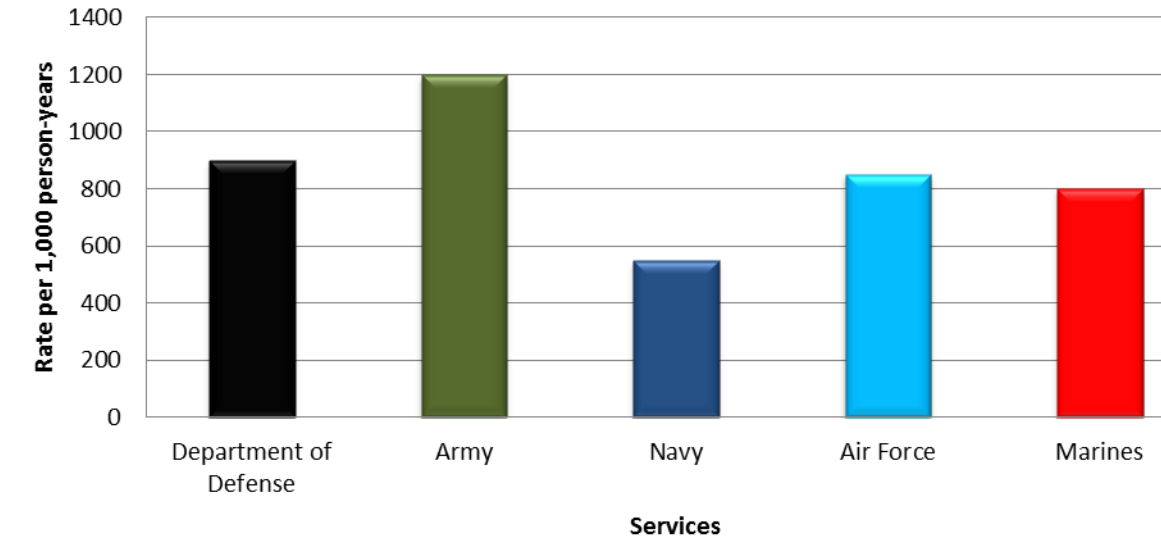


Chart adapted from Jones, et al. (2010). Medical surveillance of injuries in the U.S. Military: Descriptive epidemiology and recommendations for improvement. *American Journal of Preventive Medicine, 38*(1S): S42-S60.

Chapter 3 - A Characterization of Injuries Among Active Duty Personnel at Fort Riley, Kansas

Purpose

Surveillance is the first step in identifying the most common and most serious health issues in a population (DSOC, 2006; Jones et al., 2010). Surveillance of injuries among active duty personnel at Fort Riley has not previously been done. Therefore, the purpose of this research was to determine the incidence of injuries (specifically musculoskeletal injuries) among active duty personnel at Fort Riley, Kansas, over the course of 18 months.

Objectives

The objectives for the research project are:

1. Determine the incidence of injuries among active duty personnel at Fort Riley, Kansas, over an 18 month period.
2. Determine the most common injuries among active duty personnel at Fort Riley, Kansas, over an 18 month period.
3. Make recommendations for interventions based on study results.

Methods

The population for this study consisted of non-deployed active duty Army personnel at Fort Riley, Kansas (average monthly population of 12,299 personnel), from April 2010 to September 2011. This study was reviewed and approved by the Kansas State University IRB and found to be exempt from further IRB review. Data on injuries were obtained through the use of routine public health surveillance by searching existing medical records (outpatient and hospital) from Irwin Army Community Hospital at Fort Riley. A request was made to the medical records department for data covering the previously mentioned 18 month period. Requested data included medical encounters for ICD-9-CM codes 710 to 739 (musculoskeletal disorders) and 800-999 (injuries and poisonings), as well as demographic data (race, gender, age), and disposition after diagnosis (e.g. returned to work with no limitations, limited duty, hospitalized, etc.). Medical encounters included office visits, emergency room visits, and

hospitalizations. Unit information and body mass index (BMI) were obtained from the Office of the Assistant Chief of Staff, G1.

Because some injuries resulted in multiple medical encounters, if an individual had an encounter for the same diagnosis more than once during 60 days, the injury was counted only once. Frequencies, percentages, and rates were calculated to determine the most common injuries. The Barell Injury Diagnosis Matrix and the modified Barell Matrix for musculoskeletal disorders were used to determine injury frequencies.

Results

A total of 12,940 active duty personnel at Fort Riley sustained an injury between April 2010 and September 2011[1]. Descriptive characteristics of these personnel are presented in Table 3.1. Of those personnel who had injury diagnoses, 86.7% were male. The average age was 28.07 years (SD 7.2 years); ages ranged from 17 to 63 years.

During this time period, there were a total of 35,128 injury diagnoses occurring at a rate of 1,904 per 1,000 person-years. These injuries resulted in 62,318 medical encounters; the rate of medical encounters was 3,378 per 1,000 person-years. Figure 3.1 shows injury categories and the total number of injury diagnoses in each category. Approximately seventy percent (24,846) of injuries were musculoskeletal disorders (ICD-9-CM codes 710-739) and occurred at a rate of 1,347 per 1,000 person-years.

