

An Evidence-Based Public Health Approach to Injury Priorities and Prevention

Recommendations for the U.S. Military

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Abstract: Injuries are the leading cause of morbidity and mortality confronting U.S. military forces in peacetime or combat operations. Not only are injuries the biggest health problem of the military services, they are also a complex problem. The leading causes of deaths are different from those that result in hospitalization, which are different from those that result in outpatient care. As a consequence, it is not possible to focus on just one level of injury severity if the impact of injuries on military personnel is to be reduced. To effectively reduce the impact of a problem as big and complex as injuries requires a systematic approach.

The purpose of this paper is to: (1) review the steps of the public health process for injury prevention; (2) review literature on evaluation of the scientific quality and consistency of information needed to make decisions about prevention policies, programs, and interventions; and (3) summarize criteria for setting objective injury prevention priorities. The review of these topics will serve as a foundation for making recommendations to enhance the effectiveness of injury prevention efforts in the military and similarly large communities. This paper also serves as an introduction to the other articles in this supplement to the *American Journal of Preventive Medicine* that illustrate the recommended systematic approach.

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Introduction

Injuries in the Military: a Large Problem

Injuries are the biggest health problem confronting U.S. military forces in peacetime and combat operations.^{1,2} Injuries result in over 1.8 million medical encounters annually across the military services and affect more than 800,000 individual service members.³ The second leading cause of medical encounters, mental disorders, results in about 750,000 encounters annually, affecting about 190,000 service members. Historically, injuries have been shown to be the leading cause of deaths, disabilities, hospitalizations, and outpatient visits.^{3–7} While battle injuries are the leading cause of death in Operations Iraqi Freedom (OIF) and Enduring Freedom

(OEF), nonbattle injuries are the leading cause of health conditions serious enough to require aero-medical evacuations out of the theater of operations. Nonbattle injuries account for about 35% of such medical evacuations, compared to 16% for battle injuries and 7% for digestive diseases, the leading non-injury reason for medical evacuation (Keith Hauret, U.S. Army Center for Health Promotion and Preventive Medicine, unpublished data, 2008). Relative to other health problems, injuries have the biggest impact on the health and combat readiness of military personnel.

In the past, military surveillance of injuries and “accidents” has focused primarily on fatalities, especially motor vehicle and aviation fatalities. Since the late 1990s, however, increasing attention has been directed toward nonfatal injuries following establishment of the Defense Medical Surveillance System in 1997.⁸ As a result of the recent focus on nonfatal injuries, it has been shown that for every noncombat injury death of a military service member there are 33 hospitalizations and 3800 outpatient clinic visits for injuries.⁹ It has also been estimated that injuries result in about 25,000,000 days of limited duty among service members annually.⁹ It is clear that injuries are a tre-

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mendous drain on military manpower during peacetime and times of armed conflict.

Injuries in the Military: a Complex Problem

In addition to being a large problem, injuries are also a complex problem for the military. Among other complexities, as with civilian communities, the leading causes of injury vary widely depending on the level of severity of injuries. For instance, historically, motor vehicle crashes have been the leading cause of unintentional, nonbattle injury deaths across all the military services, accounting for 55% to 64% of all unintentional injury deaths,¹⁰ resulting in five to ten times as many deaths as the next leading specific injury causes (drowning, fires/burns, or falls, depending on the service).⁵ On the other hand, the top three causes of injury hospitalization of military personnel have been documented to be falls, athletics (sports), and motor vehicle crashes.⁶ In 2006, the leading cause of injury hospitalizations for military personnel was falls and near falls (slips and trips), which accounted for 17.5% of such hospitalizations, followed by motor vehicle mishaps at 15.4%, and sports and athletics at 13.1% (Michelle Canham-Chervak, U.S. Army Center for Health Promotion and Preventive Medicine, unpublished data, 2007).

The same three causes of injuries—falls, sports, and motor vehicle mishaps—are also the leading causes of medical evacuations from operations in Iraq and Afghanistan.² The only data readily available on causes of outpatient-treated injuries come from army field investigations. That data indicated that physical training (i.e., exercise) is the leading cause of outpatient injury visits, accounting for 25% to 40% of such injuries.^{11,12} On the other hand, motor vehicle mishaps account for less than 5% of all injuries treated in outpatient clinics and rank no higher than 7th or 8th when compared to other causes. It is clear from data such as these that if priorities for military injury prevention were based on fatalities, the major causes of the majority of injuries, physical training and falls, would not be addressed.

Adding further to the complexity of the problem of injuries, the circumstances of injuries resulting from similar causes can be quite different. As an example, falls can occur from stairs, ladders, and other heights, and on level surfaces during garrison or combat conditions.¹³ Likewise, athletics result in frequent, sometimes serious, injuries associated with a variety of sports occurring under varied circumstances.^{2,14}

With regard to prevention, success has been achieved where attention has been focused and surveillance systems are in place. For example, just as in the civilian community, the military has had great success preventing injuries and deaths associated with privately owned mo-

tor vehicle crashes.¹⁵ Furthermore, because an abundance of evidence for further prevention of motor-vehicle crashes is available from established government organizations such as the National Highway Traffic Safety Administration, the CDC, the Insurance Institute for Highway Safety, and academic organizations, the military can adopt civilian approaches already demonstrated to be effective.¹⁶ But for most injury problems, even large, potentially serious injury problems such as falls, very little prevention information is available. Research needs to be conducted before policies and programs are implemented when systematic reviews determine that scientific information is scant and where gaps in knowledge about prevention exist.

