Logistics Management Institute

Cost Estimating Model for Army Materiel Health Hazards
Supporting Documentation

CE416T3

October 1998

Gary M. Bratt
James J. Evenden
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LMI®

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Preface

The Logistics Management Institute (LMI) developed a model to estimate the costs associated with the failure to abate or control health hazards in Army materiel systems. A March 1997 LMI report, *Estimating Costs for Health Hazards of Army Materiel*, Report AR515R1, described the model. Health hazard assessors are using the cost model to estimate the potential costs incurred if materiel program managers fail to implement the recommendations for abatement and control of identified health hazards.

This report provides documentation of the process, data elements, and data sources used to develop the cost model includes

- an overview of the cost estimating process,
- the documentation necessary to understand the selection or development of each data element,
- the sources of data used to provide input to the model, and
- the equations used to estimate each cost.

This documentation will provide medical assessors and others involved in the risk management process a starting point for

- understanding our cost estimating process,
- understanding our data elements and their sources, and
- suggesting improvements and revisions of the cost model data elements.

Chapter 1
Introduction

PURPOSE OF THIS REPORT

This report provides supporting documentation for the cost estimating model for Army materiel health hazards, including

- an overview of the cost estimating process,
- an explanation of the selection or development of each data element,
- the sources of data used to provide input to the model, and
- the equations used to estimate each cost.

It also provides background information critical to understanding the Army Health Hazard Assessment Program.

ARMY HEALTH HAZARD ASSESSMENT PROGRAM

Organization and Personnel

The Army Health Hazard Assessment Program is a medical program established in Army Regulation (AR) 40-10.[1] The goal of the program is to identify, assess, and eliminate or control hazards associated with weapon systems, munitions, equipment, clothing, training devices, materiel systems, and information systems.

Health hazards are inherent in all U.S. Army materiel. If ignored, these hazards can cause serious injuries and illnesses throughout a materiel system's life cycle. The costs for treating such injuries and illnesses pose a significant financial burden on military and veteran health care systems, and the resulting lost time degrades productivity and unit readiness.

For these reasons, health hazard personnel conduct assessments of new or improved materiel. The assessments currently evaluate

- the types of hazards that exist,

[1] Headquarters, Department of the Army, Army Regulation 40-10, Health Hazard Assessment Program in Support of the Army Materiel Acquisition Decision Process, 1991.

- the injuries or illnesses likely to result from the hazards,
- the level of risk for each hazard, and
- the corrective actions needed to eliminate or abate the hazard.

They report this information to the materiel program managers, who are responsible for the development and life-cycle management of the materiel system.

Teams of medical subject matter experts perform the health hazard assessments. The Health Hazard Assessment Program Office at the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) centrally executes the program. Preventive medicine professionals assigned to installations, regional medical commands, major subordinate commands, and the Army staff provide support to the process throughout the Army.

Medical assessors perform health hazard assessments in all phases of the acquisition process. Hazards eliminated or controlled early in the process will require less attention later in the life cycle and save money. Ideally, assessors address health hazards at the concept stage and manage them throughout the acquisition process. The goal is to resolve all of the health hazard issues during the program definition and risk reduction phase. The assessment process is an integral part of manpower and personnel integration (MANPRINT) assessments and is closely tied to system safety issues. The Army addresses health hazard issues at each of the milestone reviews in the acquisition process. The system program manager or other acquisition approval authority makes tradeoffs between the costs and benefits of health hazard elimination or control.

Hazard Categories

The most common health hazards encountered involve chemical or biological substances, acoustic or radiation energy, temperature extremes, oxygen deficiency, vibration, trauma, and shock.

AR 40-10 provides further descriptions:

- *Chemical substances.* Chemical substances become a concern when their concentration level exceeds acceptable limits and adverse health effects occur. In military systems, combustion products are good examples of complex chemical substances that produce adverse health effects. Exposure to many chemical substances can cause illness, injury, and performance degradation.
- *Acoustic energy.* These hazards include continuous noise from engines and helicopter rotors, impulse noise from shoulder-fired weapons, and blast overpressure created by firing mortars, towed artillery (free-field energy

wave), and heavy weapons on crew-served vehicles (complex energy wave). Exposure to these hazards can lead to hearing loss, lung injury, and performance degradation.

- *Temperature extremes.* These hazards include the health effects of high or low temperatures that can worsen when using a materiel system, including heat and cold stress. The hazards can lead to injury, illness, and performance degradation.

- *Radiation energy.* These hazards include ionizing and nonionizing radiation. Ionizing radiation can cause ionization when interacting with living or inanimate matter. Ionizing radiation hazards include alpha and beta particles, gamma rays, x-rays, and neutrons. Nonionizing radiation refers to emissions from the electromagnetic spectrum that have insufficient energy to produce ionization of molecules. Nonionizing radiation hazards include ultraviolet, visible, and infrared light and radio frequencies, including microwaves. Lasers emit amplified electromagnetic radiation within the nonionizing spectrum. These hazards can result in illness, injury, and performance degradation.

- *Oxygen deficiency.* This hazard, resulting from oxygen displacement in crew or confined spaces, can result in shortness of breath and impaired coordination and judgment, with progression to unconsciousness and death.

- *Vibration (whole body and segmental vibration).* These hazards result from contact between the human body and a mechanically oscillating surface. They can result from riding in or driving vehicles, equipment, and aircraft and operating some hand-operated tools. The hazards can cause musculoskeletal injury and cumulative trauma disorder, resulting in performance degradation.

- *Trauma (blunt, sharp, or musculoskeletal).* These hazards occur because of sharp or blunt object impact to the eyes or body surface, or because of musculoskeletal injury resulting from lifting heavy objects such as projectiles or ammunition boxes. These hazards can result in severe injury and degradation of performance.

- *Biological substances.* These substances can result from lack of sanitation in ventilation systems, water, human waste disposal, food handling, and personal hygiene. The hazards, which include exposure to microorganisms, toxins, and enzymes, can result in illness and degradation of individual and unit performance.

- *Shock hazards.* These are a result of the delivery of a mechanical impulse or impact to an individual. This often results from contact with a medium that is accelerating or decelerating. Examples include the opening forces of a parachute harness and those delivered to the body as the result of weapon recoil. Shock hazards can result in severe injury and performance degradation.

Quantifying Health Risk

Risk per se is a probability statement. As explained in the following, however, the term *health risk* combines the probability of exposure to a hazard and the severity of the potential consequences.

The Army assesses health risk with a risk assessment code (RAC) as illustrated in Table 1-1. The first step is to estimate the hazard severity (HS)—the severity of the medical effects caused by exposure to a hazard. The next step is to estimate the hazard probability (HP), the probability of an operator being exposed to the hazard. The matrix cell where the values for HS and HP intersect shows the appropriate RAC.

Table 1-1. Risk Assessment Code Matrix

	Hazard probability				
Hazard severity	A	B	C	D	E
I. Catastrophic	1	1	1	2	3
II. Critical	1	1	2	3	4
III. Marginal	2	3	3	4	5
IV. Negligible	3	5	5	5	5

Source: Army Regulation 40-10, Health Hazard Assessment Program in Support of the Army Material Acquisition Decision Process, 1 October 1991.

The four HS categories are

- Category I—catastrophic,
- Category II—critical,
- Category III—marginal, and
- Category IV—negligible.

The five HP levels are

- A—frequent,
- B—probable,
- C—occasional,

- D—remote, and
- E—improbable.

The resulting RAC may range from 1 (a very high health risk) to 5 (a very low health risk). For example, a hazard of marginal severity (HS = III) with an exposure assessed as probable (HP = B) has a moderate overall risk (RAC = 3). The glossary appended to this report defines the HS and HP categories, as well as other important terms.

There are often instances when it is not possible to eliminate a health hazard, or even provide some hazard reduction by appropriate controls. Even with a controlled hazard there remains some health risk. This *residual* risk is the risk that remains after controlling a health hazard. Residual risk is the probability or likelihood of injury resulting from exposure to the hazard once all recommendations to eliminate or minimize a hazard have been implemented. If a hazard remains, this residual risk lasts for the life of the system. You can determine avoided costs by subtracting the assigned residual hazard risk dollars from the assigned unabated hazard risk dollars.

Providing Program Managers with Risk Estimates and Costs

Health hazard assessment reports provide the materiel system program managers with recommendations for elimination and control of health hazards identified in the systems. The program manager then makes tradeoff decisions on elimination of health hazards. Since the development of the cost model, an estimate of the medical costs associated with failure to abate or adequately control the hazards accompanies all recommendations. This cost information, coupled with the traditional information provided by the RAC, gives the program manager much better information for making tradeoff decisions.

Using the results of the model will increase the effectiveness of the risk management process. Quantifying health hazard costs improves the program manager's understanding of the life-cycle economic impact of not implementing health hazard assessment recommendations. The model's lost time component identifies personnel time away from the job, an output directly relating to unit readiness and productivity.

Cost Estimating Model

Development

We developed the model—which quantifies the costs that prevention avoids—specifically to assist the U.S. Army in estimating materiel system health hazard costs. We based the model on the probability of a hazard occurring and the severity of that hazard. The model outputs provide an understanding of a stated health risk and the likely monetary impact if no preventive or corrective actions occur.

Uses

The primary use for the model is to estimate a total system medical cost. The materiel program manager can use this information to establish priorities for health hazard abatement prior to fielding a system and to assess the impact on military readiness once it is fielded.

The individual outputs are useful for understanding the details of the medical cost expenditures caused by exposure to a health hazard. For example, some of the outputs may show a direct relation to military readiness. Injuries or illness resulting from exposure to the hazards associated with a system may result in extensive lost time on the job by affected soldiers. This statistic is critical from a military readiness perspective. Soldiers away from the job decrease the readiness of their units. Additionally, extensive lost time may require the unprogrammed acquisition and training of replacement personnel.

