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Functional Restoration for Chronic Pain Patients in the Military: Early Results of the San Antonio Military Medical Center Functional Restoration Program

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Musculoskeletal disorders are the leading cause of disability in the Army, accounting for 73% of the total disability cases between the years 1997 to 2002. Costs of disability are staggering, totaling $21 billion over all military services in 2001.[1] The rate of disability discharge for musculoskeletal disorders has increased dramatically over the last 2 decades and exceeds the rate for all other conditions combined.[1] Further, women in the Army are 67% more likely to receive a disability discharge for a chronic musculoskeletal disorder,[1] and this rate has increased as new, physically demanding military jobs have opened to women.[2] As the armed forces transition to a smaller force, retention of the most highly trained service members becomes increasingly important to overall force readiness. Preventing musculoskeletal injury, predicting risk factors for injury and disability, managing injuries when they occur, and rehabilitating individuals with musculoskeletal disorders are part of a systemic approach to reducing lost work days and disability, while optimizing a healthy force.[1,2]

Appropriate pain management is a critical component of decreasing disability and increasing return to duty for service members with chronic musculoskeletal disorders. In fact, Interdisciplinary Pain Management Centers were recently created in order to "relieve acute pain, minimize progression to chronic pain, maximize function, decrease disability, and optimize treatment…" of Soldiers and their families.[3] Functional restoration, an intensive interdisciplinary approach to pain management which involves physical strengthening and psychological conditioning, was envisioned to address one key task of the campaign plan, which is to "improve rehabilitation, reintegration, and recovery through improved pain management." The Functional Restoration Program (FRP) at San Antonio Military Medical Center (SAMMC) is described in this article and early results of the program are reported.

Background

Research shows that pain is a complex phenomenon that is best treated by the biopsychosocial model,[4] which considers physiological, psychological, and social aspects of the patient. Over the past 2 decades, it has become clear that biomedical approaches, such as opioid medications, injections, and surgery alone have not been effective in reducing chronic musculoskeletal pain for the long term. Mayer and Gatchel[5] first described functional restoration as an evidence-based pain management intervention lead by a physician and nurse that used psychological, physical, and occupational therapies in a biopsychosocial model. Treatment is delivered in an intensive format, generally consisting of 6 to 8 hours per day for 3 to 6 weeks in nationally-recognized programs such as the Mayo Clinic Rehabilitation Center (Rochester, MN), the Brooks Pain Rehabilitation Program, (Jacksonville, FL), the Rehabilitation Institute of Chicago Center for Pain Management (Chicago, IL), and the Cleveland Clinic Foundation.[4]

Research in civilian programs shows efficacy of functional restoration for a variety of outcomes. A review of 12 randomized comparisons (1,964 patients) found strong evidence for increased function for individuals with low back pain for more than 3 months following participation in the intensive multidisciplinary functional restoration programs when compared with inpatient or nonmultidisciplinary outpatient treatments.[6] Overall, strong evidence was found for improvement in function, moderate evidence for pain reduction, and mixed results reporting work-readiness. Less intensive programs did not report improvements in pain, function, or vocational

outcomes,[6] but studies have reported treatment efficacy and cost-effectiveness of interdisciplinary pain management programs.[7,8]

Functional restoration was applied to a military population in a study at Wilford Hall Medical Center (Lackland Air Force Base, Texas).[9] Outcomes measured were return to full duty; retention of at least 6 months; health care utilization for pain treatment; patient reported pain; and number of individuals on profile, disability, or separated from active duty. A total of 66 participants, matched for age, gender, race, and time since the onset of pain, were randomly assigned to a treatment comparison group (ie, participation in an anesthesia-based pain clinic) or functional restoration. Results over the 3-week program showed physical measures (including lifting floor to waist, lifting waist to ears, treadmill walking, metabolic equivalents, oxygen consumption, and lumbar flexion), as well as psychosocial measures improved in the functional restoration group compared to the treatment comparison group. No subject in either treatment arm was separated from the military secondary to pain at 6-month follow-up. However, service members in the comparison group had over 4 times as many medical appointments at the end of the one-year follow-up period than those in the functional restoration program.

Description of the SAMMC Functional Restoration Program

In March 2014, the Interdisciplinary Pain Management Center at SAMMC opened its Intensive Outpatient Functional Restoration Program. The program is located on the Brooke Army Medical Center campus, and has a dedicated gym space of approximately 2,500 sq ft. The program runs for 3 weeks, 5 days a week. The duty day starts at 7:45 AM and ends at 4 PM. Approximately 4 hours each day are spent participating in physical activity including strength training, flexibility training, functional conditioning, cardiovascular exercise, aquatic exercise, and introduction to new or modified forms of exercise. All exercise activities are geared to improve strength, body mechanics, flexibility, and endurance, as well as promote and support lifestyle changes to be continued postprogram. Currently the exercise programs are prescribed and instructed by physical therapists. Programs are designed for group participation but individualized to meet each participant's overall physical needs. The program day typically ends at the pool where program participants perform aquatic exercise and participate in confidence and team building activities. Each day includes a group session led by a pain psychologist; the programming also includes a lecture series on self-management topics such as goal setting, pain neuroscience, pain education, body mechanics, anatomy, nutrition, pain medications, and vocational resources.

The program emphasizes a self-care model that teaches participants how to manage their own pain instead of relying on primary care, emergency rooms, and specialists. Much time is spent explaining the nature of chronic pain, which does not represent new tissue damage, as distinct from acute pain, which appropriately warns of new injury. Participants are taught how to distinguish between the usual waxing and waning of their persistent pain, which should be self-managed, from new or different symptoms that should be evaluated by a medical professional. A key element in the success of this approach is it challenges the patients' fear of increased pain from physical activity by providing them with a direct experience of pushing their perceived physical limits in a safe setting. Patients typically experience initial increases in pain with increased activity levels, but begin to see functional abilities increase concurrently. At completion of the program most patients report at least a modest reduction in pain, with notable improvements in their physical function.

The program tracks changes in physical function and additional outcome measures which have been standardized for Interdisciplinary Pain Management Centers by the Office of The Surgeon Generals' Pain Management Work Group. Moreover, participants are evaluated on physical and psychosocial measures pre- and postprogram at 4-week, 4-month, and 12-month follow-ups.

Participant Examples

While there are not yet sufficient numbers for meaningful statistical analysis, the early anecdotal results have been positive, with most participants experiencing great improvements in function. A senior noncommissioned officer with 16 years of service described back pain over approximately 10 years, progressively worsening to limit activity, tolerance, and ability to perform duty requirements. He desired to continue his military career and entered the FRP. By the end of the 3-week program, he was pain free and able to mow his lawn, lift and carry his young children, tolerate standing to coach tee-ball, and perform his job requirements, all activities that had previously been limited or relinquished. At one-month follow up, he had maintained the gains and had additionally demonstrated significant improvements in cardiovascular and strength measures. He was able to control a pain flare-up with self-management techniques introduced during the program. He offered this statement:

> Going through the Functional Restoration Program has been life changing for me. I cannot imagine there is

> anything that I want to do that I now cannot do. I am very thankful for the opportunity to participate in the program and will recommend anyone with chronic pain to take advantage of the program if possible.

Another example is a senior level commissioned officer who had submitted retirement paperwork prior to the FRP due to limitations following lumbar spine fusion. He demonstrated remarkable improvements participating in the FRP. His preprogram 10-minute walking tolerance improved so much that after the program he was able to complete the 7th annual Center for the Intrepid Minitriathlon in San Antonio, TX. After completing the FRP, he reported he felt he could have continued performing his duties had he not already completed retirement processing.

Results

Early outcomes of the FRP indicate promise. The results are presented as anecdotal and no claims are made at this time as to the effectiveness of the program. At the time this article was written, 14 service members had completed the program. An additional 2 individuals dropped out of the program due to emergent personal/family situations. Individuals who completed the program comprised 6 males (43%) and 8 females (57%) with an average age of 37 (SD=4.9). Fifty-seven percent were white, 36% Hispanic/Latino, and 7% African-American. Ranks of participants ranged from specialist to lieutenant colonel. Back pain, including lower back and thoracic back pain, was the most common primary location of pain (71%), with another 21% endorsing back pain as a secondary concern. Other primary locations of pain were lower extremity (14%), upper extremity (7%), and cervical pain (7%). The average length of duration of pain was 8 years (SD=5). Fifty-seven percent of participants indicated that pain began secondary to work-related factors, primarily training accidents, work-related activities, or deployment. Other precipitating events included motor vehicle accidents (n=2), surgery (n=1), participation in sports (n=1), or unknown (n=2).

Pain Rating and Pain Interference

The goal of the FRP is to increase functioning at work and in daily life in spite of painful sensations. The nature of chronic pain is long-lasting, most often with intermittent exacerbations. Since most participants had reduced regular exercise, sometimes for years, prior to the program, engagement in the physical conditioning aspects of the FRP was expected to increase painful sensations initially. Participants in the program reported reduced pain on a numerical rating scale (0=no pain, 10=pain as bad as it can be) at the end of the program. A reduction of 2 points on this scale is considered to be moderately clinically meaningful.[10] Ratings of current pain intensity changed from 5/10 to 4/10, pain at its worst in the past 7 days from changed from 7/10 to 6/10, and average pain in the past 7 days changed from 5/10 to 4/10 from the beginning to the end of the program. Although these ratings represent a change in pain intensity, the magnitude was likely not clinically meaningful. However, any reduction of pain at the end of the program was surprising given the intense physical conditioning nature of the program.

Interference of pain in life activities was measured by the Brief Pain Inventory.[11] Figure 1 shows decreases in pain interference, including stress, mood, sleep, and activity over a 24-hour period. Small differences were found from the beginning to the end of the program that were not likely clinically significant, except for a difference found in the area of reduced interference with usual activity.

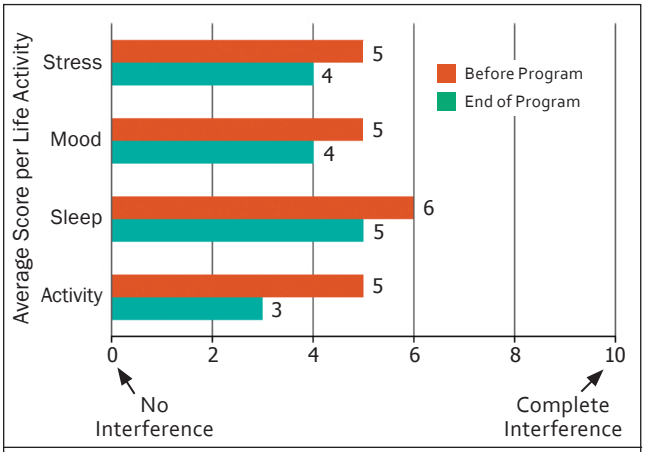

Figure 1. The average score per life activity, which reflects pain intensity and the effect of pain on functioning (interference), was assessed by the Brief Pain Inventory questionnaire before and after the Functional Restoration Program (N=14). Range: 0=no interference; 10=interferes completely.

Functional Outcome Measures

Functional outcome measures examine patients' subjective reports of their ability to perform activities or their avoidance of certain activities secondary to pain such as bending, kneeling, or walking. In a systematic review of studies looking at factors associated with workers with musculoskeletal pain who stayed at work, deVries found a consistent association with low perceived physical disability.[12] Chapman et al [13] reviewed 10 years of literature concerning treatment of CLBP. They found that perception of physical disability due to back pain was most often measured by the Oswestry Disability Index and the Roland Morris Disability Scale, indicating broad acceptance of those instruments as reliable, valid measures of functional outcomes for patients with back pain. Participants in the FRP showed improvements in functioning on both measures, as shown in Figures 2

and 3. Scores on the Oswestry Disability Index indicated a change in scores from an average perception of "severe disability" to "moderate disability" over the course of 3 weeks. Scores on the Roland Morris Disability Scale indicated an average of 42% decrease in disability perception from baseline to end of the program.

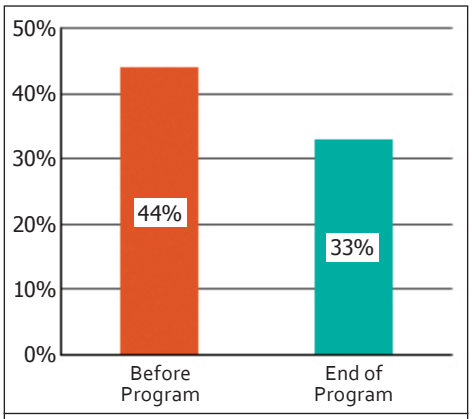

Figure 2. The average score of disability upon administration of the Oswestry Disability Index, a common outcome measure for lower back pain, before and after the Functional Restoration Program (N=14). Range: 0-20%=minimal disability; 21-40%=moderate disability; 41-60%=severe disability.

Catastrophizing

Catastrophizing is defined as "an exaggerated negative mental set brought to bear during actual, or anticipated painful experience that includes rumination, magnification, and helplessness."[14,15] Catastrophizing is associated with a variety of negative outcomes for individuals with chronic pain, to include greater levels of physical and occupational dysfunction, greater perceptions of disability, increased analgesic use, and increased depression and anxiety.[16] It is the "most consistent psychosocial factor associated with pain and dysfunction in samples of persons with chronic pain." Catastrophizing has been observed in military personnel with polytrauma following injury in Iraq and Afghanistan and is especially common in young Wounded Warriors faced with disfigurement and physical disabilities.[17] Participants were asked to think about past painful experiences and complete the Pain Catastrophizing Scale reflecting the degree which they experienced certain thoughts and feelings on a 0-5 scale (eg, "I feel I can't stand it anymore"). This measure is widely used in the pain management literature and has adequate internal consistency. A clinically relevant cut-off score was set at 30 (75th percentile) of the normative sample. Scores on the Pain Catastrophizing Scale decreased from an average of 25 to 14 following treatment in the FRP (Figure 4). Altogether, catastrophizing behavior in FRP patients reduced catastrophizing by half of the original measurement.

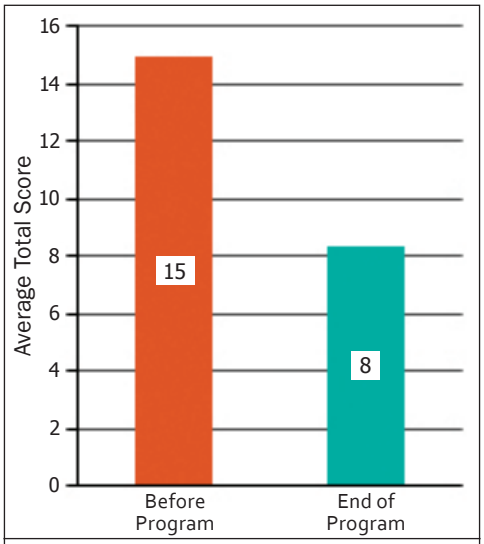

Figure 3. The average total score of disability assessed by the Roland Morris Disability Questionnaire before and after the Functional Restoration Program (N=14). Range: 0=no disability; 24=maximum disability.

Fear Avoidance Beliefs

Chronic pain patients are also prone to fear avoidance. Fear avoidance beliefs are perceptions that certain physical activities will worsen pain and should be avoided. In order to assess fear avoidance in our FRP population, we used the Fear Avoidance Beliefs Questionnaire (FABQ) which has 2 subscales to identify fearful beliefs that patients hold related to how physical activity and work affect low back pain.[18] The fear avoidance criterion is greater than 15 for the physical activity subscale and greater than 34 for the work subscale. Participants in the FRP scored lower on both subscales of the FABQ at the end of the program compared to starting scores (Figure 4). However, the majority of the participants (57% for the physical activity subscale and 71% for the work subscale) did not meet the scoring criteria for clinically meaningful difficulties in fear avoidance at the beginning of the program.

Depression and Anxiety

Depression and anxiety are mood states that are commonly associated with chronic pain. In fact, research has shown many neural networks within the brain which are associated with pain processing also play roles in mood. Patients in the FRP reported decreases in depression and anxiety measured by the Patient Health Questionnaire-9 (PHQ-9) assessment. In fact, average scores on the PHQ-9 fell from 11 (SD=6.7; moderate depression range) to 8 (SD=5.5; mild depression range) from start to completion of the program, as shown in Figure 5. Three of 4 participants who scored in the moderately severe to severe depressive ranges on the first day of the program had scores that dropped to the mild range by the end of the program. Additionally, administration of the General Anxiety Disorder-7[19] questionnaire, which is used to measure anxiety, showed average scores decreased from 8 to 5 over the course of the program, indicating a decrease in depression and anxiety, possibly attributable to FRP (Figure 5).

Physical Therapy/Functional Measures

The intensely physical nature of the FRP is essential for the restoration of function to chronic pain participants.

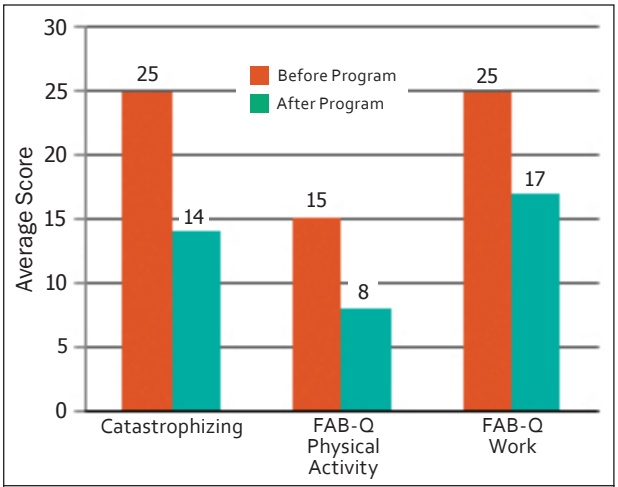

Figure 4. The average score of catastrophizing assessed by the Pain Catastrophizing Scale (score of 30 is clinically relevant) and average scores of fear avoidance behaviors assessed by the Fear Avoidance Beliefs Questionnaire (FAB-Q; max score=42) to both physical activity (FAB-Q PA) and work related activity (FAB-Q W; max score=24) before and after the Functional Restoration Program (N=14).

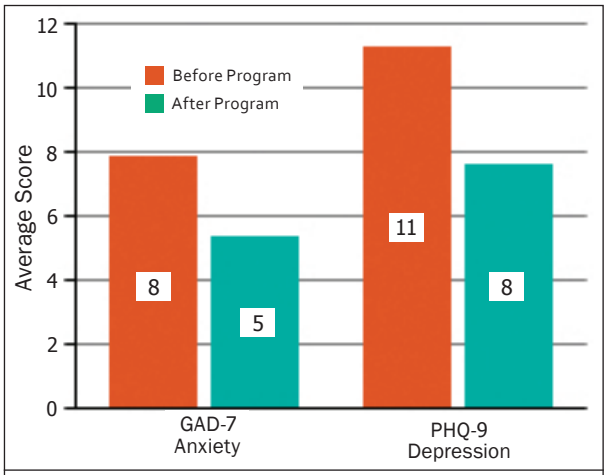

Figure 5. The average score of anxiety was assessed by the Generalized Anxiety Disorder 7 Scale (GAD-7), and the average score of depression was assessed by Pain Health Questionnaire (PHQ-9) before and after the Functional Restoration Program (N=14). GAD-7 score: 0-7=none and >8=probable anxiety disorder. PHQ-9 score: 0-4=minimal depression, 5-9=mild depression, 10-14=moderate depression, 15-19=moderately severe depression, 20-27=severe depression.

Physical measures were used to establish a functional baseline on day one of the program. Progress was tracked throughout the FRP (days 1, 8, and 15), and served as a data points to compare physically functional measures. Additionally, physical measures provided indirect insight into the degree to which kinesiophobia was a limiting factor in a participant's functional level. It should be noted that several of the tests used have a subjective component, ie, the participant determines when he or she has performed maximal effort or when

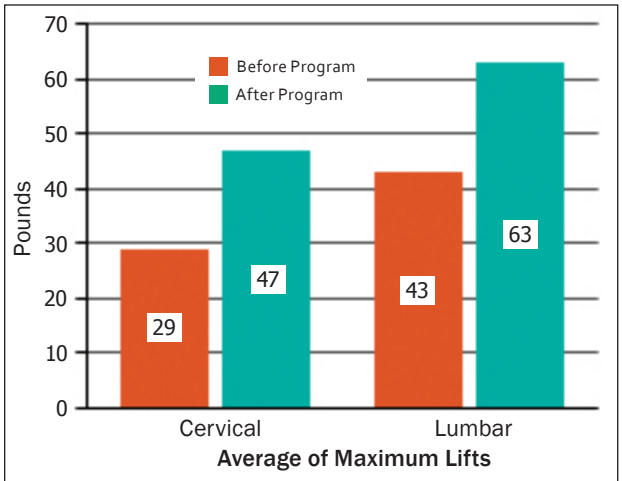

Figure 6. The ability to perform repetitive lifting as quickly as possible was assessed using the Progressive Isoinertial Lifting Evaluation. The average weight in pounds was recorded before and after the Functional Restoration Program (N=14).

pain is the limiting factor. Each participant underwent a comprehensive neuromusculoskeletal physical therapy evaluation, including a thorough evaluation and assessment of reported pain or other physical symptoms in order to rule out any previously missed diagnoses or improperly rehabilitated conditions. The evaluation included a postural assessment, gait analysis, range of motion measurements of the affected area, gross strength testing, gross flexibility testing, testing of deep tendon reflexes, light touch sensation screening, joint assessment, and other tests appropriate to specific body regions with chronic pain. When available, labs and diagnostic imaging were reviewed as well.

The Progressive Isoinertial Lifiting Evaluation[20] is a test of one's ability to lift a weighted box from the floor to waist level, and then from waist level to shoulder level in sets of 4 repetitions at a 12 lifts per minute pace. It yields a variety of qualitative and quantitative data, including strength, muscular endurance, range of motion, work tolerance, as well as the functional ability to lift. Weights are incrementally increased by 10 pounds after each set for men, and by 5 pounds for women. The test is terminated when the participant can either no longer safely perform the maneuver (judged by the physical therapist administering the test), or the participant subjectively reports that he or she cannot continue due to increased pain or fatigue. This procedure is then repeated in the same fashion raising the box from waist to shoulder level. Maximum weight attempted, maximum weight with 4 lifts completed, heart rate before and after, and reason for testing stop are all recorded. Both cervical and lumbar lift was improved in participants of FRP as shown in Figure 6.

The Star Excursion Balance Test (SEBT) is another example of a physical measurement assessed and tracked throughout the program in order to observe changes in physical function. The SEBT is a measure of dynamic strength. Participants were asked to stand in the center of a standard Total Gym mat (Total Gym Fitness, LLC, Exton, PA) having concentric circles to identify distances reached. Measurements were taken using a standard retractable tape measure and recorded in centimeters. The test was performed in the anterior, posterior lateral, and posteromedial directions. Three efforts were recorded and averaged for each of the 3 directions attempted. Analysis of the data using the SEBT demonstrated that dynamic strength on both right and left sides of the body improved from the start to the completion of FRP as shown in Figure 7. Although chronic pain patients may limit themselves physically due to psychological factors (catastrophizing and fear avoidance), consistent physical activity along with psychological support and education on chronic pain management was shown to increase physical strength measure in our cohort of FRP participants.

Comment

Early results from the SAMMC Interdisciplinary Pain Management Center Functional Restoration Program are promising. Improvements were seen in perception of disability, pain interference, catastrophizing, fear/avoidance beliefs, depression and anxiety, as well as in physical function such as lifting, balance, and range of motion. Due to the small number of subjects, these data do not have statistical significance as of yet, but show potential as an alternative management technique for chronic musculoskeletal pain. Importantly, these findings are consistent with outcomes from other, established programs in the wider civilian medical community. The Functional Restoration model has been shown to be effective in a civilian population, and these results suggest that it can be used effectively in a military population as well. We will continue statistical analysis as we cycle through larger numbers of patient cohorts.

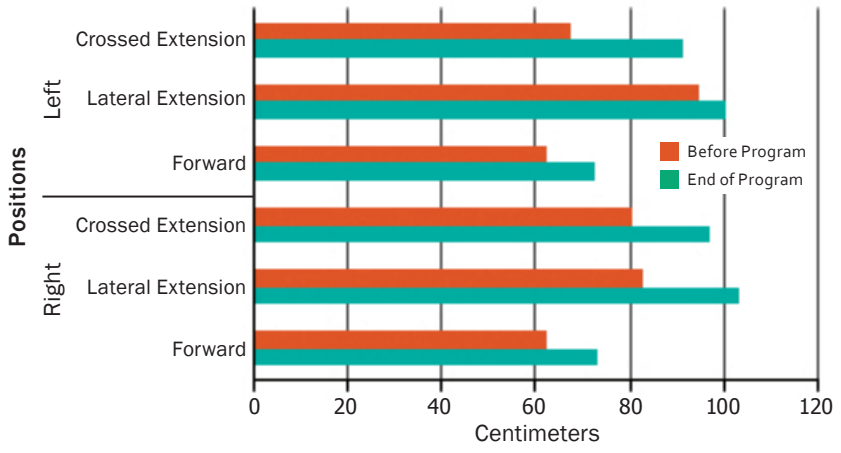

Figure 7. The average score reflecting dynamic balance requiring strength, flexibility, and proprioception was assessed on both left and right sides of the body using the Star Excursion Balance Test. The average mobility was assessed in centimeters before and after the Functional Restoration Program (N=14).

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Posttraumatic Stress Disorder: Five Vicious Cycles That Inhibit Effective Treatment

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Abstract

Despite a wide range of studies and medical progress, it seems that we are far from significantly mitigating the problem of posttraumatic stress disorder (PTSD). The problem has major social and behavioral components. Developing innovative and effective policies requires a broad scope of analysis and consideration of the highly interconnected social, behavioral, and medical variables. In this article, we take a systems approach and offer an illustrative causal loop diagram which includes individual and social dynamics. Based on the map, we discuss 5 major barriers for effective interventions in PTSD. These barriers work as vicious cycles in the system, reduce effectiveness and therefore value of PTSD treatment. We also discuss policy implications of this perspective.

Posttraumatic stress disorder (PTSD) is one of our major public health challenges. More than 2% of the US population (about 7.7 million people) are known to suffer from PTSD, and 7% to 8% report experiencing it at some point during their lifetime. Approximately 11% to 20% of veterans of the Iraq and Afghanistan wars have been coping with PTSD. These veterans are 4 times more likely to abuse alcohol and 6 times more likely to develop a marijuana dependence.[1-3] In addition to the patients, many others are indirectly affected by PTSD, including family members, friends and community members, colleagues, and employers. Their reactions toward PTSD patients (support vs exclusion) influence patients' care-seeking behavior and treatment progress. Despite a wide range of studies and medical progress, it seems that we are far from significantly mitigating the problem.

Major social and behavioral issues are involved with PTSD. Data show that about 50% to 75% of people with psychiatric disorders do not receive mental health services and, of those who do, 50% to 60% drop out from treatments.[3-5] The authors believe that developing innovative policies to address PTSD requires a broad scope of analysis and consideration of the highly interconnected social, behavioral, and medical variables. This process requires a systems approach. Drawing upon the system dynamics methodology, we offer an illustrative causal loop diagram that demonstrates 5 major barriers for effective intervention in PTSD. The model reflects shared knowledge of an interdisciplinary research team and is a step forward for using a systems approach to study PTSD.

Systems Science

System dynamics is a common method among systems scientists primarily used to analyze behavior of complex social systems.[6,7] Feedback loops are at the heart of the method to help demonstrate circular causality in a system (eg, *X* causes *Y* and *Y* causes *X*). Feedback loops are considered "reinforcing" when an increase in a variable reinforces its future increase, and "balancing" when an increase in a variable results in a future decline in the same variable. Feedback loops can be major sources of continuous growth and improvement (virtuous cycles) or exponential collapses (vicious cycles). A few recent applications of system dynamics in public health are in the studies of dental health,[8] obesity,[9,10] cardiovascular diseases,[11] and obstetrics.[12]

System dynamics provides a platform to develop causal maps and help productive discussion across different stakeholders.[13,14] These maps are effective tools for problem conceptualization.[15] Here we follow a similar goal by developing a simple but hopefully useful model of PTSD for making sense of complexities of the problem. We intend to offer first order insights by uncovering 5 major challenges for PTSD treatment.

Causal Dynamics

Our focus, PTSD treatment, is a complex process and depends on a wide range of factors. We categorize the factors as medical, social, and personal, as shown in Figure 1. Medical factors represent the quality of services provided by the healthcare system. Performance of the healthcare system, medical advancements, and timely response to needs can help patients' treatment. Social factors include how families, relatives, friends, and society in general influence PSTD treatment. Supports of a social nature are central in accelerating treatment. Personal factors include patients' willingness to receive care and their compliance with treatments. Patients should first decide for themselves that they want treatment; otherwise medical expertise and social supports

are less likely to help. In order to increase the treatment rate, we should take actions that improve all three, a complex task.

We take a further step in Figure 2, depicting how the 3 factors are influenced in a multilayer map of the system (individual, family/friend, and societal layers). The blue boxes present different layers of the model. At the Individual layer, the smallest box in Figure 2, patients are influenced by individual level dynamics which include medical factors and one's willingness to seek care. The Family/friend layer includes dynamics that are imposed by how one's close circle of people behave regarding the illness. At the Societal layer, the behavior of the society at large regarding PTSD patients is depicted, which, in turn, eventually has an effect on the Individual layer.

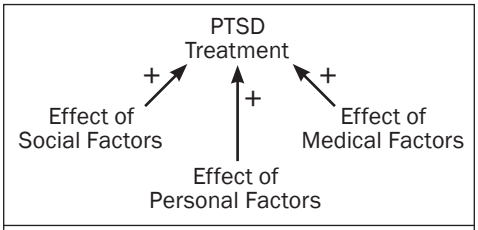

Figure 1. A simple representation of factors which influence PTSD treatment. Note: Plus (positive) signs indicate that the variables move in the same direction.

As shown in the form of balancing loops B1, B2, and B3, there are "potentially" self-correcting mechanisms that can help PTSD treatment. In the absence of social and psychological barriers, a patient is expected to seek care once he or she knows about the illness (loop B1), which reduces the PTSD extent, and reduces PTSD symptoms. Furthermore, people in close proximity to patients with whom they have regular contact, such as family members and friends (hereafter, "close circle"), can play an important role in patients' treatment. They can directly help PTSD treatment (loop B2) and encourage PTSD patients to seek care (loop B3), thus increasing the chances of early diagnosis and treatment.[16] However, there are significant barriers that work against these self-correcting mechanisms. We review 5 major ones.

Five Major Vicious Cycles

R1: Cascading Illness and Medical Complexity

A number of effective treatment procedures have been developed and successfully tested.[17] The problem is that if patients avoid actively seeking care, the illness progresses (PTSD extent goes up), and their medical condition worsens. As the disease progresses, and as other mental and physical illnesses co-occur, complications increase nonlinearly and make medical interventions complex and progressively less effective. Data indicate that about 8% of patients with PTSD develop co-occurring psychiatric disorders.[18] The link between cardiovascular diseases (including heart failure) and PTSD has been consistently found in different studies.[19,20] Patients' self-treatment in the form of alcohol or drug abuse contributes to complications. Other evidence suggests high likelihood of developing other mental disorders for PTSD patients.[21] These patterns result in a reinforcing loop (R1), which pushes mild medical illnesses to chronic and chronic to life-threatening conditions. Such a comorbidity is so regularly observed that it is referred to as a "rule."[22]

R2: Cascading Illness and Exclusion from Family and Friends

Supportive behavior is not always guaranteed. While close circles can support and help treatment, their tolerance is limited. As illness progresses with more and more PTSD-related symptoms and incidents, family and friends are increasingly likely to drop out from supporting the patient (loop R2a) and to start keeping their distance from the patient, further exacerbating the situation (loop R2b).[21] Lack of social support contributes to PTSD extent,[16] where one problem leads to another, resulting in bigger social and medical problems, cascading illness, and related complications. Examples include family problems and breakups, unemployment, homelessness, and suicidal ideation.[21] This potential cascade stresses the importance of early treatment before it becomes too late and before family members' and friends' coping capacities have deteriorated.

R3: Stigma and Social Exclusion

Stigma has been cited as the main social barrier to receiving care.[3,17,23,24] Patients revealing their mental illnesses publicly may suffer a wide range of consequences such as a higher likelihood of losing jobs or discrimination in workplaces, lower income, difficulties in finding housing, and exclusions from social communities.[25] Social exclusion is identified as one of the factors that evoke psychological mechanisms (such as fear) that contribute to worsening PTSD.[26] Consequently, a reinforcing loop emerges where PTSD treatment affected by stigma and society at large is incapable of supporting the patients. In Figure 2, Loop R3 depicts how stigma and social exclusion have a first-order effect on treatment. As the number of PTSD-related incidents increases, affecting public perception of patient risk, people increasingly keep their distance from PTSD patients or even discriminate against them in workplaces. Such social exclusion affects the PTSD treatment rate and contributes to an accumulation of untreated PTSD patients.

R4: Stigma, Fear of Exclusion, and Self-fulfilling Prophecy

One important causal mechanism depicted in Figure 2 as loop R4 is the relation between fear of social exclusion

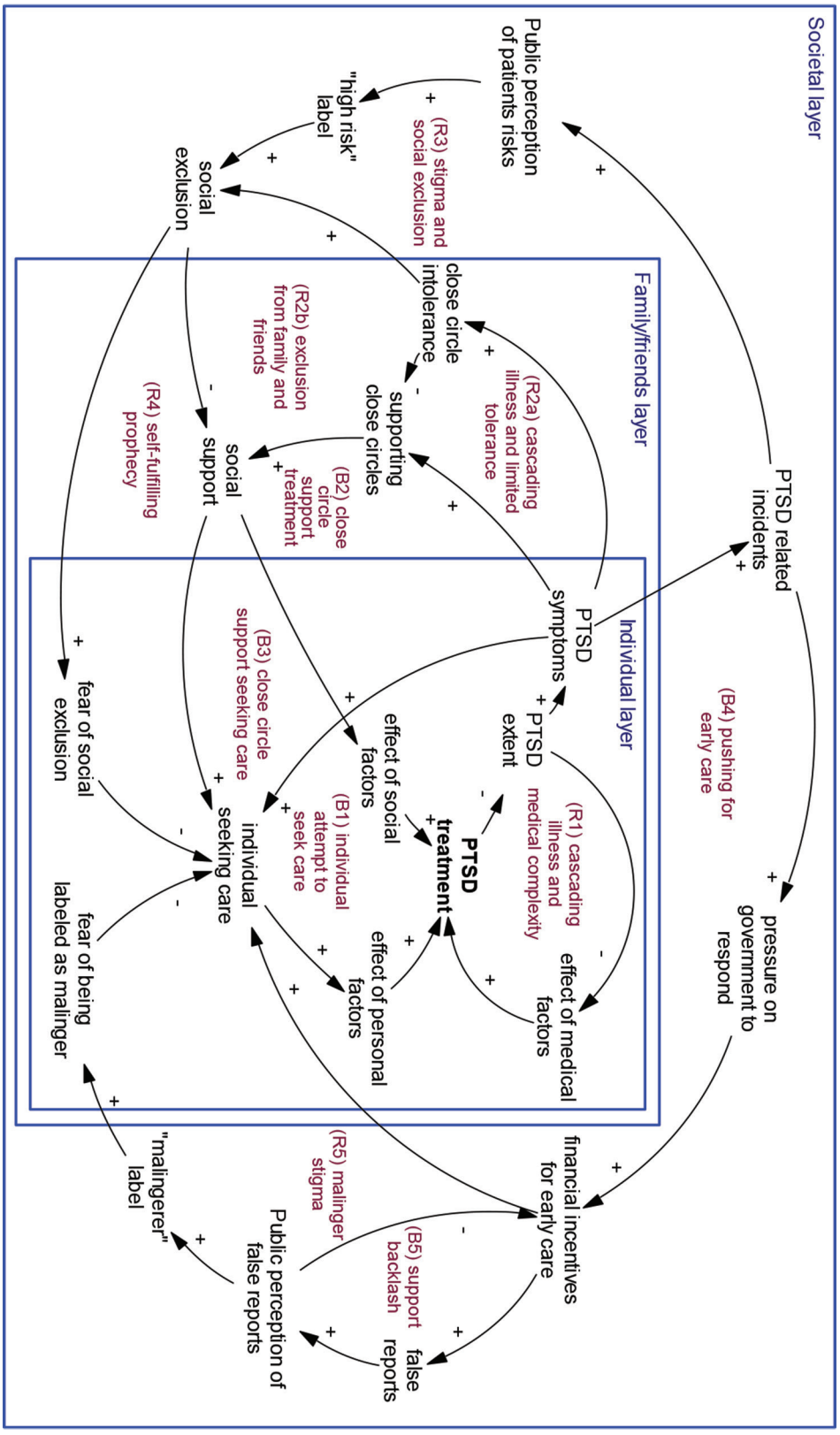

Figure 2. Multilayer dynamics affecting PTSD treatment. The multilayer dynamics are represented as individual, family/friend, and societal layers. At the individual layer, one's own health and actions are influencing treatment. At the second layer, family/friends have effects on treatment. At the societal layer, many patients' behaviors are observed and create public perceptions and the associated labels, which ultimately affect individual layer dynamics. Note: Plus (positive) signs indicate the variables move in the same direction. Minus (negative) signs mean variables move in the opposite direction.

and social exclusion. As new patients see that people with PTSD are labeled, excluded from various opportunities in the society, and lose their family members' support, they become unwilling to accept and announce their illness and seek treatment. Fear of social exclusion decreases individuals' willingness to seek care, which results in progression of illness and symptoms.[17] If the majority of patients think being labeled with PTSD has considerable negative consequences, they will hide their illness, which will exacerbate it and will actually result in considerable negative consequences once symptoms become difficult to hide. This phenomenon creates a reinforcing mechanism that is likely to work as a vicious cycle making it very difficult to break PTSD stigma. The psychology literature refers to this type of mechanism as a self-fulfilling prophecy: one's fear of possible exclusion and discrimination results in exclusion and discrimination.

This pattern is not limited to patients, but a similar self-fulfilling phenomenon can emerge when the public's expectation of risks of PTSD contributes to risks of PTSD. If, assuming that there are high risks associated with social engagement with PTSD patients, the majority of people limit their contacts with PTSD patients, those patients' well-being can suffer, illness progress can accelerate, and PTSD related incidents can increase. Thus, perception of risks of engagement with PTSD patients contributes to an increase in risks of engagement with PTSD patients.

R5: Incentives, Backlash, and the "Malingerer Stigma"

A seemingly smart policy is to increase early diagnosis and care of PTSD patients. But we do not know exactly how to do this. In the military, policymakers have offered financial incentives and early discharge policies to encourage patients to seek early care (loop B4). However, a considerable number of false reports have emerged.[29] Once identified, personnel who falsely claim PTSD are known as malingerers.[27,28] In the past 13 years, financial supports for PTSD patients have grown by about 400%.[30] Anecdotal evidence suggests that exaggeration or fabrication of symptoms might be as high as half of the population of patients.[30] Whether those anecdotes are right or wrong, they depict an emerging perception of some PTSD patients being malingerers. In military culture, malingering is an unacceptable behavior. Since false reports and malingering are eventually noticed, financial incentives lose their legitimacy (B5).

In addition, false positives have resulted in a major negative effect on willingness to seek care by those actually needing care. This is due to the emerging label of "malingerers" and its associated stigma. In the military context, many people might initially join the military with a high level of pride. They might prefer to "tough it out" with problems rather than being labeled as weak or lazy or manipulative. Society, friends, and family members have high expectations. However, as people notice that some are using PTSD as an excuse to take advantage of the system, fear of being labeled as a malingerer discourages real patients from seeking care (loop R5). Thus, providing incentives not only falls short in resolving the high risk label and associated stigma, but also creates the malingerer label and its associated stigma.

Toward Innovation

While the map illustrates several challenges for PTSD treatment, it is still a highly simplified representation of the problem. The goal was to offer an example of a systems approach to the problem of PTSD and discuss 5 major barriers for PTSD treatment that work as vicious cycles at individual, family/friends, and societal layers.