Purpose

As with any large community or occupational group, for a public health problem as big and complex as injuries in the military, a systematic approach to planning and setting priorities is needed for prevention activities to succeed. Because resources for prevention are scarce, a process is needed for setting priorities that identifies not only effective countermeasures, but also those strategies that affect the health of the largest number of personnel at the lowest costs.^{17,18} When scientific evidence is available, a process for evaluating the quality of individual studies and a mechanism for making recommendations for the aggregate findings on a particular injury problem are needed. The purpose of this paper is to outline a systematic process for identifying the largest, most severe injury problems for which effective prevention strategies have been developed, and targeting those problems for intervention. An evidence-based approach to identifying problems for which effective prevention strategies exist is described and used as a foundation for making recommendations that could be applied to the military or other similarly large populations.

A Systematic Process for Injury Prevention

The public health approach. Modern epidemiology has shown that injuries are not “accidents”; they are predictable and preventable. A comprehensive public health approach for the prevention of injuries has previously been recommended for the military services.^{4,19-21} The primary recommendation entailed establishing the five functional elements of the public health approach for injury prevention listed in [Table 1](#). For a large community or organization such as the military to successfully prevent injuries, it is necessary for each of the five functional elements to be operating. Although the approach does not necessarily need to be carried out in sequential order, all of the steps are necessary in order to successfully

Table 1. Functional steps of the public health approach to injury prevention^a

Functional step of prevention process	Description of function
1. Surveillance	Medical and safety surveillance routinely tracks frequencies, rates, and trends in injuries and other health problems. The data are used to identify ongoing and emergent problems and to help set priorities. Surveillance can also help monitor prevention policy and program effectiveness.
2. Research and field investigations on risk factors and causes	Research and to some extent public health field investigations provide information on the incidence of injuries and other health problems and determine causes and risk factors for health problems.
3. Research on interventions	Research may also entail conducting intervention trials, both randomized and nonrandomized, to determine what works to prevent injuries and other health problems. Intervention trials provide information on the efficacy of prevention strategies.
4. Program and policy implementation	Polymakers, worksite supervisors, military commanders, and other authorities direct implementation of injury prevention and other public health policies, programs, and strategies to protect populations and communities.
5. Evaluation and monitoring of programs and policies	Once policies, programs, and strategies are implemented the effectiveness of those activities should be evaluated to determine the effectiveness of the actions. Surveillance data can also be used to monitor ongoing effectiveness.

^aAdapted from other published reports.^{16,19,20} The public health approach was first described by Mercy et al.⁵⁶

prevent injuries over time. Great strides have been made since the initial recommendation of the five-step public health approach to the Armed Forces Epidemiological Board in 1996.²⁰ Routine medical surveillance of injuries resulting in hospitalization of military service members and also those treated in outpatient clinics has been implemented. Additionally, the means to evaluate public health practices implemented to prevent injuries has been demonstrated.^{22,23} The steps for which the least progress has been made are research. While occasional ad hoc injury research initiatives arise, at this time there is no dedicated injury prevention research objective or program for the military. In addition, injury cause coding of outpatient data is needed to prioritize and guide prevention efforts. Despite great progress, for injury prevention in the military to be effective, all of the steps of the process need to be improved for each of the services.

The evidence-based process. In addition to the five steps of the public health approach, cost-effective injury and disease prevention requires an evidence-based mechanism for prioritizing prevention activities and allocation of public health and prevention resources (Table 2). Priority should be given to problems for which there is scientific evidence of effective prevention policies, programs, or interventions.^{24–26} Great progress has been made in evidence-based decision making in preventive medicine and public health over the last 20 years in the U.S., starting with the U.S. Preventive Services Task Force (USPSTF) in the late 1980s.^{27,28} As described by Briss and McGinnis, the USPSTF first applied the evidence-based process to the evaluation of clinical preventive services in

the Guide to Clinical Preventive Services in 1989.^{28,29} With the development of the Guide to Community Preventive Services in 2000, that process was extended to community public health.^{27–30} The process for identifying successful evidence-based prevention strategies and setting public health and safety priorities has gained enough credence to recommend wide implementation.