Table 3.2 presents the top five general types of injury diagnoses for all active duty personnel. Overuse injuries were the most common type of musculoskeletal disorder (15,289 diagnoses; 828 per 1,000 person-years). Sprains and strains, joint derangements, fractures, and open wounds followed overuse injuries as the leading causes of injury diagnoses. The top five specific injury diagnoses are shown in Table 3.3. Low back pain was the most common injury (4,082 diagnoses; per 1,000 person-years), followed by lower extremity joint pain, shoulder joint pain, pain in limb (location not specified), and pain in feet and ankle joints. Females had a higher observed rate of low back pain diagnoses (283 per 1,000 person-years) than males did

[1] The average monthly population at Fort Riley during this time period was 12,299. The number of injured personnel (N = 12,940) exceeds the total population because personnel continuously move in and out of Fort Riley. Therefore, the actual number of non-deployed service members at Fort Riley during the 18 month period exceeds 12,299; however, this was the average monthly population.

(214 per 1,000 person-years) (Table 3.4). The top five injury diagnoses for women also included pelvic and thigh pain (118 per 1,000 person-years) and neck pain (100 per 1,000 person-years).

Table 3.5 shows overall injury rates for each of the brigades. The Combat Aviation Brigade (CAB) had the highest overall injury incidence rate at 1,852 per 1,000 person-years, followed by the 4th Brigade at 1,595 per 1,000 person-years. The 1st Brigade, 2nd Brigade, and support units had just over 1,200 injuries per 1,000 person-years. Injury-related medical encounters for each of the brigades are presented in Table 3.6. The CAB and the 4th Brigade had the highest rate of medical encounters (3,301 and 2,808 per 1,000 person-years, respectively).

Seventy-one percent (24,989) of injuries resulted in active duty personnel being released without limitations in work duty (Figure 3.2). Twenty-two percent (7,755) of injuries resulted in work duty limitations. There were 105 hospital admissions related to injuries during the specified time period. Table 3.7 shows disposition for the top five injury diagnoses. Seventy percent resulted in no limited duty and 24% resulted in work duty limitations. There was only one hospital admission as a result of the top five injury diagnoses (due to pain in limb, location not specified).

Discussion

The most common injuries among active duty personnel at Fort Riley between April 2010 and September 2011 were overuse injuries, primarily in the lower back and lower extremities. These findings are consistent with reports from Major Timothy Cass, Chief of Physical Therapy at Fort Riley, who cited low back pain and anterior knee pain as the two most common injuries that he observes among active duty personnel at this Army installation (personal communication, September 29, 2011). These results are also similar to research findings that were presented in Chapter 2 (Amoroso & Canham, 1999; Cowan et al., 2003; Jones et al., 2010). However, rates of injury were higher at Fort Riley than those that have been reported for the military as a whole. The reason for this may be that Fort Riley is an infantry post. Training for infantry personnel involves a great amount of weight-bearing activities, such as carrying heavy equipment for long distances and participating in running and strength training exercises; these activities tend to put strain on the back and lower extremities (Reynolds et al., 2009).

Females had higher rates of injuries than males, which is consistent with previous research (Jones et al., 1999; Cowan et al., 2003). Women may be at more risk for developing injuries because they are typically less physically fit upon entering the military and because of anatomical differences that predispose them to injuries (Jones et al., 1999; Cowan et al., 2003). When women and men engage in the same training program, women may be more likely to be medically discharged from the military due to injuries (Bergman & Miller, 2001).

The CAB and the 4th Brigade had the highest injury and medical encounter rates. The reason for this is not clear. However, interventions have recently been put in place to decrease the incidence of injuries within the 4th Brigade. A program called the "Building a Soldier Athlete Initiative" has recently begun in which the leadership has developed a partnership with the Kansas State University athletic training program. The purpose of the program is to increase knowledge of proper training methods and to increase the capability of active duty personnel in the 4th Brigade to maintain a high level of physical fitness while reducing the number of musculoskeletal injuries. Senior level athletic training students will be responsible for developing training programs for personnel with temporary profiles[2], and junior level students will assist with patient education in the early stages of injuries. Training in this program focuses on activities that are representative of movements commonly performed in combat. Another recent intervention within the 4th Brigade has been to attach a physical therapist to the brigade prior to deployment who trains with the personnel, and then deploys with them. The advantage of this is that a physical therapist is able to work more closely with the personnel in the brigade and is able to assess their individual needs prior to deployment. The physical therapist can then better assist the personnel with injury prevention and rehabilitation in the deployed setting (Captain Brian Stoltenberg, personal communication, October 27, 2011).

Most injuries resulted in personnel being released without work duty limitations. However, it can be assumed that even without a physician's order for work duty limitations, pain and other injuries can still limit a person's ability to adequately carry out his or her job duties. These numbers may not give an adequate representation of the cost to Fort Riley in terms of actual limited duty.

[2] A temporary profile involves limitations in training and duty responsibilities after an illness or surgery while the person is recovering (United States, 2011).

Limitations

This study may have been limited on the basis of migration bias. Active duty personnel frequently move from one duty station to another. For part of the specified time period, the CAB and 2nd Brigade were deployed to either Operation New Dawn in Iraq or Operation Enduring Freedom in Afghanistan. Only injuries occurring among those who were at Fort Riley during the specified time period were counted; for this reason, injuries among those who moved to another duty station or who were deployed were not accounted for while they were away from Fort Riley.

Even though the sample size was very large, unit information and BMI data were not readily available for approximately 30% of injured personnel. This may have had an impact on the frequencies and rates calculated for each of the brigades. Also, information about causes of injuries was not available for nearly all injury diagnoses; this information would be useful in future research to specifically target causes of the most problematic injuries.

Smoking cigarettes has been shown to be a risk factor for increased injury incidence (Jones et al., 1999). This information was not readily available, but would be useful in future research to ascertain a relationship between smoking status and injuries at Fort Riley.