What can be done? There are a few examples of structural changes that have been offered to overcome the problem of PTSD, such as addressing public stigma through providing better knowledge of PTSD, educating families, and addressing cultural barriers.[17] Several other studies of PTSD offer incremental steps for improvement. As we discussed, various sources of resistance to PTSD treatment exist which create numerous vicious cycles, making seemingly "smart" policies, such as providing financial incentives for early treatment, ineffective.

Overcoming the vicious cycles of public perception and fear of social exclusion requires positive and constructive approaches to the problems of PTSD. Public perceptions of PTSD patients are formed by seeing or hearing news about these patients. Rarely does the public hear news about riskless patients. Rather, media news focuses on individual extreme cases. As a result, low risk patients are equated with high risk patients through the PTSD label. To remove the label from patients, one solution is to offer a continuous measure of "PTSDness." The idea is that everyone in the target population (such as all military personnel) would receive a number in a continuous range—not a binary label. Such a number could, for instance, be on the scale of 1 to 99, the assigned number dependent on level of symptoms. In this approach, everyone has a positive PTSD score, rather than a binary yes or no PTSD label. Also, nobody is 100% free of PTSD (there are no zeros) and nobody is 100% PSTD (there are no 100s). The number represents the level of care that a specific patient needs. While this might be contrary to our intuition that people cognitively like simple categorizations and labels, the benefits can be considerable and can help overcome the labeling issues. Once people see

that the population of patients is dominated by low risk individuals, their judgment can more easily change and the label can lose its association with high risk patients.

The proposed model considers PTSD treatment at the center of attention with feedback loops that are beyond any single organization's boundary. This is another indicator that PTSD is a multiorganizational challenge. In simple words, no single organization is responsible for the described feedback loops. The loops are due to actions and reactions of multiple entities such as patients, patients' family members, employers, colleagues, community, neighborhood, and larger entities such as media, the military, veterans' affairs, and elected government officials. These stakeholders have different incentives and sets of interests: the military focuses on effects of PTSD on servicepersons' military readiness, the healthcare system focuses on healthcare coverage, Congress is concerned with costs, and the VA focuses on health outcomes. While all these variables are interconnected, at any given time a service member or veteran may be under the jurisdiction of a single-organization whose "systems view" is a narrow subset of the larger system we have discussed. Placing internal boundaries within the larger system and "optimizing" for the subsystem may in fact lead to negative consequences that few would support. There is no easy way to overcome the problem of stakeholder misalignments. However, systems models have been successfully used in other contexts to help different stakeholders communicate and understand the whole system.[13] Systems maps, such as the one represented by Figure 2 in this article, are used as boundary objects for effective communications across organizations with differing goals and world views.[13,14] We think an effective systems approach should consider a large boundary for the problem of PTSD, one that includes multilayer dynamics, connects all relevant variables, clarifies how different stakeholders react to changes, and elaborates on the links to the most important variable of interest: public health.

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Reliability of a Novel Return to Duty Screening Tool for Military Clinicians

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Abstract

Purpose/Hypothesis: Lower extremity and low back injuries represent a significant financial burden on the military healthcare system. Subsequent injuries often occur during the recuperation period or in the period directly after physical therapy ends when the patient returns to full duty. Medical providers have relatively few objective tools with which to determine if someone is ready for return to duty (RTD). The purpose of this study is to assess interrater and test-retest reliability of a novel gender-neutral RTD screening tool that requires minimal training, equipment, and time.

Subjects: This study included 34 active duty military participants (male=22, female=12, age=28.5±5.9). 23 subjects (male=14, female=9, age=28.7±6.3) returned for follow-up testing within one week.

Materials/Methods: After answering a medical questionnaire, all participants completed the RTD screening tool consisting of: (1) modified anterior reach, (2) modified deep squat, (3) modified trunk stability push-up, (4) modified hip abduction test, (5) forward step-down under low-light conditions, (6) modified Feagin hop test, and (7) perceived risk of future injury. Each individual event was qualitatively scored from 0 to 2 or 3. The composite score ranged from 0 to 16 with higher scores indicating better performance.

Results: For the primary rater, the mean score was 11.26±2.35 during the first trial session and 12.43±1.47 during the second trial session. For the secondary rater, the mean score during the first trial session was 11.38±2.51 and 12.61±1.73 during the second session. There was good interrater reliability for the composite score (intraclass correlation coefficient [ICC] (2,1)=0.88 (0.78, 0.94)). The test-retest reliability was moderate (ICC (3,1)=0.57, (0.21, 0.79)). The chance-corrected agreement was acceptable for all individual events except the modified hip abduction test. There were no significant differences between male and female composite scores.

Conclusions: This novel RTD screening tool showed good overall interrater reliability, suggesting that entry-level clinicians trained on the grading requirements are able to reliably administer the tool. In addition, the screen showed gender-neutrality with no significant differences between men and women. However, the RTD screening tool had only moderate test-retest reliability, suggesting the possible presence of a learning effect. The modified hip abduction test demonstrated poor chance-corrected agreement. Future research should consider including a longer practice session to ameliorate any possible learning effect and to modify the hip abduction test to improve reliability.

Clinical Relevance: This study has demonstrated that a novel RTD screening tool can reliably be administered to an active duty population to assist clinicians in making RTD decisions. However, at this time, it cannot be determined if a certain composite or individual event score will indicate increased risk for injury.

Military personnel often carry more than 100 pounds of gear and equipment during training exercises and deployment.[1] This, in conjunction with rapid and prolonged movement over rough terrain and other physically demanding tasks, results in significantly increased forces through the joints of the lower extremity and lumbar spine.[2] These factors contribute to a high rate of injury, often in the lower extremity and low back, which represents a significant burden on the military healthcare system. In 2010, approximately 2.5 million musculoskeletal injury-related ambulatory visits were reported.[3] In the same period, musculoskeletal injuries represented 67% of all limited duty profiles. In 2012, approximately 1 million medical encounters were documented for back injuries, representing almost 20,000 lost manpower days.[4]

In addition to the high cost of initial injury, subsequent injuries often occur during the recuperation period or immediately afterwards when the patient returns to full duty. This recuperation period can vary in length from a few days to several weeks depending upon the severity

of the initial injury, and reinjury during this period may depend upon both intrinsic and extrinsic factors affecting the patient.[5] Intrinsic factors include incomplete tissue healing combined with subjective symptom resolution and willingness to return to duty. Extrinsic factors include returning to difficult physical training prematurely, perceived or actual pressure from supervisors to return to prior levels of activity right away, and returning to a unit with an aggressive physical activity profile. As inflammation decreases and the healing process begins, injured personnel may have decreased pain and increasingly functional motion and strength. As such, patients may feel ready to participate in military activities even though the healing tissues are not at full strength. Additionally, injured personnel may develop musculoskeletal compensations throughout the body during the healing period, which could contribute to injuries in other regions of the body.

Medical providers have relatively few objective tools for determining if someone is ready for return to duty (RTD). Several screening tools have been developed for this purpose, but to date, they are fairly complex, resource intensive, and not specific to the military. The Functional Movement Screen (FMS) (Functional Movement Systems, Chatham, VA) has been shown to be predictive of injury risks in both athletic and military populations, but requires specialized training and specific equipment that can be expensive and difficult to transport in a deployed environment.[6,7] The Y-Balance Test has also been shown to be predictive of injury risks,[8,9] but has similar equipment requirements as the FMS and can represent a significant time investment to perform correctly. Military clinicians who diagnose and treat musculoskeletal injuries lack a screening tool that is simple yet thorough, inexpensive, and readily performed with minimal training.

The purpose of this study was to present and assess the reliability of a novel, gender-neutral, military-specific RTD screening tool that requires minimal training, equipment, and time. The tool was developed to be used by any military clinician, in any environment, to help determine whether military personnel are at risk for subsequent injury with resumption of normal training activities.

Methods

Participants

Active duty service members from Joint Base San Antonio between the ages of 18 and 50 who had a history of low back or lower extremity injury in the previous 6 months were included. Lower extremity and low back injuries were defined as injuries that forced the participant to modify their daily activities for at least one day in the past 6 months. Participants were excluded if they had any pain in their low back or lower extremities for 2 weeks prior to participating, if they were currently pregnant, or if they had low back or lower extremity surgery within the past year.

Screening Examiners

Personnel administering and grading the RTD screening tool were active duty officers currently enrolled in the US Army-Baylor University Doctoral Program in Physical Therapy. Examiners were trained in the specific RTD screening events by a senior clinician who was board certified in sports physical therapy and had approximately 12 years of relevant military clinical experience. However, none of the screening examiners had any clinical experience using RTD screening tools.

Testing Procedures

The protocol was approved by the Brooke Army Medical Center Institutional Review Board. Each participant provided informed consent and completed a medical screening questionnaire prior to performing the RTD screening tool. The screening questionnaire included demographic data and medical history questions such as date of injury, duration of symptoms, and prior treatment received.

For each event, the instructions were read from a standard script (Figure 1) by the same examiner. Two examiners simultaneously graded each event while blinded to each other's scores. Each event was scored on a scale of 1 to 2 or 3 points for level of performance when pain was not experienced. Graders could ask the participant to perform the task up to 3 times in order to determine an accurate score. The last attempt performed for each event was recorded as the score of record. If a participant experienced any degree of pain during the task, they received zero points for that task. The possible scoring ranged from 0 to 16, with higher scores indicative of better performance. The grading criteria for each event are outlined in Figure 2.

Equipment

The equipment used for this study was kept simple with the intent of designing a mobile and efficient screening exam that could be used in austere locations. Equipment used for the tasks included a 2 by 6 by 24 inch wooden board, a 3 foot length of PVC pipe, an 8 inch step, a penlight, 2 rectangular hardcover textbooks weighing a total of 12 pounds, a tape measure, and a plinth.

RTD Screening Tool Description

The 7 events used in this study were chosen based on varying levels of evidence and the senior authors'

Event	Instructions Given for Each Event
Question regarding perceived risk of injury	How would you describe your personal concern for sustaining a musculoskeletal injury within the next six months? No concern for injury. Mild to moderate concern for injury. Significant concern for injury.
Modified Deep Squat	Place your heels on the board and place your feet in a comfortable position, approximately shoulder width or slightly greater than shoulder width apart. Point your toes forward and keep them pointing forward. Hold the PVC pipe with both hands over your head in order for both your shoulders and elbows to maintain a 90-degree angle. Now, press the PVC pipe over your head and hold it there. While maintaining an upright posture, the PVC pipe over your head, and your heels on the board, descend into a deep squat in order for your thighs to break parallel with the floor. Hold this down position for a count of one and then return to the starting position.[10(p18)]
Forward Step Down in Low Lighting	While looking straight ahead, step down as you would if you were getting out of the rear of a military vehicle, using one leg at a time. Do not step or jump down with both legs simultaneously.
Modified Feagin Hop Test	From the starting position, hop directly up and down 2 times. The height of your hops should be whatever is comfortable for you; ensure that both feet clear the ground but this is not intended to be a maximum effort hop. Begin.
Modified Trunk Stability Push-up	Lay on your stomach with your hands positioned shoulder width apart with the thumbs in line with your chin. Raise your toes toward your shins and place them on the ground. Extend your knees and elbows off of the ground. Maintain a rigid torso; raise yourself as one unit, with no lag in the low back, into a push-up position.[10(p38)]
Modified Anterior Reach	Reach as far as possible with the reaching limb along the reaching line; lightly touch the line with the toes only of the reaching foot without shifting weight to or coming to rest on this foot of the reaching limb; and then return the reaching limb to the beginning position in the center reassuming a bilateral stance.[8(p340)]
Modified Hip Abduction	Please keep your knee straight and raise your top thigh and leg towards the ceiling, keeping them in line with your body, and try not to let your pelvis tip forwards or backwards.[11(p650)]

Figure 1. The standard script of instructions read by the same examiner for each event in the RTD evaluation.

experience in predicting injury in subjects without a recent history of injury. A majority of the events have been slightly modified from their original description in either the scoring rubric or the event execution. The modifications were made in order to best assess the military population used in this study. The events, any modifications, and background evidence for each are described below. Grading criteria for each event are detailed in Figure 2.

Question Regarding Perceived Risk of Injury

Psychological factors including increased levels of stress, less confidence, negative emotions, and poor coping skills are linked to increased injury rates and slower healing rates.[12-15] A study of Air Force Academy cadets found that higher levels of fear and anxiety correlated with lower scores on outcome measures.[16]

The participant was asked the following question to briefly assess his/her perceived risk of injury: "How would you describe your personal concern for sustaining a musculoskeletal injury within the next 6 months?" The participant could choose from 3 possible answers:

- No concern for injury
- Mild to moderate concern for injury
- Significant concern for injury

Modified Deep Squat

The deep squat has been shown to be a significant predictor of injury rates, particularly in physically demanding occupations.[17,18] Low scores in the deep squat may also predict how well athletes progress through a corrective exercise program.[19]

The modified deep squat used in this study was performed using a PVC pipe and a wooden board. The event was modified from the FMS deep squat by having the subjects place their feet on a wooden board.[6] A study that used the FMS deep squat in a healthy population of Marine officer candidates found that participants

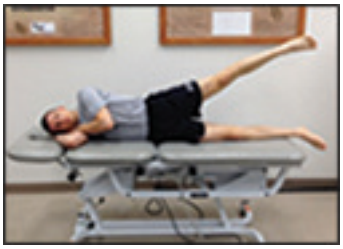
Task	Grading Criteria	Maximum Score	
Question Regarding Perceived Risk of Injury	2=No concern for injury 1=Mild to moderate concern for injury 0=Significant concern for injury	2	
Modified Deep Squat Test	3=All of the following checkpoints are met: upper torso is parallel with tibia or toward vertical, femur is below horizontal, knees are aligned over feet, and the PVC pipe is aligned over feet[10(p18)] 2=Limitation in the upper torso OR lower extremity only 1=Limitation in the upper torso AND lower extremity 0=Any pain associated with the movement	3	
Forward Step Down in Low Lighting	2=No deviation of either lower extremity into the frontal plane during movement 1=Any deviation of either lower extremity into the frontal plane during movement 0=Any pain associated with the movement	2	
Modified Feagin Hop Test	2=All of the following checkpoints are met: no deviation of either lower extremity into the frontal plane during take-off or landing, no obvious lateral pelvic rotation or compensatory spine motion noted, symmetrical and quiet landing sound heard, makes initial landing contact using the balls of the feet, and no pain noted in the lower back or either lower extremity during testing 1=No pain noted in the lower back or either lower extremity during testing and at least one additional checkpoint above is not met 0=Any pain noted in the lower back or either lower extremity	2	
Modified Trunk Stability Push-Up Test	2=Performs 1 repetition to standard 1=Unable to perform 1 repetition to standard 0=Any pain associated with the movement	2	
Modified Anterior Reach Test	3=Less than 4 cm difference side-to-side 2=4 cm to less than 6 cm difference side-to-side 1=6 cm or greater difference side-to-side 0=Any pain associated with the movement	3	
Modified Hip Abduction Test	2=No deviation from the frontal plane during active hip abduction bilaterally 1=Any deviation from the frontal plane during active hip abduction on either side 0=Any pain associated with the movement	2	
Total Score (**Range:** 0-16)		16	

Figure 2. Grading criteria for the return to duty screening tool.

scored 2 points much more frequently than they scored 3 points.[7] By using a board under the heels for the entire scoring scale of the modified deep squat, it is more likely that participants with a lower risk of injury will be able to score 3 points. It decreases the amount of ankle dorsiflexion needed to squat and alters stability and mobility requirements in the upper and lower body.[20]

The participant was instructed to place his/her heels on the board, place feet shoulder-width apart with toes pointed forward, and hold the PVC pipe with both hands overhead with their elbows at a 90 degree angle. After pushing the PVC pipe directly overhead, they descended into a squat deep enough for their thighs to break parallel, and held it for a count of one before returning to the starting position.[10(p18)] The graders scored the participant by viewing them once in the frontal plane and once in the sagittal plane.

Forward Step Down in Low Lighting

The forward step down was designed with the intention of predicting participants' risk of injury when performing tasks in low lighting. The rationale behind the exercise is that military service members are often required to perform occupational activities in environments with low lighting and uneven terrain. Research that examined parachute and air assault jumps in a military environment concluded that jumping in low light or jumping with blindfolds increased factors associated with injury.[21,22]

The forward step down in low lighting simulates holding a weapon while stepping down from an obstacle. This was performed using an 8-inch step, two 12-pound hardcover books, and a penlight as the only illumination source in the room. The participant was told to step down using one leg at a time, first with the right side, then with the left side, while an investigator directed a penlight at the back of their legs for grading purposes. If participants were wearing a reflective belt, they were asked to remove it before starting the task to limit intensification of the light source.

Modified Feagin Hop Test

Single limb tests such as the triple hop, single leg hop, and crossover hop have been shown to detect deficits and reliably measure function following anterior cruciate ligament reconstruction.[23-25] The Feagin hop test is an assessment of low impact ballistic movement capability that was introduced to clinicians by COL (Ret) John Feagin, a noted orthopedist, as a simple clinical assessment. Although the test has not yet been reported or validated in the literature, variations of the Feagin hop test and other hopping tests have been shown to be reliable methods for identifying functional ankle instability.[26,27]

Before performing the test, the participant was instructed to hop up and down 2 times on both feet at a comfortable height. Next, the participant hopped twice on the previously uninjured lower extremity (if applicable). Finally, the participant hopped twice on the previously injured lower extremity (if applicable). If the participant did not have any previous lower extremity injury or history of bilateral lower extremity injury, the right side was tested first.

Modified Trunk Stability Push-Up

The trunk stability push-up is used as part of the FMS. Lower muscular endurance as indicated by poor form and few repetitions of pushups is linked to higher injury rates.[28] In the current study, we altered the hand position to chin-level for both genders. It is assumed that most female military members can perform a regular push-up, so adjusting hand position due to gender was not necessary for our participants.[6]

The participant was instructed to lay on his/her stomach with hands positioned shoulder width apart, and thumbs in line with the chin. The ankles were in a dorsiflexed or neutral position with toes on the ground. The participant was told to extend knees and elbows off the ground and maintain a rigid torso as it was raised into a push-up position.[10(p38)] The graders viewed the participant's trunk stability push-up from the side.

Modified Anterior Reach

The anterior reach task is used as part of the lower quarter Y-balance test. Side-to-side differences in the anterior direction during the Y-balance test have been shown to be predictive of lower extremity injury.[29]

Participants were required to remove shoes and socks for the event. A standard clinical measuring tape was adhered to the floor. The participant stood with the tips of their toes at the zero mark of the measuring tape, and reached forward along the length of the tape with their opposite foot. The participant was required to maintain their balance throughout the task in order for the trial to count.[8] He/she performed three practice trials on each leg, and then performed 3 graded trials on each leg, reaching with the right leg first.

Modified Hip Abduction

Hip abductor weakness has been linked to ankle injuries, iliotibial band syndrome, and low back pain.[11,30,31] The hip abduction test described by Nelson-Wong et al[11] ranged from 0 to 3 points and was determined by degrees of frontal plane motion, with zero being no loss of frontal plane motion and 3 points being severe loss of frontal plane motion. The grading criterion for this task

Table 1. Composite Score for Each Rater by Trial and Gender of Subjects.

	Primary Rater (Trial 1)		Primary Rater (Trial 2)		Secondary Rater (Trial 1)		Secondary Rater (Trial 2)	
	Male mean (SD)	Female mean (SD)	Male mean (SD)	Female mean (SD)	Male mean (SD)	Female mean (SD)	Male mean (SD)	Female mean (SD)
Composite Score	11.27 (2.27)	11.58 (3.00)	12.93 (1.38)	12.11 (2.15)	11.45 (2.22)	10.91 (2.64)	12.57 (1.55)	12.22 (1.39)

Note: The *t*-test revealed no significant differences ($P<.05$) between male and female subjects.

was modified to simplify grading for clinicians**.** Participants were given one point if they had any frontal plane deviations, and no points if they had any pain.

Participants were in a side-lying position on the plinth to perform the modified hip abduction task. They were instructed to put their bottom arm under their head, and top arm across their stomach or chest without using either arm to brace themselves against the plinth. The participant raised their top thigh and leg toward the ceiling, attempting to keep it in line with the body and keep the pelvis stable. The participant performed the test on the right side followed by the left.

Follow-Up Screening

Following completion of the RTD screening tool, participants were asked to schedule a follow-up appointment within 3-7 (mean=6.17) days to repeat the test protocol. Graders did not give participants feedback regarding movement patterns until after the second testing session.

Statistical Analysis

Both test-retest and interrater reliability were estimated using intraclass correlation coefficients (ICCs). Test-retest reliability of the overall screening tool between initial evaluation and follow-up evaluation was calculated using ICC (2,1) and 95% CIs. Interrater reliability of 2 different raters simultaneously evaluating the performance of each individual at baseline was calculated using ICC (2,1). Test-retest and interrater reliability of each individual task was calculated using kappa coefficients. Finally, Cronbach's α analysis was used to assess the internal consistency of the screening tool.

Results

Composite Scores

For the primary rater, the mean score was 11.26±2.35 during the first trial session and 12.43±1.47 during the second trial session. For the secondary rater, the mean score session was 11.38±2.51 during the first trial and 12.61±1.73 on the second session. Paired *t* tests revealed a statistically significant difference between composite scores from the first and second trial sessions for the secondary rater only, with *P* values of .058 and .041 respectively. The interrater reliability ($ICC_{2,1}$ (95% CI)) for the composite score based on the first trial session was 0.88 (0.78, 0.94). The test-retest reliability ($ICC_{3,1}$ (95% CI)) between the first and second trial session was 0.57, (0.21, 0.79). The standard error of the measurement for the composite score was 0.84 and 1.25 for interrater and test-retest reliability respectively. The minimum detectable change for the composite score at a 95% confidence level was 3.46. As shown in Table 1, there were no significant differences between male and female composite scores ($P<.05$).

Individual Events

Reliability estimates of individual events are listed in Table 2. Interrater reliability was highest for the anterior reach and the perceived risk events. The next highest values of interrater reliability were for the deep squat, stability push-up, and hop test. Systematic bias of the raters across each event was not statistically analyzed, but a graphical depiction of the average score given by each rater per event, shown in Figure 3, showed no consistent pattern. The test-retest reliability was highest for the perceived risk question and the stability push-up (Table 2). A Cronbach's α analysis was done to look at the internal

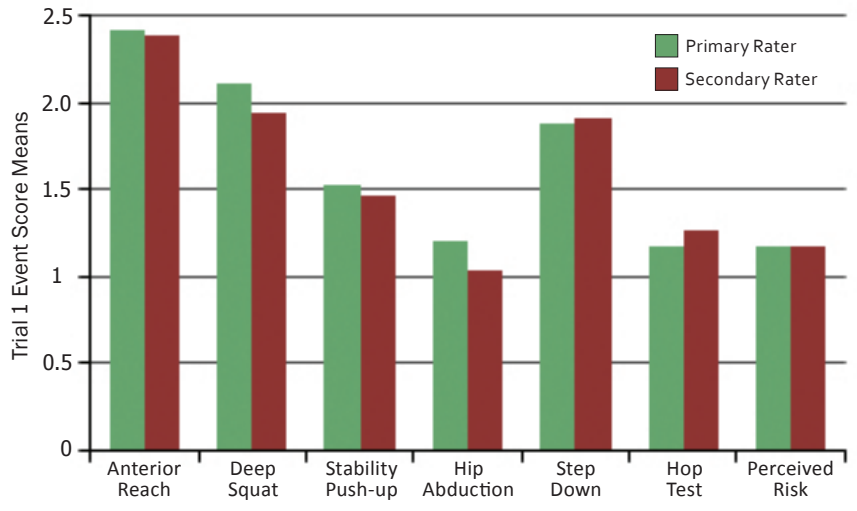


Figure 3. Individual event score means of the first trial for each rater.

Table 2. Mean Score by Gender of Subjects with Interrater and Test-retest Reliability for Individual Events.

	Male mean (SD)	Female mean (SD)	Interrater κ (CI)	% Agreement	Test-retest κ (CI)	% Agreement
Anterior Reach	2.50 (1.06)	2.25 (1.22)	0.93 (0.76,1.00)	97.1	-0.03 (-0.19, 0.17)	56.5
Deep Squat	2.00 (0.98)	2.33 (0.79)	0.57 (0.32,0.78)	70.6	0.51 (0.16,0.79)	69.6
Stability Push-up	1.68 (0.57)	1.25 (0.62)	0.67 (0.39, 0.89)	82.4	0.61 (0.24,0.90)	82.6
Hip Abduction	1.09 (0.53)	1.42 (0.51)	0.26 (-0.11,0.59)	70.6	-0.03 (-0.37,0.40)	56.5
Step Down	1.82 (0.39)	2.00 (0.00)	0.52 (-0.05,1.00)	91.2	0.45 (-0.07,1.0)	91.3
Hop Test	1.09 (0.61)	1.33 (0.65)	0.65 (0.37,0.85)	79.4	0.40 (0.03,0.74)	69.6
Perceived Risk	1.23 (0.53)	1.08 (0.51)	1.00 (1.00,1.00)	100.0	0.91 (0.70,1.00)	95.7

Note: The maximum score for the anterior reach and deep squat is 3; for all other events the maximum score is 2.

Table 3. Inter-item Correlation Matrix with Cronbach's α.

	Anterior Reach	Deep Squat	Stability Push-up	Hip Abduction	Step Down	Hop Test	Perceived Risk	Cronbach's α (if item deleted)
Anterior Reach	1.00							0.43
Deep Squat	0.04	1.00						0.47
Stability Push-up	0.12	0.16	1.00					0.52
Hip Abduction	0.16	0.20	-0.16	1.00				0.47
Step Down	0.31	-0.16	0.02	-0.03	1.00			0.50
Hop Test	0.33	0.44	0.07	0.43	0.25	1.00		0.33
Perceived Risk	0.24	0.08	-0.02	0.08	-0.05	0.09	1.00	0.49

consistency of all 7 items, detailed in Table 3. Inter-item correlations revealed the highest correlations between the deep squat and the hop test, as well as the hip abduction and the hop test. There were little to no correlations between the deep squat and anterior reach, hip-abduction and the step-down test, or the stability push-up with the step-down/hop test. Furthermore, the perceived risk question had no correlation with any event except anterior reach.

Comment

The purpose of the current study was to present and assess the reliability of a novel, gender-neutral, military-specific RTD screening tool that requires minimal training, equipment, and time. Results indicate that the composite RTD screening tool is fairly reliable when used by novice examiners, both across different raters and across different occasions. Reliability of individual events varied widely and ranged from excellent to no better than chance.

Reliability of Composite Scores

Interrater reliability, assessed between the 2 raters on the first trial session, was acceptable, indicating that entry-level clinicians can be trained on this tool and consistently grade individuals. Furthermore, there was no significant difference between male and female composite scores for this screening tool, indicating that it is gender-neutral. Graders are only required to learn one set of grading criteria that can be applied to male and female participants.

The test-retest reliability was substantially lower than interrater reliability, indicating only fair reliability. Closer inspection of composite score means revealed higher composite scores for both grader 1 and 2 on trial session two, which the authors at least partially attribute to a learning or training effect. This tool demonstrated lower test-retest reliability than the Functional Movement Screen which ranged from ICC=0.81 to 0.91.[32] While the reason for this in unknown, it could be that many of the events of the RTD screening tool are easier to perform than those of the FMS, which may allow for a small degree of improved performance during a second testing session. Test-retest reliability of the composite scores also could have been adversely affected by poor reliability of some of the individual events.

Reliability of Individual Events

The hip abduction test showed the lowest interrater reliability and also had poor test-retest reliability. This supports previous research that this task is not reliable and may indicate that it should be modified or excluded from future screening tools.[33] All other individual items showed moderate to good interrater reliability, again supporting the conclusion that the items included can be accurately assessed between 2 entry-level clinicians. This also adds support to previous studies, which have shown good interrater reliability among novice clinicians for the deep squat and the trunk stability push-up.[34-36]

Hip abduction, the anterior reach, the step down, and the hop test all showed poor test-retest reliability. This may

have been due to a learning effect. In the future, more practice trials should be allowed in order to establish a more accurate baseline. However, a restricted score range and prevalence bias may have also affected some of the items. For example, the step down test was scored on a scale from 0-2, but all participants scored either a 1 or a 2. Therefore, despite 91.3% agreement between trial 1 and trial 2, the reliability was still poor. It is interesting to note that hip abduction, step down, and hop tests (all of which had poor test-retest reliability) were also all scored on a 0-2 point scale. These tests may not differentiate between participants very well, making the information they provide less meaningful. In the future, including more items that have a wider range of variability may help to better screen participants. It also may make it more difficult for participant's improvements on the items to have such a large effect on the test-retest reliability.

Internal Consistency

Finally, a Cronbach's α analysis was done to look at the internal consistency of the screening tool. Unlike a questionnaire that aims to measure one construct, the RTD screening tool is meant to be an efficient combination of tasks, each of which measures different aspects of physical fitness. Moderate values of internal consistency are desired as this indicates that 2 tests are measuring different aspects of the same construct. The items with the highest inter-item correlation were the hop test and the deep squat, and the hop test and the hip abduction. This may suggest that these items were essentially looking at the same deficits and one or two of those items should be excluded from a future screening tool. Based on the findings of this study, it is recommended that, at a minimum, the hip abduction test be excluded from future tools due to low test-retest reliability and high correlation with items that were more reliable. The other items had lower correlations, indicating that most of the items were indeed assessing different components of functional movement.

Limitations and Future Research

Perhaps the largest limitation of the current study was highlighted by the finding of a likely learning effect between testing sessions. This might have been minimized by adding more practice trials prior to the first testing session. Additionally the grading scale used for this tool was purposefully inconsistent across events so that tests with stronger evidence were weighted more heavily than those with less evidence to support their use. A couple of events exhibited very poor reliability, which likely adversely affected the reliability of the composite tool. Lastly, having a restricted range for some items (scores 0-2) could be perceived as a limitation of the study.

The findings of the current study should drive improvements in the RTD screening tool. Future research should seek to analyze the predictive validity of an appropriately modified tool in determining those at risk of injury and potentially its convergent validity with the relative industry standard such as the FMS. This study serves as a starting point for developing a return to duty screening tool that can be reliably performed by any military clinician in an inexpensive and efficient manner.

Conclusion

This novel RTD screening tool showed good overall interrater reliability, suggesting that entry level clinicians trained on the grading requirements are able to reliably administer the tool. In addition, the screen showed gender-neutrality with no significant differences between males and females. In the future, the tool should be adapted to improve test-retest reliability.

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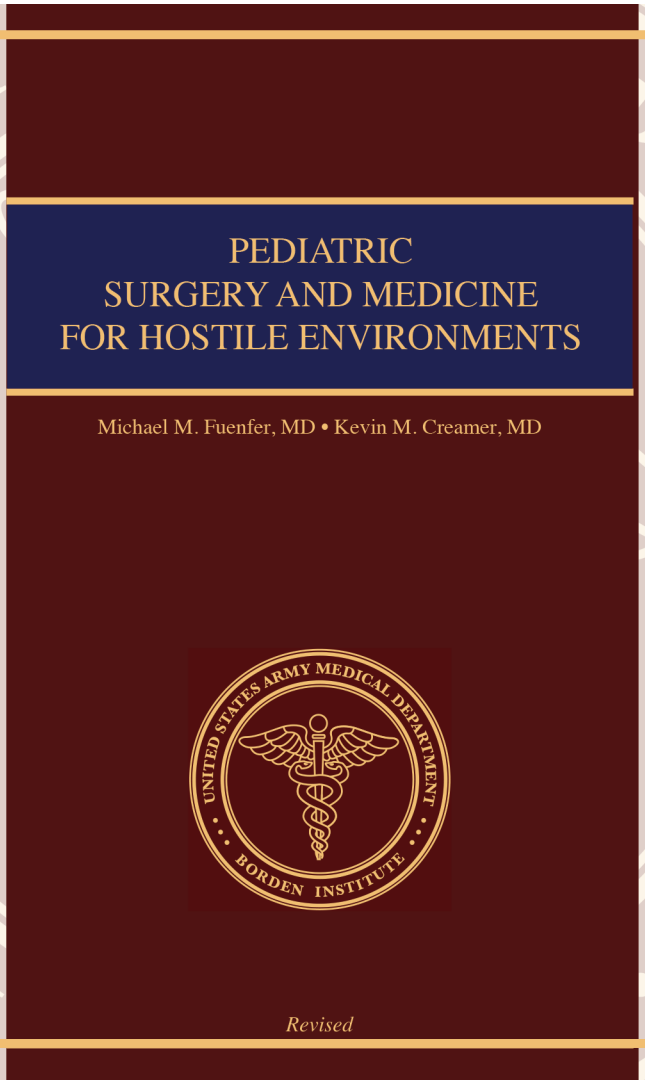

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Incremental Effects of Telephone Call Center and Healthcare Utilization Database Use to Improve Follow-up Rate in the Prevention of Low Back Pain in the Military Trial

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Abstract

Background: Studies that have relied exclusively on web-based surveys to secure follow-up have yielded inadequate follow-up rates, resulting in the need to explore whether supplementing with other methods results in incremental improvements. The primary purpose of this study was to determine the effectiveness of each follow up strategy that was used to collect the follow up data in our ongoing Prevention of Low Back Pain in the Military (POLM) trial.

Methods: This study represents a secondary analysis of the POLM trial. Twenty companies of Soldiers (N=4,325) were cluster randomized to complete one of four exercise programs. Since web-based response rates were lower than anticipated, a telephone call center was established to contact Soldiers who had not responded to the web-based survey. A military healthcare utilization database (M2) was also used to capture additional follow-up. Descriptive statistics and pairwise comparisons were performed to determine the incremental benefits of supplementing the primary web-based follow-up strategy in our ongoing POLM trial and determine whether differences existed in demographic characteristics, pain intensity, and low back pain incidence based on follow-up strategy.

Results: Of the 4,325 Soldiers who were enrolled, 632 (14.6%) subjects completed the monthly web-based survey only; 571 (13.2%) responded only to the telephone call; and 233 (5.4%) responded to both the web-based and telephone survey. Adding the telephone call center contributed 804 unique contributions to follow-up, increasing the overall follow-up to 33.2% (n=1,436) and resulting in a net 18.6% increase in follow-up rate. Querying the M2 database yielded follow-up data for an additional 2,788 Soldiers, increasing the follow-up rate by 64.5%. This rate, combined with the web-based and telephone strategies, resulted in an overall follow-up rate of 97.7%. Compared to the web-based survey, those who responded to the telephone call center tended to be younger, white, have a lower income, more likely to smoke, more likely to exercise regularly, and less likely to have low back pain (all with $P<.05$).

Conclusions: The results of this study can inform the design of future clinical trials by establishing the benefit of supplementing a web-based survey with a telephone call center to secure additional follow-up.

Achieving adequate follow-up in clinical trials is essential to establish the validity of study findings and reduce bias, helping to insure that the findings can be generalized to the population of interest and more accurately inform decision-making. Studies with low follow-up rates potentially confound interpretation by increasing the chance of attrition bias.[1] Low follow-up rates can further threaten external validity by impairing the ability of researchers to make clear scientific conclusions based on their data,[1] and follow-up rates that exceed 95% minimize the potential for attrition bias to exist, whereas follow-up rates lower than 80% pose a threat to external validity.[2,3] Even small losses to follow-up can bias a study's results if few individuals have the outcome of interest. Collectively, these issues make it imperative for researchers to conduct clinical trials that maximize retention.

Postal surveys and face-to-face interviews have long been used as a means to secure follow-up, and while more expensive than web-based surveys, they tend to yield higher response rates.[4] Due to the increasing application of technology in clinical research, web-based follow-up has become more popular in recent years, and

although potentially effective and less expensive than more traditional follow-up strategies, it is not without disadvantages.[4,5] For example, its effectiveness depends on having accurate email addresses to reach study participants and insuring emails are not delivered to "spam" folders. Web-based surveys also require that subjects have access to computers and be comfortable with technology, without which response rates are likely to be suboptimal.[4] Finally, the accuracy of subjects' responses has been shown to be lower with web-based follow-up methods compared to that received when subjects communicate directly with study staff.

Any single method to secure follow-up is likely to be inferior to follow-up approaches that use multiple follow-up methods.[6] Therefore, it seems logical to supplement follow-up in clinical trials with other available methods. For example, it is possible that supplementing follow-up further with a telephone call center could be a useful adjunct to further enhance follow-up. However, scant evidence is available to inform the extent to which each method contributes to overall follow-up rates in clinical trials. We recently completed the Prevention of Low Back Pain in the Military (POLM) trial, in which we used a novel web-based surveillance system to track subject response rate and record incidence and severity of low back pain (LBP) episodes among a group of geographically dispersed Soldiers in the US Army over a 2-year period.[7,8] Due to lower than expected follow-up rates,[9] we incorporated a telephone call center and healthcare utilization database to enhance follow-up among Soldiers who did not respond to the original web-based survey, providing a unique opportunity to determine the incremental benefits of supplementing our initially proposed web-based follow-up. Therefore, the primary purpose of this study was to determine if adding a telephone call center and healthcare utilization database to a web-based response strategy in our ongoing POLM trial increased overall follow-up. Secondly, we wanted to determine if differences in follow-up strategy existed based on demographic characteristics, pain intensity, and the incidence of LBP.

Methods

This study represents a secondary analysis of the Prevention of Lower Back Pain in the Military trial (NCT00373009) that has been registered at http://clinicaltrials.gov.[7] Soldiers (N=4,325) with no previous history of LBP were recruited from a military training setting from 2007 to 2008 and randomly assigned to receive traditional lumbar exercise, traditional lumbar exercise with psychosocial education, core stabilization exercise, or core stabilization with psychosocial education over a 12-week training period. The primary outcome for the trial was incidence of LBP resulting in the seeking of healthcare. At baseline, Soldiers completed standard demographic information (ie, age, sex, past medical history, etc) and factors related to military status (ie, current duty status [active duty, reservist, etc] and current location [within the United States or overseas]). Detailed methods and previous results from the POLM trial have been thoroughly described in previous reports.[8,10] The institutional review boards at the Brooke Army Medical Center (#C.2006.066) and the University of Florida (#130-2006) granted approval for this project. All subjects provided written, informed consent prior to their participation.

At the end of the initial 12 weeks of physical training, Soldiers were trained in a computer lab on the use of the web-based surveillance system to complete the monthly follow-up surveys. The purpose of these surveys was to record the incidence and severity of subsequent LBP episodes in the previous calendar month. Access to the web-based surveillance system was prompted by an email sent to the Soldier's official military email address on the 1st of each month. The web-based survey was initiated with an email prompting the Soldier to visit the study-hosted, confidential, secure website. Once the website was accessed, Soldiers were asked, "Have you had any back pain in the past 30 days?" A "no" answer ended the survey and Soldiers were thanked for their participation. A "yes" answer prompted the Soldiers to complete an additional set of 46 items about the back pain episode including duration, impact on work activities, whether healthcare was sought, and response to standard LBP-related questionnaires.[8,10] Soldiers were provided their login credentials during the initial training session, at the end of the 12-week trial, and in the monthly email reminders. If a Soldier did not respond to the first email, an additional email was sent on the 3rd of the month, and again on the 7th of the month if the Soldier still had not responded. Subjects were encouraged to complete monthly web-based surveys sent via email for 2 years following completion of the assigned intervention.

A telephone call center was established to contact Soldiers who had not responded to 3 monthly web-based surveys at the end of the first year. Call center personnel were comprised of graduate student personnel who attended a 45-minute training session and were provided a call center instructional pamphlet. Soldiers were queried as to whether they had current LBP or had experienced LBP since having completed the physical training component of the study. A "no" answer ended the survey and Soldiers were thanked for their participation. A "yes" answer prompted the Soldiers to answer

an additional 12 questions about the back pain episode, including duration, impact on work activities, whether healthcare was sought, and response to standard LBP-related questionnaires.[8,10] Call center personnel used a personal computer, headset, and commercial internet telephone (Skype) to make follow-up calls. Soldiers who had not responded to 3 monthly web-based surveys were called up to 3 times over a 2-week period to elicit follow-up, after which the subject was no longer contacted and considered lost to follow-up.