The key step of the evidence-based process is the evaluation of the quality of individual prevention studies or investigations (Table 2).^{31,32} The next step of the process is development of recommendations for prevention based on the overall quality and consistency of the evidence supporting or refuting the effectiveness of prevention strategies.^{31,32} Earlier steps of the evidence-based decision-making process begin with defining the problem and systematic reviews of the scientific literature, or meta-analyses. The final steps are to set priorities for prevention and research based on the magnitude or severity of public health problems; the strength and consistency of the evidence that effective solutions for the problems exist; and a determination that the identified prevention strategies are feasible to implement.^{24,25,33}

Surveillance and the evidence-based process. The evidence-based process begins with identification of the biggest and most severe health problems affecting a community or population.^{34,35} Health and safety surveillance and surveys are the logical means for identifying the most common and severe injury and other health problems of a community. In the past, the public health importance of injuries and other health problems has been established primarily using fatality data.³⁶ In the military services,

Table 2. Steps of evidence-based public health decision-making process

Step of process	Description of step
1. Identification of biggest or most severe problems	The first step of the evidence-based public health process utilizes medical, safety, and other surveillance and survey data sources to identify causes or types of injury with high rates or indicators of severity to target for potential prevention.
2. Search for evidence of effective prevention	The second step of the process uses knowledge of the most significant injury problems confronting a population from Step 1 to focus systematic reviews of the scientific literature on those problems to determine what evidence exists for their prevention.
3. Evaluation of quality of evidence for prevention	The third step of the process evaluates the quality of individual research studies using predetermined criteria to assess strengths and weaknesses of design, execution, and analysis.
4. Recommendations based on strength and consistency of evidence	The fourth step of the process assesses the strength and consistency of the overall evidence that interventions work to prevent the problems identified as a foundation for recommendations. Note: No one study design addresses all the questions requiring answers about effectiveness, harms, and real-world feasibility. One study is not sufficient to make evidence-based recommendations.
5. Prioritization of interventions	The fifth step applies predetermined criteria to rank prevention strategies for allocation of resources and implementation based on the magnitude or severity of a problem, its preventability (evidence of effective interventions), and the feasibility of implementation.
6. Identification of research gaps	The sixth and final step of the evidence-based prevention process can take place concurrently with the fifth. This step identifies gaps in knowledge of what prevents the most significant health problems confronting a population and targets them for more research.

top priorities for injury prevention are still predicated on the leading causes of deaths—motor vehicle and aviation mishaps. The prioritization process should include measures not just of mortality, but also morbidity measures such as disabilities, hospital discharges, and visits for emergency and other outpatient treatment, among others.^{9,30,37} Using fatality data for setting injury prevention priorities can be particularly misleading as the most frequent causes of injuries do not necessarily result in death.³⁸ Also, as highlighted earlier, because the leading causes of injury deaths are different than the leading causes of the more numerous nonfatal injuries, reducing the leading causes of deaths may have little impact on the overall burden of injuries on a population. As a consequence, in the initial phase of identifying the most important injury problems of a community, both magnitude and severity of injuries should be considered using fatality, disability, hospitalization, and outpatient data.

Systematic reviews and the quality of evidence. In targeting and conducting effective injury prevention, it is not enough to know what the biggest injury problems are. It is also necessary to know which are preventable. A process for identifying and evaluating the evidence for what works to prevent injuries is also essential (Table 2). A number of approaches have been established for evaluating the effectiveness of interventions to treat or prevent health problems. The best known is the process established by the U.S. Preventive Services Task Force, which has been well-described elsewhere.^{32,39,40} Similar

processes have been adopted by other groups and organizations.^{31,41,42} Most recently, a similar process has been adopted by the Guide for Community Preventive Services.^{28,30,43} What the Guide for Community Preventive Services and other such evidence-based processes have in common is the initiation of the process with a systematic review of the literature using a well-defined, pre-established approach. Once the most prevalent and severe public health problems have been identified, the second step serves to identify potential interventions/countermeasures that have been scientifically evaluated and found effective.

After the literature searches have been completed, the next step is to assess the quality of the science for identified studies and to characterize the health outcomes associated with the interventions studied and the size of the effects due to the interventions. There is a growing consensus that, whether one is assessing the effectiveness of a medication, clinical preventive services, or a community preventive service, more than just the beneficial effect of an intervention must be considered when making recommendations for prevention. The potential harms of an intervention must be assessed too.^{31,32,41,42} To work well, the process must have (1) a standardized method of finding evidence to assess, (2) a standard set of considerations in evaluating the quality of individual scientific studies, and (3) a method of arriving at a composite score for each study on a particular prevention strategy that can be compared to other studies. Such systematic reviews (lit-

Table 3. Levels of recommendations for injury prevention strategies^a

Recommendation	Reasons for recommendation
Strongly recommend	Good data on effectiveness exist, some of it high quality, and findings across studies are consistent. Effect sizes are substantial.
Recommend	At least fair evidence of intervention effectiveness exists, and findings of effectiveness are mostly consistent. Effect sizes may be modest.
No recommendation	Benefits and harms too close to make a recommendation.
Recommend against use	Data from studies of adequate sample size to show intervention effects of modest magnitude do not indicate that the intervention is effective or that the harms of the intervention outweigh the benefits.
Insufficient evidence	Insufficiency of evidence may result from a complete lack of data, few studies, or inconsistency of results.
Expert opinion	In the absence of scientific evidence on the effectiveness of interventions (e.g., insufficient evidence), utilization of expert opinion or consensus opinions on recommendations for prevention may be warranted for urgent health problems. When the basis for an intervention is expert opinion, the intervention implemented should be rigorously evaluated and closely monitored for effectiveness.