Additionally, the model can generate numerous other outputs showing the results of illness or injury due to hazard exposure. Physicians, environmental engineers, environmental scientists, and other health care personnel can use these outputs to assess the strengths and weaknesses of preventive health care. Selected component outputs of the model include estimates of the number of

- clinic visits,
- persons injured or ill,
- persons hospitalized,
- hospital days,
- persons losing time on the job,
- lost workdays,
- persons disabled,
- rehabilitation cases, and
- deaths.

Preventive Medicine Applications

We developed the model for estimating the medical costs of health hazards associated with Army materiel. However, other areas of preventive medicine may benefit from its use. The model estimates total medical costs based on the determination of a health risk. If we can determine a health risk, then we can make a medical cost estimate. Health risk determination is an important measure in other areas of preventive medicine. The following are a few examples of model applications:

- Industrial hygienists and occupational health personnel can use the model to estimate medical costs for hazards associated with industrial production line operations.
- Environmental engineers and health risk assessors can use the model to estimate medical costs for hazards associated with the cleanup of hazardous waste sites. They can also use the model to assess other health hazards from environmental pollution.
- Preventive medicine physicians, environmental science officers, sanitary engineers, and community health nurses can use the model to estimate medical costs for environmental hazards found on the battlefield.

Additionally, the selected outputs are measures of effectiveness for prevention programs. The reason for all prevention programs is the reduction of illnesses and injuries, hospitalization, lost time, disabilities, and deaths.

Benefits

Quantifying the costs of health hazards by using the model

- improves the understanding of a stated health risk,
- assists managers in making informed risk decisions,
- better justifies implementation of recommendations to eliminate or control hazards,
- provides several measures of effectiveness for prevention programs, and
- quantifies the value added in reports containing recommendations with RACs.

Cost Components

The six cost components (Figure 1-1) estimate various types of medical costs associated with exposures to hazards that result in illness or injury. The following are brief descriptions of each component:

- *Clinic costs.* Costs attributed to outpatient visits to a medical clinic or medical treatment facility by persons exposed to a hazard that resulted in illness or injury.[2]
- *Hospitalization costs.* Costs attributed to inpatient hospital stays by persons exposed to a hazard that resulted in illness or injury.[3,4]
- *Lost time costs.* Costs attributed to time away from the job by persons exposed to a hazard that resulted in illness or injury.[5]
- *Disability costs.* Costs attributed to active-duty temporary and permanent disability compensation and U.S. Department of Veterans Affairs (VA) disability compensation by persons exposed to a hazard that resulted in illness or injury.[6,7,8]

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[2] "Medical and Dental Reimbursement Rates for Fiscal Year 1996," *Federal Register,* Volume 60, Number 195, 10 October 1996, pp. 52,655–52,659.

[3] "CHAMPUS DRG Weights for Fiscal Year 1996," Table 2, CHAMPUS Weights and Threshold Summary, *Federal Register,* Volume 60, Number 207, 26 October 1995, pp. 54,851–54,862.

[4] Walter Reed Army Medical Center (WRAMC), Third Party Collection Program, Memorandum to Gary M. Bratt, Logistics Management Institute, *Determining Cost of WRAMC Care,* Washington, DC, 4 December 1995.

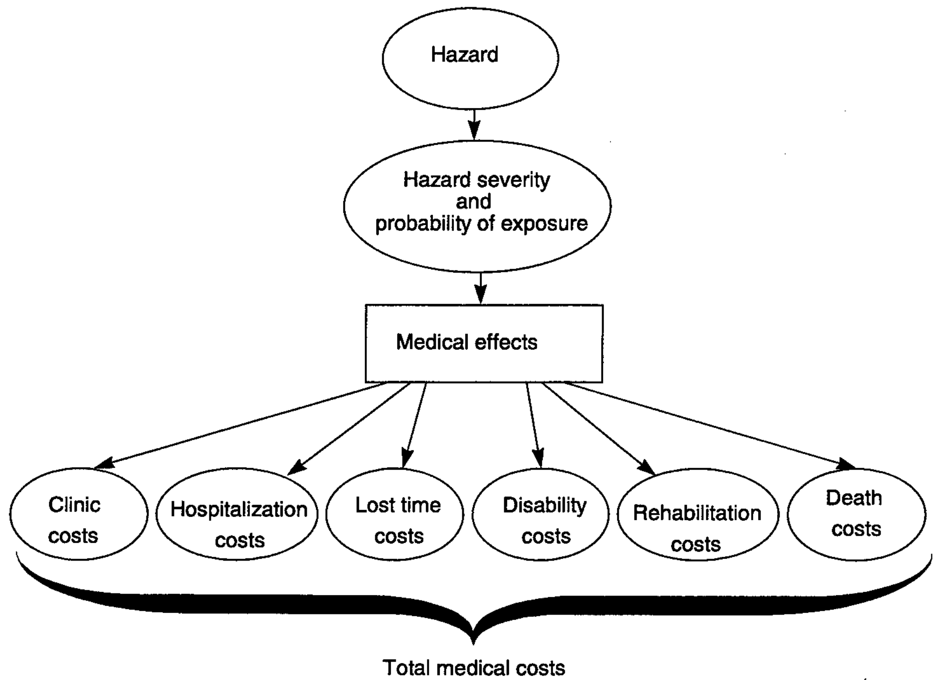
[5] "The 1996 Army Times Pay Chart," *U.S. Army Times,* 20 November 1995.

[6] COL Bruce Jones, MD, and Barbara Hansen, Ph.D., et al., "Injuries in the Military: A Hidden Epidemic," unpublished, a report for the Armed Forces Epidemiological Board, Injury Prevention and Control Work Group, November 1996.

[7] U.S. Department of Veterans Affairs, *Veterans Benefits, Fast Fact 1, Disability Compensation,* Washington, DC, 1994.

[8] U.S. Department of Veterans Affairs, *Federal Benefits for Veterans and Dependents,* Washington, DC, 1994.

Figure 1-1. The Basic Framework for Estimating Medical Costs for a Single Hazard



- *Rehabilitation costs.* Costs attributed to rehabilitation benefits received by eligible persons drawing VA disability compensation as a result of exposure to a hazard that resulted in illness or injury.[9,10]

- *Death costs.* Costs attributed to payment of insurance proceeds and the cost of casualty assistance, honor guard, burial, family, and other expenses. This is as a result of the death of persons exposed to a hazard that resulted in illness or injury complications.

We present the basic model in equation form as follows:

Hazard costs/year = clinic costs/year + hospitalization costs/year + lost time costs/year + disability costs/year + rehabilitation costs/year + death costs/year.

REPORT ORGANIZATION

We organized this report into 11 chapters:

- Chapter 1, an introduction

[9] See Note 8, this chapter.

[10] U.S. Department of Veterans Affairs, *Veterans Benefits, Fast Fact 5, Vocational Rehabilitation (Chapter 31),* Washington, DC, 1994.

- Chapter 2, an overview of the cost estimating process
- Chapter 3, which explains, in detail, the basic approach for developing the data elements
- Chapters 4 through 9, which cover the six cost components
- Chapter 10, which provides a cost estimating example
- Chapter 11, the conclusion.

We included 19 appendices that contain the data and calculations used in estimating costs:

- Appendix A, assigning risk assessment codes,
- Appendix B through D, agency illness and injury categories related to the health hazards,
- Appendix E, clinic services relating to potential hazard exposures,
- Appendix F, health hazards and related diagnostic related groups (DRG),
- Appendix G, through I, incidence rates and factor calculations,
- Appendix J through L, population case distribution and distribution factors,
- Appendix M through R, various fee and compensation factors, and compensation calculations, and
- Appendix S, various cost avoidance breakdown reports.

The six chapters dedicated to the cost equations each address the following:

- Defining the equations to estimate costs
- Defining each data element and its data objective
- Describing the data sources for each data element
- Discussing data element derivation
- Describing data element location in the cost calculator
- Discussing other useful component related information
- Performing an example calculation.

Chapter 2
Overview of the Cost Estimating Process

INTRODUCTION

One of the keys to reducing health hazards in an Army materiel system is to clearly demonstrate the costs avoided throughout the system's life cycle by eliminating or mitigating hazards. This cost model estimates those avoidable costs, focusing on the medical cost factors that contribute to them.

The type of hazard encountered and the level of risk drive the magnitude of each of these cost components. This chapter briefly explains the integration of the risk estimate into each of the cost components.

MEASURING RISK

Risk Assessment

As stated in Chapter 1, the term *health risk* combines the severity of the potential consequences and probability of exposure associated with a hazard. The Army Health Hazard Assessment Program uses the RAC matrix (Table 2-1) and the process contained in Appendix A for arriving at a RAC.

Table 2-1. RAC Matrix with HS and HP Values

Hazard severity		Hazard probability				
		Frequent A (0.9)	Probable B (0.5)	Occasional C (0.2)	Remote D (0.01)	Improbable E (0.001)
I (1)	Catastrophic	1	1	1	2	3
II (0.1)	Critical	1	1	2	3	4
III (0.01)	Marginal	2	3	3	4	5
IV (0.001)	Negligible	3	5	5	5	5

Before assigning risk to a particular operation, assessors first determine the potential hazards operators face. Next, they assign a relative level of risk for each hazard. They follow the procedure in Appendix A and sum the risk scores for HS and HP. The total risk score determines the RAC. As previously stated, HS is a relative score of the severity of the medical effects caused by exposure to the hazard, and the second component, HP, is an assessment of the likelihood of exposure.