During the course of the trial, we found that response rates to the web-based and telephone call center surveys were suboptimal, thus it became incumbent to identify alternative strategies to procure additional follow-up. Therefore, in addition to the web-based and telephone call center surveys, the Military Health System (MHS) Management Analysis and Reporting Tool (M2 database) was used to determine LBP incidence because of its comprehensive nature in capturing healthcare utilization from the direct care system (care provided in military treatment facilities), network care (care provided at civilian facilities), and deployed regions such as Iraq or Afghanistan. The M2 database was searched for relevant LBP-related International Classification of Diseases (ICD) codes for Soldiers enrolled in the POLM trial using previously defined methods for operationally defining LBP using ICD codes.[11-15]

The primary dependent variable was whether a Soldier responded to a follow-up strategy. Independent variables were the 4 levels of follow-up strategy: web-based only (sent monthly to Soldier's email addresses), telephone only (contacted by call center personnel after no response from 3 monthly emails), health utilization database only (used for those not contacted by email or phone), or both web-based and telephone strategies (Soldiers who initially answered web-based surveys, but eventually stopped responding to web based and were contacted by the call center). Descriptive statistics were used to determine the number (percentage of total cohort) of Soldiers and their different respective follow-up strategies (Figure 1). Descriptive statistics were compared between the responders and nonresponders using two sample t tests or χ^2 tests, as appropriate. Pairwise comparisons were performed to determine differences in baseline demographic characteristics, pain intensity, and the incidence of LBP. The significance level was set at .05 a priori, and all statistical analyses were performed using SAS version 9 (SAS Institute, Inc, Cary, NC).

Results and Comment

Of the 4,325 enrolled Soldiers, 608 (14.1%) subjects completed the monthly web-based survey only; 571 (13.2%) responded only to the telephone call; and 257 (5.9%) responded to both the web-based and telephone survey (Figures 1 and 2). The web-based response rate prior to implementation of the telephone call center was 20.0% (n=865). Adding the telephone call center contributed 828 unique contributions to follow-up, increasing the overall follow-up to 33.2% (n=1,436) and resulting in a net 13.2% increase in follow-up rate.

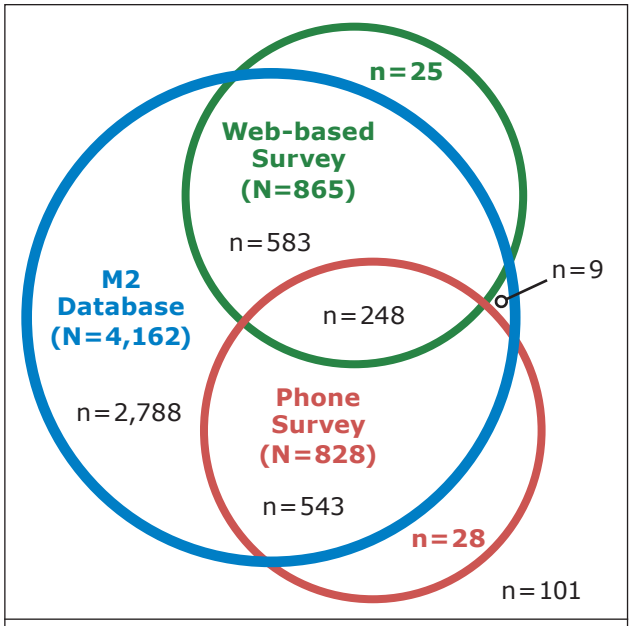

Figure 1. Venn diagram illustrating the intersection of total POLM subjects (n=4,325) based on follow-up strategy. Note that the total count for each circle (N) equals the sum of the 4 distinct components (n).

Querying the M2 database yielded follow-up data for an additional 2,788 Soldiers, increasing the follow-up rate by 64.5%. This rate, combined with the web-based and telephone strategies, resulted in an overall follow-up rate of 97.7%. Follow-up data from 101 subjects were not available for any method of follow-up (Figures 1 and 2).

Table 1 shows the comparison between Soldiers who responded to the monthly web-based survey only (n=608), those who responded only to the telephone call center survey (n=571), and those who responded to both surveys (n=257). Table 2 shows the comparison between Soldiers who responded to the monthly web-based survey (n=865, including those responded to both surveys) and those who responded only to the telephone call center survey (n=571). Among the 571 Soldiers who responded only to the telephone call survey, 203 (35.6%) reported having had LBP. Compared to the web-based survey, those who responded to the telephone call center tended to be younger, white, have a lower income, more likely to smoke, more likely to exercise regularly, and

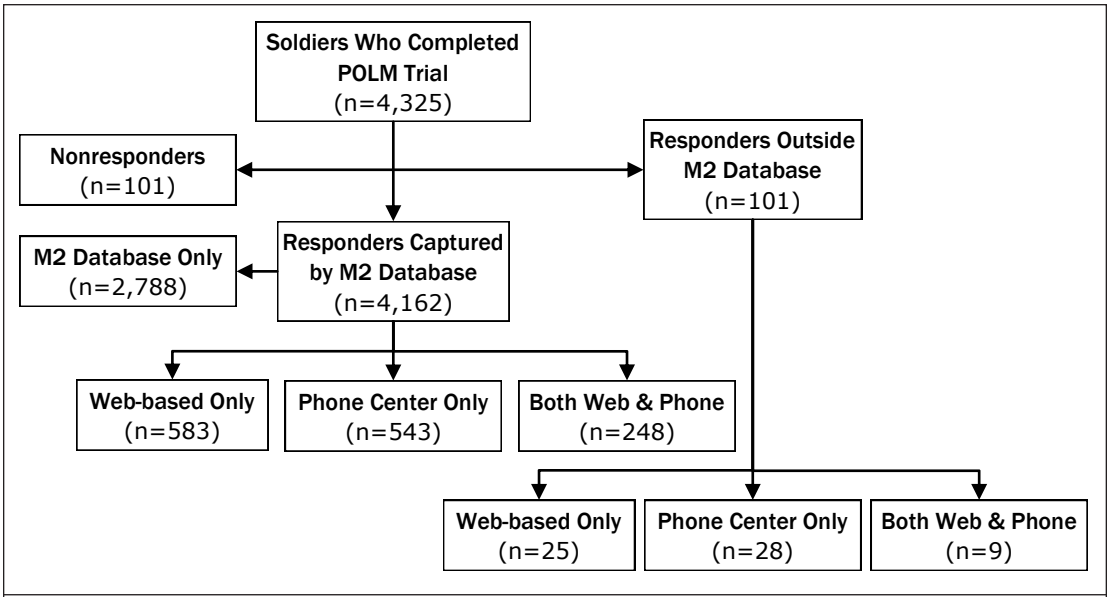

Figure 2. Flow diagram for total subjects and responders in POLM trial based on follow-up strategy.

less likely to have LBP (all with $P<.05$, Table 2). Among the 257 Soldiers who responded to both surveys (Table 1), 156 (60.7%) reported having LBP. Of those 156 Soldiers, 70 reported having LBP in both surveys; 30 responded as having LBP in the telephone call sweep but not the web-based survey; and 56 subjects responded as having LBP in the web-based survey but not the telephone call sweep.

When designing clinical trials, researchers must make important decisions about which follow-up methodologies to use, each of which has its own inherent strengths and weaknesses with respect to cost, ease of use, and success rate. It is also important to consider the known bias that exists in the characteristics of individuals likely to respond to web-based surveys. For example, in a previous secondary analysis from the POLM trial,[7] responders to the web-based survey were more likely to be older, white, have higher levels of education and income, are less likely to smoke, and have lower body mass index compared to nonresponders. Subjects who received individualized attention in the POLM trial based on having received detailed physical and ultrasound imaging examinations were also more likely to respond to the web-based survey. We found similar results when comparing differences in the characteristics of Soldiers who responded to the web-based survey versus the telephone call center. In particular, Soldiers who were stationed overseas were more likely to respond to the web-based survey compared to the telephone call center, presumably due to the difficulty of reaching Soldiers via telephone given time zone differences and lack of telephone accessibility.

The lessons learned in conducting the POLM trial gave us the opportunity to reflect on how the prevalence rates of LBP depend significantly on how of an incidence of LBP is defined (ie, patient reported vs having sought medical care, etc). For example, both the web-based survey and telephone call center queried Soldiers about their history of LBP via self-report. Although the identical question was presented, Soldiers might report LBP incidence and severity differently depending on whether the question was presented via the web-based survey versus orally via the telephone call center. Respondents to the web-based survey were in fact more likely to report LBP and higher levels of pain compared to respondents to the telephone call center. It may be that web-based surveys offer more perceived anonymity and respondents may have more time to contemplate their health history in a more relaxed setting in front of a computer, compared to answering the same questions asked by telephone call center personnel.

In contrast, the data available within the M2 healthcare utilization database necessitate using a definition based on Soldiers having sought healthcare for LBP, which is meaningful since the validity of self-report measures for determining LBP has been questioned for military populations.[16] Health policy experts also contend that using a healthcare-seeking definition of LBP is more reflective of national healthcare concerns based on studies indicating increasing rates of healthcare utilization for LBP[14,17] with trends of greatly increasing cost, but of no obvious benefit to the population.[15,18] One advantage of healthcare utilization databases is that follow-up rates are not dependent on voluntary participant response,

since their data is de facto included based on their having accessed the healthcare system as part of routine clinical care for reasons not associated directly with their participation in research. However, a comprehensive healthcare claims database will not always be readily accessible and may not contain study-specific outcome measures of interest to researchers, such as self-report questionnaires specific to the condition of interest.

Conclusion

The results of this study can inform the design of future clinical trials by establishing the benefit of supplementing a web-based survey with a telephone call center and emphasizing the value of comprehensive healthcare utilization databases. This study also highlights the importance of understanding that response rates may vary based on the use of different definitions of incidences of LBP. A few limitations from these data should be noted. For example, all Soldiers were either active duty or reserve military, thus the findings may not be generalizable to a civilian population. The results are also only applicable to outcomes that can be captured via self-report, as opposed to outcomes that require face-to-face contact (ie, physical examination, performance-based tests, etc).

Acknowledgments

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Table 1. Comparison of baseline characteristics and pain intensity information among 3 groups based on 2 surveys (those who followed-up).

Variable	Overall [N=1,436]	Monthly Web-based Survey Only* [n=608]	Phone Sweep Only* [n=571]	Web-based Survey and Phone Sweep* [n=257]	*P* value
Average Age mean (yrs)±SD	22.2±4.4	23.0±4.8	21.5±3.8	22.2±4.3)	<.0001
Gender					
Female	416	182 (30.1%)	148 (26.0%)	86 (33.5%)	.071
Male	1,015	423 (69.9%)	421 (74.0%)	171 (66.5%)	
Race					
Black	120	54 (8.9%)	44 (7.7%)	22 (8.6%)	.042
Hispanic	118	58 (9.6%)	42 (7.4%)	18 (7.0%)	
White	1,094	438 (72.3%)	456 (80.0%)	200 (77.8%)	
Other	101	56 (9.2%)	28 (4.9%)	17 (6.6%)	
Education					
High school or less	529	216 (35.5%)	226 (39.6%)	87 (33.9%)	.098
Some college	723	307 (50.5%)	287 (50.3%)	129 (50.2%)	
College graduate or beyond	184	85 (14.0%)	58 (10.2%)	41 (16.0%)	
Annual Income					
<$20,000	708	271 (44.6%)	309 (54.4%)	128 (49.8%)	.004
$20,000 or more	724	336 (55.4%)	259 (45.6%)	129 (50.2%)	
Military Status					
Active duty	683	318 (52.3%)	267 (46.8%)	98 (38.1%)	.001
Reserve	751	290 (47.7%)	302 (52.9%)	159 (61.9%)	
Other	2	0	2 (0.4%)	0	
Length of Service					
<5 months	818	352 (57.9%)	338 (59.2%)	128 (49.8%)	.046
5 months to 1 year	355	145 (23.8%)	128 (22.4%)	82 (31.9%)	
>1 year	263	111 (18.3%)	105 (18.4%)	47 (18.3%)	
Depression (BDI)	5.9±6.0	6.1±6.6	5.6±5.7	5.8±5.2	.378
Fear of Pain (FPQ)	18.1±5.6	18.3±5.8	17.9±5.6	18.1±5.4	.521
Back Beliefs (BBQ)	43.9±7.1	44.1±7.5	43.7±6.6	43.8±7.5	.679
Anxiety (STAI)	35.2±8.9	35.4±9.4	35.1±8.4	35.0±8.8	.738
Physical Health Status (PCS Total)	53.6±5.0	53.5±5.2	53.7±4.9	53.6±5.1	.693
Mental Health Status (MCS Total)	49.8±7.9	49.4±8.2	50.1±7.6	49.9±7.9	.273
Smoked prior to joining Army					
Yes	394 (27.4%)	163 (26.8%)	174 (30.5%)	57 (22.2%)	.042
No	1,042 (72.6%)	445 (73.2%)	397 (69.5%)	200 (77.8%)	
Exercise Routinely					
Yes	798	312 (51.3%)	341 (59.7%)	145 (56.4%)	.014
No	638	296 (48.7%)	230 (40.3%)	112 (43.6%)	
Low Back Pain (LBP)					
Yes	653	294 (48.4%)	203 (35.6%)	156 (60.7%)	<.0001
No	783	314 (51.6%)	368 (64.4%)	101 (39.3%)	
LBP Incidence Rate	234	100 (16.4%)	94 (16.5%)	40 (15.6%)	.941
Body Mass Index	24.7±3.1	24.7±3.1	24.7±3.0	24.6±3.4	.819
Physical Examination					
Yes	141 (9.8%)	73 (12.0%)	48 (8.4%)	20 (7.8%)	.056
No	1,295 (90.2%)	535 (88.0%)	523 (91.6%)	237 (92.2%)	

*Values in parentheses indicate %n.

BDI indicates Beck Depression Inventory; FPQ, Fear of Pain Questionnaire; BBQ, Back Beliefs Questionnaire; STAI, State-Trait Anxiety Index; PCS, Physical Component Summary of the SF-12 Health Survey; and MCS, Mental Component Summary of the SF-12 Health Survey.

Table 2. Comparison of baseline characteristics and pain intensity information between Soldiers who responded to the monthly web-based survey and those who only responded in the phone sweep survey.

Variable	Monthly Web-based Survey Only* [n=865]	Phone Sweep Only* [n=571]	*P* value
Average Age mean (yrs)±SD	22.8±4.7	21.3±3.8	<.0001
Gender			
Male	594 (68.9%)	421 (74.0%)	.038
Female	268 (31.1%)	148 (26.0%)	
Race			
Black	76 (8.8%)	44 (7.7%)	.028
Hispanic	76 (8.8%)	42 (7.4%)	
White	638 (73.9%)	456 (80.0%)	
Other	73 (8.5%)	28 (4.9%)	
Education			
High school or less	303 (35.0%)	226 (39.6%)	.028
Some college	436 (50.4%)	287 (50.3%)	
College graduate or beyond	126 (14.6%)	58 (10.2%)	
Annual Income			
<$20,000	399 (46.2%)	309 (54.4%)	.002
$20,000 or more	465 (53.8%)	259 (45.6%)	
Military Status			
Active duty	416 (48.1%)	267 (46.8%)	.200
Reserve	449 (51.9%)	302 (52.9%)	
Other	0	2 (0.4%)	
Length of Service			
<5 months	480 (55.5%)	338 (59.2%)	.238
5 months to 1 year	227 (26.2%)	128 (22.4%)	
>1 year	158 (18.3%)	105 (18.4%)	
Depression (BDI)	5.9±6.0	6.1±6.6	.378
Fear of Pain (FPQ)	18.1±5.6	18.3±5.8	.521
Back Beliefs (BBQ)	43.9±7.1	44.1±7.5	.679
Anxiety (STAI)	35.2±8.9	35.4±9.4	.738
Physical Health Status (PCS Total)	53.6±5.0	53.5±5.2	.693
Mental Health Status (MCS Total)	49.8±7.9	49.4±8.2	.273
SF-12 Total	103.1±8.7	103.9±8.1	.079
Smoked prior to joining Army			
Yes	220 (25.4%)	174 (30.5%)	.036
No	645 (74.6%)	397 (69.5%)	
Exercise Routinely			
Yes	457 (52.8%)	341 (59.7%)	.010
No	408 (47.2%)	230 (40.3%)	
Last APFT Score			
Below 150	2 (0.2%)	4 (0.7%)	.016
150-200	192 (22.2%)	96 (16.8%)	
200-250	404 (46.8%)	260 (45.6%)	
250-300	243 (28.1%)	198 (34.7%)	
Above 300	23 (2.7%)	12 (2.1%)	
Army Medical Profile			
Yes	169 (19.5%)	96 (16.8%)	.193
No	696 (80.5%)	475 (83.2%)	
Physical/USI Examination			
Yes	93 (10.8%)	48 (8.4%)	.056
No	772 (89.2%)	523 (91.6%)	
Low Back Pain			
Yes	450 (52.0%)	203 (35.6%)	<.0001
No	415 (48.0%)	368 (64.4%)	
Pain Rating	2.9±2.3	2.1±2.0	<.0001
The response number totals in the following sections of the table do not match the sample sizes (n) in the category columns due to incomplete data provided by respondents.			
Duty Status			
Active Duty	30 (39.0%)	195 (35.1%)	.602
Active National Guard and Reserve (AGR)	7 (9.1%)	43 (7.7%)	
Reservist/National Guard not currently activated	22 (28.6%)	178 (32%)	
Reservist/National Guard currently on active duty orders (not AGR)	9 (11.7%)	46 (8.3%)	
No longer in military service	9 (11.7%)	94 (16.9%)	
Location			
United States	70 (90.9%)	544 (98.7%)	<.0001
Overseas, not in combat pay area	2 (2.6%)	2 (0.4%)	
Overseas in combat pay area	5 (6.5%)	5 (0.9%)	

*Values in parentheses indicate %n.

BDI indicates Beck Depression Inventory; FPQ, Fear of Pain Questionnaire; BBQ, Back Beliefs Questionnaire; STAI, State-Trait Anxiety Index; PCS, Physical Component Summary of the SF-12 Health Survey; MCS, Mental Component Summary of the SF-12 Health Survey; APFT, Army Physical Fitness Test; and USI, ultrasound imaging.

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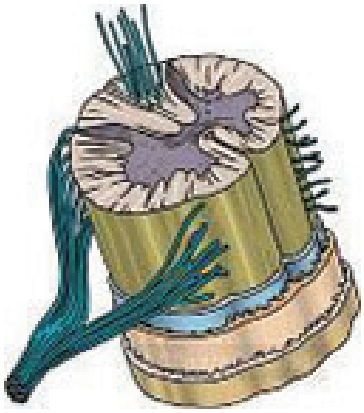

Using Evidence to Increase Compliance With Therapeutic Stretching for Chronic Low Back Pain

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Abstract

Purpose: In June 2012, a team of nurses at the Army's Landstuhl Regional Medical Center was tasked to generate an evidence-based practice recommendation for patients experiencing chronic low back pain (CLBP).

Methodology: Based on 14 articles, the evidence (*a*) validated the use of therapeutic stretching for control of CLBP, (*b*) identified specific modalities to increase patient adherence, and (*c*) supported military relevance. The team developed a questionnaire to assess previous experience with stretching exercises and preferred learning methods. Based on the responses from 32 patients, the initial goals included an increase in patient reported compliance within 3 months and a decrease in reported pain within 6 months. Long-terms goals targeted a 90% patient compliance in daily stretching regimen and a continued decrease in pain within 1 year.

Results: At 3 months, a 96% compliance rate was reported for patients returning for follow-up appointments; however, the average reported pain level did not decrease.

Implications: Similar clinics could benefit from methods/tools used in this project, especially where lack of compliance becomes a deterrent to quality of care.

Topic Selection and Forming a Team

A work group was formed in June 2012 to establish a topic of inquiry for an evidenced-based practice (EBP) project, as part of the requirement for completion of the Clinical Nurse Transition Program (CNTP) at the Landstuhl Regional Medical Center in Germany. The director of nursing encouraged selection of a topic from an outpatient setting since there was a relatively large number of inpatient EBP projects currently being implemented. The nurse manager at the Physical Medicine and Rehabilitation Center (PM&R) requested assistance in improving patient compliance with a stretching program designed to control pain for patients suffering from chronic lower back pain (CLBP). The final EBP team consisted of the 2 CNTP nurses, a mentor nurse scientist, the nurse manager of the PM&R, and 3 providers as stakeholders. The providers, as part of a nonpharmacological approach to treating lower back pain, prescribed the stretching program. The team followed the Iowa Model of Evidence Based Practice to Promote Quality Care[1] to guide the project.

Problem-Focused and Knowledge-Focused Triggers

The PM&R was a relatively new program established under the Department of Orthopedics. The mission of the clinic is to care for patients with a variety of muscle, tendon, joint, and nerve disorders using a patient-centered focus on improving the quality of life. Including the specialties of pain management, orthopedics, neurology, rheumatology, physical therapy, and occupational therapy, the clinic focuses on providing diagnostic and treatment methods to reduce pain and increase function. The mission and goal of PM&R were dictated by the Office of The Surgeon General Pain Management Task Force.[2]

The nurse manager acted as the primary point of contact and clinical expert of the PM&R. Her desire to improve the efficacy of prescribed therapeutic exercises motivated her outreach to the CNTP nurses. A meeting was set to discuss her concerns about the existing program and her suggestions for improvement. The PM&R staff had not previously attempted an EBP project and required education on the purpose, process, and goals of EBP.

During the initial meetings with PM&R staff, it was discovered that there had been little compliance tracking among patients, specifically concerning the use of therapeutic stretching. Further, due to the lack of standardization of practice among clinicians and the relative lack of continuity of care, it was difficult to ascertain what

exactly each patient was taught and by whom. These difficulties became the basis for the EBP project and the structure for forming the EBP guidelines.

PICO Development

Asking the right question is fundamental to an evidence-based practice project. The key components of the statement are captured in the pneumonic of PICO (population, interventions, comparison, and outcome). The development of the PICO statement was discussed and formal definitions for the project were accepted by the team. The identified population included patients seen at the PM&R suffering from CLBP. Adapted from a clinical standard,[3] CLBP was defined as pain, muscle tension, or stiffness lasting longer than 12 weeks. The intervention initially selected was the provision of nursing modalities to increase compliance with therapeutic stretching exercises. As a beginning evidence-based practice project led by novice nurses, the guidance focused on keeping the interventions within the scope of nursing practice. Nursing modalities were defined to be interventions and/or education performed by nursing staff to bring about a desired result. A baseline measure of the current practice, including compliance and pain level, was selected as the comparison. The outcome measures included compliance rate and pain level at selected time points after the intervention.

Synthesis of Evidence

An exhaustive literature review and article appraisal was conducted using the Army Nurse Corps Rating System for the Hierarchy of Evidence,* as well as the Johns Hopkins Nursing Quality of Evidence Appraisal.[5] The team critiqued a total of 14 articles. As shown in Table 1, the quality of the articles ranged from A (high) to C (low/major flaw). Article raters were 2 of the authors (D.R.G. and M.J.I.), both primary members of the team, as well as the nurse scientist. Each article was individually graded and then opinions of all 3 raters were compared for accuracy. Disagreements were discussed and consensus reached on the final rating given to each article.

There were 3 primary foci of the literature review. The first was to validate the use of therapeutic stretching for control of CLBP. The use of therapeutic stretching in the control of CLBP was not consistent among the clinicians. It was decided that to properly create clinical practice recommendations for increasing compliance, therapeutic stretching must be validated as an effective means of controlling CLBP. Five articles exemplifying the positive effects of therapeutic stretching were found (Table 2). The articles supported 3 basic conclusions:

- Use of therapeutic stretching in conjunction with prescribed pharmacological interventions decreased patient reported pain.
- A well-designed and regularly implemented stretching program decreased patient reported CLBP.
- Specific exercises and expected duration of a program remained unknown.

The studies were inconclusive as to which exact exercises and what length of time was optimal to have the greatest effect on CLBP; rather, it was concluded that as long as some muscular skeletal exercise was completed regularly, then favorable results could be achieved.

The second focus of the literature review discovered modalities to increase patient adherence to medically prescribed interventions for back pain. Originally, the team focused primarily on searching literature regarding increasing compliance to stretching exercises designed specifically for CLBP. However, due to the relatively low number of articles found, the team expanded the search to discover a principle behind increasing compliance for any medical interventions. Review of a total of 7 articles (Table 3) generated the following conclusions:

- Physician involvement in the instruction of the prescribed exercise regiments aided in establishing patient confidence.
- Supervision of patients are in their first attempts is important.
- Patients are more likely to comply when the disease process and therapeutic effects of therapeutic interventions are explicitly explained.
- Patient testimonials aided in establishing confidence in the therapeutic prescribed interventions.

Table 1. Synthesis of Evidence Critique of All Articles.

Level of Evidential Strength	Number of Studies	Overall Quality
Level I: Systematic reviews, meta-analysis of RCTs, EBP clinical practice based on systematic reviews of randomized controlled trials	4	4A
Level II: Well-designed randomized controlled trials	5	3A/2B
Level III: Well-designed controlled trials without randomization	0	N/A
Level IV: Well-designed case-control and cohort studies	0	N/A
Level V: Systematic reviews of descriptive and qualitative studies	0	N/A
Level VI: Single descriptive or qualitative study	5	5A
Level VII: The opinion of authorities and/or reports of expert committees	0	N/A

*Internal use document, not readily accessible by the general public. It is based on the Melnyk & Fineout-Overholt rating scale.[4]

Table 2. Evidence Supporting Use of Therapeutic Stretching for CLBP.

Source (article title)	Relevance	Level
Back Schools for Non-Specific Low-Back Pain [review][6]	Therapeutic stretching and regular medical interventions reduced CLBP.	I/A
Exercise Therapy for Treatment of Nonspecific Lower Back Pain[3]	Supports use of therapeutic stretching for control of CLBP.	I/A
Systematic Review: Strategies for Using Exercise Therapy to Improve Outcomes in Chronic Low Back Pain[7]	Supports use of individually designed therapeutic stretching for control of CLBP.	I/A
Effects of Motor Control Exercises Versus Graded Activity in Patients With Chronic Nonspecific Low Back Pain: A Randomized Controlled Trial[8]	Supports need for a well-designed therapeutic stretching program for control of CLBP.	II/A
A Randomized, Controlled Trial of Manual Therapy and Specific Adjuvant Exercise for Chronic Low Back Pain[9]	Supports use of therapeutic stretching for control of CLBP.	II/B

Table 3. Evidence Supporting Adherence to Interventions.

Source (article title)	Relevance	Level
Interventions to Improve Adherence to Exercise for Chronic Musculoskeletal Pain in Adults[10]	Adherence not affected by type of exercise prescribed.	I/A
Self-management of Chronic Neck and Low Back Pain and Relevance of Information Provided During Clinical Encounters: An Observational Study[11]	Supports education on disease process and benefits of therapeutic exercise for increasing patient compliance.	II/A
A Randomized Study of Serial Telephone Call Support to Increase Adherence and Thereby Improve Virologic Outcome in Persons Initiating Antiretroviral Therapy[12]	Telephone reminders increase patient compliance.	II/B
A Cognitive Behavioral Intervention to Increase Adherence of Adult Women Exercises[11]	Provides modalities to increase patient adherence.	II/A
How Do Care-Providers and Home Exercise Program Characteristics Affect Patient Adherence in Chronic Neck and Back Pain: A Qualitative Study[14]	Importance for professional presentation of instructional content.	VI/A
Managing Time: An Interpretative Phenomenological Analysis of Patients' and Physiotherapists' Perception of Adherence to Therapeutic Exercises for LBP[15]	Supports provider designed daily stretching programs for aid in time management.	VI/A
Mechanical Diagnosis and Therapy in Back Pain: Compliance and Social Cognitive Theory[16]	Supports the need for supervised instruction of therapeutic stretching.	VI/A

Table 4. Evidence Supporting Military Relevance

Source (Article Title)	Relevance	Level
Diagnosis and Mechanism of Musculoskeletal Injuries in an Infantry Brigade Combat Team Deployed to Afghanistan Evaluated by the Brigade Physical Therapist[17]	Establishes relevance to patient population seen at PM&R.	VI/A
Back Pain During War[18]	Establishes relevance to patient population seen at PM&R.	VI/A

- Some form of reminders, whether personal or electronic, encouraged the consistent use of the prescribed interventions.

The third focus of the literature review involved establishing military relevance and justification for exploration at a military treatment facility. Two articles described the effects of chronic lower back pain on military personnel (Table 4). Three conclusions were drawn from these articles:

- The more combat oriented the branch, the higher the prevalence of CLBP.
- Combat effectiveness and mission readiness decreased when Soldiers suffered from CLBP.
- Healthcare costs increased sharply when Soldiers struggled with CLBP.

Collection of Baseline Data

Based on the conclusions from the literature review, the team created a needs assessment questionnaire, presented as Figure 1, to gather data on 3 major areas: patient demographics, patient perception of therapeutic stretching, and preferred methods of communication. For convenience, the questionnaire was given to all patients seen at the PM&R. Baseline questionnaires were distributed and collected for one month. A total of 32 questionnaires were returned from patients seen for CLBP at a rated pain of 5 or less on a scale of 1 to 10. The

Figure 1. Needs Assessment Questionnaire

Physical Medicine & Rehabilitation (PMR) Patient Survey v2Nov2012

Please take a few minutes to fill out this ~19 question survey so that we may better assist you with your exercise program for your lower back pain. **Once completed, please drop this survey in a box located in the reception room.**

General Patient Information

Age:_____ **Service:** Air Force, Army, Navy, Marine, Civilian **Component:** Active, Reserve, NG, N/A

Years in Service:_____ **Length of Time with Injury (in weeks):**_____ **Date of Last Visit to PMR:**_____

On a scale from 0-10 how would you rate your pain over the last week, with 0 being no pain and 10 being the worst? _____

How often have you visited the PM&R within the past month? O First Visit O 2-5 Visits O >6 Visits

Are you being seen for low back pain today? O Yes → Please continue with the survey
O No → STOP! Please drop the survey in the box

Stretches

Have you received information/instruction about stretching exercises for your chronic low back pain during any of your visits with your provider? O Yes O No

If yes, what method of instruction was given to you? Mark all that apply.

O Face to Face Demonstration O Handout O Video O Email O Other:_____

If yes, how often were you instructed to do the exercises?

O Every day O Every week O Every 2 weeks O Every month

If yes, how would you rate the difficulty of the stretching exercises you were given?

O O O O O O O
Very Easy Very Difficult

If yes, were the stretching exercises adequately explained? O Yes O No

Overall, how often did you complete the recommended stretching exercise as instructed?

O <25% of the time O 50-75% of the time O >75% of the time

Physical Medicine & Rehabilitation (PMR) Patient Survey v2Nov2012

What are the biggest deterrents to regularly completing the stretching exercises? Mark all that apply.

O Actual Pain O Time Constraints O Forgetfulness O Fear of Causing Pain O Other:_____

What is your preferred method of teaching for the stretching exercises? Mark all that apply.

Video (youtube format) Demonstration O
Written Instruction O
Verbal Instruction O
One-on-one Instruction O
Group Instruction O

How much time a day would you realistically give to your stretching exercises?

O 5-10 mins O 10-20 mins O 20-30 mins O >30 mins O Other:_____

Communication

In general, what is the best way to communicate with you? O By phone call O By Email O By text message

Would you like a reminder sent to you to complete your stretching exercises? O Yes O No

If a reminder was sent, how often would you prefer a reminder to do your stretching exercises?

O Every day O Every week O Every 2 weeks O Every month

If a reminder was sent, what is the best method for you? O By phone call O By Email O By text message

Additional Feedback

Please make any suggestions that would assist us in your exercise program for chronic low back pain.

_____
_____
_____
_____
_____

~Thank you for taking the time to complete this survey.
We sincerely appreciate your feedback. ~

data from these 32 questionnaires were gathered into a spreadsheet and used to formulate the EBP recommendations. At baseline, 63% of the patients had received education on therapeutic stretching exercises. Of those who received the instructions, 85% completed the exercises 50% or more of the time. Furthermore, patients preferred one-on-one instruction (70%) with reminders sent weekly (65%) via email (65%). Two-thirds of the respondents (66%) stated that they would have 20 minutes or less available for daily exercises.

Pilot the Change in Practice

Based on the literature review, the needs assessment, and the goals presented to the PM&R staff, the following EBP guidelines were created formulating the recommendation for change in practice:

- Standard instructions among all healthcare providers, including written instruction for further reference.
- Physician provided explanation of the disease process and therapeutic stretching benefits, reinforced by nursing staff.
- Weekly compliance reminders via email.

The 2 short-term goals established from the data were a 25% increase in patient reported compliance within 3 months of implementation and a decrease in patient reported pain within 6 months, by at least a factor of 1 (0 being no pain to 10 being the worst pain ever experienced). The 2 long term goals established were a 90% patient compliance to daily therapeutic stretching and a continued decrease in pain by a factor of one within one year of implementation. The goals were generated based on the data collected from the needs questionnaire, as well as the input of the staff and stakeholders.

The EBP team narrowed the population for the pilot implementation to the patients seen by one physician. Based on the provider stakeholder preferences, 4 therapeutic stretches compiled from the US Army Medical Command pamphlet *Managing Low Back Pain: VA/DoD Clinical Practice Guidelines*[19] were selected as part of the intervention. The team created a 2-sided instruction sheet (Figure 2) to aid patients in understanding and completing the stretches. The front side of the instruction sheet detailed the 4 selected exercises and proper execution. The back side presents the rationale for the stretches and information about disease process of CLBP, as well as a weekly log for patients to track their progress. Additionally, the nurse manager arranged for weekly reminder emails to be sent to all pilot patients. A complete protocol was created that included the 4 stretching exercises, the patient education pamphlet, and specific instructions to the staff on implementation. Prior to implementation, the protocol was reviewed and evaluated by the medical director of the PM&R. After approval was received, the EBP team held a staff meeting to review the guidelines with the PM&R staff and answer all questions.

Is Change Appropriate for Adoption into Practice?

A revised questionnaire was released to patients to track the progress and compliance of the EBP guidelines starting at one month and continuing to 3 months after the implementation. Of the 45 participants completing the questionnaire during a follow-up visit, 43 reported completing the exercises 50% or more of the time (96% compliance rate). However, reported pain was unaffected, with the average pain rating at 5. Based on the data received, 2 modifications were made to the instruction worksheet to accurately measure the goals. The team attempted to collect the data again at about the 12-month period, with only 5 questionnaires returned. All 5 participants reported receiving instructions on the therapeutic stretching exercises, including explanation of the importance, demonstration, and the developed handout (Figure 2). Overall, the participants considered the instructions easy to read, easy to understand, and useful. Since the majority of these participants were on their first visit to the clinic, compliance and pain levels could not yet be applied as outcomes from the exercises. The clinic staff, however, remained 100% compliant with providing the exercises per the protocol.

Limitations

Several limitations and challenges were identified throughout the project. The first, and most significant, was gathering the patient data for baseline and outcome measures. Although the needs questionnaire provided the easiest method for collecting the appropriate data, encouraging patient participation was challenging. Due to limited staff in the PM&R and current systems, tracking patients seen by only one of the providers for CLBP was difficult. To address this problem, baseline questionnaires were gathered from 61 patients seen in the clinic for any diagnosis, of which only 32 fit the inclusion criteria.

A second limitation noted was tracking staff compliance to the protocol. It was clear from the second needs questionnaire that patients were given instruction on the performance of stretches. During audits at the clinic, however, the CNTP nurses overheard variances in how the instructions were given. Corrections were made at the time. Consistency in that instruction was difficult to determine, so it became difficult to accurately assess ways to improve the EBP recommendations.

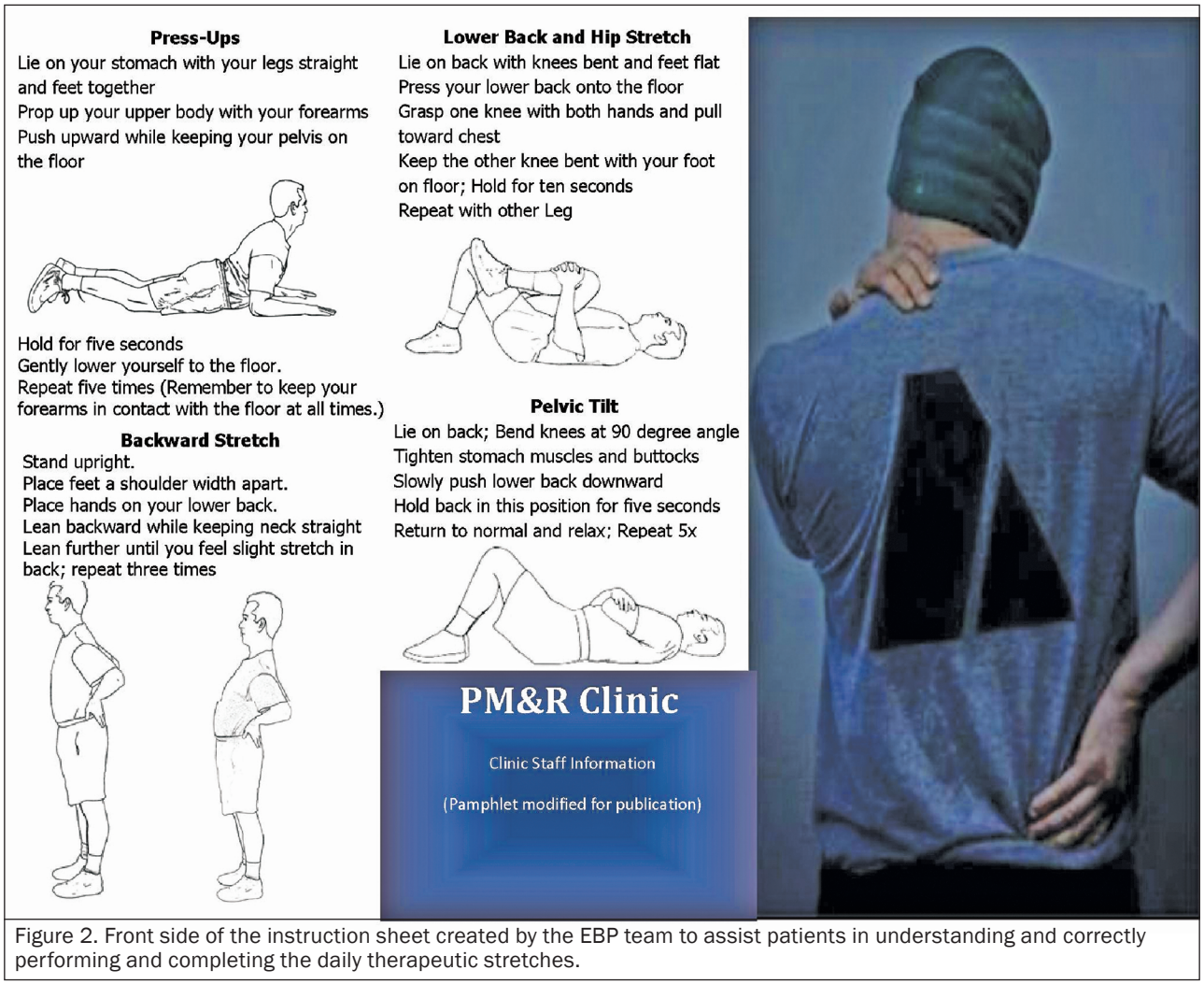

Figure 2. Front side of the instruction sheet created by the EBP team to assist patients in understanding and correctly performing and completing the daily therapeutic stretches.

Although initially implemented as nursing modalities, the instruction was primarily reinforced by the medical technicians rather than nurses. This was due to the limited availability of the PM&R's only registered nurse (RN). Admittedly, the RN oversaw the instruction on the majority of cases and ensured project parameters were met. The EBP team members also ensured all technicians were proficient in instruction. Additionally, the CNTP nurses were only allocated one day per month to assist in the process at the PM&R clinic. In order to assist the PM&R clinic on the assigned day, each CNTP's ward census/patient acuity had to be taken into consideration.