Conclusion and Recommendations

Routine surveillance of injuries should be conducted to determine priorities for injury prevention. The policies and programs that are in place at Fort Riley should be based on the findings of such surveillance and evaluated for effectiveness. Major Cass reported that courses on injury prevention are offered at the company level and that physical therapists with each brigade educate leaders on all levels about how to modify physical training and other military training to reduce injuries (personal communication, September 29, 2011). Leadership must be educated about injury prevention strategies and they must be held accountable in enforcing policies that are put into place regarding injury prevention and treatment.

Future research should investigate reasons for higher incidence rates among 4th Brigade and CAB personnel. This research should involve evaluation of each of the brigade's training programs and look more closely at risk factors among the personnel. Training programs for males and females should also be investigated further. Because women are generally more

susceptible to developing training-related injuries than men when they train together, consideration should be given to the specific training needs of this population.

The problem of injuries in the military, particularly those related to physical training, is a complex one. Physical training is essential to the duties that military personnel must perform; however, training-related injuries are the largest threat to military readiness and the health of active duty personnel, and they are costly to the military. Through continued research, education, and proper prevention interventions, the goal of the military is to significantly reduce the number of injuries among active duty personnel. Fort Riley currently has interventions in place to educate leaders and prevent injuries. Evaluation of newer programs will provide evidence of the effectiveness of these programs. With cooperation among active duty personnel, healthcare providers, and military leadership, Fort Riley has the potential to significantly reduce injuries, thereby preparing its active duty force to adequately face combat at any time.

Table 3.1. Descriptive characteristics of injured Army active duty personnel at Fort Riley, Kansas, April 2010 to September 2011

Characteristic	Value	SD	Characteristic	# of people	%
Age (years)			**Race**		
Mean	28.07	7.2	White	2,933	22.7
Mode	21		Black	704	5.4
Range	17-63		Asian/Pacific Islander	55	0.4
			Native American	26	0.2
Age Groups	**# of people**	**%**	Other	975	7.5
17 to 22	3,293	25.4	Unknown	1,231	54.2
23 to 25	2,732	21.1	Not available	7,016	54.2
26 to 29	2,483	19.2			
30 to 35	2,201	17.0	**Body Mass Index**		
36 to 63	2,231	17.2	Below 18.5	548	4.2
			18.5 to 24.9	3,851	29.8
Gender			25.0 to 29.9	3,049	23.6
Male	11,215	86.7	30.0 and higher	1,247	9.6
Female	1,725	13.3	Not available	4,245	32.8

Table 3.2 Top Five General Types of Injury, Active Duty Personnel, Fort Riley, KS, April 2010 to September 2011

Injury Rank	Diagnosis	Number of injuries	Percent of all injury diagnoses	Incidence rate per 1,000 person-years
1	Overuse (Inflammation and Pain)	15,289	43.5	828
2	Sprains and strains	3,769	10.7	204
3	Joint Derangements	908	2.6	49
4	Fractures	785	2.2	43
5	Open Wounds	694	2.0	38
Total		21,445	61.0	1,162

Table 3.3 Top five injury diagnoses, active duty personnel, Fort Riley, KS, April 2010 to September 2011

Injury Rank	Diagnosis	Number of injuries	Percent of all injury diagnoses	Incidence rate per 1,000 person-years
1	Low back pain	4,082	11.6	221.3
2	Pain in joint, lower leg	3,445	9.8	186.7
3	Pain in joint, shoulder region	1,575	4.5	85.4
4	Pain in limb, not specified	1,486	4.2	80.5
5	Pain in joint, ankle and foot	1,133	3.2	61.4
Total		11,721	33.4	635.3

Table 3.4 Top five injury diagnoses by gender, active duty personnel, Fort Riley, KS, April 2010 to September 2011

Rank	Male			Female		
	Injury	**Number of injuries**	**Rate per 1,000 person-years**	**Injury**	**Number of injuries**	**Rate per 1,000 person-years**
1	Low back pain	3,497	213.5	Low back pain	585	283.2
2	Pain in joint, lower leg	2,995	182.8	Pain in joint, lower leg	450	217.9
3	Pain in joint, shoulder region	1,403	85.6	Pain in joint, pelvic region and thigh	244	118.1
4	Pain in limb, not specified	1,255	76.6	Pain in limb, not specified	231	111.8
5	Pain in joint, ankle and foot	956	58.4	Neck pain	206	99.7
Total		10,106	616.9		1,716	830.8
	Percent of injuries among males	33.8%		Percent of injuries among females	32.9%	

Table 3.5 Injuries among active duty personnel by brigade, Fort Riley, KS, April 2010 to September 2011 (Total injuries = 35,128)

Unit	Number of injuries	Percent	Incidence rates (per 1,000 person-years)
1st Brigade	4,942	14.1	1,259
2nd Brigade	3,541	10.1	1,254
4th Brigade	6,229	17.7	1,595
CAB	3,776	10.7	1,852
Support Units	7,085	20.2	1,231
No Unit Designated	9,555	27.2	--
Fort Riley	35,128	100	1,904

Table 3.6 Injury-related medical encounters among active duty personnel by brigade, Fort Riley, KS, April 2010 to September 2011 (Total medical encounters = 62,318)

Unit and population	Number of injuries	Percent	Incidence rates (per 1,000 person-years)
1st Brigade	8,187	13.1	2,085
2nd Brigade	6,110	9.8	2,163
4th Brigade	10,965	17.6	2,808
CAB	6,730	10.8	3,301
Support Units	14,160	22.7	2,461
No Unit Designated	16,166	26	--
Fort Riley	62,318	100	3,378