The RAC resulting from the combination of these two components can range from 1 (a very high health risk) to 5 (a very low health risk). For example (see Table 2-1), a hazard of marginal severity (HS = III) with a probable exposure (HP = B) has a moderate overall risk (RAC = 3). This value is not of particular importance to our model. What is important are the two components of this RAC score, HS and HP.

Quantifying Hazard Severity and Probability

In order to quantify these probabilities as cost drivers in our model, we developed a value for each severity and probability category. We based these on the subjective interpretation of the written category descriptions in associated Army regulations.[1] We validated these values using fully qualified, experienced, practicing health hazard assessment experts from USACHPPM. We present these values (Table 2-1) in parentheses.

SELECTION OF COMPONENTS

- We developed the framework (Figure 1-1) for determining costs based on six cost components associated with exposures to hazards that result in illness, injury, or death. As stated in Chapter 1, these components are clinic, hospitalization, lost time, disability, rehabilitation, and death costs.

We selected these components to measure the potential outcomes to operator personnel as a result of an injury or illness. Although there are many system scenarios, only six basic events can occur when a soldier becomes ill or injured:

- A visit to a medical clinic for basic outpatient treatment, medication, and tests
- A visit to a hospital for inpatient observation, emergency or definitive treatment, and more detailed tests
- Loss of time away from the job due to clinic and hospital appointments, hospitalization, assignment to quarters, and inability to perform on the job as a result of illness or injury
- Disability, either immediately while on active duty or after discharge or retirement at a later date
- Rehabilitation because of disability
- Death as a result of exposure severity or complications.

[1] See Notes 1 and 3, Chapter 1.

We used industry-wide incidence rates, distribution factors, and other rates for injury, hospitalization, lost time, disability, rehabilitation, and death to

- quantify health hazard component costs and
- estimate total hazard costs per year associated with exposures to hazards that result in illness, injury, or death.

We expressed the model in equation form as follows:

Hazard costs/year = clinic costs/year + hospitalization costs/year + lost time costs/year + disability costs/year + rehabilitation costs/year + death costs/year.

INTEGRATING THE RAC AND COSTS

With the framework established we had to

- estimate costs and
- relate a RAC identified with a specific HS and HP to costs.

We developed equations (Table 2-2) for estimating costs that incorporated HS and HP values for the specific RAC assigned. Each cell within the RAC matrix has a specific HS and HP value. With these HS and HP values plugged into the equations in Table 2-2, we can calculate each of the six cost components. These six components are then added to provide a total cost. These costs provide additional information (Table 2-3) to better describe a stated health risk and its likely military readiness and monetary impact if no preventive or corrective actions occur. (We define and explain the data elements in Chapter 3.)

ASSUMPTIONS

We made two primary assumptions:

- We could estimate the incidence rates—the rate of injury or illness in a group over a period of time—based on historical industry wide data.
- A medical assessor conducted the risk assessment properly.

We developed incidence rates from comparable industry wide data, because not all the required data were available or accessible via military sources. Fully qualified, experienced health hazard assessors determined the RACs used in this report. The assignment of a RAC with its associated HS and HP is the critical element in the cost model.

Table 2-2. Cost Component Equations

Related cost component	Component calculation	Equation
All (except death costs)	Number of people exposed to hazard	$N_e = P_e \times N_s \times N_{ps}$
Clinic costs	Number of people injured or ill	$N_i = P_e \times N_s \times N_{ps} \times S_k \times I_i$
Clinic costs	Clinic costs	$C_c = P_e \times N_s \times N_{ps} \times S_k \times [V_e = (I_i \times N_c)] \times F_c$ *or* $C_c = N_v \times F_c$
Clinic costs	Number of clinic visits	$N_v = P_e \times N_s \times N_{ps} \times S_k \times [V_e + (I_i \times N_c)]$
Hospitalization costs	Hospitalization costs	$C_h = P_e \times N_s \times N_{ps} \times S_k \times I_h \times [\Sigma(D_{hd} \times D_{ho})] \times F_h$ *or* $C_h = N_h \times F_c$
Hospitalization costs	Number of persons hospitalized	$N_{ph} = N_e \times S_k \times l_h$
Hospitalization costs	Number of hospital days	$N_p = N_e \times S_k \times I_h \times (D_{hd} \times D_{ho})$
Lost time costs	Lost time costs	$C_l = P_e \times N_s \times N_{ps} \times S_k \times I_l \times [\Sigma(D_{ld} \times D_{lt})] \times W_d \times B_f$ *or* $C_l = N_l \times W_d \times B_f$
Lost time costs	Number of persons losing time	$N_{pl} = N_e \times S_k \times I_l$
Lost time costs	Number of lost workdays	$N_l = N_e \times S_k \times I_l \times (D_{ld} \times D_{lt})$
Disability costs	Disability costs	$C_{di} = P_e \times N_s \times N_{ps} \times S_k \times$ $\{[I_v \times T_v \times \Sigma(D_v \times B_v) \times 12\ months/year] + [(I_t \times B_t) + (I_p \times B_p)]\}$
Disability costs	Number of persons disabled	$N_{pd} = N_e \times S_k \times [(T_v \times I_v) + (I_t + I_p)]$
Rehabilitation costs	Rehabilitation costs	$C_r = P_e \times N_s \times N_{ps} \times S_k \times I_v \times T_v \times \sum D_r \times Q_r \times B_r$
Rehabilitation costs	Number of rehabilitation cases	$N_r = N_e \times S_k \times I_v \times T_v \times \sum D_r \times Q_r$
Death costs	Death costs	$C_{de} = N_{de} \times B_{de}$

Table 2-3. RAC Matrix with Values and Costs ($000)

Hazard severity		Hazard probability				
		Frequent A (0.9)	Probable B (0.5)	Occasional C (0.2)	Remote D (0.01)	Improbable E (0.001)
I (1)	Catastrophic	1 ($15,088)	1 ($8,471)	1 ($3,508)	2 ($365)	3 ($216)
II (0.1)	Critical	1 ($1,410)	1 ($783)	2 ($313)	3 ($16)	4 ($1)
III (0.01)	Marginal	2 ($137)	3 ($76)	3 ($30)	4 ($2)	5 ($0.152)
IV (0.001)	Negligible	3 ($13)	5 ($7)	5 ($3)	5 ($0.148)	5 ($0.015)

LIMITATIONS OF THE MODEL

There are some limitations to our model:

- We do not include pollution prevention costs avoided in the estimate of medical costs. We consider only potential dollar costs avoided for medical and lost time costs related to the illness or injury caused by exposure to the hazard.
- We do not subtract out the abatement costs of the health hazard assessment recommendations. These costs depend on the type of recommendation made, the degree of reduction of the health hazard, and the life-cycle phase. Costs may include publication or labeling, protective equipment, production process changes, engineering design, operation and maintenance, retrofitting, and disposal.
- We do not incorporate the costs to acquire and train replacements for personnel injured, ill, or killed. We also do not incorporate the costs of degraded performance or the nonmonetary effect on readiness. We did not incorporate the costs related to the impact on family quality of life. These costs could be substantial. We recognize that costs may vary, and the system program manager is in the best position to make an assessment of the impact of these extra costs.

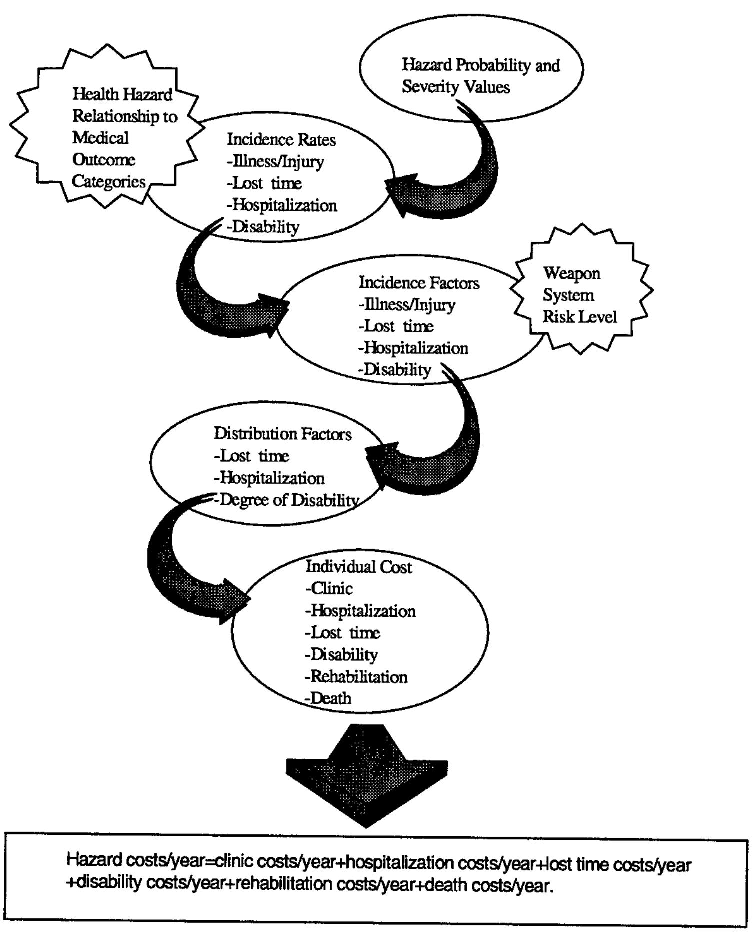
Incorporation of health hazard assessment recommendations during system design minimizes pollution prevention, hazard abatement, and other implementation costs compared to system procurement costs.

SUMMARY

In this chapter, we described an overview of the cost estimating process. In Chapter 3, we will present our approach for developing the data elements for estimating the costs avoided for Army materiel health hazards. We depict the various data elements considered in our overall process for estimating costs in Figure 2-1. The data elements considered include

- hazard severity and probability,
- incidence rates based on the health hazard relationship to medical outcome categories,
- incidence factors based on the incidence rates and system risk factor,
- population distribution factors, and
- component cost factors.