According to the final data gathered from the needs questionnaires, patient reported pain did not decrease. Although this was a goal of the project, the overall focus of the EBP—to increase compliance—was unaffected. Many factors may have contributed to the lack of effect on pain, one of which is the consistency and use of pharmacological interventions. This was not tracked and should be taken into consideration in any focus on decreasing overall pain, as the data from the literature review suggests.

Finally, funding constraints eliminated positions of two of the participating providers. Therefore, only one practitioner who saw patients with CLBP continued participation, greatly reducing the number of patients being seen at the clinic. Due to the low volume of patients with CLBP, very few outcome questionnaires were collected at the 12-month point. Even so, the project has continued and the protocol is still used by the clinic staff.

Implications

Patient compliance to medically prescribed interventions is vital to ensuring the highest quality of care. Recognizing this importance, the EBP team strove to understand the challenge specific to the PM&R clinic and to discover ways of reducing the lack of compliance. Furthermore, the prevalence of CLBP among Soldiers presents a significant challenge for military medicine. The EBP recommendations signified a bold effort to

improve the quality of care provided at the PM&R. The methods and tools used in the project may be used in similar clinics where low levels of compliance are a contributing factor to decreased quality of care.

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US Military Drawdowns 1970-1999: Army Medical Department and Military Health System Responses

Sanders Marble, PhD

As the US Army contends with manpower and budget cuts in the medium term, the Army Medical Department (AMEDD) will have to adjust to the consequential effects on its budget, manning levels, and operational capabilities. From the 1970s through the 1990s, the AMEDD coped with waves of cuts, finding new ways to operate and deliver increasingly sophisticated care with budget pressures and fewer personnel. While many of these specific responses cannot be repeated, a review of them may generate some ideas for the future while reminding us that painful cuts can be absorbed.

Background

From the American Revolution through World War II, the United States military mobilized for war and demobilized afterwards. Following the Revolution, the Army was reduced to 80 men; after the Civil War to around 25,000 men; and following World War II, from 8.3 million in mid-1945 to 684,000 in mid-1947, and 591,000 in mid-1950. There was proportionally less drawdown after the Korean War because there was no longer mobilization time in US doctrine—the US military switched from a defense philosophy of mobilization after a declaration of war to maintaining a substantial force during periods of relative peace. The Army was 1.5 million strong in 1953, but although it was reduced in following years, it remained a robust 900,000 in 1959. End strength rose to over 1.5 million in 1968, but shortly thereafter downsizing began and continued into the 1970s. Army strength stabilized in the late 1970s, but was substantially cut again in the early 1990s. Not surprisingly, the AMEDD faced its own cuts in these periods.

The AMEDD used various coping strategies:

- The AMEDD explored the use of less-expensive personnel to perform tasks; for example, physician assistants and nurse practitioners instead of physicians. This worked, but only to the limit of adversely affecting the standard of care.
- When military manpower was reduced, the AMEDD frequently hired civilians to replace lost personnel. This was successful when civilian personnel budgets were not under the same pressure as military headcount.
- The AMEDD shared programs and resources within the Military Health System (MHS). This worked in places (such as the Delaware Valley Health Services System) and not in others (such as the 1987-1991 Joint Military Medical Command in San Antonio).
- The AMEDD and MHS have sought to share resources with the Veterans Administration (VA) and other Federal healthcare systems. This has generally worked, but has avoided costs (for example, duplicate CT scanners) rather than reduce them.
- The AMEDD explored shifting costs onto the CHAMPUS/TRICARE network. This worked in the 1970s, but became more troublesome when CHAMPUS budgets were centralized.
- Eliminating some functions: the AMEDD no longer performs physical examinations at Military Entry Processing Stations, and US Department of Agriculture inspectors examine foods at plants. However, Army requests for the VA to perform some examinations were unsuccessful.
- Facilities were downsized or closed when the active duty population was reduced and/or moved.

The 1970s

The 1970s drawdown had elements of both coping with declining forces and seeking ways to recruit more personnel. The former of these seems more relevant to the near future, and recruiting methods are not covered here. This study was also limited by availability of material.

Background Factors of the 1970s

By 1970, American involvement in the Vietnam War was declining and the Department of Defense (DoD) was downsizing; there were fewer patients in Army hospitals in 1971 because the Army was shrinking. Total military numbers (both active and reserve) fell and the All-Volunteer Force replaced the draft. However, the number of medical beneficiaries increased, albeit slightly, through the 1970s. The armed forces had to simultaneously manage personnel reductions while enticing substantially more recruits. Some personnel who wanted to stay in the military were discharged and others were allowed to remain but accept a reduction in rank,

including reversion of officers to enlisted status.* Inflation, including medical inflation, was high and drove prices and wages substantially higher while the government was trying to reduce military spending. American medical practice was changing to increased outpatient treatment, but inpatient hospitalization also decreased (both in numbers of hospitalizations and length of stay) due to a broadening pharmacopeia and increasing hospitalization costs. Medicine was more physician-centered, with few physician-extenders in the Army at the beginning of the period.

AMEDD Coping Strategies in the 1970s

Even before the drawdown, the AMEDD argued persuasively that it needed to expand. The Chief of Staff of the Army proactively sought to address factors that would undermine the All-Volunteer Force, and the AMEDD argued that long waiting periods and poor facilities would be detrimental to both the AMEDD and the Army as a whole. In early 1971, the Vice Chief of Staff approved a 10.6% increase in AMEDD manning. It is not clear if the AMEDD achieved this personnel growth, but even if vacant authorizations were eventually lost, they presumably cushioned somewhat against actual personnel cuts.

The AMEDD sought, and found, some alternatives to physicians. The AMEDD had 7,000 doctors in 1969, and 4,056 in 1977, many of whom were interns and residents with practice limitations. Alternatives had to be found, especially with the growth of the beneficiary population. Some examples:

- Medical Service Corps (MSC) sanitarians were substituted for roughly 40% of preventive medicine physicians.[1]
- MSC officers were placed in command and staff positions, albeit sparingly.[2,3]
- Fewer physicians were assigned to field units in peacetime, as the Professional Filler System† was designed to fill those unit requirements in wartime.[3,5] However, this had unanticipated ramifications; since mid-rank physicians received fewer command/staff positions, few were ready for deployment as unit commanders during Desert Shield/Storm in 1990-1991. This in turn led to branch-immaterial command for qualified officers in the mid-1990s.
- MSC and Veterinary Corps (VC) officers were assigned to some medical research and development positions.[6]
- Psychologists and social workers were used where possible for psychiatrists.[7] Occupational therapists also became increasingly involved with behavioral healthcare patients.
- Physical therapists (PTs) were used to screen (and treat) some back pain and many orthopedic patients rather than first sending them to orthopedic surgeons.[3,7] In FY1979, PTs saw 6.6% of all outpatients, especially basic trainees with musculoskeletal injuries.
- Physician assistants were recognized beginning in 1970 as a viable alternative to a second physician in maneuver battalions, and the Army began training and using them. Numbers were relatively small, but increased from zero in the Health Services Command (HSC) in 1973 to 92 in 1979.[3,8]
- Nurse practitioners (including midwives) were gaining acceptance in American medicine and the Army began training and employing them. Numbers in HSC rose from 69 in 1973 to 203 in 1979.[8] Community health nurses replaced physicians as head of occupational health divisions in some hospitals.[9] Some community health nurses working in the tuberculosis program were authorized to write refills for isoniazid.[10]
- Civilian physicians were hired as government service (GS) civilians or contracted. The HSC had 200 GS physicians and 10 contractors in 1973 and 453 GS and 55 contractor physicians in 1979.[8]

Over 3,000 AMEDD military positions were civilianized, with both GS and contractors, from FY1965 to FY1967, and there were approximately 5,000 more by FY1975. By the beginning of FY1975, the ratio of enlisted to civilians in HSC was 39:61.[11] There were limits to this. Since many military personnel from military treatment facilities (MTFs) would join field units on mobilization, civilianizing positions jeopardized support of units in the field. The situation was reflected in the HSC response to one Army study:

> The decision maker who decides to further reduce AMEDD manpower resources must be willing to warn the combat Soldier that appropriate health care services in all probability will not be available to him on the next field of battle.[8]

However, one function was entirely civilianized. Medical examination of recruits of all services at Armed Forces

*Reversion of officers to enlisted status was ended by the Defense Officer Personnel Management Act (DOPMA), Pub L No. 96-513, passed in 1980, which implemented a standardized officer personnel management structure across DoD.

†The Professional Filler System, commonly known as PROFIS, predesignates qualified Active Army AMEDD personnel to fill positions in early deploying and forward deployed Army medical units supporting Unified Combatant Commands upon mobilization for execution of an operations plan or a contingency operation, or for the conduct of mission-essential training.[4]

Entrance and Examination Stations had been conducted by AMEDD personnel. Those physician requirements were civilianized with no apparent problems.

There were efforts to save money by cutting personnel grades. In FY1971, there was an effort to save money by downgrading civilian positions to counteract grade inflation.[12] In 1976, the General Accounting Office (GAO) recommended cutting the grades of officers (especially at the O6 level) and reducing the number of officers.[13] A few military positions were downgraded from officer to enlisted[11] and some VC food inspection positions were downgraded to warrant officers.[14]

Caricature used in antismoking and other harmful lifestyle awareness campaigns in the *HSC Mercury* newsletter, February 1977.

There were also efforts to reduce demand for medical care.

- Substantial health promotion efforts included antismoking campaigns, antidrinking campaigns, advice on nutrition, advice on exercise, warnings about atherosclerosis, and advice on avoiding loud noises and hearing conservation. These could be blunt, as shown in the Figure, and include headlines common today, such as, "Many US Children are Overweight."[15-21] Available data does not indicate results, but notwithstanding the effectiveness of these efforts, many patients still required care by the HSC.
- An entire category of civilian employees, Community Health Dental Hygienists, was approved to encourage dental hygiene and prevent clinic visits. However, the need for personnel in clinics was so pressing that these positions were gradually converted into ordinary hygienists.[22]
- The Occupational Safety and Health Act (Pub L No. 91-596, 84 Stat 1590) was passed in 1970, implementation of which created work for the AMEDD, but presumably reduced patient numbers over the long term.
- The AMEDD proposed raising medical and dental standards for recruits. The theory was that higher entry standards should reduce the amount of healthcare they would need early in their careers.[23] There is no indication if this was adopted, but the proposal seemed to run counter to helping the broader recruiting problems of the 1970s.

Some healthcare was administratively required, and could be reduced by changing the requirements. Instead of annual physical examinations, the AMEDD argued for periodic examinations.[23] This proposal was accepted, resulting in the requirement for an examination every 5 years. It also sought to reduce documentation and expedite "Existed Prior To Service" separations. The effect of these initiatives is not clear.

With a smaller Army, programs and facilities were closed or reduced in scale. Reduction in the number of available facilities resulted in reduced capability for mobilization and casualty care for potential major wars. The DoD responded to this by working within the government, primarily the VA, and the civilian sector to establish what is now the National Disaster Medical System.

Several recruiting programs that counted against end strength were eliminated. These included one that commissioned medical students while they were in school, and the Walter Reed Army Institute of Nursing. Replacement programs did not count against end strength.

Research, dental, veterinary, and environmental health laboratories were cut. It is not clear how much of this was related to the smaller Army reducing workload; how much closed/downsized posts changed the distribution of work; and how much to accepting increased costs in temporary assignments of personnel and shipments of samples in order to reduce numbers of personnel and facilities.[8]

Where posts closed, hospitals and clinics were closed, such as hospitals in the Panama Canal Zone and 30 clinics at Nike-Hercules air defense missile bases. The Base Closure and Realignment (BRAC) process did not yet exist, and Congressional attention could delay and/or stop individual closures. Briefings were required for members of the US House of Representatives where the justifications were explained. This was done through a process called the Case Study and Justification Folder. However, political pressure countered a number of AMEDD plans for closures. For example, the planned 1979 closure of Letterman Army Medical Center in San Francisco did not happen; it remained open until 1994.

Some hospitals on surviving posts were converted to clinics, such as Dunham Army Hospital at Carlisle Barracks, PA. This was facilitated by the shift from inpatient care to outpatient care. It appears this also was

briefed to Congress, but may have met less resistance. One general hospital (the equivalent of a medical center), the Valley Forge General Hospital, was closed, but the closure was balanced by upgrading the Eisenhower Army Hospital at Fort Gordon, GA, to a medical center.

Proposals to provide certain types of healthcare using contractors were considered. Occupational health clinics were the easiest category to approve, and the concept of hiring civilians to run facilities including small hospitals was studied as well. This was an open-ended idea, which considered civilian hospitals, medical schools, group practices, or individual providers to provide services.8 The provision of all healthcare by contract was considered for 35 Army posts. The evaluation process was lengthy, but ultimately 2 posts (Dugway Proving Ground, UT, and White Sands Missile Range, NM) were selected. However, commercial offers substantially exceeded audited government costs and the proposal was rejected in January 1977. Another effort to contract healthcare at Army facilities was begun in 1979, when DoD and the House Appropriations Committee both directed a test. The HSC looked at 5 facilities: Fox Army Hospital (Redstone Arsenal, AL), Munson Army Hospital (Fort Leavenworth, KS), Patterson Army Hospital (Fort Monmouth, NJ), Keller Army Hospital (West Point, NY), and Bassett Army Hospital (Fort Wainwright, AK). Fox Army Hospital was ultimately chosen, but the program slipped into FY1982. Ultimately, healthcare at the facility was not contracted.

Major efforts were made to facilitate sharing DoD medical facilities and personnel. "Triservice regionalized health services" were started in 4 areas in the continental United States (CONUS) on July 1, 1972, for efficiency, economy, and improved delivery of services. Three regions had one lead military service and subregions for each of the other services; the fourth had a rotating lead. This regionalization was extended to Europe and Japan on October 1, 1972, and to all of CONUS in FY1974.[9,24] Each region reported quarterly to a committee of The Surgeons General and the Assistant Secretary of Defense for Health and Environment (ASD(H&E)), later changed to ASD (Health Affairs). The HSC Annual Historical Report 1 April 1973-30 June 1975[11] included an assessment of results of the regionalization approach:

> The system worked as a give-and-take low key consortium of administrators interested in providing professional health care by the best use of their pooled assets. It helped formalize a process which had operated on an ad hoc basis for several decades.

Working on a triservice basis led to greater standardization of terms and policies. These had to be implemented on a DoD basis, which meant the ASD(H&E) was involved. In the mid-1970s, a government-wide study looked at Federal healthcare, including the Department of Health, Education, and Welfare; the DoD; and the VA. This led to calls for DoD-wide standardization in manpower methods, performance standards, staffing methodology, and accounting. Creation of a Defense Health Agency was also recommended. In the 1970s, the GAO reported on wide variances in federal healthcare and that sharing had been:

> …inhibited by cumbersome or inequitable reimbursement mechanisms, the lack of economic incentives, or agencys' and hospitals' desires to maintain autonomy and ready access to a full range of health services.[3]

A Federal Health Resources Sharing Committee was chartered in February 1978 from DoD, service Surgeons General, VA, and the Public Health Service. It largely avoided costs (for example, not establishing multiple cancer centers in Augusta, GA) and could only point to the legal problems of conflicting reimbursement mechanisms.[3] There was rationalization of medical support in certain locations. For example, the Army hospital on Okinawa was transferred to the Navy.[3]

There was a one-time savings when the Public Health Service stopped operating hospitals and clinics in the late 1970s. One hospital (San Francisco, CA) and one clinic (St Louis, MO) were transferred to the Army, avoiding projected facilities construction costs.[25] There were also occasional examples of allies funding facilities. In 1976-1977, the United States negotiated the return to Japan of the US Army Hospital Honshu and some other properties in exchange for Japan building a new Navy hospital at Yokosuka and an Army clinic at Camp Zama.[3]

The DoD also centralized approval of procurement of items over $100,000, as well as approval to begin, end, or curtail medical services.[3] There was recognition of common items and training. For instance, spectacle fabrication was better shared, with a test program to support the VA as well.[3] Some training programs began accepting personnel from multiple services.[3,10] In 1979, planning to consolidate veterinary support began. This was planned to occur over FY80-85 (later accelerated to FY80-82), with the Army assuming responsibility for all veterinary support to US armed forces. Officer manpower was cut, with substitutions by warrant officers and enlisted personnel. Some positions were civilianized, and some converted from VC to other officer corps, which generally avoided specialty pay.[3] This preserved force-structure in the AMEDD, at the expense of expanding the AMEDD's mission.

There were efforts to manage the healthcare system more efficiently. There was much hope that better

management would control costs. As mentioned earlier, there were triservice management efforts which led to systems such as the Medical Expense and Performance Reporting System. The DoD also recognized trends in civilian healthcare and sought to use health maintenance organizations as an alternative to CHAMPUS.[9] Concurrently, CHAMPUS was centralized under DoD at the beginning of FY1975. This had limited effect in controlling, let alone reducing, costs. The DoD did administratively reduce CHAMPUS reimbursement rates to physicians, but that discouraged physician participation in the program. The AMEDD sought to shift costs to CHAMPUS. Cutting AMEDD manpower and budget automatically caused increased referrals to the CHAMPUS network. Along with inflation, this caused the CHAMPUS budget to more than double in 5 years (up 142% over FY1969-1974). While arguably a rational decision for the AMEDD, this did not help the US government overall, and Congress held hearings in 1974. Late in FY1974, Secretary of Defense Schlesinger restricted some practices that had become customary but were not authorized in law. The changes meant copayments from individuals and were a deterrent to care.

The AMEDD sought to make more efficient use of scarce personnel. While physicians were in notably short supply in the 1970s, dentists were also scarce. While the Army sought to recruit more dentists, it recognized the importance of efficient use of available dentists, especially as this would help morale of dentists and enhance recruitment and retention. Dental assistants received extra training to handle certain procedures, and dental clinics were upgraded to provide multiple treatment rooms per dentist who could then see more patients in the same amount of time.[9,22,24] This proved effective, with dental workload up 77% between 1975 and 1979 despite a 9.5% reduction in dental personnel; military personnel fell 13.3%, civilian personnel fell 0.1%.[8]

Reservists were used in MTFs. From its earliest days, HSC tried to utilize reservists during their weekend and annual training, as well as inactive duty training.[9,26] This was said to improve training in the Reserve component while providing staff for HSC.[27] Eleven thousand reservists were used in 1975.[28] Members of the Individual Ready Reserve were also used, starting with 100 in 1975 and quadrupling through 1979.[8]

The AMEDD transferred functions to other military services. Certain functions were transferred to other government agencies, or were examined for transfer. In the late 1970s, Congress directed the transfer of veterinary inspection of meat and other food processing from the VC to the US Department of Agriculture. This saved 20 officer and 120 enlisted spaces.[8] It should be noted that this was not undertaken as a manpower savings, but because a group of ineffective food inspectors caused a problem into which Congress intervened.

The Army Staff (presumably with support from The Surgeon General) submitted several requests to DoD for legislation to shift both disability determinations and Temporary Disability Retirement List (TDRL) examinations to the VA. Under these proposals, the military would perform Medical Examination Boards, but the VA would be wholly responsible for Physical Examination Boards. Similarly, the AMEDD would be relieved from periodic examinations of 13,000 TDRL personnel. This proposal was studied by DoD without further action.[29]

The 1980s

Background Factors of the 1980s

The 1980s are not generally considered a period of military drawdown. However, military personnel authorizations dropped 13,000 between 1974 and 1989, roughly 1,000 personnel per year, as some positions were civilianized. Civilian personnel numbers climbed roughly 128,000, or 13%, through the decade. Thus, military manpower was flat but budget requirements rose in concert with increasing civilian manpower. The military budget rose through 1986 and then was cut slightly, with substantial cuts scheduled to start in FY1989.

Despite the drop in military manpower, CHAMPUS costs rose rapidly, partly due to costs of medical care and partly from changing beneficiary demographics: the Cold War military was retiring and getting care through CHAMPUS rather than MTFs. Thus, total CHAMPUS costs tripled between 1984 and 1994. The Secretary of Defense wrote in 1988:

> Our greatest medical challenge today is to continue improving our medical-readiness capability and to provide quality peacetime care to our over nine million beneficiaries, while containing the cost of care provided.[30]

By the 1980s, closing bases under the Federal Property and Administrative Services Act of 1949 (40 USC et al) had become highly sensitive to political pressure. In 1988, Public Law No. 100-526 authorized a "special commission to recommend base realignments and closures to the Secretary of Defense." The Carlucci Commission was chartered by the Secretary of Defense on May 3, 1988, and by December 1988 had recommended closure of 5 Air Force Bases. The Carlucci Commission continued to operate until its function was codified by the Base Closure and Realignment Act of 1990 (Pub L No. 101-501), which itself established a Commission, now commonly known simply as BRAC.

AMEDD Coping Strategies in the 1980s

The direction within AMEDD became increasingly proactive, shifting to prevention rather than cure. Health promotion and preventive medicine increasingly became the emphasis across DoD. The Secretary of the Army and the Army Chief of Staff designated 1982 as the "Year of Physical Fitness," with specific target areas of weight control, nutrition, stress management, and reductions in substance abuse (alcohol, tobacco, and drugs).[30,32] While some of the initiatives, particularly drunk-driving campaigns, were effective, healthcare costs still rose at alarming rates.

Better management techniques to reduce costs were explored. Diagnosis related groups were adopted instead of allowing CHAMPUS physicians to set their own fees. Health maintenance organizations (HMOs) and preferred provider organizations were tried, including medical centers essentially running their own HMOs. Catchment area management was tested in the late 1980s, which put CHAMPUS budgets in the hands of MTF commanders and allowed them to negotiate rates with local providers.[33] The Army Medical Enhancement Plan (started in 1985) provided more administrative and support staff to save physicians time and improve efficiency.

There was another effort at contracting care. Since many CHAMPUS patients needed a nonavailablity statement, the MTF could control network utilization. Beginning April 1, 1987, Primary Medical Care For Uniformed Services (PRIMUS) clinics were tried, government outfitted but staffed with contractors, in the hope that they would be less expensive than care delivery by CHAMPUS.[34] Available data is inconclusive on whether PRIMUS clinics were less expensive per patient visit than CHAMPUS, but they were more expensive than MTF care, and increased overall visits. They thus increased access (a goal) but at greater cost. They were phased out as TRICARE became fully established.

Military Health System Coping Strategies in the 1980s

During the 1980s, outside experts were consulted through a Blue Ribbon Panel on the Sizing of Defense Medical Treatment Facilities. The panel not only recommended that control of medical construction plans be placed under the Assistant Secretary of Defense (Health Affairs) (ASD(HA)), which was implemented, it also recommended coordination and even consolidation of service graduate medical education (GME) programs.

There were further efforts towards the establishment of joint medical organizations. Creation of a Joint Military Medical Command for San Antonio was initiated in 1986 and completed in 1987. Two similar efforts covered the Delaware Valley (including Fort Dix, NJ) and the San Francisco area (including Letterman Army Medical Center). Facilities were sometimes transferred between services. For example, Walson Army Community Hospital at Fort Dix was transferred to the Air Force in 1992 as a result of the 1991 BRAC Report which recommended realignment of mission the Fort Dix and consolidation of medical support with adjoining McGuire Air Force Base.

CHAMPUS reforms were investigated. The CHAMPUS Reform Initiative was the experiment that ultimately became TRICARE, with regional contractors assuming financial responsibility for all CHAMPUS care for a fixed price. TRICARE was initially implemented in 1987 in California and Hawaii.

More centralization initiatives during this period culminated in creation of the Defense Health Program. The ASD(HA) gained far more influence over DoD-wide healthcare delivery. The 1990 Defense Appropriations Act directed DoD to plan for more centralization of healthcare budgeting, staffing, and program accountability.[35]

The Military Health System (MHS) considered imposing user fees in MTFs on dependents and retirees, roughly equal to copays under CHAMPUS. Due to soaring costs, in 1989 the Bush Administration considered user fees in MTFs, "a proposal that had proved highly unpopular in the past."[33] The proposal was not adopted. However, to access healthcare insurance coverage of private and employer insurance plans held by eligible military beneficiaries, DoD sought legislation in the late 1980s to allow it to bill civilian insurance plans for care rendered by military medical facilities. Such legislation was enacted in the early 1990s.

The 1990s

Background Factors of the 1990s

With the end of the Cold War, the late 1980s trend of reductions accelerated, both in manpower and money. From 1989 to 1999, Army active duty strength fell 38%, from 772,000 to 480,000. The Army base budget fell one-third between 1989 and 1994, and declined slightly every year thereafter. It was not possible to hire civilians to replace military personnel, and the centralized Defense Health Program readily reflected the movement of patients to CHAMPUS/TRICARE by a military service rather than treat them in an MTF. There was strong interest in using contractors rather than government civilians, and in reducing headquarters/management personnel.

AMEDD Coping Strategies in the 1990s

The 1990s saw continued efforts to reduce the requirement for delivery of medical care to patients. The Army

Health Promotion Program sought to educate Soldiers about both risky and unhealthy behaviors. The 1994 redesignation of the Army Environmental Hygiene Agency as the Center for Health Promotion and Preventive Medicine reflected the continued efforts to promote health and reduce the need for healthcare. By the late 1990s, there was optimism that beneficiaries would increasingly find health information on the internet, resulting in healthier lifestyles and reduction in unnecessary trips to doctors.[36]

The AMEDD was granted a 2-year delay in post-Cold War reductions. The Army was persuaded that the large number of Estimated Time of Separation physicals in the early 1990s required keeping AMEDD personnel until completion of the bulk of Army-wide cuts. Surgeon General Frank Ledford was particularly outspoken against downsizing the AMEDD. In January 1991, he bluntly stated, "AMEDD manpower cuts proportional to the overall force are not acceptable" because the AMEDD mission was not going to change significantly.[37] He argued that MTF care was more cost-effective than CHAMPUS care, so cutting the MHS was no bargain. Although his arguments were well received by DoD, the AMEDD accepted consolidation and cutbacks. As the Army was both losing personnel and changing its base structure, the AMEDD was unavoidably affected. Several hospitals became outpatient clinics, and both Letterman and Fitzsimons (Denver, CO) Army Medical Centers were closed through BRAC recommendations. Personnel were to "be distributed to improve healthcare at other bases with large active-duty populations and to reduce costs", clearly reflecting DoD's 2 major concerns. Smaller hospitals, many clinics, laboratories, and other facilities were also consolidated. Both military and civilian personnel were reduced. Between 1992 and 1999, the AMEDD lost 21.4% of physicians, 27.5% of enlisted personnel, and 20.1% of civilian full-time equivalents.[38-44]

Reorganizations have always been examined as a means to save substantial numbers of personnel. Army Surgeon General Lanoue's 1993 reorganization of functions with the establishment of the US Army Medical Command reduced AMEDD headquarters staffing by 80% in Washington, DC. LTG Blanck's creation of the OneStaff in 1997 was not intended to reduce personnel, but did result in elimination of several positions.[45]

In at least one location, Fort Monmouth, NJ, the AMEDD shifted inpatient care to a civilian hospital (under contract) and restructured from a small hospital to an outpatient clinic.[46] Once TRICARE contracts were better established, inpatient services could be reduced without specific local arrangements.[47]

There was further civilianization of positions. LTG Lanoue argued that hiring civilian staff would be less expensive than using the CHAMPUS/TRICARE network. While civilian employees were cut substantially (375,000 from 1990 to 1999), the AMEDD retained approximately 2,000 more civilians than originally planned.[48-51] Civilianization included nondeploying specialties such as orthotic specialists and podiatrists.[52] The repeated arguments that MHS care was less expensive than CHAMPUS apparently prevented some cuts. Plans in 1991 called for AMEDD reductions of around 22% over the period 1987 to 1995, while combat arms as a whole would be cut 30%, combat support by 34%, and non-AMEDD combat service support by 30%.[53]

The Professional Filler System was expanded from predesignating only physicians to include the bulk of medical personnel in some TO&E* medical units. Surgeon General Blanck estimated each combat support hospital manned at "caretaker" levels meant $24 million in healthcare delivered.

There were further initiatives to improve management. The AMEDD adopted clinical practice guidelines and clinical pathways to reduce negative clinical variance. While doubtlessly effective, this action apparently did not save substantial amounts of money. The AMEDD adopted prime vendor procurement, not just in support of TDA† facilities but for deployments to Guantanamo and Haiti.[54] Some senior leaders promoted telemedicine as a tool to save some referrals.[55]

There was another move to reduce the average enlisted grade. In 1998, the Army announced changes in the noncommissioned officer (NCO) grade structure that reduced authorizations for E5 and, to a lesser degree, E6 grade personnel while increasing numbers of E3 and E4 authorizations. This was acknowledged to save $170 million per year, and helped promotion rates from grade E5 to E6. Similarly, promotion opportunities from E6 to E7 were improved.[56] However, these changes were adjusted a year later because the Army realized it was rapidly losing too much lower-level NCO leadership.[57]

MHS Coping Strategies in the 1990s

The MHS explored additional initiatives involving joint medical organizations and sharing with the VA during the 1990s. The Joint Military Medical Commands

*A Table of Organization and Equipment defines the structure and equipment for a military organization or unit.

†A Table of Distribution and Allowances prescribes the organizational structure, personnel, equipment authorizations, and requirements of a military unit to perform a specific mission for which there is no appropriate TO&E.

in San Francisco and in San Antonio were eliminated. Resource sharing continued, including purchasing and some graduate military education.[58] The Tidewater Tri-Service Managed Care Project was started in southeastern Virginia in 1992.[59] With the advent of TRICARE, the VA became a TRICARE contractor in some areas, seeing family members as well as active duty personnel and veterans.[60]

There were further efforts towards centralization. A triservice formulary was started in 1993.[61] Efforts such as the TRICARE Mail Order Pharmacy reduced costs by centralizing functions. In 1991, the ASD(HA) assumed oversight of medical research and development programs, forming the Armed Forces Medical Research and Development Agency, which was later disestablished.[62] Some clinical training programs were merged. The Army and Navy merged their tropical medicine courses in 1996.[63] The Army, Navy, and Air Force merged their dental assistant and dental laboratory technician courses in 1997; however, in 1999, AMEDD determined that dental specialist training was inadequate and returned the course to the AMEDD Academy of Health Sciences.[22] Programs, including graduate medical education, were rationalized where possible. For instance, in the Washington, DC area, Malcolm Grow Medical Center (Andrews Air Force Base) and DeWitt Army Community Hospital (Fort Belvoir) were given primary care missions, while the National Naval Medical Center and the Walter Reed Army Medical Center retained a range of secondary and tertiary programs, but reduced overlap.[64]

The DoD tried a "coordinated care" program. The ASD(HA), Enrique Mendez, wanted patients to first go to an MTF, then be referred onwards as necessary. This was something like a medical home, but it also allowed the MHS to decide which patients to send to CHAMPUS and which to treat in-house. This program was only feasible in areas around MTFs, and TRICARE was chosen instead. In the mid-1990s, DoD obtained approval for Medicare subvention. Somewhat like charging insurance companies, DoD became able to bill Medicare for care of patients aged 65 years or more.

In the 1990 Defense Appropriations Act, Congress directed a study of doctors in administrative positions, with the intent of making more available to see patients. However, the results of this study are not clearly quantifiable.

There were also proposals to make a larger and presumably more efficient medical system. At one level were proposals to merge the military health services. A unified medical command consisting of functional subordinate commands (for example, preventive medicine, doctrine/education/training, research and acquisitions, healthcare delivery) rather than service commands (Army, Navy, Air Force) was considered.[65] There was a larger proposal for a federal health agency which included merging the MHS with the VA.[65]

Conclusion

From the 1970s through the 1990s, the AMEDD faced numerous challenges in delivering healthcare. Cost was a consistent pressure. Less expensive care providers (nonphysicians) were deployed in the 1970s, and the AMEDD sought various ways to efficiently deliver care. The AMEDD also sought to have a healthier patient population and thus avoid costs. However effective this was, the savings were overtaken by cost increases elsewhere. The DoD steadily pushed the AMEDD (and the other military medical departments) for more standardization, centralization, and joint operation; this is only continuing with the Defense Health Agency. Cooperation with other federal health agencies also increased, and may well continue to expand in the future.

While the drawdowns were very painful for the AMEDD, Congress and the DoD were willing to pay for new or clear requirements. When the doctor draft was coming to an end in the early 1970s, Congress approved both the Uniformed Services University of the Health Sciences and the Health Professions Scholarship Program. These were, and remain, costly programs, but were judged necessary. Similarly, professional special pay, retention bonuses, and GME were funded. The arguments for these expenditures had to be made repeatedly, but because the requirement is genuine it was approved, even when budgets were tight. Drug testing and treatment was a new requirement in the early 1970s, and HIV/AIDS testing was new in the mid-1980s. These were funded because the President and Congress judged them necessary. In 1973, the Secretary of Defense recognized the services were not investing enough in medical facilities and not asking for enough resources, and directed the Surgeons General to reevaluate their programs. The AMEDD received $40 million more for FY1974 alone (a 23% increase, and equivalent to some $2 billion today) and even more money for a 5-year plan to replace 11 hospitals and dozens of dental clinics.

Both in the 1970s and 1990s, DoD recognized that military healthcare was important for recruiting and retention, and either provided money for personnel and facilities or at least reduced cuts. Careful stewardship of resources has always been necessary, and there have been continuous reviews of how to contain or avoid costs. There is no straight line from the past, and change will

be painful and complex, but there are strong reasons for confidence in the future of AMEDD.

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Paralysis as a Presenting Symptom of Hyperthyroidism in an Active Duty Soldier

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Abstract

Thyrotoxic periodic paralysis (TPP) is an endocrine disorder presenting with proximal motor weakness, typically greatest in the lower extremities, hypokalemia, and signs or laboratory findings consistent with hyperthyroidism. The incidence of TPP is highest in Asian males. This is a case report of a 30-year-old male active duty Soldier who presented to the emergency department complaining of several recent episodes of lower extremity paralysis. The patient underwent a workup which included serum and cerebrospinal fluid studies, and was found to be hypokalemic and hyperthyroid. Following consultation with neurology, the patient was admitted to the medicine service and treated for thyrotoxic periodic paralysis with potassium replacement and treatment of his hyperthyroidism. Since achieving a euthyroid state, he has had no recurrences of TPP. This disease should be considered in patients presenting with symmetric motor weakness and hypokalemia, whether or not symptoms of hyperthyroidism are elicited during the review of systems.

Thyrotoxic periodic paralysis is an endocrine disorder characterized by the presence of motor weakness or paralysis, hypokalemia, and clinical signs or laboratory findings consistent with hyperthyroidism.[1] in many cases, the paralysis may be the only symptom of hyperthyroidism. Because it bears tremendous similarity with other causes of hypokalemic periodic paralysis but requires different treatment, it should be strongly considered in any case of hypokalemic paralysis, particularly in patients of Asian descent.

Case Report

The patient was a 30-year-old male Soldier who presented to the emergency department in the morning after he was unable to get out of his bed secondary to profound weakness, primarily in his lower extremities. He noted that this had happened on 2 occasions recently, albeit with much less severe symptoms, and had resolved spontaneously without evaluation or treatment in each case. His medical history was significant only for hypertension, and he had no family history of similar complaints. He denied back pain, numbness anywhere, and bowel/bladder incontinence. He was initially slightly hypertensive and tachycardic, with a blood pressure of 154/63 and a heart rate of 113. His exam noted profound symmetric muscle weakness, greater in the lower extremities and proximal muscle. His deep tendon reflexes were absent in the lower extremities and significantly diminished in the upper extremities. His laboratory studies were significant for a serum potassium of 1.5 and a serum thyrotropin (TSH) and free thyroxine of 0.05 and 2.98 respectively. His EKG reflected changes consistent with hypokalemia, including a first degree AV block, a prolonged T wave, and the presence of a U wave. In combination, these findings strongly supported a diagnosis of thyrotoxic periodic paralysis. Additional studies of the serum, urine, and cerebrospinal fluid were negative for any significant abnormalities. A CT scan of the head was also normal. The patient was subsequently admitted to the medicine service for treatment and further evaluation. His symptoms resolved completely following repletion of potassium and treatment of his hyperthyroidism.

Comment

Thyrotoxic periodic paralysis (TPP) is an endocrine disorder characterized by paralysis, hypokalemia, and hyperthyroidism.[1] The condition is most common in Asian males, with greater than 90% of cases occurring in Japanese patients.[2] There have, however, also been case reports of TPP occurring in white, black, Hispanic, Polynesian, Greek, and Native American populations, as well as Pacific Islanders such as our patient.[2-8] The male to female ratio has been reported to be between 20:1 and 70:1, in spite of the fact that hyperthyroidism is more common in women.[1,6] As in our patient, the paralysis is typically worse in the lower extremities and the proximal muscle groups.[9] In one review of cases in a Chinese population, the mean serum potassium was reported to be 2.17, with the lowest reported value of 1.1.[9] Several reviews of this disorder have noted that 60% to 70% of patients have paralysis as their initial presenting symptom of hyperthyroidism.[9,10] This was true in our patient, and it underscores the importance of suspecting this condition, as there may be no other signs of hyperthyroidism. More extreme presentations have

also been reported, with many associated complications including hypokalemic EKG changes, atrial fibrillation, myxedema, renal tubular acidosis, nystagmus, deafness, and deaths from cardiac and respiratory depression.[11-16]

The pathophysiology of TPP is incompletely understood. All patients must have hyperthyroidism, usually caused by Graves' disease, however there are also case reports of TPP occurring in patients with active thyroid nodules, TSH secreting pituitary tumors, and exogenous thyroid hormone.[5,17-19] Early studies demonstrated Chinese patients with TPP were more likely than controls to have certain specific HLA antigen haplotypes, suggesting an inherited gene may play a role.[20] There is also substantial evidence to suggest that increased activity of the Na/K ATPase in response to thyrotoxicosis plays a considerable role.[21,22] Additionally, recent studies have implicated a mutation in a cell wall potassium channel named Kir2.6, which is present in 33% of TPP patients studied, and is regulated by thyroid hormone.[23,24] Attacks of TPP in susceptible individuals can be precipitated by trauma, cold exposure, carbohydrate ingestion, administration of glucose and insulin, exogenous thyroid hormone, high-dose steroids, and a number of different medications, and in some circumstances can be aborted by exercise.[5,11,25,26] Treatment of TPP includes both repletion of potassium and elimination of the hyperthyroid state.[1] Reports have generally demonstrated that the typical precipitants of TPP are unable to cause paralysis once a patient has reached a euthyroid state.[17,18,25]

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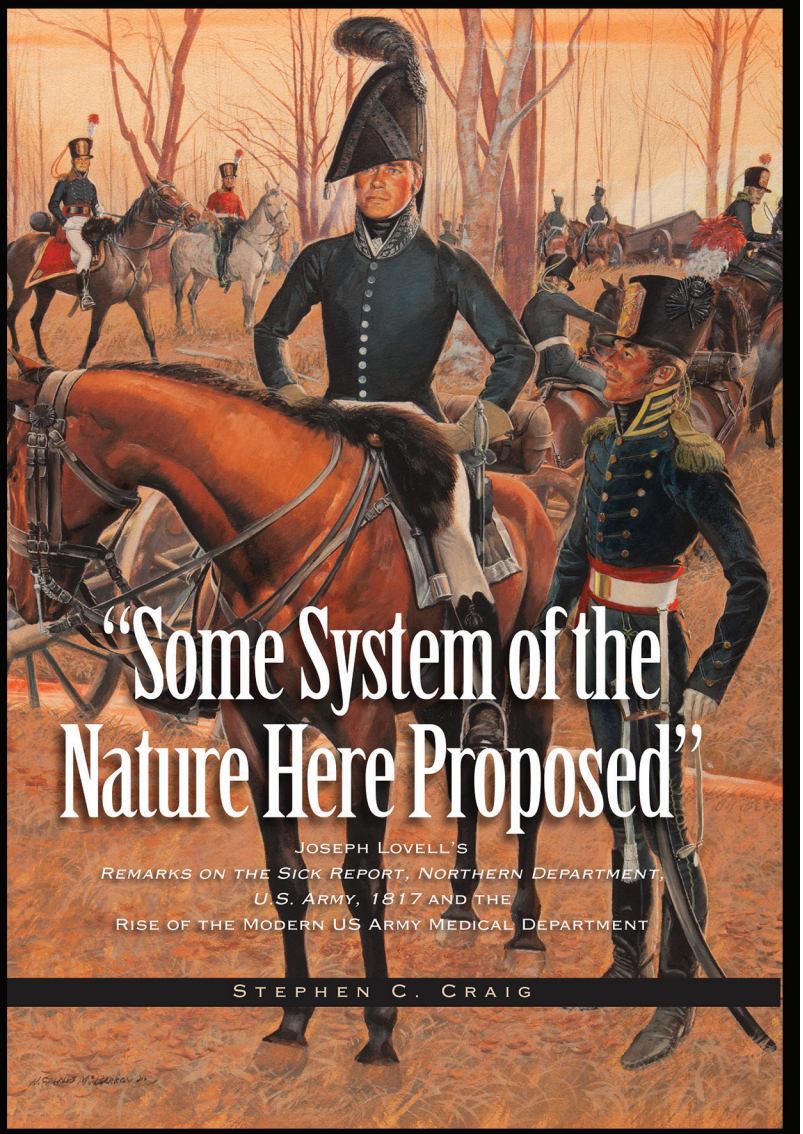

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A Field-Expedient Method for Direct Detection of Enterotoxigenic *E Coli* and *Shigella* from Stool

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Abstract

We describe a field-expedient analytic system that fills a unique and critical public health role and potentially provides a valuable aid in diagnostics. Dual-fluorigenic, hydrolysis probe (TaqMan), PCR assays for detection of causative agents of enterotoxigenic *Escherichia coli* (ETEC) disease and shigellosis/bacillary dysentery were prepared in a thermal-stable, hydrolytic enzyme resistant format. The assays were packaged as a kit for use with a portable, ruggedized, qRT-PCR thermocycler. The analytical limit of detection of each qRT-PCR: ETEC-STIa, ETEC-STIb, and ETEC-LT assay was 30 colony forming units (CFU) and *Shigella*/enteroinvasive *E coli* assay was 3 CFU. During field evaluation, testing was conducted using a blind-panel of 138 stored stool samples previously obtained from enterotoxigenic *E coli* disease (n=91) and shigellosis (n=47) patients. Sample processing and analyses were completed in 3 days. Test results of the qRT-PCR assays showed promise as aid in pathogen identification when compared to culture, digoxigenin-labeled probe (ETEC), and serotyping (*Shigella*) the qRT-PCR. The sensitivity of each of the 4 qRT-PCR assays was 100% and specificity was ETEC-STIa (92.4%), ETEC-STIb (92.6%), ETEC-LT (79.6%), and *Shigella*/enteroinvasive *E coli* (81.6%). Sequencing of qRT-PCR amplicon indicated that the sensitivity and specificity of each qRT-PCR assay exceeded the comparator methods. The system shows promise as a rapid method for direct detection of ETEC and *Shigella* from stool and is applicable for use in clinical diagnostics and biosurveillance as an extension of temporary field laboratories or as a part of fixed reference laboratory facilities.