Table 3.7 Top five injury diagnoses and disposition, active duty personnel, Fort Riley, KS, April 2010 to September 2011

Injury Rank	Diagnosis	Number of injuries	Disposition					
			Released without limitations	Released with limitations	Sick at home/ quarters	Admitted to hospital	Other	Disposition not indicated
1	Low back pain	4,082	3,041 (74.5%)	689 (16.9%)	74 (1.8%)	0 (0.0%)	10	268
2	Pain in joint, lower leg	3,445	2,212 (64.2%)	1,076 (31.2%)	22 (0.6%)	0 (0.0%)	4	131
3	Pain in joint, shoulder region	1,575	1,125 (71.4%)	365 (23.2%)	4 (0.3%)	0 (0.0%)	6	75
4	Pain in limb, not specified	1,486	1,018 (68.5%)	393 (26.4%)	11 (0.7%)	1 (0.07%)	6	57
5	Pain in joint, ankle and foot	1,133	752 (66.4%)	313 (27.6%)	9 (0.8%)	0 (0.0%)	4	55
Total		11,721	8,148 (69.5%)	2,836 (24.2%)	120 (1.0%)	1 (0.009%)	30	586

Figure 3.1 Number of injuries by category, active duty personnel, Fort Riley, KS, April 2010 to September 2011 (Total injuries = 35,128)

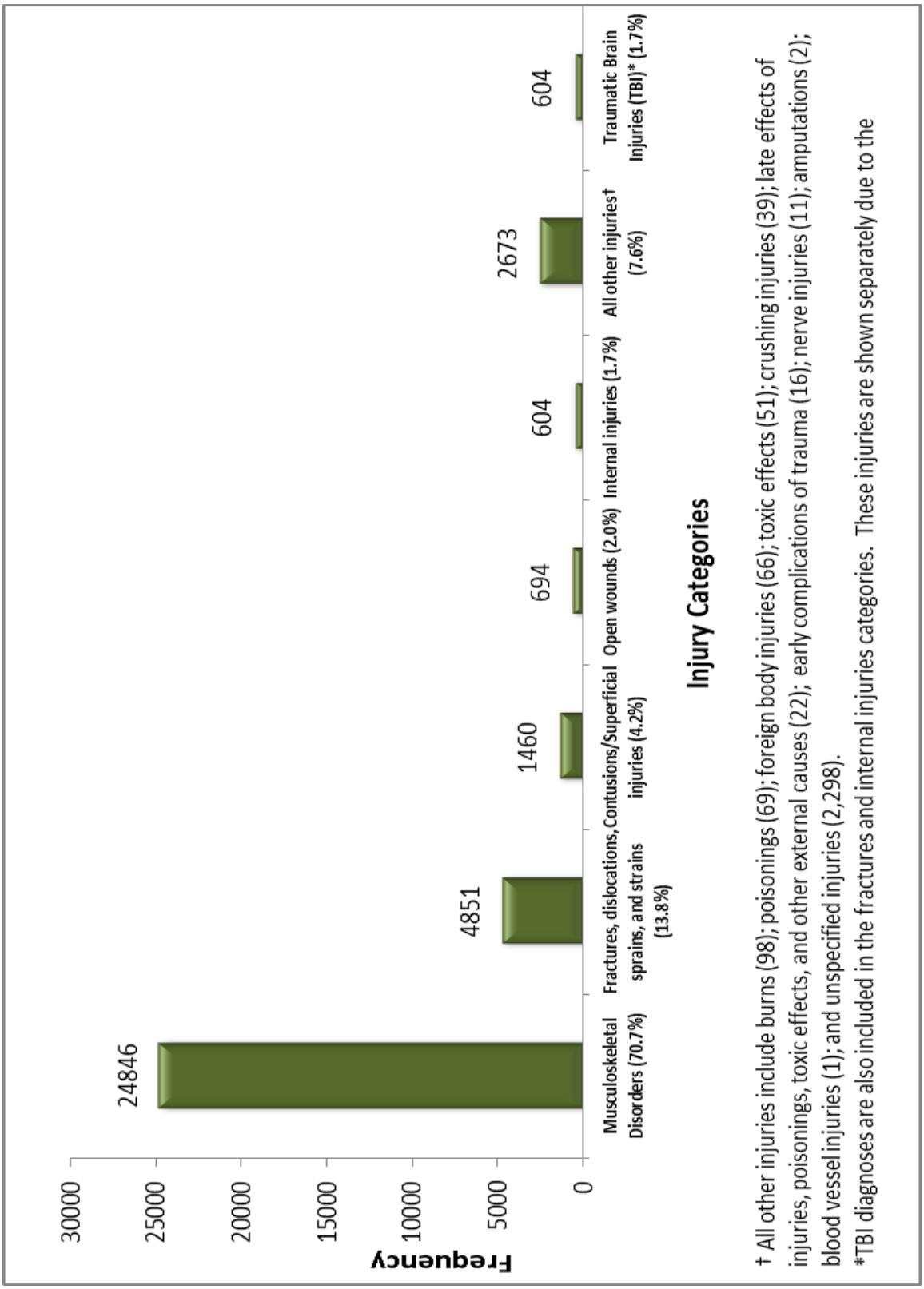
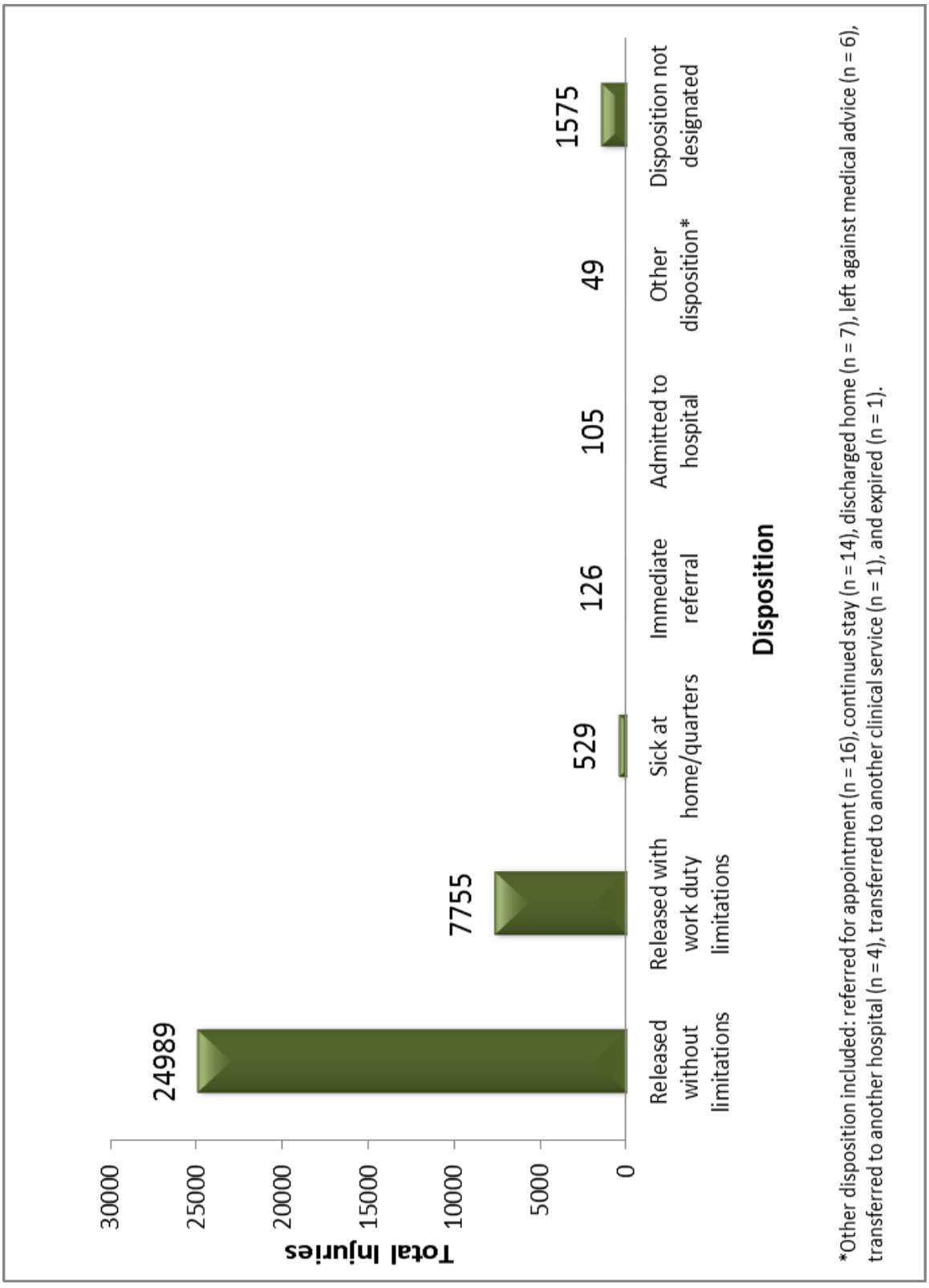