^aAdapted from other published reports.^{31–33}

erature reviews coupled with quality assessments) are now viewed as a critical part of the public health decision-making process.^{44,45}

Completing the literature search and evaluation process is time consuming and rigorous. As a consequence, Harris et al,³² in writing about the USPSTF, state that “limited resources and time requires compromises in the intensity of reviews One strategy is . . . topic prioritization Another strategy . . . is to focus the review on the questions and evidence most critical to making recommendations.” This type of process has been applied to setting priorities for military injury prevention, and an expedited process for more rapid evaluation by public health and safety organizations has been recommended.^{9,33} To facilitate more rapid transmission of evidence-based injury prevention information to decisionmakers and policymakers, an expert military panel established an expedited process for scientific study evaluation.³³ Thus several approaches can be used to facilitate more rapid transmission of information from evaluators to decision makers, including focusing the systematic review process on the most important interventions and expediting the review process itself.

Systematic reviews and the strength and consistency of evidence. Following the identification of evidence sources (studies) and the evaluation of the quality of individual studies, the next step is translation of the body of the evidence as a whole into recommendations. This step of the evidence-based process entails the assessment of the overall strength and consistency of the evidence for a particular intervention.^{29,31,32} As mentioned earlier, not only must the process evaluate how effective an intervention strategy is at preventing injuries or other health outcomes but also if any harms might arise from

implementation.^{26,29,31,32,41,42} In making recommendations, information on the quality and consistency of evidence that a strategy works must be balanced against potential harms and the costs implementation may impose.

In addition to weighing effectiveness, harms, and costs in the process of making public health recommendations, consideration should be given to what needs to be done in situations when an urgent public health or safety problem exists, but there is insufficient scientific evidence of interventions that work to prevent the problem.^{41,46} In a rating scheme for recommendations by the Strength of Recommendation Taxonomy (SORT), Ebell³¹ indicates that the lowest level of evidence is consensus or usual practices (i.e., expert opinion). In his discussion of the USPSTF, Harris warns that if evidence is deemed insufficient to make a recommendation to provide preventive services, then decision makers must rely on factors other than science.³² Claxton⁴¹ addresses the issue directly, stating that a method is needed for acquiring “judgments from experts when no evidence is available.”

With the above considerations in mind, a set of ratings for recommendations has been made that is suitable for use in a large population that frequently confronts new and significant public health and safety problems, many of which may be of an urgent nature (Table 3). The proposed categories of recommendations are as follows: strongly recommend, recommend, no recommendation, insufficient evidence, and expert opinion. To accommodate the inevitable situation in which the military and other organizations need recommendations for intervention when no evidence of preventability exists, an additional category for expert opinion was added. It should be noted, however, that when interventions without clear

evidence of effectiveness are implemented, they should be carefully evaluated.

Study design and trade-offs in validity of evidence. An issue of importance to the process of evaluating the quality and strength of evidence supporting prevention is that of study type or design. In the past, the only acceptable standard was an RCT. There is, however, a growing consensus that RCTs are not necessarily the only acceptable evidence or even the gold standard, especially for nonpharmaceutical, nonclinical, community-based interventions.^{26,32,40,42,47,48} Even the USPSTF accepts study types other than RCTs as evidence.³² This consensus has arisen from the growing awareness of the shortcomings of RCTs in documenting the harms or adverse outcomes of interventions, the inability to provide an accurate assessment of the magnitude of health benefits of an intervention in a non-experimental setting, and impracticality of conducting randomized studies in many circumstances. While RCTs may have greater internal validity, they lack the external validity offered by other study designs. Atkins et al.⁴⁶ specifically note that RCTs “may not give an accurate picture of the impact of a policy decision under real-world conditions.”

Because of time and funding constraints, RCTs frequently employ intermediate outcomes. This is not acceptable. Several authors caution that, in determining the effectiveness of an intervention, it is essential that the health outcomes of interest be assessed,^{26,46} unless the link between an intermediate outcome and the occurrence of the health outcome of interest is well established, such as the link between seat belt use and decreased risk of traffic fatalities.

A variety of valid alternative, nonrandomized study designs may be useful in assessing the effectiveness of interventions intended to be implemented on a wide scale in communities and populations. These study types include nonrandomized prospective and retrospective cohort studies, pre-post studies, time-series, case-control, and natural experiments, as well as other quasi-experimental or observational types of studies.^{26,47,48} Such studies may be better at determining the efficacy of interventions in real-world community settings than RCTs. Teutsch notes that data from RCTs is scarce for many interventions, so investigators should not be deterred from using other more practical study designs.²⁶ Group randomized trials provide another alternative to RCTs.^{47,48} What is important in choosing a study design is that it be able to determine whether implementation of an intervention changed the incidence of the health outcome of interest.

Furthermore, Mercer et al.⁴⁷ state “No one study establishes causality.” Rather, consistent outcomes from multiple studies make a better foundation for evidence-based health and public health policy. Atkins et al.⁴⁶ caution

that “policymakers should be skeptical of evidence derived from a single study.” The fact that no one study or study type is an adequate basis for policy and public health decisions argues for greater use of systematic reviews that make use of all available evidence regardless of study type, published or unpublished.⁴⁶⁻⁴⁸ Weighing evidence from multiple studies of different types provides a greater opportunity to balance effectiveness against harms and costs. While RCTs provide confidence that study findings are not due to chance or bias resulting from inadequate study design (i.e., internal validity), other types of well-designed studies may be more practical, less costly, and more generalizable (i.e., externally valid).