Figure 2-1. Data Elements Considered in Overall Process for Determining Costs



Chapter 3
Developing the Data Elements

HP and HS Data Elements

These two data elements, derived from the RAC matrix (Table 1-1), are the key drivers in the model. The resultant risk is highest in the upper left corner of the matrix and lowest in the lower right corner of the matrix. Assessors present HP and HS data for individual weapon system health hazards in the health hazard assessment reports.

As previously discussed, the problem with the probability and severity data is that it is descriptive rather than numerical. We could not use descriptions in our cost model (e.g., frequent, catastrophic, occasional, critical), so we developed numerical values for these categories.

Quantifying the Probability (P_e)

HP refers to the likelihood that a hazard will occur. It reflects the duration of exposure and the number of exposed personnel.

Our first step was to convert the qualitative statements that describe HP to numerical values for use in the cost model. We did this by convening a panel of occupational health experts and developing numerical values that quantified the probability description. We validated the numerical values developed by the panel of experts using USACHPPM practicing health hazard assessment experts. These experts used the values in assigning HP categories identified in materiel systems. The development of "true" HP values is an area that is worthy of further study. Table 3-1 presents the numerical probability factors (P_e) we developed.

Table 3-1. Probability of Exposure to Hazard (P_e)

Hazard probability (P_e)				
A. Frequent	B. Probable	C. Occasional	D. Remote	E. Improbable
0.900	0.500	0.200	0.010	0.001

Note: Occurrences are based on an estimate for a year. The values presented are a consensus of the opinions of internal and external expert panels in industrial hygiene and health hazard assessments.

Quantifying the Severity *(S_k)*

HS is an assessment of the potential health consequence. It addresses degree of bodily injury, illness, performance degradation, or bodily system damage that could occur. It reflects the magnitude of exposure to a hazard and the medical effects of the exposure.

We used the same process to develop the numerical HS values that we used in developing the numerical probability values. A panel of internal LMI occupational health experts developed the initial values. We validated these values with health hazard assessors at the USACHPPM. We assumed the relationship between severity categories to be logarithmic; however, this is an area requiring future study. Table 3-2 presents the HS factors *(S_k)* we developed.

Table 3-2. Hazard Severity Factor (S_k)

Severity category	Factor (S_k)
Catastrophic (I)	1.000
Critical (II)	0.1
Marginal (III)	0.01
Negligible (IV)	0.001

Note: The values presented are a consensus of the opinions of internal and external expert panels in industrial hygiene and health hazard assessment.

Use in the Model

We can now input numerical values into the model for the

- probability of a hazard exposure occurring and
- severity of the hazard.

Calculated costs will vary for a given health hazard depending on its assigned HP and HS. This results in a logical gradation of costs depending on the HP and HS.

IDENTIFYING DATA SOURCES

We needed to establish potential medical outcomes (disease or diagnosis) for each of the health hazards identified. The medical outcomes then drive the clinic, hospitalization, lost time, and disability cost components. In this section, we discuss our data sources.

Illness and Injury Data

The primary sources we used to obtain illness and injury related data were the:

- USACHPPM Army *Medical Surveillance Monthly Report* hospitalization data,[1,2,3,4,5]
- U.S. Department of Labor (DOL), Bureau of Labor Statistics lost time data,[6,7,8,9] and
- VA disability data.[10,11,12,13,14]

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[1] U.S. Army Center for Health Promotion and Preventive Medicine, "Table S1, Active Duty Hospitalizations, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report*, Aberdeen Proving Ground, MD, April 1995.

[2] U.S. Army Center for Health Promotion and Preventive Medicine, "Table S2, Active Duty Hospitalization Rates, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report*, Aberdeen Proving Ground, MD, April 1995.

[3] U.S. Army Center for Health Promotion and Preventive Medicine, "Table S3, Total Active Duty Hospital Sickdays, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report*, Aberdeen Proving Ground, MD, April 1995.

[4] U.S. Army Center for Health Promotion and Preventive Medicine, "Table S4, Non-Effective Rates, Active Duty Hospitalization, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report*, Aberdeen Proving Ground, MD, April 1995.

[5] U.S. Army Center for Health Promotion and Preventive Medicine, Memorandum to Gary M. Bratt, Logistics Management Institute, *Active Duty Army Hospitalizations 1994*, Aberdeen Proving Ground, MD, 1994.

[6] U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1993*, Washington, DC, December 1994.

[7] U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1992*, "Table 23, Percent Distribution of Nonfatal Occupational Injuries and Illnesses Involving Days Away from Work by Source of Injury or Illness and Number of Days Away from Work, 1992," Washington, DC, December 1993.

[8] U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1992*, "Table 24, Percent Distribution of Nonfatal Occupational Injuries and Illnesses Involving Days Away from Work by Event or Exposure Leading to Injury or Illness and Number of Days Away from Work, 1992," Washington, DC, December 1993.

[9] U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1992*, Table 21, Percent Distribution of Nonfatal Occupational Injuries and Illnesses Involving Days Away from Work by Nature of Injury or Illness and Number of Days Away from Work, 1992, Washington, DC, December 1993.

[10] U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Grand Total Report as of March 1995*, Washington, DC, undated.

[11] U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Persian Gulf War Report as of March 1995*, Washington, DC, undated.

Army Hospitalization Data

We obtained hospitalization data from the USACHPPM *Army Medical Surveillance Monthly Report.*[15] It provides medical surveillance information of broad interest to the medical community. One of the areas of interest on which they routinely report is Army active duty hospitalization rates and hospital sick days by International Classification of Diseases (ICD)-9 categories.

The data are current and concerned with active duty military only. This was adequate for our work with *soldiers* operating weapon systems. The presentation of hospital sick days by age was not useful in our case; however, the USACHPPM provided us a breakout of ICD-9 category cases by length of stay (days) category, which was. This was comparable to the presentation of the DOL Bureau of Labor Statistics data. A disadvantage to the hospital sick day data was that it included bed days, convalescent sick days, and medical hold days. A recent hospitalization data by "bed day" breakout indicates that overlap is probably minimal.[16] The data categories did not directly link to health hazards, and they were not directly comparable to the disability or lost time data. However, this did not present insurmountable problems in addressing the costing methodology.

We selected illness and injury categories that linked to the nine health hazards. We used the rate data to develop the factor for incurring hospitalization. We used the hospital sick day data to develop a hospitalization length of stay distribution matrix.

DOL Lost Time Data

We obtained lost time data from the Bureau of Labor Statistics survey for occupational injuries and illnesses.[17] It contained historical data addressing incidence rates for occupational injuries and illnesses by standard industrial classification (SIC) code for industry divisions. It also contained the distribution

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[12] U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Specific Diagnosis, Major-Disability Compensation, Total Service Connected as of March 1995*, Washington, DC, undated.

[13] U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Numerical Index of Disabilities," 38 CFR, Chapter 1, Appendix B to Part 4, *Pensions, Bonuses and Veteran's Relief*, Washington, DC, July 1994.

[14] U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Alphabetical Index of Disabilities," 38 CFR, Chapter 1, Appendix C to Part 4, *Pensions, Bonuses and Veteran's Relief*, Washington, DC, July 1994.

[15] See Notes 1–5, this chapter.

[16] U.S. Army Center for Health Promotion and Preventive Medicine. Medical Surveillance Activity, Fax to Gary M. Bratt, Logistics Management Institute, Hospitalization Sick Day Tables, 21 July 1997.

[17] See Note 6, this chapter.

of lost time by nature of injury, body part affected, source of injury, and event or exposure leading to injury or illness.[18]

The data were current and concerned with days away from work as a result of an occupational illness or injury, which was adequate for this project. The data categories did not directly link to health hazards, and they were not directly comparable to the hospitalization or disability data. However, this did not present problems in addressing the costing methodology. We selected lost time categories by nature of injury or event leading to exposure that linked to the nine health hazards and the incidence rate data to develop the factor for incurring lost time. We used the lost time data to develop a lost time distribution matrix.

VA Disability Data

We obtained disability data from the VA National Center for Veteran Analysis and Statistics.[19] They were historical data addressing the degree of disability by case for given disability diagnoses.

The data were current and concerned with compensation of veterans' disabilities, which was adequate for this project. The data categories did not directly link to health hazards, and they were not directly comparable to the hospitalization or lost time data. However, this did not present problems in addressing the costing methodology.

We selected disability categories that linked to the nine health hazards. We used the data to develop the factor for incurring disability. We used the length of lost time data to develop a disability distribution matrix.

Data Source Comparisons

The medical outcome categories do not directly correlate with the medical effects expected with exposure to a health hazard. Additionally, the specific medical outcome categories are not directly comparable to each other. These shortcomings do not present a problem in determining medical costs.

From our research, it was apparent that—except for the DOL data (and it's not a perfect comparison)—there were no direct comparisons between a given hazard and the diagnostic categories. This is not unexpected. The Army hospitalization and VA disability data focus on medical surveillance and specific reporting based on medical diagnostic categories. The DOL lost time data focus on safety surveillance and nature of exposure or event. This is primarily because the medical diagnostic categories are common ones for the whole population, while the labor data are specific for occupational illness and injury.

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[18] See Notes 7–9, this chapter.

[19] See Notes 10–14, this chapter.

Clinic and Hospital Cost Data

To determine clinic and hospital costs, we linked medical outcomes to the clinic service types and the diagnostic related groups (DRGs). The primary sources of our data were the

- DoD medical and dental reimbursement rates[20] and
- DoD CHAMPUS DRG weights.[21]

DoD Medical and Dental Reimbursement Rates

We obtained clinic service information from the Federal Register. (OSD revises and publishes this information yearly.) It contained a listing of FY96 outpatient rates for various types of clinic services. We used the "other" category rates because they contained no subsidized costs.