Diarrhea is a leading cause of disease related morbidity and mortality worldwide, especially for children younger than 5 years.[1] Enterotoxigenic *Escherichia coli* (ETEC) and *Shigella* are primary infectious agents of bacterial diarrheal disease. Depending on the ETEC strain, 2 classes of heat-stable (STIa and STIb) and/or heat-labile (LT) plasmid-encoded toxins are produced and manifested by acute diarrhea.[2] The shigellosis or bacillary dysentery form of diarrheal disease is caused by various chromosomal and plasmid produced virulence factors including invasion plasmid antigen H (Shig-ipaH) encoded by a gene conserved across *Shigella* and enteroinvasive *E coli* (EIEC) species.[3] In the absence of prompt and appropriate treatment, these pathogens have the ability to cause fatal diarrhea.

Efficacious treatment and prevention and control of transmission present significant challenges to clinicians and public health practitioners worldwide.[4] Accurate and rapid diagnosis and epidemiological surveillance focused utilization of public health resources in areas and populations most at risk of developing diarrheal disease can result in significant reductions in morbidity and mortality and economic cost. However, current limitations in diarrheal disease diagnostics drive the need for rapid and sensitive tests. Identification of diarrheagenic *Escherichia coli* disease, shigellosis, and EIEC causative agent by culture can take days to weeks. Diagnosis, therefore, is often retrospective clinically as well as epidemiologically. Time critical treatment and public health response are unachievable. The time required for routine culture as well as relatively poor sensitivity have driven the development of molecular-based identification technologies that are rapid and highly sensitive and specific. Molecular-based technologies are becoming well established in diarrheal disease diagnostics, surveillance, and food and water safety protocols. This includes restriction enzyme analyses, conventional and RT-PCR, multiplex PCR, loop-mediated isothermal amplification, microarray technologies, and the TaqMan Array Card.[5-18] Immunochromatographic "dipstick" technologies show promise in diarrheal disease agent detection.[19] However, traditional culture remains the reference methodology.

Disproportionately high diarrheal disease morbidity and mortality occur in developing countries and can increase exponentially during times of natural disaster

or political conflict.[4] The risk of diarrhea outbreak is often heightened in these situations due to lack of clean water, poor hygiene, malnutrition, inadequate medical intervention, and limited or absent prevention and control intervention. Medical care providers in regions with underdeveloped medical and public health resources or in situations with failing or totally absent infrastructure operating under austere conditions often have no access to laboratory facilities or fundamental public services such as electricity, water, or an intact transportation system. Under these conditions, culture and microscopy methodologies and molecular-based technologies designed for use within conventional laboratory infrastructure are unsuitable. These obstacles drive the need for mobile, stand-alone analytic capability.[20,21]

In this article we describe a unique analytic capability; highly sensitive and specific thermal-stable hydrolytic enzyme resistant ETEC-STIa, STIb, LT, and *Shigella*/enteroinvasive *E coli* (EIEC) TaqMan PCR detection assays with portable, ruggedized, real-time qRT-PCR instrumentation that shows promise as a field-expedient method for direct detection from stool.

Methods

Study Site

Field-evaluation of ETEC-STIa, STIb, LT, and *Shigella*/EIEC (Shig-ipaH) TaqMan qRT-PCR detection assays was conducted at the Walter Reed Research Unit Nepal (WARUN) central laboratory in Kathmandu. Kathmandu is located in south-central Nepal within the Hill Region (called Pahar in Nepali) where elevations are mostly between 1,000 m and 4,000 m. Pahar is the most heavily populated region of Nepal, however, development of infrastructure and social services have been hindered due to its geographical isolation, limited economic potential, and a history of political instability. Testing was conducted during March 31 to 2 April, 2009. March through April is considered the spring season with daily temperatures ranging from 10°C to 27°C and 80% to 100% humidity with occasional short bursts of rain. The ETEC and Shig-ipaH qRT-PCR assays, thermocycler ("Ruggedized" Advanced Pathogen Identification Device (R.A.P.I.D.), BioFire Diagnostics, Inc (BDI), Salt Lake City, UT), and equipment and supplies were packed in 2 hardened cases (Pelican Products, Inc, Torrance, CA). A single individual transported the system by commercial aircraft as checked-baggage from Department of Enteric Diseases, Armed Forces Research Institute of Medical Sciences (AFRIMS), Bangkok, Thailand, to WARUN. The field-laboratory was established in a single room of a building without environmental control using 2 tabletops approximately 1 m^2 in area. The qRT-PCR assays, nucleic acid preparation reagents, and RAPID instrument were transported and stored and sample preparation and analyses conducted under ambient temperature and humidity conditions, vastly simplifying reagent management. The RAPID is powered by 110-220 V source such as an electric generator or, if necessary, from the battery of a vehicle with the engine running using a power inverter. For this study, the field laboratory was equipped with main 220 V power.

Samples and Microbiology

For the purpose of this study, a test panel of 138 well characterized diarrheagenic *E coli* disease and shigellosis stored stool samples was prepared. Enterotoxigenic *Escherichia coli* and *Shigella* infecting agents were previously identified by using a combination of culture with hybridization of DIG-labeled probe (ETEC) and *Shigella* serotyping. The test panel consisted of STIa (n=21), STIb (n=30), LT (n=40), and Shig-ipaH (n=47) positive samples. Sampling protocol, stool processing, and ETEC and *Shigella* identification methodologies have been previously described.[22] Under a previous study, clearance for the collection and use of stool samples was obtained from the Ethics Review Board at the Nepal Health Research Council (NHRC) and the Institutional Review Board (IRB), Walter Reed Army Institute of Research (WRAIR), Silver Spring, Maryland (WRAIR IRB #1276 and #1311). Clearance for the use of de-identified samples under this study was obtained from the NHRC and IRB, Privacy Board, Wilford Hall Medical Center, Lackland AFB, San Antonio, Texas.

Stool samples were labeled by code and double-blinded testing was conducted. Routine culture, DIG-labeled probe (ETEC), and serotyping (*Shigella*), were compared to qRT-PCR and sequences of amplicon products. Prior to field-evaluation, quantification of qRT-PCR assay linearity, limit of detection (LOD), and in vitro sensitivity and specificity were accomplished with well characterized reference strains from culture using the RAPID instrument. Type strains were subcultured on agar plates and several colonies were picked and suspended in normal saline. The measured absorbance at 625 nm was compared to 0.5 McFarland (OD≈0.088-0.133) spectrophotometrically. Stocks of undiluted cell suspension (viable cell count 1.5×10^8 cells/mL) were established; extracted nucleic acid was prepared and serially diluted at 1.5×10^8 cells/mL to 1.5×10^0 cells/mL. Linearity and LOD of ETEC STIa, STIb, LT, and Shig-ipaH qRT-PCR assays were quantified using ETEC strains ETEC-STIa AF-ETEC727, ETEC-STIb AF-ETEC771, ETEC-LT AF-ETEC966 and *Shigella flexneri* strain ATCC12022, respectively.

Nucleic Acid Preparation

Extracts were prepared using a commercially available kit; a 10% (wt/vol) stool suspension was prepared with sterile distilled water and clarified by centrifugation at 2,600 × *g* for 15 minutes. Nucleic acid was extracted with NucliSens Magnetic Extraction Kit (bioMérieux, Inc., Durham, NC) according to the manufacturer's instructions. Briefly, 300 μL of the stool suspension was treated with 1.4 mL lysis-buffer and mixed with paramagnetic silica particles. The bound nucleic acid was washed twice with 400 μL wash buffer I (5 M guanidine thiocyanate, Tris-HCl, Triton X 100, and EDTA), twice with 500 μL wash buffer II (MES), and once with 500 μL wash buffer III (disodium tetraborate). Finally, the nucleic acid was eluted from the silica by incubation in 75 μL elution buffer for 5 minutes at 60°C. The field site used in this study was equipped with a -70°C freezer within which purified nucleic acid was preserved until used for qRT-PCR testing.

Polymerase Chain Reaction

Existing wet reagent ETEC-STIa, ETEC-STIb, ETEC-LT and Shig-ipaH TaqMan assays were adapted for use in the preparation of thermal-stabilized, hydrolytic enzyme resistant RAPID-based qRT-PCR freeze-dried assays.[5-7,23,24] Separate *Shigella* and EIEC qRT-PCR assays were not developed because the treatment of shigellosis is the same for infection by either of these agents. Moreover, *Shigella* and EIEC bacteria differ in endemicity and relative prevalence and as such presumptive identification is often made prior to confirmation testing.

Optimal wet reaction conditions for STIa, STIb, LT, and Shig-ipaH qRT-PCR assays were: 400 nM Forward Primer, 400 nM Reverse Primer, and 150 nM TaqMan Probe, 1:10 dilution of 10X qRT-PCR buffer with BSA and 30 mM $MgCl_2$ (BDI part number 1770), 1:10 dilution of 10X 2 mM dNTP mixture (BDI part number 1774), and 2 μL of a mixture of 10X Taq polymerase (0.16 μL), antibody (0.16 μL), and enzyme diluent (1.68 μL) (BDI). Reaction volume was 20 μL consisting of 18 μL of master mix and 2 μL of template. A standardized qRT-PCR thermocycling protocol consists of an initial DNA denaturation at 95°C for 3 minutes, and qRT-PCR for 45 cycles at 95°C for zero seconds (sinusoidal temperature curve) for template denaturation and 60°C for 20 seconds of combined annealing and primer extension. Primer and probe sequences were: ETEC STIa Forward Primer (5'-ACCTCG CATATAACATGATGCAA-3'), Reverse Primer (5'-CTAATGTAATTTTCTCTTTTGAAGAGTCA-3'), and Probe (5'-FAM-TTAGCTTTTTCATGTTACCTCCCGTCATGT-TAMRA-3') designed using BLAST database nucleic acid sequence of the *E coli* toxin I (*estA1*) gene at GenBank accession number M58746; ETEC STIb Forward Primer (5'-TTCACCTTTC(G/C)CTCAGGATGC-3'), Reverse Primer (5'-ATAGCACCCGGTACAAGCAGG-3'), and Probe (5'-FAM-TCACAGCAGTAATTGCTACTATTCATGCTTTCAGGA-TAMRA-3') target sequence was *E coli* heat-stable toxin (*st*) gene at GenBank accession number M29255; ETEC LT Forward Primer (5'-GTTTTATT TACGGCGTTACTATCCT-3'), Reverse Primer (5'-GGGACTTCGACCTGAAATGTT-3'), and Probe (5'-FAM -CTTTTGCCTGCCATCGATTCCGTATAT-TAMRA-3') target sequence was *E coli* heat-labile enterotoxin B subunit at accession number S60731; Shig-ipaH Forward Primer (5'-CCTTTTCCGCGTTCCTTGA-3'), Reverse Primer (5'-CGGAATCCGGAGGTATTGC-3'), and Probe (5'-FAM-CGCCTTTCCGATACCGTCTCTGCA-TAMRA-3'), target sequence was invasion plasmid antigen H (*ipaH*) gene at accession number M32063.[24,25] Each of the ETEC-STIa, STIb, LT and Shig-ipaH qRT-PCR assay formulations were optimized by using standardized RAPID master mix reagents (BDI).[26,27]

Thermal-stable qRT-PCR Assays and Validation Testing

Each of the ETEC-STIa, STIb, LT and Shig-ipaH qRT-PCR assays were freeze-dried in a thermal-stable, hydrolytic enzyme resistant formulation by a proprietary process and packaged in a preformatted kit by BDI. The freeze-dried qRT-PCR master mix reagents only required hydration and addition of sample template prior to analysis. Assays were prepared according to manufacturer (BDI) instructions. A standardized qRT-PCR thermal cycling protocol was used (described above). Linear regression analysis was conducted using triplicate dilution series samples spanning 6 orders of magnitude (1.5×10^8 cells/mL to 1.5×10^3 cells/mL). Correlation coefficient (R^2) values were established at unity "best fit" and slope and error calculated by an algorithm provided in the RAPID analytical software (Roche Molecular Biochemicals, Indianapolis, IN). Based on linear regression analysis results, the LOD of each assay was estimated and subjected to replicate testing (n=60) by 2 individuals over 3 days. Validation testing of ETEC-STIa, STIb, LT, and Shig-ipaH qRT-PCR assay in vitro sensitivity and specificity were conducted using panels consisting of well characterized nucleic acid extracts. Stringent cross-reactivity testing of each qRT-PCR assay was conducted using each genetic near neighbor as well as other common diarrheal pathogens. To determine the ability of the assay to detect multiple strains of the same organism (in vitro sensitivity), extract of

1-fold LOD and 10-fold LOD viable cell concentrations were prepared and testing was conducted in triplicate. To determine whether the assay cross-reacts with other closely- and distantly-related organisms (specificity), extract of at least 1000-fold LOD viable cell concentrations were prepared and testing was conducted in triplicate.

Table 1. Linearity of qRT-PCR assay.

	STIa (AF-ETEC727)	STIb (AF-ETEC771)	LT (AF-ETEC966)	*Shigella flexneri* (ATCC12022)
Correlation coefficient	1.00	1.00	1.00	1.00
Slope	3.512	3.357	3.438	3.306
Error	0.0428	0.0793	0.0283	0.0787

Table 2. Limit of detection replicate testing of qRT-PCR assays expressed as critical threshold (Ct).

	ETEC-STIa Ct (Mean/STDV)	ETEC-STIb Ct (Mean/STDV)	LT Ct (Mean/STDV)	*S. flexneri* Ct (Mean/STDV)
Replicate 1	34.07/0.49	33.66/0.77	34.94/0.59	36.03/0.65
Replicate 2	34.63/0.37	34.88/0.29	34.56/0.33	36.33/0.65
Replicate 3	35.94/0.35	34.07/0.69	34.93/0.43	36.32/0.48
Average	34.88/0.40	34.20/0.58	34.81/0.45	36.23/0.59

N=20 for all qRT-PCR assays.

Data Acquisition and Analyses

Sample identification and specifications were entered electronically in the RAPID operating system run protocol. Analyses and results were automatically archived. The criterion for a positive result was a significant increase in fluorescence over background levels, ie, critical threshold (Ct), defined by an algorithm provided in the RAPID analytical software (Roche Molecular Biochemicals, Indianapolis, IN, USA). The Ct is defined as the first PCR cycle with significant fluorescence when normalized against background fluorescence.[26,27] The Ct cutoff value was 40 or less.

Nucleic Acid Sequencing

Diarrheal agent identification by methods using qRT-PCR and a combination of culture with DIG-labeled probe (ETEC) and *Shigella* serotyping were compared to qRT-PCR amplicon product sequencing. The sequencing reaction was one direction. The acceptance standard for identification was at least 90% genetic homology using generated sequence of 150 or more base pairs of an acceptable quality. Several samples tested by qRT-PCR reported fluorescence below the Ct cut-off value, however, these samples produced an insufficient concentration of amplicon for use in sequencing. The associated qRT-PCR results were excluded from sequencing comparison testing. Excluded samples were 2 ETEC STIb (n=30-2 excluded=28) and one *Shigella-ipaH* sample (n=47-1 excluded=46). Additionally, *Shigella* positive samples by culture were excluded from sequencing comparison with *Shigella-ipaH* qRT-PCR (n=46-31 positive culture=15).

RESULTS

Linearity and Limit of Detection of qRT-PCR Assays

Linear regression analyses of all 3 ETEC qRT-PCR assays resulted in an estimated LOD at 30 CFU per 20 μL of reaction volume and 3 CFU per 20 μL reaction volume for Shig-ipaH qRT-PCR assay (Table 1). Replicate testing by 2 different operators, over 3 days, running 20 samples per day at the estimated LOD achieved a replicate test score of 100% (60/60) for all qRT-PCR assays. Results for LOD replicate test results are reported in Table 2.

Positive and Negative Template Control Reactions

Positive template control (PTC) reactions were prepared for each of the 4 assays at 10-fold LOD concentrations. The template was prepared from ETEC and *Shigella* strains ETEC-STIa AF-ETEC727, ETEC-STIb AF-ETEC771, ETEC-LT AF-ETEC083, and *Shigella sonnei* ATCC25931, respectively. The PTC reactions consistently reported fluorescence at the expected Ct value (≈30) under laboratory and field conditions. Negative template control (NTC) reactions consistently reported fluorescence at or below background levels.

Sensitivity and Specificity Testing Using Reference Strains

In laboratory testing, ETEC STIa, STIb, LT and Shig-ipaH qRT-PCR assay sensitivity and specificity test results were concordant with reference strains (Table 3). In sensitivity testing, 3 reference strains representing each pathogen were tested in triplicate. Extracts were tested at LOD and 10-fold LOD concentrations. In specificity testing, 2 reference strains representing each pathogen were tested in triplicate (Table 4). Extracts were tested at 1000-fold LOD concentrations. Cross-reactivity and inhibition of qRT-PCR were not observed. Throughout laboratory-based testing, PTC reactions reported fluorescence at the expected Ct value (≈30) and NTC reactions did not report fluorescence above background.

Field-evaluation Using Stool Samples

In field-testing, ETEC STIa (n=21) , STIb (n=30), LT (n=40)and Shig-ipaH (n=47) qRT-PCR assay sensitivity and specificity test results showed promise when compared to DIG-labeled probe (ETEC) and serotyping (*Shigella*) results (Table 5). Subsequent comparison of sequences of qRT-PCR amplicon indicated that all 4 assays were 100% sensitive and 100% specific (Table 6). Amplicon product of each of the 4 assays was confirmed

as sequences of target pathogen at 90% or greater homology. Sequencing and qRT-PCR concordances were: ETEC-LT 100% (40/40), ETEC-STIa 100% (21/21), ETEC-STIb 100% (28/28), and Shig-ipaH 100% (15/15). Sample preparation, nucleic acid extraction, and analyses were conducted without provision for spatial separation.

Table 3. Results of ETEC and *Shigella*/EIEC-ipaH qRT-PCR sensitivity testing using reference strains from culture.

Strain	Pathogen(s)	PCR Assay	Ct (1xLOD)[a] (Mean/STDV)[b]	Ct (1xLOD)[a] (Mean/STDV)[b]
AF-ETEC929	ETEC STIa	ETEC-STIa	37.36/0.26	33.91/0.09
AF-ETEC727	ETEC STIa	ETEC-STIa	35.81/0.07	32.09/0.16
AF-ETEC721	ETEC STIa and LT	ETEC-STIa	36.43/0.50	32.57/0.47
AF-ETEC877	ETEC STIb	ETEC-STIb	34.85/0.10	31.09/0.54
AF-ETEC771	ETEC STIb	ETEC-STIb	34.66/0.66	30.61/0.54
AF-ETEC816	ETEC STIb and LT	ETEC-STIb	34.09/0.28	30.79/0.09
AF-ETEC966	ETEC-LT	ETEC-LT	34.18/0.46	31.05/0.09
AF-ETEC083	ETEC-LT	ETEC-LT	33.81/0.50	30.34/0.11
AF-ETEC816	ETEC-LT and STIb	ETEC-LT	34.23/0.25	31.00/0.08
ATCC12022	*Shigella*	*Shigella*/EIEC-ipaH	36.32/0.61	33.01/0.32
ATCC25931	*Shigella*	*Shigella*/EIEC-ipaH	34.01/0.12	30.59/0.10
2457T	*Shigella*	*Shigella*/EIEC-ipaH	35.57/0.29	32.67/0.21

[a] ETEC-STIa, STIb, and LT assay LOD=1.5×104 cell/mL; Shigella/EIEC-ipaH assay LOD=1.5×103 cell/mL
[b] Samples were run in triplicate.

Comment

Enterotoxigenic *Escherichia coli* ETEC-STIa, STIb, LT and Shig-ipaH qRT-PCR assay linearity and LOD test results were robust and reproducible. The established LOD of each qRT-PCR assay was validated in stringent replicate sample testing. Using a diverse panel of reference strains representing genotypically similar and clinically significant organisms, all 4 assays proved to be highly sensitive and specific. Under field-deployed conditions, ETEC STIa, STIb, and LT and Shig-ipaH qRT-PCR assays proved to be highly sensitive and specific tests for direct detection of diarrheagenic *E coli* and shigellosis disease agents from stool samples. Sensitivity test results indicated that the qRT-PCR assays performed at clinically significant detection limits evidenced by DNA sequencing. No false negative or false positive results were observed. Compared to qRT-PCR amplicon sequencing, culture methodology was specific but sensitivity levels and associated negative predictive values were not as robust as qRT-PCR. Furthermore, comparison between DIG-probe (ETEC) and *Shigella* serotyping to qRT-PCR amplicon sequencing clearly showed that the qRT-PCR assays were more sensitive. Reproducible PTC fluorescence indicated that the assays remained stable at ambient temperatures. Cross-over contamination monitored by NTC consistently reported no fluorescence above background.

Table 4. Results of ETEC and *Shigella*/EIEC-ipaH qRT-PCR specificity testing using reference strains from culture.

Strain	Pathogen(s)	ETEC-STIa qRT-PCR (1000xLOD)*	ETEC-STIb qRT-PCR (1000xLOD)*	ETEC-LT qRT-PCR (1000xLOD)*	*Shigella*-ipaH qRT-PCR (1000xLOD)*
AF-ETEC929	ETEC STIa	Positive	Negative	Negative	Negative
AF-ETEC727	ETEC STIa	Positive	Negative	Negative	Negative
AF-ETEC877	ETEC STIb	Negative	Positive	Negative	Negative
AF-ETEC771	ETEC STIb	Negative	Positive	Negative	Negative
AF-ETEC966	ETEC-LT	Negative	Negative	Positive	Negative
AF-ETEC083	ETEC-LT	Negative	Negative	Positive	Negative
ATCC25931	*Shigella sonnei*	Negative	Negative	Negative	Positive
ATCC25922	*Escherichia coli*	Negative	Negative	Negative	Negative
ATCC70819	*Campylobacter jejuni*	Negative	Negative	Negative	Negative
AF-SAL0085	*Salmonella* gr. E4	Negative	Negative	Negative	Negative
AF-SAL445	*Salmonella paratyphi* A	Negative	Negative	Negative	Negative

*ETEC-STIa, STIb, and LT assay LOD=1.5×10^4 cell/mL; *Shigella*/EIEC-ipaH assay LOD=1.5×10^3 cell/mL.

In the absence of vaccines against ETEC, *Shigella*, and EIEC bacteria and current limitations in diagnostics, the risk of an outbreak situation is increased, especially where medical and public health resources are overburdened or absent. In this study, our analytic system was rapidly deployed to an underdeveloped region and integrated into a community health program. In support of ongoing disease surveillance, 138 stool samples were processed and sensitive and specific identification of diarrheagenic *E coli* disease and bacillary dysentery agents was accomplished in 3 days. Processing and analyses of a batch of 30 samples was completed in less than 3 hours. This has important clinical implications in decision-making of the necessity and appropriate selection of antibiotic therapy and time critical treatment.[22] Diarrheagenic *E coli* and bacillary dysentery symptoms are easily confused with those of other diarrheal diseases as well as other common infectious diseases and

treatment is most effective when started 24 to 48 hours after the onset of diarrhea.[28-30] An accurate diagnosis is needed quickly for efficacious treatment. In contrast to our qRT-PCR system, culture required one week of labor-intensive effort requiring advanced skills, and results showed lower sensitivity and positive predictive values compared to qRT-PCR.

Table 5. Sensitivity and specificity of ETEC and *Shigella* assays (138 samples) comparing real time qRT-PCR results to hybridization of DIG-labeled probe (ETEC) and serotyping (*Shigella*) results.

qRT-PCR	Sensitivity %	Specificity %
ETEC STIa	100	92.4
ETEC STIb	100	92.6
ETEC LT	100	79.6
Shig-ipaH	100	81.6

Current limitations in diagnostics drive the need for effective disease prevention and control. The results reported here and in previous studies indicate that diarrheal disease prevalence may be underestimated in epidemiological surveys conducting using culture methodology versus more sensitive technologies.[7,10,13,19] Rapid and accurate identification of causative agents are essential to timely and focused implementation of priority intervention measures directed at preventable conditions. This is especially important in socioeconomic developing regions during times of disaster when local public health resources are often overwhelmed. Human and environmental surveillance data collected in a spatially focused and expedient manner augment the predictive power of transmission risk. Correctly collected and interpreted data on human infection and contaminated food, water, and environment integrated with other key transmission indicators (severity of cases, virulence of the circulating agent, identification of vulnerabilities in critical contamination control points, and climatic and geographical factors) provide for accurate transmission risk assessment. These data assist decision-makers in the appropriate use of antibiotics to mitigate transmission and epidemiological approach, and the dedication of resources for focused application of control measures such as potable water sources, hand washing stations, and monitoring food preparation and hygienic practices. Agile, field-deployable diarrheal agent surveillance capability can provide valuable assistance to local public health practitioners by serving to alert and direct focus of preventive and control measures.

We have described a field-expedient method for direct detection of enterotoxigenic *E coli* and *Shigella* from stool unique in its capability to fill a critical role in public health and potentially provide a valuable diagnostic aid.

Table 6. Analyses of real-time qRT-PCR and standard methods using DNA sequencing as the comparator test.

Test Method	Positive Specimens by Test Method/Sequencing	Sensitivity (%)	Sequence Homology (%)
ETEC STIa real-time qRT-PCR	21/21	100	98-100
ETEC STIa hybridization DIG-labeled probe	13/21	72.4	
ETEC STIb real-time qRT-PCR	28/28[a]	100	91-100
ETEC STIb hybridization DIG-labeled probe	23/28	84.8	
ETEC LT real-time qRT-PCR	40/40	100	98-100
ETEC LT hybridization DIG-labeled probe	20/40	66.7	
Shig-ipaH real-time qRT-PCR	15/15[a,b]	100	99-100
Shig-ipaH serotyping	8/15[a,b]	68.2	

[a] Positive samples from qRT-PCR with insufficient amplicon concentration for DNA sequencing were excluded from comparison testing (ETEC STIb (n=30-2 excluded=28) and Shigella-ipaH (n=47-1 excluded=46).

[b] Positive samples from qRT-PCR but negative by culture were selected for sequencing (Shig-ipaH; n=46-31 positive culture=15).

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RECENT RELEASE

Traumatic brain injury (TBI) is a complex condition for which limited research exists.
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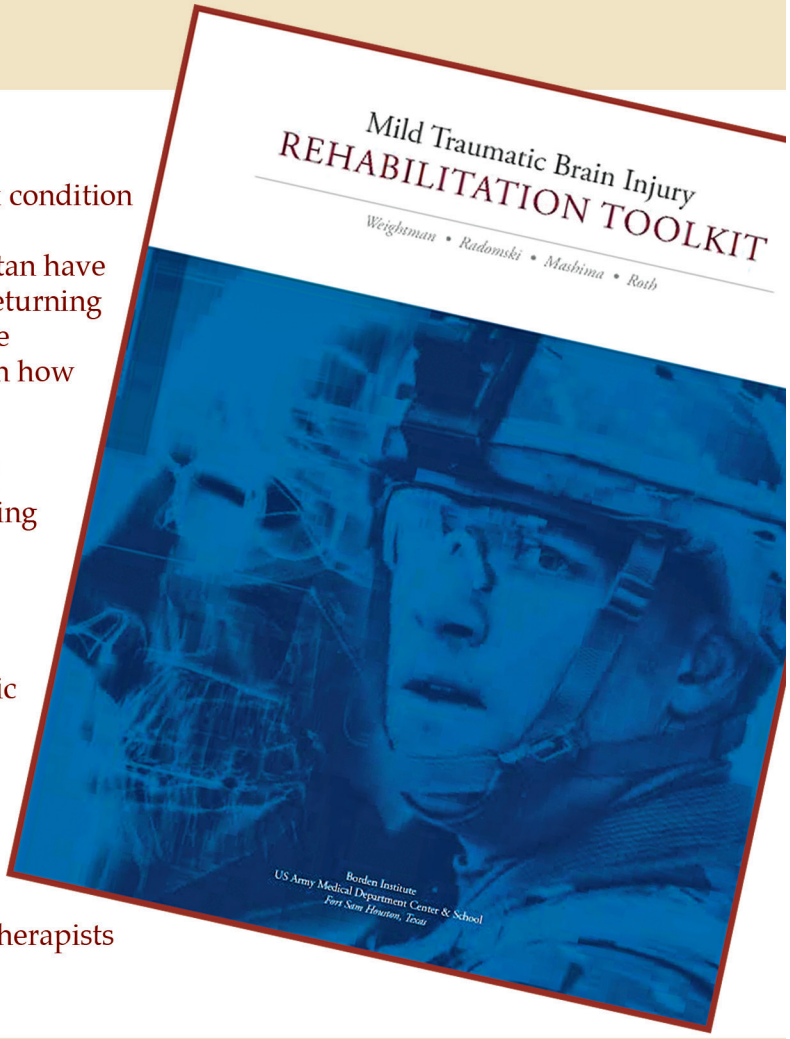

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Data Analytics Under Deployed Conditions: A Case Study

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Abstract

Like their colleagues in fixed facilities, healthcare planners operating in a combat environment face the problem of transforming data into actionable information. Not all data is useful for decision-making and not all data comes neatly packaged. In this case study, the authors present an effort to collect and analyze data about forward surgical team utilization. The article shares the variety of data collected and the process of analysis, and concludes with a recommended process for data analysis in the field.

Much like the business world, today's combat environment is awash in data which is gathered for a variety of operating purposes. Healthcare in the deployed environment is not an exception. The "Big Data" movement is largely about taking advantage of the data that is already resident in the various systems that a company operates and turning it into actionable information.[1] The key change over the last several years is an increase in volume, velocity, variety of data.[2] There is more data, it is coming in faster than ever before, and it is coming from different sources. This change is true both in civilian and military applications.

The battlefield is different from a peace-time environment. The battlefield is more austere; the pace of change is rapid and subject to sudden and possibly violent turns. Nevertheless, decision-making in the battlefield environment is a data-driven process. Data allows decision-makers to go beyond vague intuitions.[3] Data from various systems can be used to improve leaders' situational understanding, a critical part of the operations process.[4]

In his book, Knight[5] distinguishes between risk and uncertainty, allowing that risk was properly envisioned as those things which can be measured and thereby controlled through proper planning. Unlike risk, uncertainty is unmeasurable. It arises from conditions that could not be quantified. Much of battlefield planning involves trying to identify those things that can be quantified and planned for, while preparing as best as possible for those things which are truly uncertain.

What follows is a case study of decision-making under conditions of austerity. There are 2 sets of lessons to be learned from this case study: (1) despite limitations, authors Mellott and Mapes devised a reasonably useful heuristic for allocating battlefield medical assets; and (2) the process they used illustrates good principles for future leaders to follow when faced with the problem of developing similar heuristic approaches.

Methods

Background

During Operation Enduring Freedom (OEF) XII, the 2nd Medical Brigade deployed to Afghanistan as part of Task Force Medical-Afghanistan (TF MED-A), which had the mission to provide world-class health support to Coalition Forces conducting operations in coordination with Afghan National Security Forces at the Joint Echelon Above Brigade Combat Team level.[6] This meant TF MED-A was responsible for coordinating joint medical operations between US military units from all 3 services, as well as coordinating with allied coalition forces and their respective medical elements to provide medical support for the entire Afghan theater. The Coalition mission in Afghanistan during OEF XII was to begin the process of transferring control of military operations to the Afghan government and withdrawing from the country. This process required continuous adjustment as troop levels and operations changed throughout the theater in response to the withdrawal, making command and control of medical assets more complex.

Part of the TF MED-A mission was to ensure there was surgical care in remote locations. The majority of this care was delivered by 16 TF MED-A Forward Surgical Teams (FST) and Forward Surgical Elements (FSE) that could provide forward surgical support. The FST

> …is a 20-man team which provides far forward surgical intervention to render nontransportable patients sufficiently stable to allow for medical evacuation to a Level III hospital.[7]

The FSE is a nondoctrinal subunit of the FST, providing the same surgical capability, but with less depth in personnel and equipment. An FST may be separated into 2 FSEs to cover a larger geographical area with less average patient load. However, over half of the larger hospitals in theater were run by Coalition partners such as the British, Spanish, French, and Germans, and some of the forward surgical support was provided by Coalition partners not under the command and control of TF MED-A. Further, the theater was divided into regional commands, with some of the regions commanded by Coalition partners. Coordinating with Coalition partners created challenges for the TF MED-A decision-making process. Some of those challenges were the result of language, cultural, and organizational barriers. A critical impediment was that Coalition partners and US forces did not share a robust medical information system.

The US-operated Medical Situational Analysis in the Theater (MSAT) is a robust platform that brings together a number of data feeds, some of which are addressed later in this article. The MSAT is designed to integrate medical information about US forces into a single system.[8] However, the MSAT includes information about the disposition of US forces and personnel that is not shared with Coalition units. Furthermore, the MSAT only runs on the US Secret Internet Protocol Router Network (SIPRNet), to which Coalition forces are not allowed access. To share information with Coalition forces, TF MED-A instead used CENTRIXS, a separate system designed to be shared with Coalition partners. Using the full functionality of MSAT would cause double reporting: once for the International Security Assistance Force-Joint Command, in CENTRIXS; and once for US forces only, in MSAT. The reality was that both systems were partially used. Leaders had to look across 3 computer systems searching for information to develop an understanding of the medical situation, and to acquire data necessary to facilitate decision-making.

The issue of data quality in the field was related to the problem of incomplete data in the MSAT. Some measures that could have been captured in MSAT were not, or were not readily available at the TF MED-A level for decision-making purposes. For example, the Triage Revised Trauma Score (T-RTS) is commonly used to measure trauma workload. The T-RTS is an aggregated measure of 3 physiologic scores: the Glasgow Coma Scale, systolic blood pressure, and respiratory rate. These 3 scores were not captured across the theater in the electronic medical record (EMR) by all of the FSTs, so the T-RTS measure was not available from MSAT. The field EMR is a derivation of the EMR used in fixed US military medical facilities, and often asks for more information than the provider in the field has time to enter.

Operating in a coalition environment also presented a complex set of medical rules of engagement (MROE). The MROE established who is seen at each facility, and included rules for the medical care of contractor, Afghan military partners, and local national healthcare in deployed US military treatment facilities. The multiple classes of individuals who could be treated at a medical facility, and how they were either evacuated or transferred depending on their status further complicated the analysis of the medical situation.

Problem

The TF MED-A commander, like all leaders, was presented with an economic problem: he was required to provide forward surgical support in the many remote areas of the theater with only 16 FSEs. Because his resources were limited, he had to leave some areas without coverage or with a lower level of coverage than he would have preferred. Like any commander, his goal was to reduce risk by increasing his knowledge of the situation.[9] As a result, he needed a metric or metrics to guide his decision-making. He needed metrics that could measure the activity of an FST to determine if the FST was being sufficiently utilized, or if its workload had dropped enough, possibly as a result of withdrawal and transfer activities, that it could be reassigned elsewhere in theater.

In a civilian or military hospital in the United States, the most common measures of clinical workload are relative value units (RVU) and relative weighted products (RWP).[10] These measures are commonly accepted as representative of the amount of effort engaging a provider and an organization. The RVU and RWP weight outpatient encounters and inpatient admissions, respectively, to allow cross-comparison of work between providers and facilities. In addition to the complexity and fluidity of the battlefield, no such readily available metric exists for the medical commander in theater to help him/her make decisions.

During OEF XII, the commander of TF MED-A requested that authors Mellott and Mapes develop a method of measuring FST/FSE workload that could be used to support planning for reduced personnel numbers, in particular, support decisions about reallocating FSTs and FSEs.

Process Improvement Goal

Develop battlefield appropriate metrics to support FST/FSE allocation.

Metrics Development Process

Establish key requirements for the metrics based on commander's intent.

- Any metric be both valid and reliable.[11] The metric is valid if it actually measures what it was supposed to measure. The metric is reliable if it returns the same results each time it is used in similar circumstances. There can be a tradeoff between validity and reliability, especially when trying to measure something as complex as the need for forward surgical capability. A very good measure for validity may require time and effort to appropriately capture the most accurate information. In a field setting, medical personnel are primarily worried about saving patients' lives. Time-consuming measures are unlikely to be treated as important, and therefore compliance is likely to be low. Low compliance will result in low reliability of the measure. A simple measurement process is likely to get better compliance and more accuracy.
- Recognizing the trade-off between validity and reliability and an unwillingness to move resources from patient care to measurement, the authors emphasized using existing data sources. By limiting the measurements to existing data, no additional burdens were placed on the units in the field, and compliance/reliability issues were reduced.
- Given the 2 baseline requirements above, the metrics still had to account for the complexity of the intervention. Any attempt to measure workload must allow for some form of weighting, so, for example, that sick call workload is not treated the same as trauma. Furthermore, not all traumas the same. In an environment where evacuation is key, an abdominal gunshot wound could consume much more time and resources than other traumas.
- Additionally, there should be an adjustment for surges in patients for a unit. For example, in a large hospital with a number of surgeons and operating rooms, multiple wounded may or may not mean a mass casualty event. However, 2 individuals with multiple wounds may represent a significant mass casualty event at an FSE.
- The metrics also must allow for the different types of patients the units would be treating. The MROE dictates how the treating units must deal with the patients they see, with different patient types having different requirements for evacuation or transfer, causing differences in workload, even for patients with the same diagnosis.
- Finally, there was a requirement to account for personnel numbers. As the presence of Coalition forces in Afghanistan was reduced, medical coverage and the number of medical personnel also needed to decrease.