Criteria for setting priorities. The need for a mechanism for setting priorities for allocation of resources for prevention of injuries and disease is widely recognized.^{17,24-26,35,37,41,49-52} The Institute of Medicine’s Committee on Injury Prevention and Control stated that, for injury prevention, “Whatever the overall level of public investment . . . priorities for research and social action must be set. The challenge facing the field is developing criteria for setting these priorities.”³⁵

A number of approaches to establishing prevention priorities employing a variety of criteria have been suggested, including using the burden of disease,³⁷ consideration of the magnitude, severity, and costs of problems^{49,53} or these in combination with preventability/effectiveness¹⁷ and feasibility factors such as acceptability, available resources, and legal authority.^{24,25,50,54} Runyan^{16,25} and Fowler²⁴ have described more comprehensive criteria than others and created decision matrices specifically for setting injury prevention priorities. Their criteria for setting injury prevention priorities can be aggregated into several overarching categories including effectiveness (preventability considering benefits and harms), costs, feasibility (funding, infrastructure, personnel, legal authority), acceptability (social and political), and sustainability.

Process for setting priorities based on criteria. Once criteria are established for setting priorities, a process for ranking the potential priorities must be developed. Fowler²⁴ described a qualitative process using rankings of “high,” “moderate,” and “low” for each criterion in a decision matrix. Runyan²⁵ suggested that either qualitative or quantitative methods for applying criteria can be employed to set priorities, provided that decision makers consider the most important factors likely to determine policy, program, or intervention success. Claxton et al.⁴¹ expressed a preference for a quantitative approach to such decision making, stating: “In particular, evidentiary criteria are not tied formally and quantitatively to benefits, risks, and costs associated with an intervention and as a result do not maximize health benefits.” As a conse-

Table 4. Priority-setting criteria employed by military injury prevention working groups

Criterion	Scoring
A. Program or policy is consistent with mission of the working group/organization	If YES—Continue with scoring. If NO—Stop here.
B. Importance of problem to public health or workplace productivity	(10 points; 1=low, 10=high)
Considerations:	
<ol style="list-style-type: none"> 1. Magnitude of the problem (e.g. frequency, incidence) 2. Severity of problem (e.g., degree of effect on personnel health and performance) 3. Cost of the problem (e.g., training, property, and personnel costs) 4. Size of population at risk 5. Degree of concern (e.g., leadership concern, public and Service member concern, visibility of problem) 	
C. Preventability of problem	(10 points; 1=low, 10=high)
Considerations:	
<ol style="list-style-type: none"> 1. Cause(s) are identifiable 2. Risk factors are modifiable 3. Proven prevention strategies that reduce existing injury rates exist 4. Prevention strategies that reduce existing injury rates can be designed 5. Effect size 	
D. Feasibility of program or policy	(10 points; 1=low, 10=high)
Considerations:	
<ol style="list-style-type: none"> 1. Existence of infrastructure to support implementation and sustainability of the program or policy (e.g., medical staff and facilities, safety staff and resources, manpower availability) 2. Perceived adequacy of funding to support implementation and sustainability 3. Authority to implement and sustain the program or policy is held or obtainable by the implementing organization(s) 4. Program or policy will not undermine essential missions 5. Political and cultural acceptability of program or policy 6. Accountability and responsibility for implementation and sustainability exists or can be established 	
E. Timeliness	(5 points; 1=low, 5=high)
Considerations:	
<ol style="list-style-type: none"> 1. Time to implementation 2. Time to results 	
F. Evaluation of program or policy	(5 points; 1=low, 5=high)
Considerations:	
<ol style="list-style-type: none"> 1. Ability to evaluate effects of program or policy (i.e., availability of metrics) 2. Benefits of program or policy outweigh the costs of implementation and sustainability 3. Collateral benefits as a result of implementation (i.e., increased readiness, decreased attrition, and decreased other health problems) 	

quence of this kind of thinking, several military injury prevention working groups have adopted a quantitative approach to setting priorities.^{9,33,55} The criteria employed by these military working groups and the scoring of criteria are provided in Table 4. The synthesis of criteria for prevention priorities enumerated by these military working groups actually began at the CDC in 2000 with work started there by one of the authors (BHJ).