We selected those clinic service types that linked to potential medical outcomes as a result of exposure to the nine health hazards.

DoD CHAMPUS Rates

We obtained DRG information from the Federal Register. (OSD revises and publishes this information yearly.) It contained a listing of FY96 CHAMPUS DRG weights as well as the arithmetic and geometric average lengths of stay for all CHAMPUS DRGs.

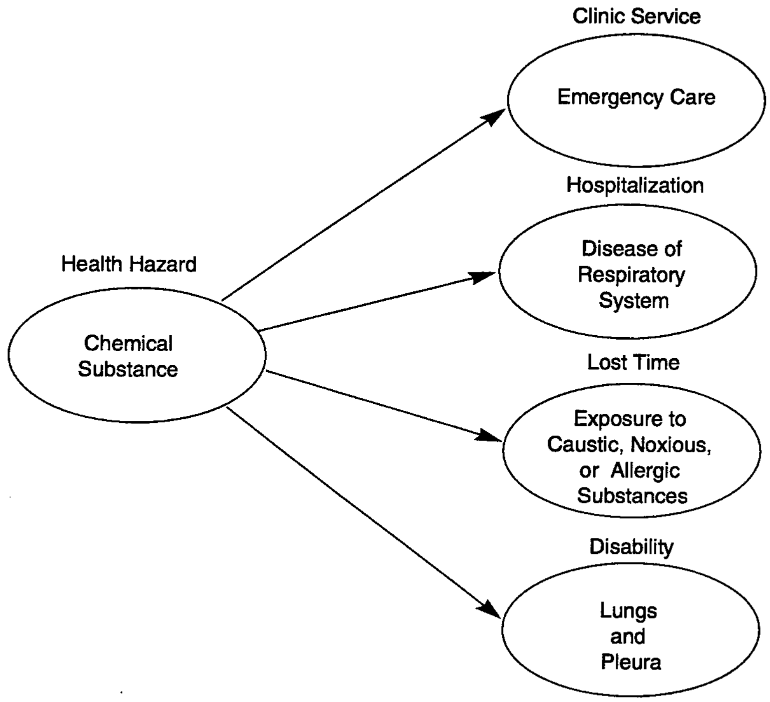
We selected those DRGs that linked to potential medical outcomes as a result of exposure to the nine health hazards. We used a weighting factor for a large hospital.

Building the Links Between Data Elements

The challenge was to link the nine health hazards to potential medical outcomes so we could estimate costs. We linked health hazards and their potential medical effects with medical outcome categories. In Figure 3-1, we portray a health hazard exposure to a chemical substance. We used the clinic service, hospitalization, lost time, and disability medical outcome categories. We obtained the types of clinic services from the Federal Register and the hospitalization, lost time, and disability data from the Army, DOL, and VA, respectively.

[20] See Note 2, Chapter 1.
[21] See Note 3, Chapter 1.

Figure 3-1. Linking a Health Hazard Category to Medical Outcome Categories



We present the detailed links among the nine health hazards and the Army, DOL, and VA data in Appendixes B, C, and D, respectively. We based the links on potential medical effects (medical outcomes) caused by acute or chronic exposure to each one of the nine health hazard categories.

We present the clinic service types in Appendix E. The links between health hazard categories and DRGs are in Appendix F. A detailed listing of specific information sources we reviewed is in the bibliography.

Simplifying the Model

We decided that for the first iteration of the model, the data for the selected medical outcome categories would be combined for all hazards. This was because we lacked a direct comparison between medical outcome categories and specific health hazards, and several similar medical outcome categories could relate to the given health hazards. While this would lose the specific hazard costs relating to specific medical outcome categories, we believed this approach was more feasible and would reduce error at the outset.

We used the incidence rate data for illness and injury, hospitalization, lost time, and disability and developed several factors. We used these factors for determining what segment of the population of soldiers could incur illness and injury, hospitalization, lost time, and disability as a result of exposure to a health hazard. We used these factors in the cost formula.

We used the population distribution data for hospitalization and lost time to determine the number of days lost as a result of health hazard exposure. We determined the degree of disability that may occur as a result of health hazard exposure from the population distribution data for disability. In any exposure event, you could reasonably expect a distribution of outcomes to occur rather than every soldier exposed incurring the same outcome. We use these distribution data in the cost formula.

Developing the Risk-Level Link

Our challenge was to link the level of risk in materiel systems to an industry category so that we could use industry illness and injury data in the cost model.

SELECTING THE STANDARD INDUSTRIAL CLASSIFICATION

We used incidence rates as a surrogate for risk. We selected three industrial classifications from the 1994 Bureau of Labor Statistics data that represent the range of illness and injury rates within the Army:

- The construction industry, which represents high-risk occupations (12.2 injuries or illnesses per 100 full-time workers per year)
- The transportation industry, which represents occupations with medium risk (9.5 injuries or illnesses per 100 full-time workers per year)
- The service industry, which represents occupations with low risk (6.7 injuries or illnesses per 100 full-time workers per year).

ASSIGNING RISK LEVELS TO ARMY MATERIEL SYSTEM CATEGORIES

We then determined high-, medium-, and low-risk levels for Army materiel system categories.[22,23,24,25]

We developed average system risk values by determining the average weighted risk associated with each of the materiel system categories. We calculated this average weighted risk value by summing the products of the number of specific system hazards in each RAC category and the RAC weighting factor (Table 3-3), then dividing this sum by the number of systems in the category. The average calculated weighted values are in Table 3-4.

Table 3-3. Risk Assessment Code (RAC) Weighting Factors

RAC	1	2	3	4	5
Weight	100	100	50	50	1

Source: Logistics Management Institute. Memorandum to Sandra Monk, U.S. Army Center for Health Promotion and Preventive Medicine, *Development of Draft Occupational Risk Factors (ORF).* November 9, 1995. McLean, VA.

Next, we segregated the material systems listed in Table 3-4 into three risk categories of high, medium, and low. We made the initial tentative segregations based upon our analysis of the weighted risk averages. We provided this suggested segregation to the USACHPPM health hazard assessors for review. They made some changes based upon their technical expertise and intimate knowledge of the systems and hazard types. The right column in Table 3-4 presents the consensus risk levels assigned to each of the 15 categories of materiel systems. These risk levels require periodic verification as new systems are evaluated.

ASSIGNING THE RISK-LEVEL LINKS

Once we completed the analysis of the industry and Army system data, we linked materiel system category risk levels with industry category risk levels. By so doing, we could use the industry data for cost calculations. Table 3-5 provides the final links we use in the model.

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[22] U.S. Army Center for Health Promotion and Preventive Medicine, *U.S. Army Systems Health Hazards Manual—Procedures Guide*, Aberdeen Proving Ground, MD, 1994.

[23] Logistics Management Institute, *Understanding the Army Readiness Equipment Module (AREM)*, unnumbered and unpublished introduction report, Michael J. Konvalinka and Elizabeth B. Dial, April 1995.

[24] Logistics Management Institute, *Using the Army Readiness Equipment Module to Identify Problem Line Item Numbers*, unnumbered and unpublished introduction report, Michael J. Konvalinka and Elizabeth B. Dial, October 1994.

[25] U.S. Army Center for Health Promotion and Preventive Medicine, *Health Hazard Assessment Database*, Aberdeen Proving Ground, MD, 1995 and 1996.

Table 3-4. Materiel System Category Average Weighted Values and Initial and Consensus Risk Levels

System category	Weighted value	Initial risk level	Consensus risk level
Air defense systems	94.41	High	Medium
Ground antitank weapons	78.11	High	Medium
Armored fighting vehicles	76.75	High	High
Engineer and logistics equipment	69.91	High	High
Tube artillery	64.33	High	High
Aircraft technology and armament	54.55	Medium	Medium
Surveillance/fire control/electronic warfare	52.82	Medium	Low
Missile artillery	51.35	Medium	High
Smokes and obscurants	48.93	Medium	Medium
Infantry weapons	48.29	Medium	Medium
Chemical defense equipment	45.97	Medium	Low
Clothing and individual equipment	34.31	Low	Low
Other	33.87	Low	Medium
Communication/command/control	25.96	Low	Low
Training devices	21.42	Low	Low

Source: Historical health hazard assessment data maintained by the USACHPPM Health Hazard Assessment Office.

Table 3-5. Industry and System Risk-Level Links

Industry category	Risk level	System category
Construction	High	Armored fighting vehicles
Construction	High	Engineer and logistics equipment
Construction	High	Missile artillery
Construction	High	Tube artillery
Transportation	Medium	Air defense systems
Transportation	Medium	Aircraft technology and armament
Transportation	Medium	Ground antitank weapons
Transportation	Medium	Infantry weapons
Transportation	Medium	Other
Transportation	Medium	Smokes and obscurants
Service	Low	Chemical defense equipment
Service	Low	Clothing and individual equipment
Service	Low	Communications, command, and control
Service	Low	Surveillance, fire control, and electronic warfare

DEVELOPING THE INCIDENCE RATES AND FACTORS

In this section, we describe the incidence rates and factors we developed to account for the expected number of soldiers who would incur illness and injury, hospitalization, lost time, and disability.

We initially focused on the Bureau of Labor Statistics industry-wide incidence rates for illness and injury, which are presented by SIC code and include an overall incidence rate for United States industry.

These data provide incidence rates for a broad range of SIC codes. The hazards encountered in each of the SIC codes are the primary factor that determines the incidence rates for illness and injury. The incidence rates (number of workers ill or injured per 100 full-time workers) ranged from 12.2 for high hazard occupations (construction work) to 6.7 for low hazard (service industry). This range will suffice for the Army populations until there is appropriate data developed for illness and injury rates within the Army or DoD. Since these data were not an exact match to the military population, we chose initially to group the incidence rates into the three categories of high, medium, and low risk.