With these requirements, the authors searched for existing data sets that could potentially provide workload information that could be used to reliably model forward surgical capability requirements. Two data sets, the EMR and blood usage were extracted from the MSAT. In addition to these data sets, surgical data, evacuation data, and personnel data were pulled from other existing reports. Mellott and Mapes recognized that there was a trove of data already being collected, and in the following sections, the variables selected and the reasoning behind their selection are discussed. Ultimately the goal was to take existing data already resident in available systems and processes and transform it into useful information for decision-making.

MSAT - Electronic Medical Record

The electronic medical record (EMR) provided patient-level data about workload at each unit. For the purpose of the analysis, 3 months of medical records were extracted directly from MSAT. The variables the authors drew from the EMR to attempt to gauge workload included:

- Encounters. This field offered a simple, unweighted count of the number of times providers gave care to patients. It serves as a partial proxy for workload. Because of its unweighted nature, it gives an incomplete picture by itself since it does not differentiate the level of care provided during the encounter.
- Injury Type. Injury type included 3 possible entries: disease, nonbattle injury, and battle injury. Since the FSTs/FSEs were primarily assigned for their surgical capability, the authors wanted to identify whether the units were being used for surgery or for general medical support.
- Visit Type. This was a simple binary choice of new visit or follow-up. The authors would not expect a high level of follow-up care, which could also indicate misuse of the unit.
- Disposition. There were 3 possible dispositions: patients were admitted (held for over 12 hours within the facility), evacuated, or returned to duty. Although not doctrinally part of the FST/FSE mission, minimal holding capability is sometimes a necessity due to austere conditions.
- ICD-9 Diagnosis. The ICD-9 code allows for greater clarity regarding the type and severity of injury. Diagnosis codes would allow an analysis of the kind and intensity of care being provided at the unit.
- Patient Branch of Service. Within MSAT, this variable would allow the authors to decipher the status of a patient with regard to the MROE. The variable

included codes for US service member, Coalition member, contractor, DoD civilian, member of the Afghan National Security Forces, or a local national. Although there are other fields within MSAT providing similar information, the researchers found clinicians most consistently used this particular variable.

The MSAT and particularly the EMR were selected for use in modeling because the MSAT is the system of record, and the EMR can provide a longitudinal view of patient care. There are problems with using the EMR, particularly concerning data quality. Field patient records, especially during high volume periods, were frequently left incomplete or were only partially completed by providers. Failure to complete the record arose from 2 factors:

- Complexity of the Record. Although the EMR is the system of record, it was more appropriate for a hospital/clinic setting because it required excessive granularity of data and offered too many choices to providers. Furthermore, the complexity made it unfriendly for developing intheater specific reports—it was designed as a patient record, not for aggregation and decision-making.
- General Provider Compliance and Completion. Providers, particularly at FSTs and FSEs, are often focused on immediate lifesaving activities, not on data capture. To a degree, TF MED-A could and did influence EMR completion by directing provider compliance. However, even with completed EMRs, data quality could be of concern. This would be especially so if a provider is completing the record from memory after the fact, days, weeks, or months after the encounter.

Despite its shortcomings, the EMR encounter record was identified early on as a core metric. Other data might also be identified as core, or might be identified as useful in modifying the encounter data to provide weighting, much as RVU weights are assigned to encounters in a nondeployed healthcare setting.

MSAT - Blood Usage

Blood usage is also tracked in the MSAT and this data was extracted. Blood usage was conceived of as a measure of acuity, with the thought that more serious surgical interventions of the type for which FSTs/FSEs were allocated would require more blood. Thus, a higher level of blood use would be a good proxy for a higher level of surgical acuity. If this was an accurate proxy, it would provide a simple and objective measure for deciding which units were being used appropriately for their surgical capability. For measures, the authors used the monthly number of blood transfusions per facility. Using blood as a measure is a good example of the tradeoff between validity and reliability. The accuracy of the blood usage data was high because it is tracked through the logistics ordering system and requires no further manipulation. However, this measure did not provide information about how much blood was used per patient. Consequently, usage per month could look the same for a facility that treated several patients with a few units of blood and another facility that treated one patient with many units of blood.

Surgical Data

Surgical data variables were derived from the International Security Assistance Force (ISAF) Joint Command Medical Assessment Report. This report was updated every 3 hours by each Coalition medical facility in Afghanistan and accessed through CENTRIXS. The surgical data measures drawn from the data set included:

- Number of Surgeries. An unweighted count of the number of surgeries, not unlike patient encounters.
- Number of Surgical Hours. An unweighted count of the number of surgical hours reported. Surgical hours did not differentiate among the number of personnel involved in providing the surgical intervention.
- Average Hours per Surgery. As with the two above, an unweighted average not adjusted for acuity, equipment, or personnel.

The variables drawn from this dataset were envisioned as possibly serving as proxies for acuity. There were 2 main, known concerns with this dataset. First, there was no check on accuracy; numbers may have been inflated or underreported. Secondly, the numbers reported in this dataset were aggregates not connected to particular surgeries. As a result, the information in this system is not directly helpful for the sick and wounded US service member as numbers of hours per surgery and related information are not applied to an individual patient record. Although not helpful to the individual deployed service member's record, it is a measurement across the Combined Joint Operations Area–Afghanistan and includes information from Coalition partners. Further, as this is an online spreadsheet in SharePoint, it is easy to update as mandated. Lastly, this metric is commander-friendly. Commanders rely on metrics like these and others such as bed status and availability of operating rooms to make medical-operational decisions.

Evacuation Data

Evacuation data variables were derived from the ISAF Joint Command Patient Evacuation Cell. This report was updated in near real-time and monitored by each regional command, and was serving as the central repository for casualty evacuation data in theater. The data was maintained in an online spreadsheet, making it easy

to access and update through CENTRIXS. The evacuation data measures drawn from the data set included:

- The average number of patients per evacuation gives trend data on the intensity coming from each location. Higher average numbers per evacuation indicates more intense rates of casualties per incident.
- Number of patients evacuated to/from each location.
- Evacuation category of the patient.

One of the purposes of the report was to keep commanders informed of nonstandard evacuations. Nonstandard evacuations are evacuations of patients by nonmedical transport. One of the goals of the medical system was to minimize nonstandard evacuations to ensure quality of patient care. The evacuation data in this report was cross-checked systematically against monitored helicopter flight hours and nonstandard MEDEVAC missions.

Data Gathering

Three months of retrospective data for the 19 FSTs/FSEs were pulled from each of the data sets listed above to perform the analysis. The advantage of this methodology is reliance on historical data already resident in the systems discussed without the burden of collecting additional data on units being studied. In some cases where units were outliers, a follow up with the unit commander clarified business processes reflected in the data. Otherwise, the organizations were not further burdened in the production of the information.

Analysis and Results

The review of the listed data sets yielded extensive raw data from each. The mission was to take that data and turn it into actionable information for the commander. To that end, the data was analyzed from the perspective of the surgical team mission in support of the wider military effort. The primary mission of the FSTs/FSEs was far-forward surgical treatment of trauma, although inevitably the team treated other forms of injuries and illnesses. [12]

Since the commander's priority was to allocate surgical resources where they were most needed, the authors determined that the core measure for determining team utilization was the EMR encounters. However, this unweighted measure alone could potentially be misleading, depending on the business processes and local utilization of each surgical element. While the mission of a surgical team is trauma surgery for Coalition forces, providers will generally perform other medical missions such as sick call as well. Further, based on TF MED-A's experience, they will also provide care for Afghan soldiers and local nationals on occasion. These latter functions happen, but are not part of the primary mission for which the TF MED-A commander is staffing when making decisions about allocation of medical resources on the battlefield.

The EMR data from the 19 sites were first filtered by patient category, excluding patients who should not have been cared for under the MROE, such as local nationals. Since care for these patients was not the mission of the team, and this workload should not have been used in determining future resource allocation.

Second, the data was filtered by ICD-9 code, excluding those with ICD-9 codes that indicated the encounter did not represent treatment that was part of the surgical team's primary doctrinal mission of trauma surgery. Encounters with ICD-9 codes in the 800-999 range (injury and poisoning categories) were included, and further screened using supplemental "E" codes that identify the specific mechanism of injury, which also allowed further elimination of nontrauma encounters. All trauma, including nonbattle trauma such as accidental vehicle rollovers, were included.

As a result of this 2-step filtering process, there were 1,626 encounters that represented FST/FSE-appropriate workload spread over the 19 sites. A sample of the data analyzed in the EMR is shown in the Figure.

At this stage, the remaining workload was aggregated by site and by month for an initial review. The goal of any decision-making model matches the logic of Occam's Razor: it is best to seek the simplest model possible.[13] If one data point is capable of providing the information that a commander needs to make a decision, it is inefficient to seek more. The gathering and analysis of data requires resources—manpower and time at a minimum—and there are certainly diminishing returns to search.[14]

Table 1 presents the array of workload by unit. In terms of average workload, there appears to be 3 clusters, with one outlier at the top of the distribution. As noted previously, this data is unweighted, with each encounter counted the same as any other, even though some of the encounters may have represented much more serious injuries. Nevertheless, this distribution provides the framework for further analysis.

The low number of encounters seen among the units at the bottom of the distribution supported a recommendation to have those units relocated to areas with a heavier medical mission. One of the units was ultimately moved; 2 were left in place despite their low utilization. Of the 2 left, one was providing support to very remote

Encounter Date	Initial Visit Flag	Injury Type	Patient Branch of Service	Disposition	ICD9 Diagnosis	Primary ICD9	Facility Description	ICD93 Code	Facility Branch of Service	All ICD9	Encounter Timestamp	Patient Category
J	Y	Nonbattle Injury	CIV	Returned To Duty	Traumatic Amputation of One Leg Below Knee Complicated: Right leg traumatic BKA	897.1	FSE H	897	USA	897.1	41075.2939	K92
J	Y	Battle Injury	UNK	Returned To Duty	Gunshot Wound of the Thorax	879.8	FSE H	879	USA	879.8	41088.5754	null
M	Y	Nonbattle Injury	UNK	Limited Duty	Closed Fracture Neck of Femur Intertrochanteric Left	820.21	FSE H	820	USA	820.21	41056.3121	null
M	Y	Nonbattle Injury	UNK	Limited Duty	Cerebellar Contusion With Concussion	851.49	FSE H	851	USA	851.49	41053.4527	null
M	Y	Battle Injury	FMIL	Evacuation	Burns: <10% BSA mixed full and partial thickness burns of post neck , right ear, and upper back	949.0	FSE H	949	USA	949.0	41059.5045	K74
M	Y	Battle Injury	FMIL	Limited Duty	Injury Due to War Shrapnel Grenade: face, right arm and right thigh	E991.4	FSE H	E991	USA	E991.4	41059.3609	K74
A	Y	Battle Injury	FMIL	Evacuation	Gunshot Wound of the Forearm Left: through and through L forearm	881.00	FSE H	881	USA	881.00	41017.2738	K74

A sample of the extracted electronic medical record data after it had been refined to isolate workload information appropriate to the study.

units. Evacuation from the area of operations was precarious at best, and, although there were relatively few patients brought to the surgical team, the TF MED-A commander deemed the mission valid. The second unit was left in place despite low utilization for other considerations, which are not within the scope of this article. These examples show that a quantitative model must still be tempered by mission requirements. At the top of the distribution, policy was adjusted for FST D, the high outlier. Because this location continuously saw significantly more action than the other FSTs/FSEs, personnel were periodically rotated to other FSTs/FSEs.

Average workload is the frame for the analysis, but finding some proxy for acuity was important to generate a more robust representation of actual medical need. To that end, other data sets were reviewed.

Surgical workload was examined in terms of the number of surgeries, the total number of surgical hours, and the average number of hours per surgery. The authors found that the number of surgeries correlated strongly (0.85) with the number of surgical hours, as might be expected. However, neither the number of EMR encounters nor the number of surgeries correlated with the average number of hours per surgery. If average surgical hours are a measure of the acuity of the work done at the site, it would seem that the acuity was somewhat arbitrary. This could be a result of a random distribution of injuries throughout the theater and among the sites. However, further qualitative analysis through discussions with the units indicated that there was significant variance in terms of practice by the individual surgeons. Some surgeons attempted to do more at the site, extending the duration of the surgery, while other surgeons primarily stabilized seriously injured patients for further evacuation.

The number of transfusions is an objective measure and is moderately correlated with the number of surgeries (0.48) and number of surgical hours (0.56). Because this measure is objective, it was looked at favorably for inclusion as a measure of acuity.

Evacuations from each site was another objective measure that was tracked outside of the respective FST/FSE. Evacuations are most strongly correlated with number of EMR encounters and number of surgeries, but weakly correlated with surgical hours per surgery.

Table 2 presents correlations among data variables. Many of the variables show low correlation with each other. High correlation between/among variables would suggest a relationship, and in some cases it appears that we do see higher levels of correlation.

For this kind of effort, low correlation between variables is actually potentially useful. If 2 variables have low correlation, it could be that these variables are capturing unrelated aspects of the unit operation. If all the data shared high correlations, we could ignore it most of it for the purpose of developing decision-making metrics. The fact that transfusions are not perfectly correlated with EMR encounters, for example, tells us that the transfusions data has additional information captured in it that is not captured in the EMR encounters data. This is congruent with our knowledge that the EMR encounters represent a very incomplete picture. Managers looking for data to guide decision-making do not necessarily want data with high correlation. For decision-making purposes, data with high correlation likely provides confirmation; data with low correlation likely provides a different perspective.

Table 1. FST/FSE Workload.

Location	Encounters			
	Month 1	Month 2	Month 3	Average
FST D	71	127	164	120.7
FST E	78	46	37	53.7
FST C	38	69	40	49
FST K	49	41	51	47
FST G	34	65	49	49.3
FST H	49	39	32	40
FST J	32	54	32	39.3
FSE A	50	18	7	25
FSE H	24	18	17	19.7
FST F	1	25	23	16.3
FST B	16	20	13	16.3
FSE G	1	28	20	16.3
FSE F	19	12	12	14.3
FST A	6	16	16	12.7
FSE C	10	10	6	8.7
FSE E	0	8	9	5.7
FSE B	0	10	0	3.3
FST I	1	5	1	2.3
FSE D	2	0	0	0.7

Moments

N=57
Mean=18.37, SD=9.44
Standard error of the mean=1.25
Upper 95% Mean=20.87
Lower 95% Mean=15.86

Ultimately, EMR encounters were used as the primary measure of workload. Transfusions, surgical hours, and evacuations from the site were used as secondary measures of acuity to make resourcing decisions. This combination of metrics helped to meet the requirements for metrics development. The EMR encounter metric was reliable and valid. The fact that it was incomplete in itself was offset by using the other measures in a dashboard approach. Other mission considerations such as the difficulty of evacuation assets reaching the FST/FSE and strategic positioning of assets due to other considerations played into the analysis as well, but the metrics identified were used for baseline analysis. EMR encounters were the core metric for decision-making. Because they lacked weighting, other metrics were used alongside the encounters data to provide a more nuanced understanding. The authors considered combining the supporting metrics into some sort of weighted value, like an RVU, thus creating a single number. However, the idea was not pursued because the process of combining the data into one number would diminish the informational value of the metric.

Comment

While imperfect, the measures Mellott and Mapes developed were usable. The primary strength of the approach was that they relied on existing data streams, without imposing additional reporting requirements on subordinate units.

It is recognized that there are many weaknesses to this effort. Some of them arise from the environment in which TF MED-A was operating. Military operations in theater are always austere, and resources are limited. Furthermore, in this case, data reporting that was split over multiple networks and reporting systems as a result of working with Coalition and Afghan forces, requiring the authors and many of their colleagues to maintain 3 computers at any given time in order to switch between networks.

Table 2. Correlations Among Data Variables.

	Number of Transfusions	Number of Surgeries	Number of Surgical Hours	Average Hours per Surgery	Average Patients per Evac Mission	Number of Locations Flown From	Surgeons per Team	Average Hours per Surgeon	Manning	Workload to Team Member
EMR	0.4637	0.7084	0.565	0.2067	0.0316	0.7641	0.5529	0.3413	0.3789	0.9292
Number of Transfusions		0.4793	0.564	0.3048	-0.0027	0.5325	0.3619	0.4819	0.2707	0.3815
Number of Surgeries			0.8468	0.1175	0.0245	0.7478	0.4476	0.7234	0.1342	0.6994
Number of Surgical Hours				0.4112	0.085	0.5438	0.4328	0.9209	0.2094	0.5395
Average Hours per Surgery					-0.0204	0.0269	0.3667	0.3958	0.5105	0.1041
Average Patients per Evac Mission						-0.066	-0.0057	0.0712	-0.0524	0.051
Number Locations Flown From							0.5559	0.3138	0.2301	0.7171
Surgeons per Team								0.1582	0.5762	0.387
Average Hours per Surgeon									0.058	0.3741
Manning										0.0703

In a more stable environment with more robust reporting, higher quality variables might have been captured for analysis. Some things that would have been available in the more robust civilian environment would have included measures such as the Triage-Revised Trauma Score, Glasgow Coma Scale, vital signs, etc, for quantification of acuity upon admission to the FST. This data was not readily available, and gathering such information would have imposed additional data collection requirements on the subordinate units.

One question worth further consideration is whether surgery unrelated to trauma, such as appendicitis, should be included in the analysis. At the time, the decision was made to exclude surgeries of that type since they are not the doctrinal mission of the FST/FSE and should be treated farther back in the lines of evacuation. The actual incidence of such surgeries could be analyzed for discussion in future research to determine if some amount of additional manpower should be allocated to the FST in order to support that function.

Conclusion

This article does not attempt to provide a final model for the allocation of forward surgical resources. It is an attempt to document a specific case of decision-making under austere and shifting circumstances. This article provides an examination of the process whereby staff officers can develop metrics to support command decision-making while minimizing information costs on subordinate units.

The use of data analytics to guide decision-making in theater will continue to grow as the information systems continue to be integrated into all aspects of operations. The civilian sector has only recently begun to recognize the value of the data that is often captured during ordinary business operations. If it is analyzed properly, it can yield significant operational insights. This case study has shown how Mellott and Mapes examined data readily available to them, and how they filtered and processed the data into information for command decision-making. Despite limitations, they devised a reasonably useful heuristic for allocating battlefield medical assets that did not require additional resources to sustain. The process illustrates good principles for future leaders to follow when faced with the problem of developing similar heuristic approaches.

The process steps are as follows:

1. Identify existing data sources that have data potentially bearing on the problem.
2. Identify which variable(s) is(are) core to decision-making.
3. Filter the data to fit the doctrinal mission.
4. Identify supporting variables.
5. Filter out redundant supporting variables by examining correlations.

Further focus on the process of developing command decision-making metrics should be integrated into military medical leadership training, integrating the principles shown in this case study.

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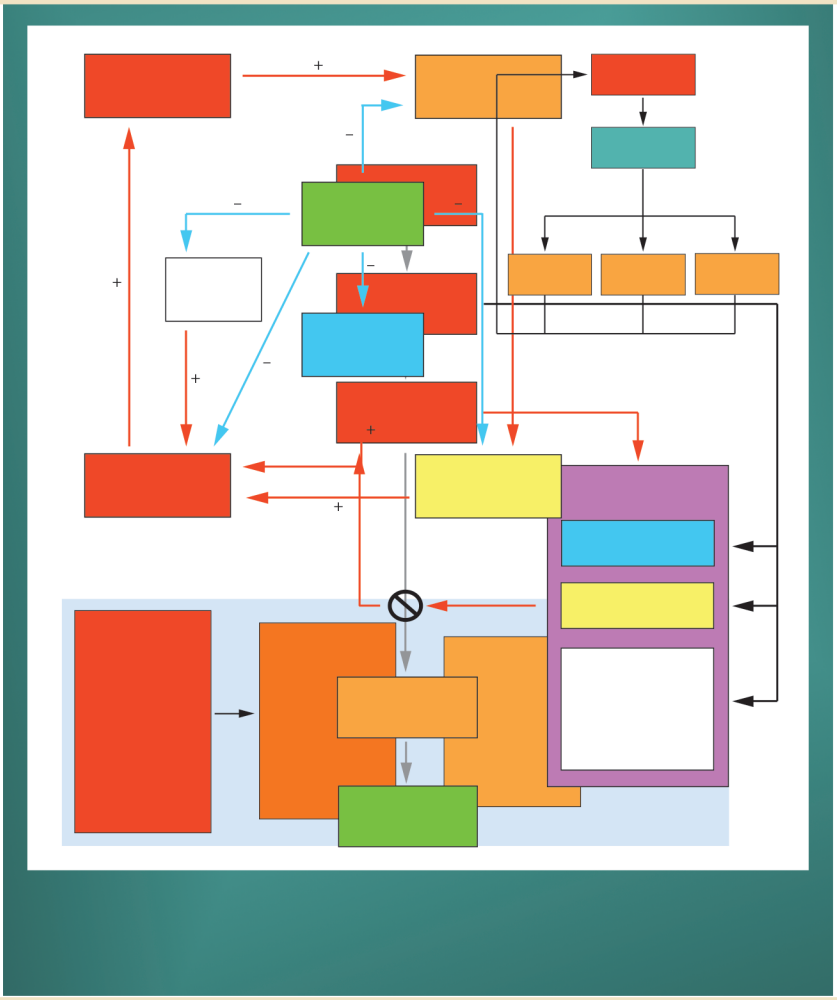

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Leveraging Health Information Technology to Improve Quality in Federal Healthcare

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Abstract

Purpose: Healthcare delivery in America is extremely complex because it is comprised of a fragmented and nonsystematic mix of stakeholders, components, and processes.

Within the US healthcare structure, the federal healthcare system is poised to lead American medicine in leveraging health information technology to improve the quality of healthcare. We posit that through developing, adopting, and refining health information technology, the federal healthcare system has the potential to transform federal healthcare quality by managing the complexities associated with healthcare delivery. Although federal mandates have spurred the widespread use of electronic health records, other beneficial technologies have yet to be adopted in federal healthcare settings. The use of health information technology is fundamental in providing the highest quality, safest healthcare possible. In addition, health information technology is valuable in achieving the Agency for Healthcare Research and Quality's implementation goals.

Methods: We conducted a comprehensive literature search using the Google Scholar, PubMed, and Cochrane databases to identify an initial list of articles. Through a thorough review of the titles and abstracts, we identified 42 articles as having relevance to health information technology and quality. Through our exclusion criteria of currency of the article, citation frequency, applicability to the federal health system, and quality of research supporting conclusions, we refined the list to 11 references from which we performed our analysis.

Results: The literature shows that the use of computerized physician order entry has significantly increased accurate medication dosage and decreased medication errors. The use of clinical decision support systems have significantly increased physician adherence to guidelines, although there is little evidence that indicates any significant correlation to patient outcomes. Research shows that interoperability and usability are continuing challenges for implementation.

Comment: The Veterans Administration is the only entity within the federal health system that has published research on the use of health information technology to improve quality. The federal healthcare system has existing systems in place with computerized physician order entry systems and clinical decision support systems, but these should be advanced.

Conclusion: Particular focus and attention should be placed on data mining capabilities, integrating the electronic health record across all aspects of care, using the electronic health record to improve quality at the point of care, and developing interoperable and usable health information technology.

The 1999 report from the Committee on Quality Health Care in America of the Institute of Medicine, *To Err is Human: Building a Safer Health System*,[1] brought the issues of medical quality to national attention. The report revealed that between 44,000 and 98,000 Americans die each year as a result of medical errors in hospitals, resulting in an annual loss of $17 to $29 billion.[1(pp1-2)] By nature of their duties, healthcare workers are often charged with managing several competing demands, including caring for multiple patients simultaneously, data entry, and data interpretation. In healthcare administration, processes, protocols, and regulatory requirements exist to guide, assist, or direct staff in the execution of these duties, however it must be recognized that there are limits to human ability. Heavy reliance upon the human factor, at some point, leads to error. In a healthcare setting, error is a leading cause of reduced healthcare quality. Error can lead to patient harm or decreased patient safety, including omission of important information, duplicative and/or unnecessary testing, incorrect data interpretation, and increased costs. The Agency for Health Care Policy and Research was established in 1989 with the mission to improve the quality of healthcare in America. In 1999, congress reauthorized and

redesignated it as the Agency for Healthcare Research and Quality[2] to address the growing quality concerns brought to light by the Institute of Medicine report.[1]

Alongside the increased focus on healthcare quality was the rise in health information technology and its implementation across America. With the advent and expansion of health information technology, the Agency for Healthcare Research and Quality identified the need to provide a more defined framework for using health information technology to achieve its goal of improving healthcare quality. In 2009, the Agency for Healthcare Research and Quality published 5 goals to help healthcare institutions implement health information technology toward meaningful use and improving quality. These goals are to (*a*) improve patient safety by reducing medical errors; (*b*) increase health information sharing between providers, laboratories, pharmacies, and patients; (*c*) help patients transition between healthcare settings; (*d*) reduce duplicative and unnecessary testing; and (*e*) increase our knowledge and understanding of the clinical safety, quality, financial, and organizational value and benefits of health information technology.[3] In this study, we examine the existing body of literature on health information technology and healthcare quality to provide recommendations for using health information technology toward those goals.

The federal healthcare system, comprised of the Veteran's Administration (VA), Department of Defense (DoD), and the Indian Health Service, is a complex system in which the implementation of health information technology could be easily accomplished. Despite being separated among the different entities, the federal healthcare system is closed and existing command and control channels can directly affect it, thus making it easier to perform improvements than can be accomplished on most civilian health systems. The federal healthcare system, and more specifically, the VA and DoD, have placed renewed emphasis on quality of care practices over the past few years. With the current state of health information technology and the amplified focus on quality, the federal healthcare system is primed to be the lead toward integrating and leveraging health information technology to meet quality goals.

Methods

To gain the fullest appreciation for current literature on the topic of health information technology and quality, we began our analysis with a broad search strategy; we refined the search strategy based on our initial, cursory review. We conducted a systematic literature review with 2 primary objectives: (*a*) examine results from studies of existing and emerging health information technologies and their potential to improve quality and (*b*) identify the challenges of widespread adoption of health information technology. We performed our searches using the Google Scholar, PubMed, OVID, and Cochrane databases.

Despite its lower precision over specific individual academic databases (eg, ScienceDirect, EBSCO),[4] we selected Google Scholar as part of our search strategy. Although using Google Scholar's metasearch capability is more time-consuming for researchers because of the excess nonrelated information that it frequently yields, we desired Google Scholar's expansive web-crawling capability as it returns a greater number of literature results than that provided by a single academic database.[4]

We used PubMed because of its advantage over Google Scholar in that it is human-curated, meaning literature review committees select which literature is included in the PubMed database.[5] PubMed focuses on clinical and biomedical journal publications, which are the focus areas of our study; hence, a PubMed search yields highly rigorous results. Additionally, since the information about each article is entered into the PubMed database in a tightly organized method, the likelihood of receiving spurious results is substantially decreased.

The advantage of using OVID lies in the web-searching software that Ovid Technologies created and the purview of the search engine. In other words, OVID provides an extensive search across multiple databases—albeit, not as expansive as what Google Scholar provides—and focuses on healthcare-related literature and databases. Using OVID, researchers can select multiple databases in which to simultaneously execute the search query criteria and can refine previous searches through the use of Boolean operators to return a limited set of applicable articles.

Additionally, based on the high level of research-based clinical evidence it provides, we chose to perform a search within the Cochrane database. The Cochrane database is derived from the Cochrane Library. It is a highly regarded compilation of databases that house superior evidence-based healthcare research designed to aid healthcare decision making.

We performed our search using the Boolean search terms and syntax:

> health information technology OR electronic health record OR federal health system AND quality OR patient safety OR AHRQ OR usability OR transition of care OR patient safety

Initially, our search strategy returned excessively high numbers of results; therefore, we refocused our search on review articles since 2005 and research articles since 2010 to try and identify the most current literature available. In total, we identified 42 articles through a review of the title and abstract as having relevance to health information technology and quality. Since many articles provided significantly overlapping information, we first reduced the list from 42 to 20 by taking those articles that were the most current, most frequently cited, and published in peer-reviewed, commonly identified professional journals. Review articles since 2005 were given stronger consideration as they provided the most current overview of health information technology as it relates to quality. We further refined the list of articles based on the factors of generalizability to the topic, applicability to the federal healthcare system, and quality of research conducted as related to our topic. After applying the search criteria noted above and refining the article selection, we selected 11 references from which we performed our analysis.

Results

The vast majority of studies show some positive effects of health information technology on quality measures; however, it is mostly in the context of provider adherence to guidelines and not outcome measures, of which there is a paucity of research.[6] Specifically, research has conclusively shown that the use of a fully-integrated electronic health record has led to improved adherence to clinical guidelines and a reduction in medication errors, but no significant influence on mortality statistics, with at least one study specifically showing an increase in mortality following electronic health record implementation.[7]

The focus on computerized physician order entry and clinical decision support system tools, though not evaluating the relevance to consumers or interoperability, has provided some benefit to the field,[8] however, emphasis is still lacking in key information regarding implementation and usability. The body of research is limited to the evaluation of proper medication dosing and the reduction in medication errors, even though there are studies that show a slightly negative effect of computerized physician order entry systems due to "alert fatigue,"[9] the phenomenon by which alerts lose all effectiveness due to the sheer number of alerts with which the physician is inundated. Research is ongoing into the effect of other common uses of computerized physician order entry systems such as within radiology and laboratory ordering; however, none of significance has yet been published.

Another concern related to, and in some cases, caused by, excessive alerts is that of healthcare practitioners creating "workarounds."[10,11] When the number of alerts becomes excessive from the perspective of the user of the health information system, the user may create a workaround to compensate for the excessive alerts. On one hand, workarounds can be assistive tools for healthcare practitioners, such as a flow diagram of how to maneuver through different areas of the health information technology user interface. On the other hand, workarounds may be detrimental—even dangerous—if they are methods of disabling or bypassing patient safety protections built into health information technology systems.[10,11]

Recently, some more specific studies in the use of health information technology to improve quality have been undertaken.[6,12-14] The current literature on health information technology reveals that it has positive outcomes in a healthcare setting. One particular review that included 105 studies noted that:

> 78% showed at least 1 finding that indicated positive impact on quality of care from health information technology. Among the more frequently studied types of health information technology, computerized reminders (91%) and patient self-management applications (88%) had high rates of positive findings, while the rates were somewhat lower for CDSS (74%) and for order entry (71%).[13]

In another systematic review:

> Of the 154 included studies, 96 (62 percent [sic]) were positive, indicative of associated improvement in 1 or more aspects of care of health information technology, with no aspects worse off; and 142 (92 percent [sic]) were either positive or mixed-positive.[14]

The Jamal et al[6] and Sukh et al[12] studies focus on using clinical decision support systems functions that can be implemented within health information technology, which has been shown to reduce medical errors through the reinforcement of clinical practice guidelines. During our search, we found that the VA is the only entity of the federal healthcare system that has published research on quality improvements through the use of health information technology.[15] The VA found that adherence to specific clinical practice guidelines increased significantly when the clinical practice guidelines were implemented as a set of reminders within the electronic health record.[15] This effect is particularly prominent in the care of diabetic patients, wherein the use of electronic health records with clinical decision support systems has led to a significant improvement in diabetes outcome measures.[16] Within inpatient care settings, research literature has shown a reduction in unnecessary blood transfusions, although we found no documented effect on mortality rates.[14] Emerging studies are looking at the benefit of electronic health records with clinical

decision support systems tools and the improvement in asthma care and hospital complications. Patient records include a variety of data in a wide range of formats including images, numbers, text, and videos. Such data may suffer from problems of inaccuracy or incompleteness, complicated by different coding schemes and a lack of interoperable frameworks. If developed and implemented, data and transaction standards could be used to enhance the accuracy of data exchanged.[13]

In addition to evaluating the effect of health information technology on clinical quality measures, researchers have looked into the use of health information technology in the actual performance of quality management tasks. Health information technology can be useful in addressing process complexity and process improvement. Currently, there is high variability in care processes. To be improved, processes must be managed and measured, and these measurements must be derived from data. Health information technology is a tool that can be used to collect and analyze the data needed to measure performance and outcomes for process improvement. Health information technology can also be leveraged to document processes and identify and incorporate lessons learned.[17]

Studies have shown a significant increase in the performance of hospital quality practices directly attributable to the implementation of health information technology.[18] By implementing health information technology, it would seem intuitive to automate the quality measurement process. Studies have shown a methodological challenge with using health information technology to acquire the data to track quality.[8] For example, of the 257 articles that comprised the Chaudhry and colleagues study,[8] 3 papers from the VA addressed using health information technology to automatically capture quality-of-care metrics. The study found that although the workload to capture quality metrics was lowered when an automated approach was introduced, the majority of the studies (2 of the 3) yielded validity limitations with the automated methods, that is, inaccurate/underestimated database query results and biased results caused by false positives.[8]

Although the preceding challenges are shortcomings of health information technology, these inadequacies will likely dissipate as health information technology is further developed to provide useful tools to perform, track, monitor, and report on quality processes. However, the full realization of optimal, integrated health information technology will likely be a lengthy process.[19] As an example of the positive potential of health information technology, and contrary to the troubling VA system papers, Chaudhry and colleagues identified 3 areas of quality benefits gained from the use of health information technology: "increased adherence to guideline-based care, enhanced surveillance and monitoring, and decreased medication errors."[10].

Health information technology can also be used to filter, access, and translate patient data into meaningful, real-time information such as patient history, pattern identification, prescription conflicts, and treatment protocols for providers. This capability can shield providers from data overload and help them to make timelier, informed decisions in patient care. In general, a major benefit of health information technology is its capability to reduce data complexity while improving its accuracy, timeliness, consistency, interoperability, and comprehensiveness.

In federal healthcare, the Veteran's Affairs Medical Center has been a leader in 1 form of health information technology; their medical records are "recognized as one of the most comprehensive and integrated electronic health systems to date."[20] As of late, Veteran's Affairs Medical Center records have limited interoperability with the records in the Military Health System.

Comment

There is limited literature and research on the use of health information technology within the federal health system; however, some themes can be taken from published literature and applied to federal healthcare. The VA is the only federal healthcare entity we found with published research that shows the benefits of their electronic health record on quality measures. Computerized physician order entry is fully integrated within all federal health system components including medication, laboratory, and radiology ordering. Although research has not been reported, anecdotal reports indicate these systems have reduced errors similar to that noted throughout the reviews referenced in this article.

The highest barriers of health information technology adoption arise from the human element. In a healthcare setting, there are often resource constraints and the introduction of health information technology can initially strain workflow.[13] Learning curves involved with implementation of new technology, as well as possible resistance from employees, can pose a challenge for managers who are balancing many competing demands. Simply investing in health information technology is not enough; a manager must be able to promote a culture of improvement and growth in technology. Otherwise, they may not get the buy-in they need from their staff. There are several areas in which managers may be able

to influence buy-in. We will mention two. First, Weigel and colleagues[21] found moderate, positive correlations between the relative advantages of the new technology and the likelihood the user will be interested in adopting the technology. Likewise, they found that degree to which someone can experiment with a new technology also has a moderate, positive correlation to the likelihood the user will be interested in adopting the technology.[21] With that information, managers can focus on explaining the advantages of the new system and provide experimental systems for the employees.

Despite the benefits of health information technology, the aforementioned alert fatigue and workarounds combined with the human factor that is part of medicine exist, and errors continue. Clinical decision support systems tools are more frequently found within the VA system than in the DoD and Indian Health Service (IHS) systems. Clinical decision support systems tools, in the form of the integration of clinical practice guidelines into the electronic health record at the point-of-care, have been steadily increasing over the past few years. Several studies have shown that these clinical decision support systems tools positively affect quality outcomes, specifically regarding diabetes care.[16]

In our view, the areas in which the federal healthcare system is most lacking in the implementation of health information technology toward improving quality are no different from what is noted repeatedly as weaknesses by national studies. These factors are usability, interoperability, full integration, and data mining. Specifically within the DoD, there are separate systems for order entry, outpatient electronic health records, inpatient electronic health records, and surgical electronic health records. Even though the necessary information exists, it does not transfer between systems and thus, is not interoperable. Interoperability includes the spread of the information across the federal healthcare system. Many patients are dual-eligible beneficiaries for a combination of the VA, DoD, and IHS systems, and therefore, receive portions of their care among different agencies. However, as previously mentioned, the health information technology systems among the 3 systems have limited interoperability between one another. This limited interoperability poses substantial quality and patient safety concerns.

In its 2012 report on health information technology and patient safety, the Institute of Medicine called for "the establishment of an independent federal entity for monitoring and analyzing patient safety data."[22] Otherwise known as the Health Information Technology Safety Center, this entity is envisioned to be the central exchange of health information technology subject matter expertise and best practices. While budgetary constraints have prevented the creation of the Health Information Technology Safety Center as of yet, it is clear that as a nation we are making strides and moving toward universal adoption of health information technology.

Although new tools have been created to improve the usability of the health information technology within the federal healthcare system, these tools have not been fully integrated across all platforms. Therefore, most the health information technology does not yet offer the usability necessary at the point-of-care to improve provider efficiency, compliance with guidelines, and overall quality outcomes.

Lastly, although there is much data within our health information technology systems, the vast majority of it still must be compiled manually. Although a data mining tool was designed into the DoD electronic health record, its capability to monitor, mine, analyze, and report on quality measures is lacking. Having to manually compile all quality measures creates human error and significant delay in producing timely, actionable data.

Conclusions

Despite the fact that the federal healthcare system has successfully implemented several health information technology systems that are beneficial toward quality care, more work still must be done to raise the system to the Agency for Healthcare Research and Quality's goals. To meet the goal of improving patient safety by reducing medication errors, a health information technology system with full integration of the electronic health record and patient safety reporting systems must be developed and implemented. The ability to enter the patient safety reporting immediately with direct connection to the patient electronic health record would drastically improve reporting percentages and lead to better safety processes. Information sharing and transition of care would benefit from a fully integrated and interoperable health information technology system across all aspects of care. Although duplicative testing is markedly reduced with the current computerized physician order entry system within federal healthcare, having the health information technology system interoperable across the VA, DoD, and IHS would further reduce this concern.

The fifth goal of the Agency for Healthcare Research and Quality—to increase our knowledge and understanding of the clinical safety, quality, financial, and organizational value, and benefits of health information technology—can only be accomplished through full integration, ease of use, and education. Federal healthcare system

employees would be more inclined to use the health information technology systems if they provided improved clinical decision support systems tools, incorporating clinical practice guidelines at the point-of-care. Additionally, if healthcare information technology systems had the capability for employees to report concerns directly through the electronic health record that produced actionable and timely data, and were easy to use, adoption would be more widespread. After a full implementation of these criteria and integration into all aspects of patient care, educating staff on the benefits of using data will promote further knowledge and understanding. These goals are attainable, albeit not immediately. The continued perseverance of federal healthcare system information technology experts, combined with the continued improvement in health information technology and drive toward quality of care provides the federal health system the potential to be the preeminent organization to leverage technology toward quality improvement.

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Implementation of TeamSTEPPS at a Level-1 Military Trauma Center: The San Antonio Military Medical Center Experience

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Abstract

Context: When a health care system deals with complex trauma patients while simultaneously serving as an educational platform, teamwork and clear communication are imperative. While there are numerous tools and resources available to address the concerns surrounding patient safety, Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) emphasizes a team approach to improve communication among all caregivers and is specifically designed to improve patient safety through improved communication. This article reports the interim results of implementation of TeamSTEPPS in the operating room environment at the most complex and busiest tertiary military trauma center in the Department of Defense in the midst of the longest period of continuous combat operations in US history.

Methods: Data were collected from December 2013 through March 2014 on the number of total cases performed by month, number of debrief surveys submitted for those months, and associated percentage of surveys completed based on case category.

Results: The overall compliance rate for the TeamSTEPPS process (from the pre-op brief to the debrief survey completion) was 75.1%. Responses showed a decrease in concerns in all areas during the period of observation. Equipment-related complaints decreased by 48%; instrument-related issues decreased by 29.9%; supply issues decreased by 53.3%; personnel issues decreased by 90.5%; case scheduling issues decreased by 35.7%; and preference card issues decreased by 72.1%.