A similar set of criteria to those for setting prevention priorities can be used to set research priorities. In 2002, a preliminary set of such criteria was developed by the U.S. Army Center for Health Promotion and Preventive Medicine and the Johns Hopkins Center for Injury Research and Prevention (Table 5).⁵⁵ In setting injury prevention and other public health prevention priorities, a primary criterion is scientific evidence that effective interventions

Table 5. Suggested priority-setting criteria for military research

A. Program or policy is consistent with mission of the working group/organization
B. Importance of problem to force health and readiness
Considerations:
1. Magnitude and severity of problem
2. High costs of problem
3. Size and/or vulnerability of population at risk
4. Degree of concern (command or public)
5. Gaps in knowledge of effective prevention strategies, or modifiable causes and risk factors exist
6. Military uniqueness
C. Potential value of research
Considerations:
1. Cross-cutting (cuts across types of injury)
2. Likelihood of identifying discrete modifiable risk factors
3. Demonstrated preventability in civilian population
D. Feasibility of research program or project
Considerations:
1. Public health and medical infrastructure exists to support research efforts
2. Research partners exist
3. Technologic feasibility of doing research (ability to collect data)
4. Adequacy of resources

exist. On the other hand, a primary criterion for setting research priorities is that adequate evidence of effective interventions does not exist. Thus, the most obvious evidence that research is needed is when a big problem is identified, but no research is found to support prevention. Insufficient evidence is also another indicator that research is needed, as multiple studies are typically required to establish the validity of a suggested prevention strategy. The most efficient way to set both prevention and research priorities may be to conduct both at the same time, because the process for identifying important, preventable injury or other health problems will be the same, and the criteria for setting priorities will be similar with the exception that there will be evidence to support interventions in the former and not for the latter.

Conclusion and Recommendations

The problem of injuries for the military is large enough and costly enough to warrant the time and resources needed to conduct a systematic, data-driven, and evidence-based process of defining prevention priorities. To effectively implement such a process, all the functional capabilities/steps of the public health approach listed in Table 1 are

necessary. While the infrastructure needed to address each step of the public health approach exists within the Department of Defense, it also needs to be strengthened. Currently, the strongest element of the U.S. military's injury prevention system is medical and safety surveillance. While improvements such as the addition of outpatient injury cause coding are needed, these data are currently adequate to identify significant military injury problems and to monitor changes in rates of injuries over time following implementation of interventions, programs, or policies.

In regard to getting prevention information to those who need it, the infrastructure for disseminating injury prevention information is readily available through the military service safety centers and chains of command. Likewise, once the effectiveness and feasibility of an injury prevention strategy has been demonstrated, the infrastructure and mechanisms exist within the military to rapidly implement the strategy.

The ability to evaluate programs and document success at the installation and service level has also been demonstrated,^{22,23,33} but human and fiscal resources for this essential public health service are currently limited. In addition, despite the fact that an evidence-based approach to making recommendations for injury prevention and setting priorities has been employed in the past, the process has not been institutionalized in the military.^{9,33}

Finally, the weakest step in the process for the Department of Defense is research. Even though injuries are the single biggest health problem of all of the military services, there is no specific injury-prevention scientific or technical objective to which resources can be routinely applied, with the exception of occasional monies directed to address ad hoc problems, such as traumatic brain injuries. Without an injury-research program guided by data-driven priorities and without identification of gaps in prevention knowledge, progress with military injury prevention will cease once off-the-shelf solutions have been exhausted.

With the above considerations in mind, the following recommendations are made to establish a comprehensive, evidence-based approach to military injury prevention:

- Use readily available military surveillance databases (deaths, disabilities, hospitalization, outpatient, and safety) to identify the largest and most severe military injury problems.^{4,19}
- Commission systematic reviews of prevention and safety literature to determine what has been shown to work for prevention of the largest, most serious military injury problems.

- Establish committees of medical and safety subject matter experts to routinely access and set priorities for both injury prevention research and program/policy implementation.
- Implement or adapt proven prevention strategies in a prioritized manner.
- Evaluate effectiveness of all implemented policies, programs, and interventions/countermeasures.
- For the largest, most serious injury problems, where information on effectiveness does not exist or is insufficient to make evidence-based recommendations, empanel subject matter experts to make best-practice recommendations.
- For the largest, most serious injury problems for which evidence for prevention does not exist or is inadequate, commission research.
- Establish routine channels for disseminating information from each of the steps of the public health and evidence-based decision-making processes to ensure that key stakeholders receive the information and training necessary to effectively reduce the impact of injuries on the health and readiness of military personnel.
- Work with partners in injury prevention (e.g., the CDC, CDC Injury Research Centers, NIH, Agency for Healthcare Research and Quality) to complete the systematic reviews and research needed to advance injury prevention.

In following these recommendations, the military services and Department of Defense have an opportunity not only to substantially reduce the incidence of injuries to service members, but also to establish a model for public health practice for military and civilian communities.

The papers that follow this introduction to the systematic evidence-based process of injury prevention illustrate: (1) how priorities can be set using military surveillance and research data; (2) how surveillance data can be used to define and monitor injury problems for the military; (3) how systematic reviews can be employed to provide military-relevant information on what works to prevent injuries; and (4) what have been some of the results of military injury-prevention program evaluations and research.