The HP and HS drive the risk: more system hazards, with higher HS, present a greater risk and a higher incidence of illness and injury. Therefore, we tie illness and injury incidence to risk levels (high, medium, and low) based on the number of given system hazards and the hazard RAC weighting. We do not consider the occupation (military occupational specialty) or system mission area (combat, combat support, or combat service support).

Determining Injury and Illness Incidence Rates and Factors (I_i)

Table 3-6 contains the incidence rates and factors (I_i) for illness and injury with assigned risk levels related to the industry-wide occupational categories. The industry categories and illness and injury and lost time incidence rates we selected are in Appendix G.

Table 3-6. Incidence Rates and Factors (I_i) for Illness or Injury Calculations

Industry division	Incidence rate	Risk level[a]	Factor (I_i)
Construction	12.2	High	0.122
Transportation and public utilities	9.5	Medium	0.095
Services	6.7	Low	0.067

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1993*, Washington, DC, December 1994. Injury and illness incidence rate are per 100 full-time workers.

[a] The risk levels selected compare with military operations.

As previously discussed, we selected the construction industry to represent high-risk operations, the transportation industry to represent operations with medium risk, and the service industry to represent operations with low risk. We obtained *single* incidence rates for each selected industry category from the Bureau of Labor Statistics overall data on illness and injury. We used the factors as a surrogate for probability.

Determining Hospitalization Rates and Factors (I_h)

Table 3-7 provides the incidence rates and factors (I_h) for hospitalization with assigned risk levels related to industry categories.

Table 3-7. Incidence Rates and Factors (I_h) for Hospitalization Calculations

Industry division	Incidence rate[a]	Risk level[b]	Factor (I_h)
Construction	13.207	High	0.013
Transportation and public utilities	6.927	Medium	0.007
Services	0.646	Low	0.0006

Source: U.S. Army Center for Health Promotion and Preventive Medicine, "Table S2, Active Duty Hospitalization Rates, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report*, April 1995.

[a] The incidence rates are per 1,000 soldiers.

[b] The risk levels selected compare with military operations.

We summed the incidence rates for ICD-9 categories that linked to the nine health hazards and determined the mean. One standard deviation plus or minus provided the high and low incidence rates. (See Appendix H for the calculations.) We assumed a direct relationship to the industry categories for calculation purposes. We used the factors as a surrogate for probability.

Determining Lost Time Incidence Rates and Factors (I_l)

Table 3-8 provides the incidence rates and factors (I_l) for lost time with assigned risk levels related to the industry-wide occupational categories.

We selected the construction industry to represent high risk occupations, the transportation industry to represent occupations with medium risk, and the service industry to represent occupations with low risk. We obtained *single* lost time incidence rates for each selected industry category from the Bureau of Labor Statistics data (Appendix G). We used the factors as a surrogate for probability.

Table 3-8. Incidence Rates and Factors (I_l) for Lost Time Calculations

Industry division	Incidence rate	Risk level[a]	Factor (I_l)
Construction	5.500	High	0.055
Transportation and public utilities	5.4	Medium	0.054
Services	2.8	Low	0.028

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1993*, Washington, DC, December 1994. Injury and illness incidence rate are per 100 full-time workers.

[a] The risk levels selected compare with military operations.

Determining Disability Incidence Rates and Factors

In this subsection, we discuss the three disability incidence rates. They are the VA disability incidence rate, the active-duty temporary disability incidence rate, and the active-duty permanent disability incidence rate.

INCIDENCE OF VA DISABILITY (I_v)

Table 3-9 provides the incidence rates and factors (I_v) for VA disability with assigned risk levels related to industry categories.

We developed incidence rates for disability based on the VA National Center for Veteran Analysis and Statistics data. We summed the incidence rates for the disability categories that linked to the nine health hazards and determined the mean. One standard deviation plus or minus provided the high and low incidence rates. The lower standard deviation was negative, so we assigned a number that approached zero (statistical minimum). (See Appendix I for the calculations.) We assumed a direct relationship to the industry categories for calculation purposes. We used the factors as a surrogate for probability.

Table 3-9. Incidence Rates and Factors (I_v) for Disability Calculations

Industry division	Incidence rate[a]	Risk level[b]	Factor (I_v)
Construction	32.2	High	0.032
Transportation and public utilities	12.0	Medium	0.012
Services	0.05	Low	0.00005

Source: U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Persian Gulf War Report as of March 1995*.

[a] Incidence rates are per 1,000 soldiers.

[b] The risk levels selected compare with military operations.

INCIDENCE OF ACTIVE-DUTY TEMPORARY DISABILITY (I_t)

We selected the incidence of active-duty temporary disability (I_t) from a report by the Armed Forces Epidemiological Board Injury Prevention and Control Work Group on illness and injury.[26] This report provided basic information on active-duty temporary and permanent disability compensation. For this incidence rate, we selected a single incidence only because of the limited data presented in the report. We determined an active-duty temporary disability incidence rate of 1 person disabled per 1,000 soldiers per year. We used the factor (0.001) as a surrogate for probability.

INCIDENCE OF ACTIVE-DUTY PERMANENT DISABILITY (I_p)

We selected the incidence of active-duty permanent disability (I_p) from the report by the Armed Forces Epidemiological Board Injury Work Group on illness and injury.[27] The report provided basic information on active-duty permanent disability. For this incidence rate, we selected a single incidence only because of the limited data presented in the report. We determined an active-duty permanent disability incidence rate of 11 persons disabled per 1,000 soldiers per year. We used the factor (0.011) as a surrogate for probability.

Summary

We cannot emphasize enough that this is the first iteration of the model. The first step was to develop a basic model—a tool to calculate costs avoided for the Army—which will be improved in the future. When refined, it will be able to determine costs avoided by the Army based on specific hazards for various scenarios. As more Army data become available, we will replace the industry-wide data currently used in this model.

DEVELOPING VISIT, LENGTH OF STAY, AND DEGREE OF DISABILITY FACTORS

Clinic Visits (N_c)

We developed the values for the number of clinic visits (N_c) by injured or ill persons based on the seriousness of the medical effects that could occur. An increase in the severity of hazard medical effects should relate to an increase in the number of clinic visits. We subjectively determined the values based on a consensus of internal and external subject matter expert panels. We list the values selected for each HS category in Table 3-10.

[26] See Note 6, Chapter 1.

[27] See Note 6, Chapter 1.

Table 3-10. Number of Clinic Visits (N_c) *for HS Categories*

HS category	Number of clinic visits (N_c)
I	5
II	3
III	2
IV	1

Hospitalization Length of Stay Factors (D_{hd})

We based the factor for the average number of days in the hospital (D_{hd}) on historical hospital length of stay data. This provides for a future capability to discriminate between hospital stay times (bed days). It also correlates directly with the hospitalization population distribution.[28] For this model component, we determined numerical factors for four categories. The category values represent the midpoints of the range of days in each category. The exception is the greater than 30 day category. Because the historical data available only listed the bed days as greater than 30 days, we selected a conservative value of 30 days for this category. The values are listed in Table 3-11.

Table 3-11. Factors for Average Number of Days in Hospital (D_{hd}) *(days/person)*

Length of stay in hospital	Factor (D_{hd})
<2 days	1.0
2–5 days	3.5
6–30 days	18.0
>30 days	30.0

Duration of Lost Time Factors (D_{ld})

We based the factor for the average number of days of lost time (D_{ld}) on historical distribution data for lost workdays. This approach provides a future capability to discriminate between selected lost day categories and correlates directly with the lost time population distribution.[29] For this model component we determined numerical values for the four categories of lost time. We determined these factors in the same manner as the hospital factors (Table 3-12).

[28] See Notes 1 and 5, this chapter.

[29] See Notes 8 and 9, this chapter.

Table 3-12. Factors for Average Number of Days of Lost Time (D_{ld}) (days/person)

Number of days of lost time	Factor (D_{ld})
<2 days	1.0
2–5 days	3.5
6–30 days	18.0
>30 days	30.0

Degree of Disability Factors

We based the factor for the average degree of disability on historical disability data. The approach, when combined with the VA disability population distribution factor for degree of disability, provides a future capability to discriminate between categories of disability costs. For this model component, we determined numerical factors for the four categories of degree of disability. The category values represent the actual (for 10% and 100%) and the degree of disability range midpoints in the two other categories (Table 3-13). We used this data for assigning appropriate compensation factors. We discuss these factors in the Compensation Factor section later in this chapter.

Table 3-13. Average Degree of Disability for Calculations

Degree of disability	Average degree of disability
10%	0.10
20%–50%	0.35
60%–90%	0.75
100%	1.00

Note: We use the 10% and 100% categories as is. We based the 35% and 75% categories on the midpoint of 20%–50% and 60%–90% breakpoints respectively.

DEVELOPING THE POPULATION DISTRIBUTION FACTORS

We know that in a population exposed to a hazard, each individual exposed may react differently and may require different levels of medical treatment having different costs. These distribution factors attempt to account for the variability in medical outcomes and their associated costs. This section presents the distribution factors for hospitalization, lost time, and disability.

Because events in a general population are not the same, we developed distribution tables for use in the calculations. We obtained actual data for hospitalization[30] and lost time.[31] The data listed specific diagnostic categories or nature of injury or event for 1 day, 2 days, 3–5 days, 6–10 days, 11–20 days, 21–30 days, and 31 or more days hospitalization and days of lost time, respectively. We combined the data into four categories, assuming that for any hospitalization and lost time there would be a relative distribution of outcomes within these categories. We considered this approach reasonable because when an adverse exposure occurs, one would not expect the population involved to all incur the same amount of hospitalization or lost time.