Conclusions: Our results demonstrate that TeamSTEPPS can be successfully implemented in an integrated level-1 trauma center in the midst of combat casualty care with a greater than 75% overall compliance with TeamSTEPPS briefs. Further study on the sustainability of these results and the effect on operating room safety, productivity, and efficiency is necessary.

When a health care system deals with complex trauma patients while simultaneously serving as an educational platform, teamwork and clear communication are imperative.[1] The San Antonio Military Medical Center is the largest inpatient medical facility in the Department of Defense (DoD) and is one of only 31 hospitals in the United States (the only one in the DoD) that holds both Level I trauma certification and accreditation from the American Burn Association. The hospital sustains over 89 accredited educational programs including 38 graduate medical education programs, 6 nursing programs, 25 allied health education programs, 18 enlisted allied health programs, and programs in administration and allied health specialties. The San Antonio Military Medical Center (SAMMC) is the result of the consolidation of the inpatient missions of the Brooke Army Medical Center and the (USAF) Wilford Hall Medical Center as a result of recommendations by the 2009 Base Realignment and Closure Commission (BRAC).[2] The pressure inherent in the BRAC-mandated integration of these large military treatment facilities run by separate services was accompanied by an expectation to increase productivity while maintaining safety and efficiency. This mandate occurred during a period of ongoing global conflict which resulted in the admission of complex casualties in need of multidisciplinary care, in addition to the number of civilian trauma patients typical in a large urban environment as well as the broad spectrum of elective cases. Improved teamwork, communication, and operative processes within this complex surgical environment were clearly needed to continue to meet the mission of quality patient care.

Transforming to a culture of safety and high reliability is a challenging task when there are an increasing number of quality metrics being measured and the hospital leadership is focused on many laudable yet diverse priorities. While there are numerous tools and resources available to address the concerns surrounding patient safety, one in particular emphasizes a team approach to improve communication among all caregivers. Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) is an evidence-based approach developed on the basis of 20 years of research by the Agency of Healthcare Research and Quality of the Department of Health and Human Services and DoD as a resource specifically designed to improve patient safety through improved communication.[3-5] TeamSTEPPS is comprised of 5 core principles: team structure, leadership, situation monitoring, mutual support, and communication, with implementation based on Kotter's Principles of Change, which uses a holistic approach to change that allows organizations to continuously adapt and thrive.[6,7]

In response to a May 2011 US Army Medical Command-wide directive to implement TeamSTEPPS, in May 2012, the Commander of Brooke Army Medical Center directed all departments to implement TeamSTEPPS with a target of 85% implementation by October 1, 2012. TeamSTEPPS "champions" were identified throughout the organization and participated in a multiple day, off-site "train the trainer" event. The champions then trained the staff with a 4-hour combined didactic and participatory training event.

Brief Checklist
Team Introductions
Surgeon
• Procedures and plan for the day
• Instruments/supplies not normally used
• Implant verification
• Anticipated complications/blood loss
• Special requests (x-ray, reps, etc)
• Postop plan (PACU, ICU, etc)
• Concerns
Anesthesia
• Antibiotics/allergies
• Anesthesia plan/regional anesthesia
• Blood availability
• Concerns
Nurse/Technician
• Equipment/instrument/supply/implants
• Contact precautions
• Correct bed/positioning
• Concerns

Figure 1. Standardized topics discussed at the morning brief. All scheduled cases for the day are covered during the initial brief.

Debrief Checklist
Surgeon
• Procedures performed
• Verify specimens
• Verify implants
• What went right
• What went wrong
• Concerns
Anesthesia
• Verify postop plan
• Concerns
Nurse/Technician
• Counts correct
• Wound classification
• Medications
• Concerns
• Complete debrief tool

Figure 2. Standardized topics discussed at completion of each case.

During this period, the hospital's operating rooms were experiencing a multitude of disruptions in daily operations due to the BRAC-driven integration that impeded efficiency and productivity. While TeamSTEPPS had been implemented successfully both at the combat support hospital in Baghdad, Iraq (and spread throughout the combat theater of operations), and Madigan Army Medical Center in Washington state, it was unclear whether implementation would succeed at SAMMC in such a tumultuous setting, especially within the highly complex operative environment.[8]

This article describes the interim results of TeamSTEPPS implementation in the operating rooms at the most complex and busiest tertiary military trauma center in the DoD, while in the midst of the longest period of continuous combat operations in US history.

Methods

In November 2013, after additional multidisciplinary team training geared specifically to the surgical environment, SAMMC implemented TeamSTEPPS within its operating rooms. The team consisted of surgeons, anesthesiologists, nurses, information technology personnel, and key administrative leaders in the surgical departments. The team used 2 of the key tenets of the TeamSTEPPS process, the "Brief" and the "Debrief," to develop the concept of operations. At a time specified prior to the first case start of all elective cases scheduled during the normal business day, staff surgeons were required to be present for a morning Brief with the entire operative team (staff surgeon, staff anesthesia provider, operating room nurse, and scrub technician). The topics discussed at this morning meeting were standardized (Figure 1), and all of the scheduled cases for the day were covered during this initial Brief (no requirement to repeat the Brief prior to each case). After the completion of each case, the entire team would participate in a Debrief using a standardized Debrief checklist (Figure 2). The results of the Debrief findings were electronically captured using a Debrief survey instrument (Figure 3). For emergent, urgent, and time- and space-available cases, an informal "Huddle" (same

checklist as the Brief) was recommended (but not required) as the team felt that this added communication would enhance patient safety and efficiency even in nonscheduled and emergent situations. The Huddles were not considered in the data analysis in this study which only included the process completion on electively scheduled cases.

Compliance with the TeamSTEPPS process is defined as adherence to the process from the morning Brief to Debrief survey completion on all regularly scheduled cases. Nonadherence to any portion of the process was considered a failure. The measures for effectiveness of TeamSTEPPS implementation at SAMMC included elective surgery workload and the number of identified issues for each case. Each Debrief survey contained questions surrounding issues or concerns that potentially caused a case delay.

Data were collected from December 2013 through March 2014 on the number of total cases performed by month and the number of cases performed during the normal business day for each month. Case counts were obtained from the Surgery Scheduling System. A normal business day was identified as cases that were performed between 7:30 AM and 3:30 PM Monday through Friday, excluding holidays. Data were also collected on the number of Debrief surveys submitted for those months and associated percentage of surveys completed.

Debrief Survey Questionnaire
Q1: Was a satisfactory brief/huddle completed prior to the case? If no, please comment.
Q2: Was there a delay in the first time start or the expected 30 minute turnover between cases? If yes, please provide delay reason.
Q3: Was there a delay during the case? If yes, please provide delay reason.
Q4: Was the case scheduled correctly? If no, please provide details.
Q5: Was there a preference card issue? If yes, please provide specific details to fix: Staff Surgeon (if other than the one listed), specific procedure name, specific problem/correction
Q6: Were there any equipment issues? (equipment means something plugged directly into the wall) If yes, please provide specific information: name, ECN#, specific problem, whether or not it has already been reported for a work order.
Q7: Were there any instrument issues? (instrument means something reusable that is sterilized) If yes, please provide specific information: initials, load number, etc.
Q8: Were there any supply issues? (supply means nondurable, sterile packaged, single use item) If yes, please provide details: product name, number, specific problem, whether or not the packaging/product was saved and reported to the operating room or Medical Supply.
Q9: Were there ancillary support issues? (radiology, pathology, pharmacy) If yes, please describe the problem(s).
Q10: Was there a staffing issue? If yes, please describe the issue.
Q11: Was a patient safety issue identified? If yes, please complete a Patient Safety Report (PSR).
Q12: Please describe any quick wins (issues that were identified and fixed today).
Q13: Suggestions for ideas/comments/improvements.

Figure 3. The results of the Debrief findings were electronically captured using the 13 question Debrief Survey questionnaire with the ability to free text responses on each question if necessary.

Results

The overall compliance rate for the TeamSTEPPS process (from the preoperative Brief to the Debrief survey completion) was 75.1% (Table 1). While the total number of routine cases increased 7.2% during the first 4 months of implementation, the percentage of completed Debrief surveys dropped by an average of 24.2% (Table 2). Responses showed a decrease in concerns in all areas during the period of observation. Equipment-related complaints decreased by 48.0%; instrument-related issues decreased by 29.9%; supply issues decreased by 53.3%; personnel issues decreased by 90.5%; case scheduling issues decreased by 35.7%; preference card issues decreased by 72.1% (Table 3).

Comment

Our results demonstrate that TeamSTEPPS can be successfully implemented in an integrated level-1 military trauma center in the midst of combat casualty care with an overall compliance with a defined TeamSTEPPS process greater than 75%. While this leaves much room for improvement, this result is promising given the amount of personnel turnover at the largest medical training facility in the DoD. In fact, orthopaedic surgeons, a population generally identified as poor communicators in the literature, completed the process 98% of the time.[9,10]

While demonstrating promising results, our study does have several limitations. First, as an analysis of interim data, the generalizability of our results is admittedly poor. However, this is the first study of its kind in a military trauma center during any period, so data generated during a period of active warfare are especially important. Second, we did not conduct any type of survey to gauge the degree of acceptance from the perioperative

Table 1. Tabular data of the TeamSTEPPS compliance rate by month. The overall compliance rate throughout the data collection period is 75.1%.

Month	Debrief Surveys Completed (A)	Total Cases (B)	% Debrief Surveys Completed (A/B)	Total Cases (NBD,* Mon-Fri) (C)	% Debrief Surveys Completed (A/C)	Total Routine Cases in NBD* (excluding TSA,† urgent, emergent, after hours) (D)	% Debrief Surveys Completed (A/D)
December 2013	859	1285	66.8%	1226	70.1%	1059	81.1%
January 2014	874	1405	62.2%	1354	64.5%	1148	76.1%
February 2014	972	1381	70.4%	1300	74.8%	1129	86.1%
March 2014	651	1372	47.4%	1290	50.5%	1135	57.4%
Totals	3356	5443	61.7%	5170	64.9%	4471	75.1%

*NBD indicates normal business day.
†TSA indicates time- and space-available.

staff to assess what role this may have played in the noncompliant cases. As the implementation of TeamSTEPPS was a command-directed process, perioperative staffs were required to participate, regardless of degree of personal acceptance. Thus, there is the potential that the completed TeamSTEPPS Debrief survey could be incomplete or erroneous as an effort to simply "check the box." This could explain some of the drop in the overall rate of problems that were reported over the first 4 months (Table 3) as individuals may not have reported issues simply because of the additional time required to complete a Debrief survey when issues are identified. Finally, while compliance was relatively high, this study is unable to associate TeamSTEPPS with any changes to the measures of operating room efficiency such as on-time or first case starts, or changes to measures of operating room quality such as administration of prophylactic antibiotics 60 minutes prior to incision, or the administration of perioperative beta blockers. Although there has been some suggestion that the process decreased the historical surgical case times in some service lines following implementation, our data set does not answer that question; this claim requires further study.

Table 2. Total number of routine cases increased 7.2% during the first 4 months of implementation, but the percentage of Debrief Survey completions dropped by an average of 24.2%.

Months	Change in Case Volume	% Change	Change in Number of Debrief Surveys Completed	% Change
Dec to Jan	89	8.4%	15	1.7%
Jan to Feb	-19	-1.7%	98	11.2%
Feb to Mar	6	0.5%	-321	-33.0%
Dec to Mar	76	7.2%	-208	-24.2%

Conclusion

Our results demonstrate that TeamSTEPPS can be successfully implemented in an integrated level-1 trauma center in the midst of combat casualty care with overall compliance with a defined TeamSTEPPS process greater than 75%. Further study on the sustainability of these results as well as validation of effects on quality measures is necessary.

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Table 3. Comparison of number of complaints between beginning and ending months of TeamSTEPPS implementation. Responses showed a decrease in concerns in all areas during the period of observation.

Complaint Category	December			March			% Change
	Number of Debriefs	Number of Complaints	Complaint Rate	Number of Debriefs	Number of Complaints	Complaint Rate	
Equipment	859	43	5.0%	651	17	2.6%	-48.0%
Instrument	859	75	8.7%	651	40	6.1%	-29.9%
Supplies	859	26	3.0%	651	9	1.4%	-53.3%
Personnel	859	18	2.1%	651	1	0.2%	-90.5%
Case Scheduling	859	12	1.4%	651	6	0.9%	-35.7%
Preference Cards	859	37	4.3%	651	8	1.2%	-72.1%

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Integration and Coordination of Governmental, Nongovernmental, and Host Nation Preventive Medicine Assets During Medical Stability Operations

CDR Jeffrey Stancil, MSC, USN

Preventable diseases such as cholera, typhoid, malaria, and dengue often thrive in the aftermath of societal, economic, or natural disruptions. It is into these situations that members of the US armed forces are often called to assist in the provision and distribution of relief supplies, restoration of essential services, and assisting the host nation government to return to normalcy. It is critical for both US force health protection concerns and the contribution to the host nation public health campaign that preventive medicine assets across the spectrum of participating organizations coordinate their efforts.

The Department of Defense (DoD) defines "stability operations" as:

> An overarching term encompassing various military missions, tasks, and activities conducted outside the United States in coordination with other instruments of national power to maintain or reestablish a safe and secure environment, provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief.[1(p230)]

Further, the DoD policy regarding stability operations is stated as:

> Stability operations are a core US military mission that the Department of Defense shall be prepared to conduct with proficiency equivalent to combat operations.[2(p2)]

DoD Instruction 6000.16 refers to "medical health support for stability operations" as medical stability operations (MSOs).[3(p1)] It also states DoD policy regarding MSOs as:

> MSOs are a core US military mission that the DoD Military Health System (MHS) shall be prepared to conduct throughout all phases of conflict and across the range of military operations, including in combat and non-combat environments. MSOs shall be given priority comparable to combat operations and be explicitly addressed and integrated across all MHS activities including doctrine, organization, training, education, exercises, materiel, leadership, personnel, facilities, and planning in accordance with Reference (b) [*DoDI 3000.05*[2]].[3(p1)]

The logical inference of the DoD definition of stability operations is that MSOs will often be key components of such operations. Moreover, DoD policy for the planning and conduct of stability operations specifies that DoD shall:

> …collaborate with other US Government agencies and with foreign governments and security forces, international governmental organizations, nongovernmental organizations, and private sector firms as appropriate to plan, prepare for, and conduct stability operations.[2(p2)]

The operating environment following a natural disaster or societal upheaval is inevitably complex and confusing. The nuances of each situation will vary with geography, local customs and history, and the level of preincident development. What is constant is the presence of host nation governmental agencies, international governmental and nongovernmental organizations (NGOs), media, and multiple agencies of the US government ostensibly working towards the same goal. It is clear that all organizations involved in relief operations need a central point of coordination to efficiently and effectively use available resources. This is especially true for disease control operations as preventive medical assets are often limited and at best a tertiary concern regarding resource allocation. An additional challenge is the nature of preventive medicine and public health programs in general, which often require years of development and decades of sustainment. Consequently, the US military role in these efforts is typically limited both temporally and materially; collaborations must be a priority for that role to be effective.

In application and practice, MSOs broadly encompass both foreign disaster relief and foreign humanitarian assistance (FHA)* as defined in *Joint Publication 1-02*.[1(pp93,94)] The formal lines between the two are often blurred (even within doctrine). While both responses

*Domestic civil support, addressed by *Joint Publication 3-28*,[4] is outside the scope of this article.

are designed to relieve human suffering, it is beneficial to consider them separately when discussing the role of military preventive medicine assets and coordination of effort.

Foreign disaster relief, particularly in the acute phase, evolves rapidly with multiple entities trying to restore some semblance of order, few of which can rival the logistical and organizational capabilities of the DoD. In a foreign disaster relief scenario (such as the response to the 2010 earthquake in Haiti), the official process of DoD involvement is specified by *DoD Directive 5100.46*.[5] The simplified steps for DoD participation, delineated in *Joint Publication 3-29*,[6] start with the responsible (in the case of Haiti, the remaining) elements of the host nation government requesting assistance from the United States via the Ambassador or other official US government representation in that country. If approved, DoD preparation and coordination is led by the Assistant Secretary of Defense for Special Operations/Low-Intensity Conflict. The Chairman of the Joint Chiefs of Staff is responsible for developing planning guidance for the appropriate combatant commander, often leading to the establishment of a joint task force. The joint task force, by doctrine, functions in a supporting role to the lead US government entity (often the United States Agency for International Development (USAID)) and must coordinate operations to maximize relief efforts. The US government response occurs at the request and approval of the host nation government and must be coordinated with that country's responsible agencies and any United Nations coordination elements as well. Reasonably clear in doctrine but often less so in execution, the effect of the disaster and visible human suffering will add to the "fog of war," combined with limited communications often conducted in multiple languages, a host nation government directly affected by the disaster, and a literal flood of foreign governments, NGOs, private sector companies, and disaster tourists—all converging on the same affected location to create an exceptionally challenging operational environment.

In this phase of the response, military preventive medicine assets should be primarily concerned with force health protection and ensuring responders do not become victims, either to natural or manmade environmental risks, including preventable diseases The Army's noteworthy success in the prevention of ebola and malaria infection in Soldiers during Operation United Assistance* is a great example of this. Operational coordination is often largely internal and the primary mission focus is on areas such as mortuary affairs; delivery of palliative medical care; and provision of basic water, food, and shelter needs; with secondary or tertiary focus on preventable diseases. However, coordination with US government, host nation, and NGO stakeholders at this stage will serve to solidify medical intelligence available prior to the incident, perhaps provide opportunities to assist in the location for and inclusion of sanitation and hygiene considerations in relief camps, and will assist planners in identification of areas of focus for longer term recovery efforts. The real benefit of early coordination will be learning who the "players" are and establishing personal relationships that will ideally engender trust and create opportunities for additional assistance during the recovery phase.

As foreign disaster relief efforts move from response to recovery, they begin to resemble or in fact become FHA missions. Official coordination of efforts will have solidified, per *Joint Publication 3-29*,[6] in the form of a Humanitarian Assistance Coordination Center, a Civil-Military Operations Center, or a Humanitarian Operations Center (HOC).

Large scale stability programs will be guided at some level by the stakeholders represented in the HOC, including preventive medicine and public health programs. In the Haiti earthquake response, the coordination of most preventive medicine programs fell under the United Nations cluster system, specifically the water and sanitation cluster which brought together United Nations, host nation, and foreign governmental representatives with NGOs, academia, and private industry to address multiple issues including preventable water-borne, food-borne, and vector-borne diseases.

A HOC will not exist in programmed FHA operations that are conducted under the purview of the geographic combatant commander, and the overall coordination process is less formal. The allocation of military assets and funding lines are also different, but whether conducted as part of a foreign disaster relief recovery process or a more routine FHA mission, public health programs will have short-term and long-term goals in which the US military can play a role.

Short-term and long-term efforts in both recovery and routine FHA operations should be conducted in close coordination with or perhaps under the direct guidance of USAID or the designated Department of State representative. For their part, USAID should be coordinating

*Operation United Assistance (September 2014 – May 2015) was the US military participation in the international effort to assist the west African countries of Guinea, Liberia, and Sierra Leone contain the serious ebola virus outbreak in those countries. Source: http://www.defense.gov/home/features/2014/1014_ebola/.

efforts with the host nation as well as established, reliable NGOs and other agencies for which the military can be a significant resource multiplier and accomplish rapid progress by virtue of its inherent logistical and organizational acumen. This close coordination and communication is most beneficial in the planning phase of FHA missions where it may be expected that host nation, USAID, and NGO partners are trusted within the community in need, are local subject matter experts, and can provide expert guidance in the most effective utilization of military capabilities. Planning should also be based around quantifiable measures of effectiveness to establish goals and document progress in achieving these goals to justify resource allocation.

In summary, the US military's ability to respond to the requirements of foreign disaster relief and foreign humanitarian assistance is unrivaled by other government or nongovernmental agencies, and is the epitome of soft power projection. While, by definition, the US military is not a humanitarian organization, it is capable of remarkable humanitarian acts and assistance. This assistance, including preventive medical efforts, must (by doctrine) and should be conducted in support of and in coordination with other US government, host nation, international, NGO, and private entities to maximize efforts and optimize use of resources to best help those in need.

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A Review of Supplementary Medical Aspects of Post-Cold War UN Peacekeeping Operations: Trends, Lessons Learned, Courses of Action, and Recommendations

LTC Ralph J. Johnson III, MS, USAR

Abstract

Post-Cold War United Nations Peace Keeping Operations (UN PKOs) have been increasingly involved in dangerous areas with ill-defined boundaries, harsh and remote geographies, simmering internecine armed conflict, and disregard on the part of some local parties for peacekeepers' security and role. In the interest of force protection and optimizing operations, a key component of UN PKOs is healthcare and medical treatment. The expectation is that UN PKO medical support will adjust to the general intent and structure of UN PKOs. To do so requires effective policies and planning informed by a review of all medical aspects of UN PKO operations, including those considered supplementary, that is, less crucial but contributing nonetheless. Medical aspects considered paramount and key to UN PKOs have received relatively thorough treatment elsewhere. The intent of this article is to report on ancillary and supplemental medical aspects practical to post-Cold War UN PKO operations assembled through an iterative inquiry of open-source articles. Recommendations are made about possible courses of action in terms of addressing trends found in such medical aspects of PKOs and relevance of US/NATO/European Union models and research.

A vital component of United Nations (UN) peacekeeping operations (PKOs) is provision of health services for mission personnel.[1,2] The aim of medical support is the physical and mental welfare of deployed personnel, preservation of human resources, conservation of life, and minimizing residual physical and mental disabilities. Arguably, peacekeepers function better when they are healthy and know that high-quality medical treatment is there in case of injury or illness. Also, UN PKOs must meet various multidimensional mandates, all while facing considerable financial constraints.[3,4] Furthermore, in the Post-Cold War era they operate increasingly in hostile environments with poorly defined boundaries, continued armed conflict, and little if any assurance of safety.

The hope is that UN PKOs will become streamlined, more effective, quicker to respond, and more capable in order to be involved in more wide-ranging, multifaceted operations conducted over large, diverse, and remote geographies.[5] Consequently, the expectation for medical support is that it will likewise adjust to the larger configuration of the UN PKO. However, gearing medical support to the demands of post-Cold War UN PKOs requires informed planning that considers all medical aspects, including those supplementary to operations but nonetheless important to mission success. Just as with small internecine conflicts, it is the little things that can quickly turn into big things if not considered and accounted for. No accounting exists for such medical aspects, though the literature contains comprehensive pieces that consider paramount or pivotal medical aspects of post-Cold War UN PKOs related to operations and medical planning.[6]

Since the first step in developing policy and planning for UN PKO medical support for post-Cold War UN PKOs is a comprehensive understanding of all medical aspects personnel confront (whether great or not so great, but just as important), this article reports on an inventory of those less pivotal medical aspects. These aspects were gleaned through iterative probing into open-source articles in the medical literature for useful conceptual categories and themes across peacekeeping missions regarding medical aspects that influenced recent missions and their medical support and might be influential in the future—peacekeeping missions and their analogs in which the United States, European Union (EU), and North Atlantic Treaty Organization (NATO) members may easily find themselves involved one day. The supplemental aspects include:

- Humanitarian assistance/military humanitarianism
- Women's health
- Electronic medical documentation

- Medical professional personnel backfill
- Quick reaction force concept
- Medical command structure

The fundamental aspect that altered the planning requirements and set the stage for these supplemental aspects was the changed nature of UN PKO missions. The hope is that this report will assist planners and policymakers to enhance well-rounded medical support to UN PKOs (and non-UN PKOs) and better ensure the health and well-being of UN PKO members. This is the ideal of medical support incorporated in the UN's medical mission statements.[1]

Some basic assumptions apply. This review emphasizes deployed military peacekeeping personnel, even though all civilian and military personnel assigned to a UN PKO are entitled to medical care. Underlying trends will continue or accelerate. This article explicitly addresses the expanded post-Cold War era UN peacekeeping missions and supplemental medical aspects found in the literature influencing those operations.

Medical Aspects

Changed Nature of UN PKOs

During the Cold War, UN PKOs were relatively benign affairs with impartial unarmed peace observers or lightly armed peacekeepers interposed to separate former belligerents who consented to a ceasefire until there was a peaceful settlement (an exception was the UN mission in the Democratic Republic of the Congo in the early 1960s).[4,7] The nature of UN PKOs dictates their medical needs, which in turn prescribe their medical support requirements and planning. For example, McKee et al reported that peacekeepers deployed in a classic Cold War UN PKO observer-interposition role on the Bosnia-Herzegovina mission (UNMIBH) had minor medical ailments typically associated with noncombat deployment, such as orthopedic conditions and respiratory diseases.[8]

Post-Cold War, the nature of UN PKOs changed dramatically. They have become fluid, comprehensive, sophisticated, complicated, and dangerous operations designed to enable security, stability, and reconstruction of failed or decompensating nations.[4,9] There have been nearly as many deaths among peacekeepers post-Cold War as in all previous UN PKOs.[7,10,11] The first 40 years of UN peacekeeping had 13 missions, all of which were relatively temperate, except for the 1960s mission to the Democratic Republic of the Congo. However, over the next 25 years, more than 40 large, difficult, dangerous, and complicated missions were undertaken in hazardous environments. Logically, medical events would substantially consist of emergency trauma (eg, high-velocity penetrations, multiple deep lacerations, blast and blunt force injuries, complicated fractures) along with indigenous exotic illnesses. Indeed, this finding is reflected in changes in the nature and probability of casualties and fatalities reported for field workers in different nongovernmental organizations (NGOs) and humanitarian organizations (HOs) working alongside UN PKOs.[12-17] However, NGO/HO figures are suspected to be grossly underreported.

Two reasons have been cited for the greater danger to UN PKOs and resulting fatalities: (1) the increased number, scale, and coverage of UN PKOs and (2) their more robust operations (ie, "combat-like") in more remote areas with questionable consent from "former" belligerents.[18] Durch and Berkman[19] and Pugh[14] all argued that these operations have assumed only the veneer of classic consensual peacekeeping. The greatest overall risk factor in terms of wounded and casualties were complicated robust missions in failed states in Africa that included humanitarian assistance operations, or what is termed "military humanitarianism."[7,14] Despite what side they are on, some belligerents may target peacekeepers for aggression, perceiving and portraying them as "taking sides" and "helping their enemies." Specifically, Seet states[7]:

> …peacekeepers are being deployed into hostilities between belligerents where not all belligerents may feel they consented to the peace process, and, with no real peace to keep, are increasingly drawn into the conflict with dire (medical) consequences.

Holt et al[20] cited the post-Cold War mission (circa 2005) to the Democratic Republic of the Congo, where confirmed intelligence pointed to rogue armed fighters and groups planning to attack innocent villages and even vulnerable UN installations and personnel.[2,9] As the mission's mandate permitted "protection of civilians in immediate danger," preemptive robust, combat-like operations were required to check the imminent threat.

Humanitarian Assistance/Military Humanitarianism

Humanitarian assistance or military humanitarianism are subjects in their own right. Consequently, their brief and broad brush treatment herein only speaks to how they pertain to medical aspects and operational/medical planning for PKOs. To promote civil-military cohesion and improve public relations, UN PKO medical components are increasingly tasked with providing general/family practice clinical services to civilian nationals in the most remote and rugged areas (ie, "military medical humanitarianism"). Note that Kevaney et al[21] found "medical resources for helping the local population in the case of emergencies are valuable tools for confidence building at the local level" and

> …use of mission assets (such as construction engineers or medical resources) for appropriate local public health and medical outreach projects will also contribute (1) to building good relations with the local population and authorities, (2) contribute to restoring the national infrastructure, (3) have a normalizing and stabilizing effect, and (4) may be part of the mission.[21]

Through ingratiation with the local population "with the simplest of help," as Reade pointed out about the Kosovo mission,[22] these medical humanitarian relief efforts have treated substantial volumes of patients with minimal medical resources. However, these efforts further expose personnel to both the physical dangers and horrors of conflict, as well as the risks of attendant psychological conditions.[23,24] For example, Outram[13] noted with respect to the Economic Community of West African States, that despite the relatively large number of military peacekeeping personnel, without consent to the peace process, the forces were still insufficient to defend and protect humanitarian assistance distribution sites. Thus, peacekeepers were further exposed to risk.[17]

Pugh maintained that in situations where consent to the peace process was questionable, providing humanitarian assistance blurred the pre-Cold War UN concepts on which all UN PKOs are supposedly based: impartiality, neutrality, and assistance based solely on need without political discrimination.[14] Thus, eventually one side or the other, or both, come to view peacekeepers as helping their enemies and, therefore, peacekeepers also become "the enemy" and targets for armed aggression. For example, although Japan did not participate in the Rwanda mission directly, it did provide a small contingent of medical support to Gome Zaire to attend to Rwandan refugees fleeing hostilities. The Japanese Ministry for Foreign Affairs reported that humanitarian assistance was exceptionally popular with the local population and authorities.[25] However, the local ongoing conflict made that work harrowing and transformed the work and workers into targets for renegade belligerents from Rwanda whose consent to the peace process was questionable. Therefore, the need for cooperation with local authorities and the UN, particularly for security, became paramount for ensuring smooth operations. The Japanese report also supported Pugh's contention regarding the newer post-Cold War UN PKOs in that hostilities do not respect national boundaries.[14] The trend toward including military medical humanitarianism in UN PKOs has grown, and the number of such PKO missions is predicted to rise.[26] This aspect of medical support to UN PKOs lends credence to the contention that deployment of medical support and evacuation is not simply a question of distance and time, but security must also be a consideration.[27]

Women's Health

Milosevic reported that the shift in peacekeeping from relatively benign to more robust operations has resulted in a consequent shift in the protection of civilians, particularly women and children.[2(pp171-177),26,28] Thus, since 2002, women have constituted a greater percentage of UN PKO forces. He drew on the example of the Chad mission, noting that the increased inclusion of women overall in the medical component of that UN PKO was not new.[28] However, the increased representation of women in roles traditionally considered the province of males was new. In turn, female peacekeepers in UN PKOs provide new possibilities to effect peace as women can engage women, particularly where cultures forbid man-to-woman contact. Furthermore, female health providers have offered medical treatment to women (and children) as the humanitarian medical aspects of UN PKOs have increased. He suggested that planners give more consideration to female healthcare (and family practice) providers on missions and deployment considerations.

Electronic Medical Documentation

Universal and fully integrated electronic medical documentation is an ideal that is probably unworkable, if not unrealistic. However, regarding the Kosovo mission, Reade reported that a secure, but operationally integrated, computerized medical records system enabled the expedient transmission of peacekeepers' medical information.[22] This was especially true in cases of emergency trauma. Electronic information systems proved immensely useful and practical for intramission retention and transfer of peacekeepers' medical treatment, stock control and resupply, summary statistics for epidemiological analyses of trends and quality assurance, and information transfer to civilian care and quick resolution of any postdeployment disability claims. Regarding medical imaging for the Kosovo mission, Mun et al also observed that adoption of electronic systems was practical and cost-efficient.[29] These medical systems eliminated shipping and storage of bulky new and unexposed films with fixed shelf lives, processing of chemicals and water, and toxic discharge that had to be collected and transported out of the deployed area. The same can be true for medical records and documentation in that electronic systems dispense with the storage, retrieval, transport, and eco-unfriendliness of bulky paper copies, as well as the expense and encumbrance of paper, printers, ink and printing, and upkeep.

Medical Professional Personnel Backfill

Concerning the mission in Kosovo, Reade reported that the medical service component was severely understaffed, mainly lacking physicians.[22] Thus, it was necessary to draw on reservists for short deployments to

augment their active service counterparts. He reported that use of reservist medical personnel caused no loss in quality or standards of medical care due to consistent training and skills certification. He also noted that individual augmentees in previous UN PKOs have a substantially higher risk for mission-related psychological stressors and morbidities, possibly due, as Mehlum et al[30] also noted, to the absence of preventive prophylaxis in the form of social support found in being deployed as integral parts of cohesive units.

Quick Reaction Force Concept

Few people familiar with UN or regionally led PKOs think they can operate at the level of a quick reaction force.[2(pp285-290),26,31] However, the UN's goal has been to be in a position to launch a multidimensional PKO mission within 90 days.[16(pp255-279)] Even this has proven to be exceedingly difficult. Nevertheless, to reduce response time to crises and streamline the slow and cumbersome redress of emergent crises, advocates have contended that UN PKOs should shift to a quick reaction force concept (eg, a standby, high-readiness brigade (SHIRBRIG)).[16(pp255-279),31] Specifically, there has been increased emphasis on predeployment planning, mobility, prepositioning of supplies in regional depots, prearrangement of transport, improved intelligence, and enhancement of early warning systems.[25] This includes similar efforts in coordination and consistency within various UN departments and agencies that deal with UN PKOs and member nations. This concept also extends to aspects of UN PKO medical support. The precedent for advancing this concept was the Kosovo resolution that asserted that human rights abuses and crimes against humanity coincident with the rapid collapse of a state merit international intervention with all due speed.[1,4]

Despite calls for the quick response force concept at the time, the Liberian mission (Economic Community of West African States-UNDPKO, 2005) reported an absence of vital medical capabilities early in the mission concerning effective communications, capable medical support, and adequate life support.[31] A tight timeline compounded these shortages and led to recommendations for improvements in prepositioning and preplanning. These concerns were also voiced regarding the post-Cold War mission (circa 2005) to the Democratic Republic of the Congo with regard to inadequate medical supplies hampering offensive operations, and the rapid response necessary to protect citizens and UN PKO installations from rogue belligerents.[16] Indeed, the UN all but abandoned the SHIRBRIG 6 years ago, a symbolic capitulation that a quick response peacekeeping force was an unworkable ideal at the time.[32] But this did not signal the end to the calls for more rapid and responsive UN PKO missions, including their medical support elements.

Medical Command Structure

Reade[22] and Joshi[33] both described problems related to the separation of medical command and medical authority common to military components supporting UN PKOs. Indeed, Reade[22] argued this separation is ingrained in western military cultures. Specifically, senior medical authorities were physicians, whereas medical commanders were professional administrators. He reported that in the field, this separation proved dysfunctional and inefficient. For example, medical service officers countermanded medical authorities' use of assets because they had little familiarity with the practical provision of medical treatment. On the other hand, medical authorities who were physicians knew the ins and outs of patients but not the ins and outs of the administrative offices running their medical facilities. Thus, they made medical decisions that effectively usurped their unit's medical administration. Unfortunately, Reade offered no solution. Without a viable alternative, this state of affairs is expected to continue at least for the foreseeable future. Yet, there must be an ongoing awareness of its dysfunctional effects on medical support to UN PKOs.

Comment

The literature of expanded and more robust post-Cold War UN PKOs highlighted several trends and recommendations in their medical aspects, in particular, the less pivotal or supplementary aspects:

1. UN PKOs are no longer classic observer-interposition missions of small numbers of peacekeepers in lightly armored vehicles maintaining ceasefires.[2,15] They are now fluid, comprehensive, sophisticated, complicated, and dangerous paramilitary operations designed to enable security, stability, and reconstruction of failed or decompensating nations.[4,9] This also means that the nature and extent of medical events has transformed and consequent medical support must in turn adapt for paramount or pivotal medical aspects, as well as ancillary or supplemental ones.

2. As such, planners should consider that the demand for civil/military-driven humanitarian medical outreach far into the margins of already risky and dangerous situations adds a new and even more risky dimension to UN PKO missions and their medical components. Treatment of civilians "in the cross-hairs of conflict," in particular women and children, also creates a need for generalist/family practice medical professionals along with other medical subspecialties in particular surgical subspecialties.

3. Planners should therefore provide for women's (and family) health and include female medical providers. This is particularly true if the mission has a humanitarian aspect and/or a need to be sensitive to local cultures' customs. Humanitarian outreach, military humanitarianism, and women's/family health may need to be factored into security considerations.

4. There should be some degree of employment of electronic medical information systems that can reliably, rapidly, and cost-efficiently collect, store, transmit, receive, and integrate data, in particular medical records data. Note: this recommendation must be balanced against the notion that, though universal electronic medical records would be ideal in a perfect world, this is probably unrealistic and unworkable.

5. The length of UN PKO missions and the requirement for scarce medical treatment providers suggests the need for an a priori system for backfilling with replacements.

6. Consequently, reliance on individual augmentees, along with the changed nature of UN PKO missions, the fact that they are lengthy, and humanitarian assistance or military "humanitarianistic" components all increase the risk for psychological morbidities.[23,24] Therefore, there is a requirement for the mission-wide incorporation of mental health personnel to monitor and address attendant psychological morbidities that emerge consequent to peacekeepers' mission involvement.[22,34]

7. A quick reaction force concept is probably unworkable in the near future. But there is gravitation toward missions that require increased rapid responsiveness. Supporting a shift in UN PKO medical care to further rapid deployment would require prepositioning of depot, cache, tracking and management, maintenance of equipment, and contracting and financial specialists to assist. This might require an extra inventory or a specialized inventory for plug-in-and-play, depending on operational requirements. This also would require a redundancy of material that has proven to be useful in previous and prolonged operations that generated a need for maintenance and replacement of worn and broken equipment.[1,27]

8. Previous critiques of the system of separation of medical authority vs command have offered no viable resolution. Without a more appealing alternative, these systems that are so much an ingrained part of the culture of western military medicine should remain in place for now. Nevertheless, there should be improved awareness that this bifurcation exists, which, if unchecked, can become counterproductive to the provision of efficient and high-quality medical care.

9. Given increasingly fluid and dynamic UN PKOs, there is a need for field medical treatment support capable of moving itself, while retaining the ability to deliver care throughout a UN PKO theater. This must be accomplished to provide medical treatment in far forward areas of operations. This is especially true for trauma care, which sustains extended and comprehensive operations, peacekeeper maneuvers, and humanitarian outreach and women's/family care.[27]

10. Given the experience of past UN PKOs, in addition to fundamental structural modifications, future UN PKOs will need to adopt a medical support planning mindset that reaches above simple fixes or additions of modules to purpose-build medical care to UN PKO requirements. This mindset should incorporate consideration of all medical aspects that influence UN PKOs, whether great or not so great.

11. The near absence of peer-reviewed articles on medical aspects of UN PKOs, especially on less central medical aspects, calls for more peer-reviewed research in these areas. Nevertheless, it should be noted that both the US military, in particular the US Army, and NATO/EU may have much to contribute in this regard, the supporting facts of which should be examined more closely:

- Undoubtedly, both the United States and NATO/EU have had extensive involvement and experience in combat and military/security operations. Those operations include "other than war" operations on par with the recent change in UN PKOs, especially regarding deployment and responsive and adaptive modular development of medical support.[1,35-40]
- United States military forces and NATO/EU routinely include military humanitarian outreach into their operations and insert medical practitioners deep in the periphery, including a high percentage of women.[41-48] In doing so, US and NATO/EU forces also factor in commensurate security and psychiatric care considerations.
- The US military has a proven track record for vetting, using, and deploying highly effective electronic medical documentation systems in such capacity that they can easily adapt these systems to the degree necessary for the parallel incorporation of non-US multinational partner nations embedded in US operations.[50-54]
- United States forces have extensive documented experience with a standing reserve medical personnel backfilling system to compensate for treatment

provider shortfalls.[55,56] The US military and NATO/EU have interwoven mental health providers to address psychiatric morbidities early on, especially for missions with humanitarian outreach, substantial individual augmentees, and women service members.[22,57,58]

- The US military in particular has standing quick response forces including medical support with all the implied attendant worldwide logistical and sustainment infrastructure, to the extent it is often taken for granted.[59-62] Soon NATO/EU will have similarly structured forces as well.
- Nevertheless, the established command and control structure for US and NATO/EU medical support forces probably will remain in place into the foreseeable future. However, there are initiatives in US military medical forces toward adoption of more of a team and collegial approach.[63-66]

Therefore, US and NATO/EU militaries have subject matter expertise and adaptable models of medical support that can be lent to UN PKOs regarding supplementary medical aspects. Furthermore, they have conducted substantial research into the feasibility and workability of those models,[67,68] but there is still much to be done in terms of their applicability to the contexts and constraints of the UN system and UN PKOs—not just for the little things, but the big ones as well.