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References

1. Brundage JF, Johnson KE, Lange JL, Rubertone MV. Comparing the population health impacts of medical conditions using routinely collected health care utilization data: nature and sources of variability. *Mil Med* 2006;171(10):937–42.
2. U.S. Army Medical Surveillance Activity. Frequencies and characteristics of medical evacuations of soldiers by air (with emphasis on nonbattle injuries), Operations Enduring Freedom/Iraqi Freedom (OEF/OIF), January–November 2003. *Medical Surveillance Monthly Report* 2004;10(3):8–12.
3. U.S. Army Medical Surveillance Activity. Estimates of absolute and relative health care burdens attributable to various illnesses and injuries, U.S. Armed Forces, 2005. *Medical Surveillance Monthly Report* 2006;12(3):2–23.
4. Jones BH, Perrotta DM, Canham-Chervak ML, Nee MA, Brundage JF. Injuries in the military: a review and commentary focused on prevention. *Am J Prev Med* 2000;18(3S):S71–84.
5. Powell KE, Fingerhut LA, Branche CM, Perrotta DM. Deaths due to injury in the military. *Am J Prev Med* 2000;18(3S):S26–32.
6. Smith GS, Dannenberg AL, Amoroso PJ. Hospitalization due to injuries in the military. Evaluation of current data and recommendations on their use for injury prevention. *Am J Prev Med* 2000;18(3S):S41–53.
7. Songer TJ, LaPorte RE. Disabilities due to injury in the military. *Am J Prev Med* 2000;18(3S):S33–40.
8. Rubertone MV, Brundage JF. The Defense Medical Surveillance System and the Department of Defense serum repository: glimpses of the future of public health surveillance. *Am J Public Health* 2002;92(12):1900–4.
9. Ruscio B, Smith J, Amoroso P, et al. DoD Military Injury Prevention Priorities Working Group: leading injuries, causes, and mitigation recommendations. Washington: Office of the Assistant Secretary of Defense for Health Affairs, Clinical and Program Policy, 2006. www.stormingmedia.us/75/7528/A752854.html.
10. Wortley WH, Feierstein G, Lillibridge A, Parli R, Mangus G, Seibert JF. Chapter 3. Fatal and nonfatal accidents/mishaps: safety center data. *Mil Med* 1999;164(8S):S1–88.
11. Knapik JJ, Darakjy S, Jones SB, et al. Injuries and physical fitness before and after deployment by the 10th Mountain Division to Afghanistan for Operation Enduring Freedom. Aberdeen Proving Ground MD: U.S. Army Center for Health Promotion and Preventive Medicine, 2007. Report No. 12-MA-05SD-07.
12. Knapik JJ, Jones SB, Darakjy S, et al. Injury rates and injury risk factors among U.S. Army wheel vehicle mechanics. *Mil Med* 2007;172(9):988–96.
13. Senior L, Bell NS, Yore MM, Amoroso PJ. Hospitalizations for fall-related injuries among active-duty Army soldiers, 1980–1998. *Work* 2002;18(2):161–70.
14. Lauder TD, Baker SP, Smith GS, Lincoln AE. Sports and physical training injury hospitalizations in the army. *Am J Prev Med* 2000;18(3S):S118–28.
15. Krull AR, Jones BH, Dellinger AM, Yore MM, Amoroso PJ. Motor vehicle fatalities among men in the U.S. Army from 1980 to 1997. *Mil Med* 2004;169(11):926–31.
16. Doll LS, Bonzo SE, Mercy JA, Sleet DA, eds. *Handbook of injury and violence prevention*. New York: Springer, 2007.