We calculated overall mean distribution factors for hospitalization and lost time based on the combined diagnostic categories. We used this mean value for the medium-risk level. This distribution factor plus one standard deviation equaled the high-risk level. The distribution factor minus one standard deviation equaled the low-risk level. We then normalized the data.

Population Distribution Factors for Hospitalization Days (D_{ho})

We based the factor for the hospitalization population distribution (D_{ho}) on historical data for persons hospitalized for four selected hospital length of stay distribution categories. This distribution approach, when combined with the hospitalization length of stay factor, provides for a future capability to discriminate between hospital length of stay categories. For this model component, we determined numerical values for the four hospitalization population distribution factors within each risk category based on the historical data. The high- and low-risk category factors within each length of stay category represent normalized values of the medium (mean) values plus or minus one standard deviation. We list the system risk categories with their distribution factors in Table 3-14.

Table 3-14. Factors for Hospitalization Population Distribution (D_{ho}) by Length of Stay in Hospital for System Risk Categories

System risk category	Length of stay in hospital			
	<2 days	2–5 days	6–30 days	>30 days
High	0.40	0.35	0.17	0.08
Medium	0.40	0.36	0.18	0.06
Low	0.42	0.37	0.20	0.02

Note: The detailed hospitalization data calculations are in Appendix J.

[30] See Note 5, this chapter.

[31] See Notes 8 and 9, this chapter.

Population Distribution Factor for Lost Time (D_{lt})

We based the factor for lost time population distribution (D_{lt}) on historical data for the percentage of persons losing time for four selected lost workday distribution categories. This distribution approach, when combined with the factor for the average number of days of lost time, provides for a future capability to discriminate between lost workday categories. For this model component, we determined numerical values for the four lost time population distribution factors based on historical data. The high- and low-risk categories within each length of lost time category represent the normalized values of the medium (mean) values plus or minus one standard deviation. We list the values in Table 3-15.

Table 3-15. Factors for Lost Time Population Distribution (D_{lt}) by Days of Lost Time for System Risk Categories

System risk category	Lost time			
	<2 days	2–5 days	6–30 days	>30 days
High	0.22	0.30	0.29	0.20
Medium	0.20	0.33	0.31	0.16
Low	0.15	0.43	0.38	0.04

Note: The detailed lost time data calculations are in Appendix K.

Population Distribution for VA Disability (D_v)

We based the disability population distribution factor (D_v) on historical data for the percentage of persons disabled for four selected disability distribution categories. VA establishes disability in 10 percent increments. The four categories allow for the future capability to discriminate between categories of disability costs. Considering the historical data, we assigned a distribution factor for each risk category. The high- and low-risk category levels represent the normalized values of the medium (mean) values plus or minus one standard deviation. We list these factors in Table 3-16.

Table 3-16. Factors for Disability Population Distribution (D_v) by Degree of Disability for System Risk Categories

System risk category	Degree of disability			
	10%	20%–50%	60%–90%	100%
High	0.44	0.42	0.10	0.04
Medium	0.44	0.44	0.09	0.03
Low	0.43	0.48	0.08	0.01

Note: The detailed disability data is in Appendix L.

Population Distribution for Rehabilitation (D_r)

We selected the factor for the eligible VA disability population distribution for rehabilitation (D_r) based on historical data for the percentage of persons disabled for three selected disability distribution categories. The values in Table 3-17 are the same as those listed in Table 3-16 except for the 10% category. Rehabilitation eligibility begins with a disability of 20 percent or more. This distribution approach provides for a future capability to discriminate between categories of rehabilitation costs.

Table 3-17. Eligible VA Disability Population Distribution Factors (D_r) by Degree of Disability for System Risk Categories

System risk category	Degree of disability			
	10%	20%–50%	60%–90%	100%
High	0.0	0.42	0.10	0.04
Medium	0.0	0.44	0.09	0.03
Low	0.0	0.48	0.08	0.01

DEVELOPING THE COMPENSATION FACTORS

Clinic Visit Fee Factor (F_c)

The clinic visit fee (F_c) is an average cost based on the mean value for various types of clinic service visit fees. We found that the average fee was $122 per clinic visit.[32] (See Appendix M for detailed fee calculations.)

Hospital Fee Factor (F_h)

The hospital fee variable (F_h) is an average cost based on various types of hospital diagnosis related groups and the classification of the disease. We found the average hospital fee was $1,669 per day.[33] (See Appendix N for detailed fee calculations.)

Average Wage Factor (W_d)

We based the average wage per day (W_d) on the salaries and the number of persons drawing each salary for a selected group of personnel. We determined the

[32] See Note 2, Chapter 1.

[33] See Note 4, Chapter 1.

average wage to be $53.97 per day.[34] (See Appendix O for detailed salary calculations.)

Fringe Benefit Factor (B_f)

We assigned the fringe benefit factor (B_f) a value of 1.41. It is a standard factor within the government used for programming personnel budget requirements and is considered representative of other corporate benefit factors.

Disability Compensation Factors

In this subsection, we discuss the three disability compensation rates: VA disability, active-duty temporary disability, and active-duty permanent disability.

VA Disability Compensation Factor (B_v)

We based the VA disability compensation factor (B_v) on historical data for selected degree of disability categories.[35] The approach, when combined with the VA disability population distribution factor, provides for a future capability to discriminate between degree of disability costs.

For this model component, we calculated numerical values for the four VA disability compensation factors by degree of disability population distribution factors (Table 3-18). VA pays disability in 10 percent disability increments. (See Appendix P for the detailed calculations.)

Table 3-18. VA Disability Compensation Factors by Degree of Disability Category (B_v) (dollars/month/person)

Degree of disability	VA disability compensation factor (B_v)
10%	$91.00
20%–50%	$340.25
60%–90%	$915.50
100%	$1,865.00

Active-Duty Temporary Disability Compensation Factor (B_t)

We based the active-duty temporary disability compensation factor (B_t) on 1990 historical compensation costs for permanent and temporary disability in the three military services.[36] Using the data provides a future capability for discriminating between the costs of military and VA disability.

[34] See Note 5, Chapter 1.

[35] See Notes 7 and 8, Chapter 1.

[36] See Note 6, Chapter 1.

We found the average active-duty temporary disability compensation to be $9,242 per year per person. (See Appendix Q for the detailed calculations.) We assumed that the temporary disability list would remain constant—that is, removing people from or adding people to the list balances.

ACTIVE-DUTY PERMANENT DISABILITY COMPENSATION FACTOR (B_p)

We based the active-duty permanent disability compensation factor (B_p) on 1990 historical compensation costs for permanent and temporary disability in the three military services.[37] Using the data provides a future capability for discriminating between the costs of military and VA disability.

We found the average active-duty permanent disability compensation to be $12,864 per year per person. (See Appendix R for the detailed calculations.)

VA REHABILITATION BENEFIT FACTOR (B_r)

We estimated the rehabilitation benefit factor (B_r) to be $12,000 per year per person. Rehabilitation benefits may vary per person, but we considered $12,000 to be a reasonable estimate. Other benefits may be available for eligible disabled persons, but we did not consider them.[38]

DEATH BENEFIT AND EXPENSES (B_{de})

There is great variability in calculating the cost of a person's death. Values presented in the literature have varied from $100,000 to over $1,000,000. It is another area deserving further study. Our cost of death includes costs paid by insurance policies, in addition to expenses relating to casualty assistance, honor guard, funeral and burial, family, and other related expenses. Serviceman's Group Life Insurance can pay a beneficiary up to $200,000 for the death of a soldier. Other expenses incurred by the Army can be substantial. As previously discussed, we did not consider training and personnel replacement costs.

For the death benefit and expenses factor (B_{de}), we selected a numerical value of $200,000.

Other Critical Factors

CLINIC VISIT CONSTANT FACTOR (V_e)

The visit constant factor (V_e) equals 0.75 based on exposure to a health hazard that results in illness or injury. We assumed that if an exposure event occurs, then 75 percent of all persons exposed to the hazard will visit the clinic for an examination to determine whether any injury has occurred. (Environmental exposures

[37] See Note 6, Chapter 1.

[38] See Notes 8 and 10, Chapter 1.

received by soldiers in the Persian Gulf during Operation Desert Storm heightened the importance of being examined by a physician. The Army encouraged clinic visits even though medical symptoms of illness or injury may not be readily apparent after exposure to a hazard.) Often, an outpatient reports to a screening or general clinic before referral to an appropriate specialty clinic.

VA Qualification Factor for Rehabilitation (Q_r)

We assumed the qualification factor for rehabilitation (Q_r) to be 0.05. We selected this value based on an estimate of the percentage of people who may apply for and be accepted for rehabilitation benefits. The qualification factor selected may be low; for example, the Baltimore VA region estimated its acceptance rate for the VA rehabilitation program to be greater than 20 percent. However, the value is adequate for use in this model.

VA Disability Adjustment Factor (T_v)

The VA disability adjustment factor (T_v) reduces the VA disability population. Eligible veterans receive VA disability after leaving military service. One would likely see disabilities compensated by the VA only later in the life of a system. We assumed that for a system with an operational life of 20 years, we could expect to see VA disabilities at 15 years. Considering this assumption, we assigned a VA disability adjustment factor of 0.25 (5 years/20 years).

Number of Deaths (N_{de})

We assumed that a potential for death existed only in the catastrophic HS category. We had limited reliable sources of data. This is an area requiring further research to refine our model. The report by the Armed Forces Epidemiological Board Injury Prevention and Control Work Group showed that overall there was approximately 1 death per 1,000 clinic visits. While this number is appropriate from an overall injury perspective, the results obtained when applied to our example were not believable.[39] We assumed that only rare circumstances would allow more than one death per year related to a materiel system before an immediate resolution occurred.