Figure 3.2 Injury disposition, active duty personnel, Fort Riley, KS, April 2010 to September 2011 (Total injuries = 35,128)



References

1st Infantry Division. (2009). Fort Riley Veterinary Services mission statement. Retrieved from http://www.1id.army.mil/UnitPage.aspx?unit=vet&nav=NewArrivals

1st Infantry Division. (2012). The history of the 1st Infantry Division. Retrieved March 21, 2012, from http://www.1id.army.mil/bigredone/history.aspx

Amoroso, P. J. & Canham, M. L. (1999). Disabilities related to the musculoskeletal system: Physical Evaluation Board data. In Jones, B. H. (Ed.), *Atlas of injuries in the U.S. armed forces* (pp. 4-1 to 4-73). Supplement to *Military Medicine, 164* (8).

Armed Forces Health Surveillance Center (AFHSC). (2009). Diagnoses of Overweight/Obesity AC, U.S. Armed Forces, 1998–2008. *Medical Surveillance Monthly Report (MSMR),*16: 2-6.

Bergman, B. P., & Miller, A. S. J. (2001). Equal opportunities, equal risks? Overuse injuries in female military recruits. *Journal of Public Health Medicine (23)*1: 35-39.

Bullock, S. H., Jones, B. H., Gilchrist, J., & Marshall, S. W. (2010). Prevention of physical training-related injuries: Recommendations for the military and other active populations based on expedited systematic reviews. *American Journal of Preventive Medicine, (38)*1S: S156-181.

Cowan, D. N., Jones, B. H., & Shaffer, R. A. (2003). Musculoskeletal injuries in the military training environment. In D. E. Lounsbury (Ed.), *Military preventive medicine: Mobilization and deployment* (pp.195-210). Office of the Surgeon General, Department of the Army.

Defense Safety Oversight Council. (2006). DoD Military Injury Prevention Priorities Working Group white paper: Leading injuries, causes and mitigation recommendations. Retrieved September 18, 2011, from http://www.nmcphc.med.navy.mil/

Hauret, K. G., Jones, B. H., Bullock, S. H., Canham-Chervak, M., & Canada, S. (2010). Musculoskeletal injuries: Description of an under-recognized injury problem among military personnel. *American Journal of Preventive Medicine, 38*(1S): S61-S70.