17. Maciosek MV, Coffield AB, McGinnis JM, et al. Methods for priority setting among clinical preventive services. *Am J Prev Med* 2001;21(1):10-9.
18. Maciosek MV, Edwards NM, Coffield AB, et al. Priorities among effective clinical preventive services: methods. *Am J Prev Med* 2006;31(1):90-6.
19. Jones BH, Amoroso PJ, Canham ML, Weyandt MB, Schmitt JB. Atlas of injuries in the U.S. Armed Forces. *Mil Med* 1999;164(8S):9-1 to 9-26.
20. Jones BH, Hansen BC. An Armed Forces Epidemiological Board evaluation of injuries in the military. *Am J Prev Med* 2000;18(3S):S14-25.
21. Sleet DA, Jones BH, Amoroso PH. Military injuries and public health. *Am J Prev Med* 2000;18(3):1-3.
22. Knapik J, Darakjy S, Scott SJ, et al. Evaluation of a standardized physical training program for basic combat training. *J Strength Cond Res* 2005;19(2):246-53.
23. Knapik JJ, Darakjy S, Swedler D, Amoroso P, Jones BH. Parachute ankle brace and extrinsic injury risk factors during parachuting. *Aviat Space Environ Med* 2008;79(4):408-15.
24. Fowler CJ. Injury prevention. In: McQuillan KA, Von Rueden K, Harstock R, Flynn MB, Whalen E, editors. *Trauma nursing: from resuscitation through rehabilitation*. 3rd ed. Philadelphia PA: W.B. Saunders, 2001.
25. Runyan CW. Using the Haddon matrix: introducing the third dimension. *Inj Prev* 1998;4(4):302-7.
26. Teutsch SM, Berger ML, Weinstein MC. Comparative effectiveness: asking the right questions, choosing the right method. *Health Aff (Millwood)* 2005;24(1):128-32.
27. Kohatsu ND, Melton RJ. A health department perspective on the Guide to Community Preventive Services. *Am J Prev Med* 2000;18(1S):S3-4.
28. McGinnis JM, Foege W. Guide to Community Preventive Services: harnessing the science. *Am J Prev Med* 2000;18(1S):S1-2.
29. Briss PA, Zaza S, Pappaioanou M, et al. Developing an evidence-based Guide to Community Preventive Services—methods. The Task Force on Community Preventive Services. *Am J Prev Med* 2000;18(1S):S35-43.
30. Zaza S, Lawrence RS, Mahan CS, et al. Scope and organization of the Guide to Community Preventive Services. The Task Force on Community Preventive Services. *Am J Prev Med* 2000;18(1S):S27-34.
31. Ebell MH, Siwek J, Weiss BD, et al. Strength of recommendation taxonomy (SORT): a patient-centered approach to grading evidence in the medical literature. *Am Fam Physician* 2004;69(3):548-56.
32. Harris RP, Helfand M, Woolf SH, et al. Current methods of the U.S. Preventive Services Task Force: a review of the process. *Am J Prev Med* 2001;20(3S):S21-35.
33. Jones BH, Bullock S, Canham-Chervak M. Military training task force white paper: a model process for setting military injury prevention priorities and making evidence-based recommendations for interventions. Washington: Defense Safety Oversight Council, Military Training Task Force, 2005.
34. Institute of Medicine Committee for the Study of the Future of Public Health. *The future of public health*. Washington: National Academy Press, 1988.
35. Bonnie RJ, Fulco CE, Liverman CT, eds. *Reducing the burden of injury: advancing prevention and treatment*. Washington: National Academy Press, 1999.
36. Holder Y, Peden M, Krug E, Lund J, Gururaj G, Kobusingye O, eds. *Injury surveillance guidelines*. Geneva: World Health Organization, 2001.
37. Gross CP, Anderson GF, Powe NR. The relation between funding by the National Institutes of Health and the burden of disease. *N Engl J Med* 1999;340(24):1881-7.
38. *Injury prevention: meeting the challenge*. The National Committee for Injury Prevention and Control. *Am J Prev Med* 1989;5(3S):S1-303.
39. Barton MB, Miller T, Wolff T, et al. How to read the new recommendation statement: methods update from the U.S. Preventive Services Task Force. *Ann Intern Med* 2007;147(2):123-7.
40. Guirguis-Blake J, Calonge N, Miller T, Siu A, Teutsch S, Whitlock E. Current processes of the U.S. Preventive Services Task Force: refining evidence-based recommendation development. *Ann Intern Med* 2007;147(2):117-22.
41. Claxton K, Cohen JT, Neumann PJ. When is evidence sufficient? *Health Aff (Millwood)* 2005;24(1):93-101.
42. Helfand M. Using evidence reports: progress and challenges in evidence-based decision making. *Health Aff (Millwood)* 2005;24(1):123-7.
43. Zaza S, Carande-Kulis VG, Sleet DA, et al. Methods for conducting reviews of the evidence of effectiveness and economic efficiency of interventions to reduce injuries to motor vehicle occupants. *Am J Prev Med* 2001;21(45):23-30.
44. Rosenstock L, Thacker SB. Toward a safe workplace: the role of systematic reviews. *Am J Prev Med* 2000;18(4S):S4-5.
45. Wagenaar AC. Importance of systematic reviews and meta-analyses for research and practice. *Am J Prev Med* 1999;16(1S):S9-11.
46. Atkins D, Siegel J, Slutsky J. Making policy when the evidence is in dispute. *Health Aff (Millwood)* 2005;24(1):102-13.
47. Mercer SL, DeVinney BJ, Fine LJ, Green LW, Dougherty D. Study designs for effectiveness and translation research: identifying trade-offs. *Am J Prev Med* 2007;33(2):139-154.
48. Sanson-Fisher RW, Bonevski B, Green LW, D'Este C. Limitations of the randomized controlled trial in evaluating population-based health interventions. *Am J Prev Med* 2007;33(2):155-61.
49. Mulder S, Meerding WJ, Van Beeck EF. Setting priorities in injury prevention: the application of an incidence-based cost model. *Inj Prev* 2002;8(1):74-8.
50. Vilnius D, Dandoy S. A priority rating system for public health programs. *Public Health Rep* 1990;105(5):463-70.
51. Rafferty M. Prevention services in primary care: taking time, setting priorities. *West J Med* 1998;169(5):269-75.
52. Rivara FP, Johansen JM, Thompson DC. Research on injury prevention: topics for systematic review. *Inj Prev* 2002;8(2):161-4.
53. Haider AH, Risucci DA, Omer SB, et al. Injury prevention priority score: a new method for trauma centers to prioritize injury prevention initiatives. *J Am Coll Surg* 2004;198(6):906-13.
54. Pickett G, Hanlon JJ. *Public health administration and practice*. St. Louis: Times Mirror/Mosby College Publishing, 1990.
55. Canham-Chervak M, Jones BH, Lee RB, Baker SP. Focusing injury prevention efforts: using criteria to set objective priorities. American Public Health Association Annual Meeting. Philadelphia PA; 2005.
56. Mercy JA, Rosenberg ML, Powell KE, Broome CV, Roper WL. Public health policy for preventing violence. *Health Affairs* 1993;12(4):7-29.