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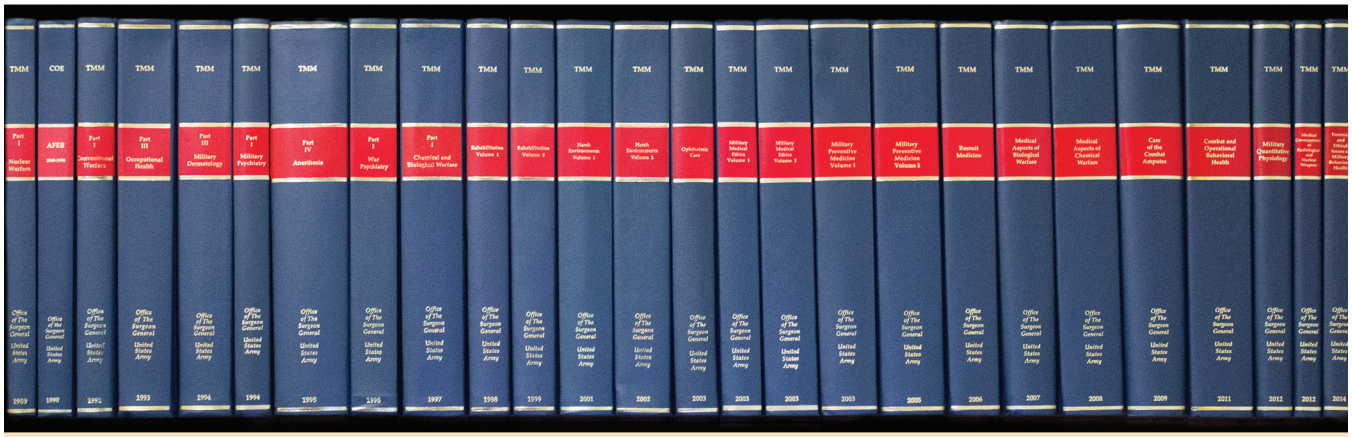

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Nursing in the 8th Evacuation Hospital, 1942-1945

LTC William J. Brown, AN, USA

Abstract

This article describes the experiences of Army nurses in the University of Virginia sponsored 8th Evacuation Hospital during World War II. In addition, it examines gender and role differences within the Army Medical Department, and how nurses' contributions helped shape the profession. This research used traditional historical methods of inquiry to include both primary and secondary sources of information. Primary sources include newspaper clippings, letters, citations, and photographs from the archival collections of the 8th Evacuation Hospital located in the University of Virginia Historical Collections and Services, Charlottesville, VA, and journal articles from that period. Secondary sources consisted of bibliographical and historical texts. Evidence suggests that advances in the chain-of-evacuation, antibiotics, dissemination of blood products, and nurses' expanded roles all contributed to increased survival of the wounded. Nurses' performance garnered an enduring respect from combatants who received care, as well as the medical officers and enlisted personnel with whom they worked on a daily basis. Collaboration, mutual respect, and coordinated teamwork were critical for mission success. Army nurses demonstrated that they had the mettle to go into a war zone and perform in an exemplary manner.

Thousands of nursing students in schools across the country would graduate in 1940, the last year before America entered World War II. Many new graduates would eventually find themselves in stateside military hospitals, while others would deploy to evacuation hospitals in austere environments directly supporting troops. The declaration of war required mass mobilization of not only troops, but also of all facets of private and public industry to support the war effort. Nursing in the private sector and in the military would undergo significant changes in the years ahead. Ten thousand nurses had answered the call to active duty, but tens of thousands more would be required.

This article describes the experiences of Army nurses in the University of Virginia sponsored 8th Evacuation Hospital during World War II. In addition, it examines gender and role differences within the Army Medical Department, and how nurses' contributions helped shape the profession. From 1942 to 1945, the 8th Evacuation Hospital (8th Evac) endured significant logistical challenges and extremes in terrain and weather, from the oppressive heat in the North African desert to the mountainous and snow-laden Italian peninsula.[1]

Background

With Japan's premeditated attack on Pearl Harbor on December 7, 1941, the United States was at war. At the onset of hostilities there were less than 1000 active duty Army Nurse Corps (ANC) officers.[2] The superintendent at that time was MAJ Julia Flikke who had held this key leadership position since 1937. Prior to that role, she had been the Assistant Superintendent for 10 years. Flikke demanded much of her nurses in the Corps and certainly set the bar high. In a letter to a newly accessioned Army nurse, she writes:

> No one appreciates a nurse who shirks her duties, and leaves unfinished the tasks, which rightfully belong to her, for someone else to do; who is always surly and disagreeable on duty, in the home or at play; who delights in gossip and criticism of others who complains of the food, the hospital management and her sister nurse. To us such a nurse is a great disappointment and her continuation as a member of the ANC is not desired. In accordance with Army regulation 40-20 she may be dropped.[3(p159)]

The sudden demand for nurses put increased stress on the Army to recruit more nurses. Alumnae of the Army School of Nursing, which had been closed in 1931 due to budget constraints, advocated for its reopening.[3] Flikke did not see it as a viable and cost effective option because there were sufficient numbers of civilian schools that could meet the demands for nurses.[4] In a relatively short time, the Corps quickly grew to 12,000 in 6 months, peaking at 57,000 nurses at the end of the war.[5] However, throughout the war there were supply vs demand issues as the ANC attempted to grow its force.

Race and Gender

Racial and gender issues posed barriers that hindered recruitment of skilled nurses. African American nurses were available but largely underutilized despite vocal proponents such as Mabel Staupers, a representative of the National Association of Colored Graduate Nurses, who had corresponded with President Roosevelt to end

segregation. These efforts were unsuccessful and there was minimal use of African American nurses throughout the war.

Similarly, male nurses were not eligible to be commissioned officers in the Army Nurse Corps (ANC). The Army Medical Department eventually let men join the Red Cross Reserve, but the Army never intended to use them within their assigned role. Collectively, they were too few in number to bridge any gender gaps within the Nurse Corps and lacked the political and organizational power base to affect or change policy.[3]

Similar to World War I, exaggerated gender differences were common in both society and the military. Simply, men took up arms to fight and the women stayed home.[6] Female nurses did serve in World War I, but there were no female military surgeons. This policy continued until Congress passed the Sparkman Act in 1943. The Act authorized the commissioning of female physicians with the privileges of a commissioned officer.[7]

Although nursing was a recognized and valued profession within society, gender discrimination was evident. Women were not treated with the same respect and stature that were afforded to men. Just as there was much inertia to overcome in order to change society's views of the roles and status given to women in various professions, change within the Army presented its own special challenges. A key and potentially divisive issue was that of rescinding the order of relative rank. The ANC had stringent requirements for appointment to the active or reserve component. Yet, nurses did not have the same power and authority as other military personnel because nurses' ranks were relative. Relative rank meant that women in the Nurse Corps (Army and Navy) carried officers' titles but were accorded less power and pay than their male counterparts.[8] Nurses were the second line of authority after medical officers and were denied the right of command.[3]

There was much debate among the lawmakers on Capitol Hill, and the War Department had long been opposed to the idea of permanent commissions for Army Nurses despite avid support by First Lady Eleanor Roosevelt, the new Surgeon General, MG Norman T. Kirk, and among many Congressmen. Permanent commissioning afforded additional benefits to nurses. Unfortunately, the Army only granted temporary commissions for the remaining years of the war, plus an additional 6 months. Nursing personnel would not be granted permanent commissioned officer status until April 1947; several years after the war had ended.[3]

The Changing Nature of War

The Second World War would see the mobility of armies as a key to strategic success on the battlefield.[9] This type of warfare was exhibited in the most ferocious way with the German military forces (Wehrmacht) use of the Blitzkrieg or lightening war during its attack on Poland in 1939, and later again against France, Russia, and other European and Mediterranean countries. The keys to this strategy were coordinated deep armor thrusts with support of mobile infantry units, in conjunction with close and intense air support.[10] The Allies recognized the importance of mobility as well. To meet this threat, US Army armor doctrine developed broad maneuver capabilities, becoming synonymous with combined arms operations.[9] Consequently, those medical assets that supported the Allied armies had to be mobile to keep pace with rapidly advancing forces.

Recruiting the Staff

In late 1941, Staige D. Blackford was Chief Medical Officer in the University of Virginia Medical Department. He convinced the University to provide a medical unit as it had done in World War I. On February 27, 1942, the Secretary of War granted approval. It would be designated the 8th Evacuation Hospital and Blackford along with the Chief of Surgery, E. Cato Drash, had the responsibility of recruiting all the personnel.[11] Blackford immediately recognized the need for a skilled nurse to recruit and take command of 52 highly qualified nurses for the newly forming hospital unit. Blackford previously met Ms Ruth Beery, RN, then a science instructor in the School of Nursing at the University. In a letter dated February 16, 1942, Blackford writes[12]:

> Dear Ruth:
>
> As you know, we are forming an Evacuation Hospital Unit here, which requires 52 Nurses. Nurses to be eligible must be in the American Red Cross First Reserve, which means that they are single, between 21 and 40 and physically fit. I would like a lot to get you to be Head Nurse but I find on looking up your age that you are 40 and 5 months. I think we might possibly get a special ruling on your age if you could pass a physical examination and would be interested in accepting the position as chief nurse. Drop me a line as soon as you can and let me know what you think about it.
>
> Sincerely yours,
> Staige D. Blackford, MD

Several weeks later on March 2, Blackford advocated for Ms Beery to be granted entry to active duty service, writing CPT Florence Blanchfield, Assistant Superintendent of the Army Nurse Corps[12]:

> Dear Capt. Blanchfield:
>
> I am very much interested in having Miss Ruth Beery, who has been on staff here, made Chief of Nursing Service…she has passed her physical…but she was forty years old last May, and the purpose of this letter is to ask you if there is any way in which her age can be waived so that we can get her as Chief of our Nursing Corps…Miss Beery is the only person that I have been able to think of as yet who would fulfill the regular requirements of this position satisfactorily.
>
> With kindest regards,
> Staige D. Blackford, MD

Recognizing the importance of having experienced nurses serve in key leadership positions, the Office of The Surgeon General raised the age limits for nurses who had not passed their 45th birthday. CPT Blanchfield notified Dr Blackford and Ms Beery of this important policy change,[13] which was instrumental in bringing experienced nurses to the battlefront.

Further recruiting was required to obtain the necessary personnel to staff the hospital. The Army Medical Department had specific requirements for equipment and personnel in all of their hospitals. The 750 bed 8th Evac required 417 personnel: 47 physicians, 52 nurses, and 328 Soldiers. Board certification or equivalent training and age determined initial rank structure for the physicians. However, these rules did not apply to nurses as the Chief Nurse held only the rank of 1st lieutenant. The policies suggest that the male physicians held power and authority within the military hospital, paralleling societal norms.[1]

Chief Nurse

In early 1942, Ruth Beery returned to the University of Virginia to assume the role of Chief Nurse in the newly formed 8th Evacuation Hospital. She was a perfect choice for the position of Chief Nurse due to her calm and composed disposition, and the focus she placed on the welfare of her staff and her hospitals' reputation.[1] Beery's task of recruiting nursing volunteers was much more difficult than recruiting medical officers. She spent a great deal of time on correspondence and travel, to ensure that all potential recruits were fully qualified for service. As a new 1st lieutenant, Beery spoke to nursing groups in Roanoke, Harrisonburg, and Richmond in an effort to recruit nurses.[12] During a talk in Winchester, Beery's sense of duty and patriotism were quite evident[12]:

> Nurses of America are now needed in increasing numbers to care for the Nation's armed forces, whether at home or overseas…Thousands who are needed are not responding as rapidly as might be wished. Fifty-two nurses are needed by this Evacuation Hospital, which will render emergency service as a mobile unit. If American boys are going into danger, it is up to America's nurses to care for them. That is our duty and we cannot escape it.

Preparation for Duty

The need for realistic military training was essential to mold the new members into a cohesive team. Neither the new medical officers - nor the newly recruited Army nurses were prepared for the military. The unit's first formal training occurred from July 1 to August 22, 1942, in Pageland, SC, where it participated in maneuvers with the 3rd Evacuation Hospital. Then from August 24 to September 16, the 8th Evac participated in additional training at Fort Benning, Georgia. Personnel kept busy with physical training including road marches, and with lectures on a variety of subjects including basics such as military courtesy, administration, bivouacs, and camouflage.[1]

In mid-September, the 8th Evac moved to a staging area at Camp Kilmer, NJ, where it waited for new orders. On October 8, 1942, the 8th Evac was notified that the nurses would not deploy overseas. Despite Blackford and Beery's several trips to Washington, DC, orders for the nurses to accompany the troops were not forthcoming until the corps surgeon considered it safe and expedient for them to rejoin the unit overseas. Meanwhile, a group of corpsmen would serve as nurses.[1] An Army colonel stated his concerns and the importance of female nurses:

> There's no argument about it. We can't do without nurses, even in the combat zone. We have good corpsmen, but you can't make a doctor or a nurse out of a layman in one year. It takes training to develop the inborn sense of sterility a nurse has. In the operating room every tray to her is an individual problem. She doesn't have to look for an instrument. She knows where it is. If she didn't have anything more to do than mingle with the patients she'd be doing a great service. The patient's morale goes up 100 percent when they know a woman is looking after them.[14(p268)]

The *Santa Paula*

On the morning of November 1, 1942, members of the 8th Evac, including the nurses who were now allowed to deploy overseas, boarded the troop transport ship *Santa Paula*, which departed at 4 AM on November 2, 1942. Members of the unit awoke to a large formation of 35 to 40 ships, including a battleship, aircraft carrier, and numerous destroyers, which zigzagged as it crossed the Atlantic Ocean. This convoy eventually merged with the massive Western Task Force on November 8, 1942, which encompassed over 500 warships and 350 transports, and would spearhead the attack on North Africa.[1]

The Captain of the *Santa Paula* had concerns about the transportation of such a large party of women aboard his ship. However, these fears were unfounded. Upon completion of the journey, he sent a memorandum for record to the commanding officer of the 8th Evac, thru the Commanding General, Atlantic Base Section[12]:

> 1. It seems proper to call to your attention the fine conduct and excellent discipline on shipboard of the group of 52 nurses of your organization, which came to Africa on this vessel under the command of 1st Lt Ruth Beery, ANC N-741970, along with a group of the 11th Evacuation hospital.
>
> 2. In my experience a transport commander is inclined to look forward with some anxiety to having a large number of nurses aboard, fearing that they might present problems outside of his range of experience and hence difficult (sic).
>
> 3. They were no problem on this ship. They were model passengers, competently commanded – a splendid group of women it was a pleasure to have aboard. They were an asset to ship life as well as valuable assistants in the hospital, and if there were any problems connected with them these were handled by ANC officers in command of the groups without coming to my attention. If there conduct on the shipboard is any criterion these fine women are fully worthy of the difficult and vital task your unit has to perform.
>
> 4. A similar letter is being sent to the Commanding Officer of the 11th Evacuation Hospital.
>
> Ward L. Schrantz
> Colonel, T.C.
> Transport Commander

The leadership of Beery and the exemplary conduct of the ANC officers illustrate the professionalism of this group who only 8 months earlier were civilians. This professionalism would serve them well in their imminent deployment.

North Africa

Operation Torch in 1942 was the first large-scale Allied offensive military operation and was the best alternative to an invasion of France.[15] The purpose was to defeat the Axis powers and provide a staging platform for future operations. The Army organized a new experimental chain of evacuation that saw its first use after the invasion. The ensuing success of the new chain of evacuation resulted in the same procedure being employed in every theatre of operations during the war.[2]

When a Soldier was injured or wounded in combat, a series of events would transpire in evacuating the Soldier rearward. Aid men treated the casualty's initial wounds and called for a litter squad to transport the casualty back to battalion aid stations (BAS). At the BAS, a battalion surgeon would provide additional care as necessary. The casualty was then sent to a collecting station, and then to a division clearing station, for transport rearward. Unstable casualties would have surgery at field hospitals performed by attached surgical teams. Stabilized casualties were moved to evacuation hospitals, which had a robust capacity to perform significant lifesaving procedures, and allowed additional recovery time.[16] Soldiers recovering from chest or postoperative abdominal wounds would stay from 5 to 10 days respectively, before being sent to station or general hospitals.[2]

Nursing Care of the Wounded

Depending on the tactical situation, a Soldier may have travelled from 3 to 30 miles before reaching the 8th Evac. Soldiers were triaged and sent to the medical units if disease or infection were present, or to surgical units if medically stable. Soldiers with serious injuries and wounds were triaged to the shock tent, the equivalent of an emergency room. There were no gurneys, but simple sturdy sawhorses upon which the Soldier's litter (stretcher) would be placed.[1] For many Soldiers, this critical period was their first exposure to nursing care.

Nurses in the shock tent typically worked 12-hour shifts or longer when heavy fighting caused increased casualties. Boundaries between medicine and nursing blurred in the 8th Evac as nurses executed tasks that were customarily performed by physicians. Nurses performed plasma infusions and blood transfusions, as well as administering antibiotics and tetanus toxoid injections. There were 3 wards; one for the serious and 2 for those with less serious injuries. Overall, the entire section could hold 100 patients during any given time.[1]

Although the primary role of the 8th Evac was surgical care of injured and wounded, disease put the greatest strain on the unit. The 8th Evac's medical team often treated Soldiers' medical conditions including upper respiratory, gastrointestinal, and nonsurgical musculoskeletal disorders like trench foot, which affected 5,700 Soldiers in the Fifth Army over a 6-month period.[17] Medical cases went to the 36-bed ward where enlisted personnel assisted them. As in the shock tent, nurses worked 12-hour shifts with 22 nurses working days and 12 nurses working nights.[1]

Following the Fifth Army

Working as a team, the nurses and physicians of the 8th Evac supported the Soldiers of the Fifth Army throughout the North African and Italian Campaigns. While deployed, the 8th Evac moved 16 times as it traveled from North Africa to Sicily, and all the way up the Italian peninsula to its final destination of Desenzano (Lake

2LT Dorothy Sandridge, Nurse Anesthetist, 8th Evacuation Hospital, in theater circa 1943-1944.

Garda) in the northeast part of the country. During one arduous move, MG Joseph Martin commended the unit for the speed in which it had transferred a working hospital from one area to another. It was the longest move and the most rapidly effected setup so far in Fifth Army's medical record.[18]

In December 1943, the hospital served near Teano, Italy, the site of some of the most intense fighting of the war. It was a mountainous region with rain, sleet, and snow. The hospital saw its worst casualties after the 36th Infantry Division assaulted German positions across the Rapido River. In several days of intense fighting, over 900 casualties were transported to the 8th Evac.[1]

This period marked a critical change in the treatment of wounded Soldiers with the widespread use of penicillin, and the establishment of a blood blank in Naples, Italy, in February 1944. Gas gangrene from infected wounds practically ceased with the use of penicillin. The blood bank's dissemination of blood products resulted in reduced mortality rates following injuries, enabled performance of longer and more complex surgeries, and decreased the incidence of transfusion reactions.[1] The earlier campaigns in Tunisia as part of Operation Torch had shown blood transfusions to be more effective in reducing mortality rates than plasma.[16]

As is the nature of warfare, having adequate supplies, equipment, and trained personnel to fill all the assigned roles presented numerous challenges in the 8th Evac. The ANC anticipated the need for additional nurse anesthetists, and from 1939 to 1941, it increased the number of nurses attending educational courses. However, more were required than could be trained in the initial phases of the war.[3] Shortages of trained anesthesiologists also persisted through 1943.[19] CPT Linus Miller, a trained anesthesiologist and 2 previously trained nurse anesthetists, 1LT Nova Dowd and 1LT Alice Eagle, determined that more staff was needed to administer anesthesia, particularly in mass casualty situations. To meet the demand, 3 additional ANC lieutenants were trained while in theatre to administer anesthesia, including intravenous sodium pentathol and nitrous oxide.[1]

Surgery

As the Chief Nurse, CPT Beery had numerous administrative and personnel tasks to attend to, as did her Assistant Chief, 1LT Mary J. McCone. However, this did not preclude them from filling in wherever needed, which was most often in the auxiliary shock wards. The nurses in the unit served in almost all the professional services. The surgical area represented the most essential aspect of the evacuation hospital. Nine sections of tent were utilized, which included a "dirty" surgery annex and covered entrances which ensured protection against the elements, as well as providing sufficient blackout to conceal the hospitals location from the enemy. The completed operating room was 90 ft long, 17.5 ft wide, and 6 ft high at the sides.[1]

In the Italy Theater, circa 1943-1945. From left: CPT Ruth Beery, 8th Evac; Congresswoman Edith Rogers; CPT Helen Wharton, RN, Fifth Army.

The surgical teams operated on one of the 8 available operating tables. Two medical officers, a circulating nurse, an anesthetist, and a surgical technician made up the teams. The nurse kept the sterile supplies stocked, circulated, and scrubbed in when needed. The nursing supervisor along with 5 circulating nurses and 5 corpsmen worked 12-hour shifts, but in times where there were increased casualties it was common to work 20 or more hours. Despite experience, skill, and coordinated

Evacuation Hospital surgical teams in the European theater, circa 1943-1945.

effort, it was difficult to treat more than 100 casualties in a 24-hour period.[1]

Nurses played a key role in the preparation and maintenance of the operating room as well as preoperative and postoperative care of wounded Soldiers. This was critical, as thoracic surgery was a key intervention performed in the surgical unit of evacuation hospitals like the 8th. The nature of modern warfare resulted in severe wounds from high velocity rifle bullets and shrapnel from artillery fire. Thoracotomies were performed on Soldiers with severe open chest, thoraco-abdominal, and cardiac wounds. Wounds that prevented adequate ventilation such as sucking chest wounds or hemothorax required urgent surgical intervention. Often these required chest wall debridement, placement of chest tubes, thoracentesis, nerve blocks, and bronchoscopies. Nurses played a key role in the efficient and coordinated effort required to ensure success in these types of procedures. Preparation was important and nurses were instrumental in that role, efficiently and confidently reacting to potential uncertainties.[20]

Victory in Europe

On May 8, 1945, Nazi Germany unconditionally surrendered to Allied forces and the war in Europe was over. It would not be long until Japan also surrendered on August 13, 1945. World War II, the bloodiest war in human history, had finally ended. The 8th Evac had performed superbly in support of the Fifth Army for over 2½ years, and its personnel had cared for over 48,047 patients in the hospital; 31,057 with disease, 10,487 with wounds, and 7,563 with injuries. Another 45,000 were seen in outpatient departments.[1] These accomplishments garnered considerable recognition, as both the unit and its members would receive numerous awards and citations, including the Legion of Merit (6), Silver Star (1), Soldiers' Medal (2), Bronze Star (28), Air Medal (1), and Purple Heart (7) awards.[11]

Conclusion

More than 57,000 American nurses served in the ANC during World War II, over 201 of whom died while in service to their nation.[2] Aided by nurses, over 60% of the 500,000 Soldiers wounded in battle returned to active service.[21] Evidence suggests that advances in the chain-of-evacuation, antibiotics, dissemination of blood products, and the expanded roles of nurses all contributed to increased survival.

Nurses received enduring respect from combatants who received care first-hand, as well as the physicians and Soldiers with whom they worked on a daily basis. Collaboration, mutual respect, and coordinated teamwork were critical. The history of the 8th Evac illustrates the evolutionary aspect in which necessity, innovation, and technology combined to bring about important practice changes. The performance of nurses garnered recognition among many facets of society for their unique and valuable contributions during the war, and pushed the boundaries of what women could achieve. Army nurses would again answer the call to duty during the many ensuing conflicts. The geopolitical reasons for war would change, but the critical need for nursing care of Soldiers will not, and this proud legacy of service continues today.

Acknowledgements

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FORENSIC AND ETHICAL ISSUES IN MILITARY BEHAVIORAL HEALTH

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A New Monograph From the Borden Institute

Airborne Hazards Related to Deployment

Editors:
Coleen P. Baird, MD, MPH
Deanna K. Harkins, MD, MPH
US Army Public Health Command
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LTC Daniel E. Banks, MC, USA

> You are holding a unique book, one that demonstrates the commitment of the Army and the Nation to its Soldiers…. Inside, the reader will find medical doctors and scientists reaching conclusions that are at odds with each other. This book puts these contradicting learned opinions under one cover, for it is important that readers absorb these writings and come to their own conclusions.
>
> LTG Patricia D. Horoho
> The Surgeon General of the US Army
> Commanding General, US Army Medical Command

In October 2011, the Institute of Medicine issued the report Long-Term Health Consequences of Exposures to Burn Pits in Iraq and Afghanistan. The report identified and measured the toxic components released from the burn pit at Joint Base Balad in Iraq, and it addressed the potential adverse respiratory health effects associated with these exposures. Although most pollutants detected were present in amounts less than those measured in typical urban areas in the United States and below values thought to cause injury, the amount of particulate matter in the air exceeded values thought to be safe. In the end, the Institute of Medicine's findings were considered to be inconclusive, and a call for additional research was made.

Despite the inconclusive nature of the report's findings, the report's contents prompted the Department of Defense and the Veterans Administration to join forces. As a team, they devised a plan to identify both the population and individuals who had been exposed to the pollution of burn pit fires and were at risk through the use of a registry. The intent was to provide healthcare for those with health effects associated with burn pit exposure. To that end, a research agenda was developed to identify and care for those with respiratory impairment attributable to deployment, in general. As a part of this effort, the Veterans Administration and the Department of Defense hosted the Joint Airborne Hazards Symposium in August 2012. This monograph summarizes the content of the symposium, and also includes additional perspectives from other experts who have published research relevant to deployment-related airborne hazards.

Published by the Borden Institute and endorsed by The Surgeon General, this monograph comprises 33 chapters outlining important issues that remain to be considered in addressing Soldier respiratory health. The issues include the following:

- Although a comprehensive health assessment is provided to each Soldier prior to deployment, lung function tests are not part of that assessment. Although adding to the cost of care, this approach would be useful to better understand the effects of deployment on respiratory health. Chapters in this book provide considerable discussion as to whether this would be a useful approach to understanding changes in lung function associated with deployment.
- The pros and cons of a registry identifying those with an "adverse respiratory exposure while deployed" are debated. Although it is attractive to undertake epidemiological studies on a population of Soldiers with a common exposure to areas recognized to cause lung disease, the value of such a registry is less clear when the criteria for enrolling in the registry is solely based on the Soldier's recollection, and no clear quantification of the extent of exposure to adverse agent(s) is available. Furthermore,

in some Soldiers, the effects of confounding exposures, specifically cigarette smoke, may make it difficult to understand outcomes associated with an exposure that may cause lung injury, such as those that occurred in association with burn pit exposure.

- The clinical illness constrictive bronchiolitis is described in a population of Soldiers who were short of breath after their deployment, some with clear-cut burn pit exposures and some without. Most were without airway obstruction as measured by lung function tests or abnormalities on the chest radiograph or chest computerized tomography scan. Yet, a large number of these individuals had a lung biopsy with changes in the lung consistent with this pathologic entity. This is a very different clinical presentation than that described in nearly all cases associated with other toxic exposures resulting in these pathologic lung changes. In many cases where this pathologic entity was previously reported as caused by other exposures, lung function approached "end-stage," and dramatic changes were apparent on chest imaging. This description of disease, as well as the lung biopsy in the absence of lung function or abnormities in lung imaging, has engendered considerable discussion in the pulmonology community about how to understand this illness and how to relate this presentation to our previous understanding of this disease.
- Although the cases show pathologic features in the lung of constrictive bronchiolitis, what is missing is a serial follow-up of these individuals. In previous reports of individuals with this illness, the great majority fail to improve with therapy. In this instance, there are no reports addressing the clinical outcomes of these Soldiers once the diagnosis of constrictive bronchiolitis was made. Of particular relevance would be the response of symptoms to therapy, as well as a serial assessment of lung function and chest imaging to address progression of the disease over time.
- The final aspects of the discussions in the report related to the ways doctors should evaluate those Soldiers who return from deployment with respiratory complaints. Authors propose and detail clinical steps to address and explain why the Soldier has complaints prior to lung biopsy.

What investigations are ongoing to better understand the health of Soldiers as they progress through their careers? The Department of Defense and the Veterans Administration have worked together to provide information on the short- and long-term health and well-being of US military veterans and Soldiers. The Millennium Cohort Study was initiated after the 1991 Gulf War and launched a large longitudinal health survey of US service members beginning in 2001—immediately prior to the Iraq and Afghanistan conflicts. The intent was to evaluate the effect of military service, including deployments, on the long-term health of service members. The study, originally planned to last 21 years, was extended to last 67 years, the life span of a generation of veterans. The cohort consists of more than 200,000 service members from all branches of the service enrolled in 2001, 2004, 2007, and 2011. Evaluations are scheduled at 3-year intervals. Participation is by invitation of a randomly sampled population. Additional enrollment and continued follow-up are scheduled to continue for several decades. The survey is mailed or emailed to the participants and responses collected from more than 1,000 questions. Topics include mental and physical health, military experiences, and lifestyle. An interesting aspect of this survey is the linkage of the individual responses to the TRICARE database (addressing ICD-9 codes for illness) and the Pharmaceutical Data Transaction Service, a way to follow prescription drug therapy.

A second, smaller, and much more focused study is the Study of Active Duty Military for Pulmonary Disease Related to Environmental Deployment Exposures (also known as STAMPEDE). This study was designed to assess and explain new onset of respiratory symptoms occurring relatively soon after returning from deployment in southwest Asia. Of the 50 Soldiers initially studied, 21 were not diagnosed with lung disease; yet, 6 of these Soldiers had cellular abnormalities in the lung, thus implying a subclinical illness. Lung biopsies were not performed. Among those with identifiable respiratory illness, the most common explanation was the development of asthma while deployed. The first manuscript describing the investigations and outcomes in this population can be viewed at http://www.atsjournals.org/doi/pdf/10.1164/rccm.201402-0372OC. Similar studies on a larger population of deployed Soldiers returning with respiratory complaints are ongoing.

In summary, the comments by LTG Horoho at the beginning of this review reflect the presentation of information in this monograph. The full story of the outcome of respiratory health of the Soldiers who were deployed to southwest Asia is not yet understood. The editors of this book, Dr Baird and Dr Harkins, have presented a fair perspective on the current state of our understanding of these health effects. They have made a great effort to include both Department of Defense and Veterans Administration representatives, as well as those in the practice of academic medicine, to present what information is available and spur their colleagues to better understand

the respiratory effects of the exposures. These efforts are a very important step forward in better understanding the adverse respiratory health effects associated with deployment in southwest Asia.

LTC Banks is a former Director and Editor-in-Chief of the Borden Institute.

AIRBORNE HAZARDS RELATED TO DEPLOYMENT

Developed from the Airborne Hazards Symposium held in Washington, DC, in August 2012, this book covers such topics as diagnosis and workup of symptomatic individuals, exposure characterization, current epidemiology, the potential role of pulmonary function testing (spirometry) in surveillance, strategic research planning, clinical follow-up and registries, risk communication, etc. Symposium presentations were delivered by a diverse group of scientific experts and contain valuable veteran perspectives. This book represents a compendium of what is currently known regarding the potential long-term health consequences of exposure to airborne hazards during Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn deployments. Airborne Hazards Related to Deployment presents a balanced, comprehensive approach to furthering the understanding of airborne hazards during deployments and other military operations, ultimately improving airborne hazard prevention, protection, and avoidance while improving healthcare and minimizing adverse health outcomes of our service members and veterans.

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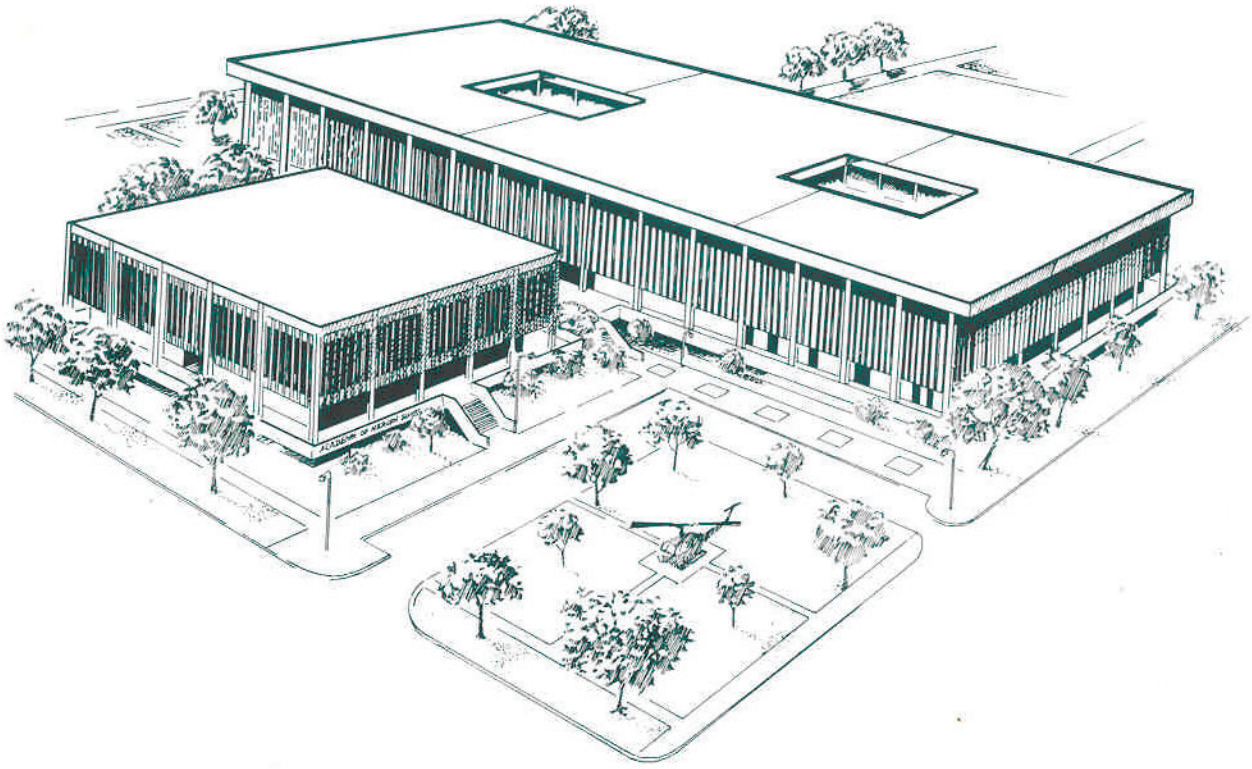

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The US Army Medical Department Regiment

The US Army Medical Department was formed on 27 July, 1775, when the Continental Congress authorized a Medical Service for an army of 20,000 men. It created the Hospital Department and named Dr Benjamin Church of Boston as Director General and Chief Physician. On 14 April, 1818 the Congress passed an Act which reorganized the staff departments of the Army. The Act provided for a Medical Department to be headed by a Surgeon General. Dr Joseph Lovell, appointed Surgeon General of the United States Army in April 1818, was the first to hold this position in the new organization. The passage of this law marks the beginning of the modern Medical Department of the United States Army.

Throughout its early history, the size and mission of the US Army Medical Department would wax and wane in response to military events around the world. There was, however, no formal regimental organization until World War I. Then, in the late 1950s, the brigade replaced the regiment as a tactical unit. In the reorganization that followed, some Army units lost their identity, their lineage, their history. This loss did not go unnoticed. The US Army Regimental System was created in 1981 to provide soldiers with continuous identification with a single regiment. Department of the Army Regulation 600-82, The US Army Regimental System, states the mission of the regiment is to enhance combat effectiveness through a framework that provides the opportunity for affiliation, develops loyalty and commitment, fosters a sense of belonging, improves unit esprit, and institutionalizes the war-fighting ethos.

The US Army Medical Department Regiment was activated on 28 July, 1986, during ceremonies at Fort Sam Houston in San Antonio, Texas, the "Home of Army Medicine." Lieutenant General Quinn H. Becker, the US Army Surgeon General and AMEDD Regimental Commander, was the reviewing officer.

The Regimental web site (http://ameddregiment.amedd.army.mil) is designed to provide useful information about the US Army Medical Department (AMEDD) Regiment. Through the web site, you can learn the history of the AMEDD Regiment, the symbolism behind our heraldic items, how to wear the Regimental Distinctive insignia, and various programs available to you and your unit.

The Office of the AMEDD Regiment is located in Aabel Hall, Building 2840, on Fort Sam Houston, Texas. The Regimental staff can provide further information pertaining to the history of the Army Medical Department and the AMEDD Regiment, and also to assist with any of the services described in the web page.

For additional information please contact the Army Medical Department Regimental Office at the following address:

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3630 Stanley Road
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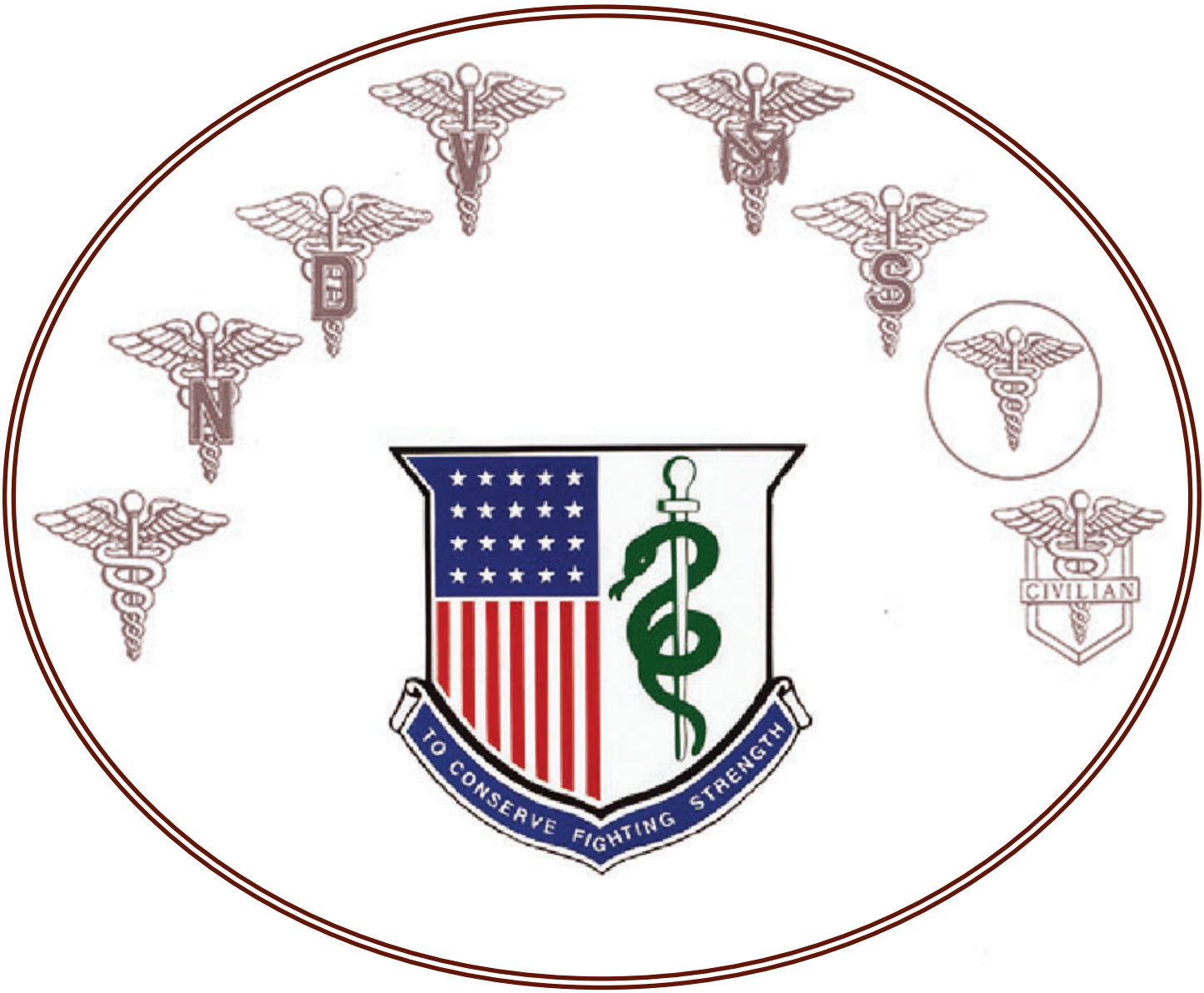

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