Irwin Army Community Hospital. (n.d.). Iriwn history. Retrieved March 21, 2012, from iach.amedd.army.mil/history.asp

Itskoviz, D., Maronm, T., & Ostfeld, I. (2011). Trends of stress fracture prevalence among Israel Defense Forces basic trainees. *Military Medicine, 176*(1): 56-59.

Jones, B. H. & Hansen, B. C. (1996). Injuries in the military: A hidden epidemic. A report for the Armed Forces Epidemiological Board. Retrieved September 18, 2011, from http://dodreports.com/

Jones, B. H., Amoroso, P. J., Canham, M. L., Weyandt, M. B., & Schmitt, J., B. (1999). *Atlas of injuries in the U.S. Armed Forces.* Supplement to *Military Medicine, 164*(8).

Jones, B. H., Canham-Chervak, M., Canada, S., Mitchener, T. A., & Moore, S. (2010). Medical surveillance of injuries in the U.S. Military: Descriptive epidemiology and recommendations for improvement. *American Journal of Preventive Medicine, 38*(1S): S42-S60.

Jones, S. B., Knapik, J. J., & Jones, B. H. (2008). Seasonal variations in injury rates in U.S. Army ordnance training. *Military Medicine, 173*(4): 362-368.

Kesaniemi, Y. A., Danforth, E., Jensen, M. D., Kopelman, P. G., Lefebvre, P., & Reeder, A. (2001). Dose-response issues concerning physical activity and health: An evidence-based symposium. *Medicine & Science in Sports and Exercise, 33*(6): S351-S358.

Knapik, J. J., Canham-Chervak, M., Hauret, K., Laurin, M. J., Hoedebecke, E., Craig, S., et al. (2001). Seasonal variations in injury rates during US Army Basic Combat Training. *Annals of Occupation Hygiene, 46*(1): 15-23.

Lopez, M. DoD Military Injury Metrics Working Group white paper. U.S. Department of Defense, Washington, D.C., 2002. Retrieved September 18, 2011, from http://www.denix.osd.mil/ergoworkinggroup/metrics.cfm

Reynolds, K., Cosio-Lima, L., Bovill, M., Tharion, W., Williams, J., & Hodges, T. (2009). A comparison of injuries, limited-duty days, and injury risk factors in infantry, artillery, construction engineers, and special forces soldiers. *Military Medicine, 174*(7): 702-708.

Riley County Historical Museum. (n.d.). History of Riley County. Retrieved March 21, 2012, from http://www.rileycountyks.gov/

United States Army Public Health Command. (n.d.). Organization. Retrieved March 21, 2012, from phc.amedd.army.mil/organization/Pages/default.aspx

United States. Department of the Army. (2011). Army regulation 40-501: Medical Services standards of medical fitness. Retrieved April 2, 2012, from http://www.apd.army.mil/pdffiles/r40_501.pdf

Appendix A - Barell Injury Diagnosis Matrix

(http://cdc.gov/nchs/injury/ice/barell_matrix.htm)

The Barell Injury Diagnosis Matrix, Classification by Body Region and Nature of the Injury

based on **5** digit icd-9 CM codes

Body region	Sub-region	No.	Site	ICD-9-CM codes	A FRACTURE 800-829	B DISLOCATION 830-839	C SPRAINS & STRAINS 840-848	D INTERNAL 850-854,860-869 952, 995.55	E OPEN WOUND 870-884, 890-894	F AMPUTATIONS 885-887, 895-897	G BLOOD VESSELS 900-904	H CONTUSION / SUPERFICIAL 910-924	I CRUSH 925-929	J BURNS 940-949	K NERVES 950-951 953-957	L UNSPECIFIED 959
Head and Neck	Traumatic Brain Injury	1	Type 1 TBI	800,801,803,804(.1-.4,.6-.9), (.03-.05,.53-.55) 850(.2-.4), 851-854, 950(.1-.3), 995.55	800,801,803,804(.1-.4,.6-.9) 800,801,803,804(.03-.05,.53-.55)	/	/	850(.2-.4) 851-854*, 995.55	/	/	/	/	/	/	950.1-.3	/
		2	Type 2 TBI	800,801,803,804(.00,.02,.06,.09) (.50,.52,.56,.59) , 850(.0,.1,.5,.9)	800,801,803,804(.00,.02,.06,.09), 800,801,803,804(.50,.52,.56,.59)			850(.0,.1,.5,.9)								
		3	Type 3 TBI	800,801,803,804(.01, .51)	800,801,803,804(.01,.51)	/	/	/	/	/	/	/	/	/	/	/
	Other head, face and neck	4	Other Head	873(.0-.1,.8-.9), 941.x6, 951, 959.01	/	/	/	/	873.0-.1,.8-.9	/	/	/	/	941.x6	951	959.01*
		5	Face	802, 830, 848.0-.1, 872, 873.2-.7, 941(.x1,.x3-.x5,.x7)	802	830	848.0-.1	/	872, 873.2-.7	/	/	/	/	941.x1,.x3-.x5,.x7	/	/
		6	Eye	870-871, 918, 921, 940, 941.x2, 950(.0,.9)	/	/	/	/	870-871	/	/	918, 921	/	940, 941.x2	950(.0,.9)	/
		7	Neck	807.5-.6, 848.2, 874, 925.2, 941.x8, 953.0, 954.0	807.5-.6	/	848.2	/	874	/	/	/	925.2	941.x8	953.0, 954.0	/
		8	Head, Face and Neck Unspecified	900, 910, 920, 925.1, 941.x0, .x9, 947.0, 957.0, 959.09	/	/	/	/	/	/	900	910, 920	925.1	941.x0,.x9, 947.0	957.0	959.09
spine and back	Spinal Cord (SCI)	9	Cervical SCI	806(.0-.1), 952.0	806.0-.1	/	/	952.0	/	/	/	/	/	/	/	/
		10	Thoracic/Dorsal SCI	806(.2-.3), 952.1	806.2-.3	/	/	952.1	/	/	/	/	/	/	/	/
		11	Lumbar SCI	806(.4-.5), 952.2	806.4-.5	/	/	952.2	/	/	/	/	/	/	/	/
		12	Sacrum Coccyx SCI	806(.6-.7), 952(.3-.4)	806.6-.7	/	/	952.3-.4	/	/	/	/	/	/	/	/
		13	Spine+ Back unspecified SCI	806(.8-.9), 952(.8-.9)	806.8-.9	/	/	952.8-.9	/	/	/	/	/	/	/	/
	Vertebral Column (VCI)	14	Cervical VCI	805(.0-.1), 839(.0-.1), 847.0	805.0-.1	839.0-.1	847.0	/	/	/	/	/	/	/	/	/
		15	Thoracic /Dorsal VCI	805(.2-.3), 839(.21,.31), 847.1	805.2-.3	839.21,.31	847.1	/	/	/	/	/	/	/	/	/
		16	Lumbar VCI	805(.4-.5), 839(.20,.30), 847.2	805.4-.5	839.20,.30	847.2	/	/	/	/	/	/	/	/	/
		17	Sacrum Coccyx VCI	805(.6-.7), 839(.41-.42), 839(.51-.52), 847.3-.4	805.6-.7	839(.41-.42, .51-.52)	847.3-.4	/	/	/	/	/	/	/	/	/
		18	Spine+ Back unspecified VCI	805(.8-.9), 839(.40,.49), 839(.50,.59)	805.8-.9	839(.40,.49,.50,.59)	/	/	/	/	/	/	/	/	/	/
Torso	Torso	19	Chest (Thorax)	807(.0-.4), 839(.61,.71), 848(.3-.4), 860-862, 875, 879(.0-.1), 901, 922(.0-.1,.33), 926.19, 942.x1-.x2 953.1	807.0-.4	839.61,.71	848.3-.4	860-862	875, 879.0-.1	/	901	922(.0,.1,.33)	926.19	942.x1-x2	953.1	/
		20	Abdomen	863-866, 868, 879(.2-.5), 902(.0-.4), 922.2,942.x3, 947.3, 953(.2,.5)	/	/	/	863-866, 868	879.2-.5	/	902.0-.4	922.2	/	942.x3, 947.3	953.2, 953.5	/
		21	Pelvis & Urogenital	808, 839(.69,.79), 846, 848.5, 867,877-878 902(.5,.81-.82), 922.4, 926(.0,.12), 942.x5,947.4, 953.3	808	839.69,.79	846, 848.5	867	877-878	/	902(.5, .81-.82)	922.4	926(.0, .12)	942.x5, 947.4	953.3	/
		22	Trunk	809, 879(.6-.7), 911, 922(.8-.9), 926(.8-.9), 942(.x0,.x9), 954(.1,.8-.9), 959.1	809	/	/	/	879.6-.7	/	/	911, 922.8-.9	926.8-.9	942.x0, 942.x9	954.1, .8-.9	959.1
		23	Back and Buttock	847.9, 876, 922(.31-.32), 926.11, 942.x4	/	/	847.9	/	876	/	/	922.31-.32	926.11	942.x4	/	/
Extremities	Upper	24	Shoulder & upper arm	810-812, 831, 840, 880, 887(.2-.3), 912,923.0, 927.0, 943(.x3-.x6) ,959.2	810-812	831	840	/	880	887.2-.3	/	912, 923.0	927.0	943.x3-.x6	/	959.2
		25	Forearm & elbow	813, 832, 841, 881(.x0-.x1), 887(.0-.1), 923.1, 927.1, 943(.x1-.x2)	813	832	841	/	881.x0-x1	887.0-.1	/	923.1	927.1	943.x1-x2	/	/
		26	Wrist, hand & fingers	814-817, 833-834, 842,881.x2, 882, 883, 885-886, 914-915, 923(.2-.3) ,927(.2-.3), 944 ,959(.4-.5)	814-817	833, 834	842 /	/ /	881.x2,882, 883	885-886	/ /	914-915, 923.2-.3	927.2-.3	944 /	/ /	959.4-.5
		27	Oher & unspecified	818, 884, 887(.4-.7), 903, 913, 923(.8-.9), 927(.8-.9), 943(.x0,.x9), 953.4, 955, 959.3	818	/	/	/	884	887.4-.7	903	913,923.8,.9	927.8-.9	943.x0,.x9	953.4, 955	959.3
	Lower	28	Hip	820, 835, 843, 924.01, 928.01	820	835	843	/	/	/	/	924.01	928.01	/	/	/
		29	Upper leg & thigh	821, 897(.2-.3), 924.00, 928.00, 945.x6	821			/	/	897.2-.3	/	924.00	928.00	945.x6	/	/
		30	Knee	822, 836, 844.0-.3, 924.11, 928.11, 945.x5	822	836	844.0-.3	/	/	/	/	924.11	928.11	945.x5	/	/
		31	Lower leg & ankle	823-824, 837, 845.0, 897(.0-.1), 924(.10,.21), 928(.10,.21), 945(.x3-.x4)	823-824	837	845.0	/		897.0-.1	/	924.10,.21	928.10,.21	945.x3-.x4	/	/
		32	Foot & toes	825-826, 838, 845.1, 892-893, 895-896, 917, 924(.3,.20), 928 (.3,.20), 945 (.x1-.x2)	825-826	838	845.1	/	892-893	895-896	/	917, 924.3,.20	928.3,.20	945.x1-.x2	/	/
		33	Other & unspecified	827,844(.8-.9), 890-891, 894, 897(.4-.7), 904(.0-.8), 916, 924(.4-.5), 928(.8-.9), 945(.x0,.x9), 959.6-.7	827	/	844.8,.9	/	890-891,894	897.4-.7	904.0-.8	916, 924.4-.5	928.8,.9	945.x0,.x9	/	959.6-.7
Unclassifiable by site	Other & unspecified	34	Other/ multiple	819, 828, 902(.87,.89), 947(.1-.2), 953.8, 956	819, 828	/	/	/	/	/	902.87,.89	/	/	947.1-.2	953.8, 956	/
		35	Unspecified site	829, 839(.8-.9), 848(.8-.9), 869, 879(.8,.9), 902.9, 904.9, 919, 924(.8,.9), 929, 946, 947(.8,.9), 948, 949, 953.9, 957(.1,.8,.9), 959(.8,.9)	829	839.8-.9	848.8-.9	869	879(.8-.9)	/	902.9, 904.9	919, 924.8,.9	929	946, 947.8,.9 948, 949	953.9, 957.1,.8,.9	959.8,.9
	System wide	36	System-wide & late effects	905-908, 909 (.0,.1,.2,.4,.9), 930-939,958, 960-994, 995.50-.54,.59, 995(.80-.85)	Foreign body (930-939), Early complications of trauma (958), Poisoning (960-979), Toxic Effects (980-989), Other and unspecified effects of external cause (990-994) Child and adult maltreatment (995.50-.54,.59, 995.80-.85) Late effects of injuries, poisonings, toxic effects and other external causes (905-909) excluding 909(.3, .5)											

Special diagnostic codes for trauma: Flail Chest (807.4) Pneumothorax (860)

For purposes of classification, head injuries are labeled as **Type 1 TBI** if there is recorded evidence of an intracranial injury or a moderate or a prolonged loss of consciousness (LOC), Shaken Infant Syndrome (SIS), or injuries to the optic nerve pathways.

Type 2 TBI includes injuries with no recorded evidence of intracranial injury, and LOC of less than one hour, or LOC of unknown duration, or unspecified level of consciousness. **Type 3 TBI** includes patients with no evidence of intracranial injury and no LOC.

* **Note from CDC:** 959.01 (added to ICD-9-CM in 1997) is not intended to be assigned to TBI cases; however, in the USA it has been assigned incorrectly to a substantial proportion of cases previously coded 854.

The Matrix is available on the net at www.cdc.gov/nchs/about/otheract/ice/barellmatrix.htm

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Appendix B - Modified Barell Injury Diagnosis Matrix for Musculoskeletal Disorders including assigned diagnosis codes (ICD-9-CM)

Body Region	Inflammation and pain (overuse)	Joint derangement	Joint derangement with neurological involvement	Stress fracture	Sprain/strain/ rupture	Dislocation
Vertebral column						
Cervical	723.1	722.0	722.71, 723.4	--	--	--
Thoracic/dorsal	--	722.11	722.72, 724.4	--	--	--
Lumbar	724.2	722.10	722.73, 724.3	--	--	--
Sacrum, coccyx	720.2	--	--	--	--	--
Spine, back unspecified	721.7, 724.5	722.2	722.70, 724.9	733.13	--	--
EXTREMITIES						
Upper						
Shoulder	716.11, 719 (.01, .11, .41), 726 (.01, .1, .2)	718 (.01, .11, .81, .91)	--	--	727 (.61, .62)	718.31
Upper arm, elbow	716.12, 719 (.02, .12, .42), 726.3	718 (.02, .12, .82, .92)	--	733.11	--	718.32
Forearm, wrist	716.13, 719 (.03, .13, .43), 726.4	718 (.03, .13, .83, .93)	--	733.12	--	71f8.33
Hand	716.14, 719 (.04, .14, .44)	718 (.04, 14, .84, .94)	--	--	727 (.63, .64)	718.34
Lower						
Pelvis, hip, thigh	716.15, 719 (.05, .15, .45), 726.5	718 (.05, .15, .85, .95)	--	733 (.14, .15, .96-.98)	727.65	718.35
Knee, lower leg	716.16, 717.7, 719 (.06, .16, .46), 726.6	717 (.06, .9), 718 (.06, .16, .86, .96)	--	733 (.16, .93)	717.8, 727 (.66-67)	718.36
Ankle, foot	716.17, 719 (07, .17, .47), 726.7, 728.71, 734	718 (.07, .17, 87, .97)	--	733.94	727.68	718.37
UNCLASSIFIED BY SITE						
Others and unspecified						
Other specified and multiple	716 (.18, .19), 719 (.08, .09, .18, .19, .48, .49) 726.8, 727.2	718 (.08, .09, .18, .19, .88, .98, .99)	--	733.19	727.69	718 (.38, .39)
Unspecified site	716.10, 719 (.00, .10, .40), 726.9, 727.3, 729.1	718 (.00, .10, .80, .90)	729.2	733 (.10, .95)	727.60, 728.83	718.30