For this model component we assigned a numerical value of 1 death for HS Category I and a value of zero for all other HS categories (Table 3-19).

[39] See Note 6, Chapter 1.

Table 3-19. Number of Deaths (N_{de}) for Hazard Severity Categories

Hazard Severity Category	Number of Deaths (N_{de})
I	1
II	0
III	0
IV	0

Summary

We developed the

- cost components;
- HP and HS factor values;
- health hazard and medical outcome links;
- the risk-level link;
- the incidence rates and factors for illness and injury, hospitalization, lost time, and disability;
- visit, length of stay, and degree of disability factors;
- the population distribution factors for hospitalization, lost time, disability, and rehabilitation;
- the compensation factors for
  - clinic visit fee,
  - hospital fee,
  - average wage,
  - fringe benefit,
  - VA disability compensation factor,
  - active duty temporary disability compensation factor,
  - VA rehabilitation benefit factor, and
  - death benefit and expenses;
- other critical factors for

- ➢ clinic visit constant,
- ➢ VA qualification factor for rehabilitation,
- ➢ VA disability adjustment factor, and
- ➢ number of deaths;

- ◆ the cost equations for clinic services, hospitalization, lost time, disability, rehabilitation, and death.

We require these data elements for calculating the costs of health hazards. We now present the equations used for the derivation of the costs.

COST EQUATIONS

Cost Component Equations

In chapter 2, we presented the general formula for calculating health related costs. The model in equation form is as follows:

Hazard costs/year = clinic costs/year + hospitalization costs/year + lost time costs/year + disability costs/year + rehabilitation costs/year + death costs/year.

We developed equations for estimating costs that incorporated HS and HP (Table 2-2). The equations included costs per year for clinic services, hospitalization, lost time, disability, rehabilitation, and death.

Data Elements

We used industry-wide incidence rates, distribution factors, and other component rates to quantify health hazard costs based on the six cost components—our model framework—to estimate the costs of exposure to hazards. We list the data elements and values in Table 3-20 along with a brief description.

Table 3-20. Data Elements

Related cost component	Data element	Variable value	Description
All (except death costs)	P_e	See Table 3-1.	Probability of exposure per year, based on the determined HP category.
All (except death costs)	S_k	See Table 3-2.	HS factor based on the determined HS category.
All (except death costs)	N_s	Number of systems	Number of systems—the total number individual items of materiel, equipment, or weapon systems in the Army inventory.
All (except death costs)	N_{ps}	Number of persons	Number of persons per system, or crew size for system or item.
All (except death costs)	N_e	Calculated	Total number of people exposed to hazard per year for the systems or items.
Clinic costs	C_c	Calculated	Cost of clinic visits.
Clinic costs	N_i	Calculated	Number of people injured or ill.
Clinic costs	N_v	Calculated	Number of clinic visits.
Clinic costs	V_e	0.75	Visit constant as result of exposure. The visit constant (V_e) equals 0.75 based on exposure to a health hazard that results in illness or injury. We assumed that if an exposure event occurs, then 75 percent of all persons exposed to the hazard will visit the clinic for an examination to determine whether any injury has occurred.
Clinic costs	I_i	See Table 3-6.	Incidence of injury or illness based on the determined risk level for the individual item of materiel.
Clinic costs	N_c	See Table 3-10.	Number of visits by injured or ill personnel based on the determined HS category. The HS category determines the seriousness of the medical outcomes that could occur. As the severity increases, the number of clinic visits increases. For this cost component, based on values selected by a panel of experts, we assigned the number of visits based on the HS category and the potential medical outcomes.
Clinic costs	F_c	$122 per visit	Average fee per clinic visit, based on the average of various types of clinic service visit fees. We found the average fee was $122 per clinic visit.
Hospitalization costs	C_h	Calculated	Cost of hospitalization.
Hospitalization costs	N_{ph}	Calculated	Number of persons hospitalized.
Hospitalization costs	N_h	Calculated	Number of hospital days.
Hospitalization costs	I_h	See Table 3-7.	Incidence of hospitalization based on the determined risk level for the individual item of materiel.
Hospitalization costs	D_{hd}	See Table 3-14.	Factor for the average number of days in hospital per person based on historical hospital stay distribution.
Hospitalization costs	D_{ho}	See Table 3-11.	Factor for the hospitalization population distribution for average number of days in hospital.
Hospitalization costs	F_h	$1,669 per day	Average fee per hospital day. Average cost based on various types of hospital diagnosis related groups and the classification of the disease. We found the average hospital fee was $1,669 per day.

Table 3-20. Data Elements (Continued)

Related cost component	Data element	Variable value	Description
Lost time costs	C_l	Calculated	Cost of days of lost time.
Lost time costs	N_{pl}	Calculated	Number of persons losing time.
Lost time costs	N_l	Calculated	Number of lost workdays.
Lost time costs	I_t	See Table 3-8.	Incidence of lost time based on the determined risk level for the individual materiel item.
Lost time costs	D_{ld}	See Table 3-12.	Factor for the number of lost workdays per person based on historical lost workday distribution.
Lost time costs	D_{lt}	See Table 3-15.	Lost time population distribution based on average lost workday distribution.
Lost time costs	W_d	$53.97 per day	Average wage per day. We based the average wage per day (W_d) on the salaries and number of persons drawing each salary for a selected group of personnel. We determined the average wage to be $53.97 per day.
Lost time costs	B_f	1.41	Wage fringe benefit factor. We assigned the fringe benefit factor (B_f)a value of 1.41. It is a standard factor within the government used for programming personnel budget requirements and is representative of other corporate benefit factors.
Disability costs	C_{di}	Calculated	Cost of disabilities
Disability costs	N_{pd}	Calculated	Number of persons disabled
Disability costs	I_v	See Table 3-9.	Incidence of VA disability based on the determined risk level for the individual item of materiel, equipment, or weapon system
Disability costs	T_v	0.25	VA disability adjustment factor for delayed disability (5 years/20 years)
Disability costs	D_v	See Table 3-16.	VA disability population factor based on historical rate of disability distribution
Disability costs	B_v	See Table 3-18.	VA disability compensation factor per month per rate of disability
Disability costs	I_t	0.001	Incidence of active-duty temporary disability (1 case/1,000 persons)
Disability costs	B_t	$9,242 per person	Active-duty temporary disability compensation per year
Disability costs	I_p	0.011	Incidence of active-duty permanent disability (11 cases/1,000 persons)
Disability costs	B_p	$12,864 per person	Active-duty permanent disability compensation per year
Rehabilitation costs	C_r	Calculated	Cost of rehabilitation
Rehabilitation costs	N_r	Calculated	Number of rehabilitation cases
Rehabilitation costs	D_r	See Table 3-17.	Eligible VA disability population factor based on rate of disability distribution equal to or greater than 20 percent
Rehabilitation costs	Q_r	0.05	VA rehabilitation qualification factor (5 cases/100 persons eligible)

Table 3-20. Data Elements (Continued)

Related cost component	Data element	Variable value	Description
Rehabilitation costs	B_r	$12,000 per year per person	VA rehabilitation benefit per year per person. We estimated it to be $12,000 per year per person. Rehabilitation benefits may vary per person, but we considered $12,000 to be a reasonable estimate. Other benefits may be available for eligible disabled persons, but we did not consider these other benefits.
Death costs	C_{de}	Calculated	Cost of death
Death costs	N_{de}	See Table 3-19.	Number of deaths per year
Death costs	B_{de}	$200,000	Death benefit and expenses

SUMMARY

In the next six chapters we will explore each of the six cost components. We will address the following:

- defining the equations to estimate costs,
- defining each data element and its data objective,
- describing the data sources for each data element,
- discussing data element derivation,
- describing data element location in the cost calculator,
- discussing other useful information, and
- performing an example calculation.

As an example, we will estimate costs for an Army system evaluated by health hazard assessors. Remember that health hazards are inherent in all U.S. Army materiel systems. If ignored, however, these hazards can cause serious injuries and illnesses to military and civilian operators throughout the life of the system. In our case, the medical costs for treating those injuries and illnesses can pose significant financial burdens on the Army and VA health care systems. Implementation of recommendations to control health hazards in this example system results in avoiding potential medical and lost time costs of approximately $345 million over its life.

This system had 10 health hazards: weapons combustion products, fire extinguishing agents, carbon dioxide, impulse noise, steady-state noise, cold stress, heat stress, oxygen deficiency (ventilation), nonionizing radiation, and ionizing radiation. For the individual cost component calculations in Chapters 4 through 9, we will address only the weapons combustion product hazard. In chapter 10 we will summarize the results for all the hazards.

For our system example (Table 3-21), these are the identified health hazards and assigned RACs derived by the health hazard assessors during their evaluation.

Table 3-21. System Health Hazards and Associated Risk Indices

Hazard Category	Hazard	RAC	HS	HP
Chemical substances	Weapons combustion products	1	I	I
Chemical substances	Fire extinguishing agents	2	II	II
Chemical substances	Carbon dioxide	3	II	II
Acoustical energy	Impulse noise	2	II	II
Acoustical energy	Steady-state noise	2	II	II
Temperature extremes	Cold stress	2	II	II
Temperature extremes	Heat stress	2	II	II
Oxygen deficiency	Oxygen deficiency (ventilation)	2	II	II
Radiation energy	Nonionizing radiation	2	II	II
Radiation energy	Ionizing radiation	4	II	II

Chapter 4

Estimating Clinic Costs

INTRODUCTION

We attribute clinic costs to outpatient visits to a medical treatment facility by persons exposed to a hazard that resulted in illness or injury.[1] We used the illness and injury data from the Bureau of Labor Statistics survey on U.S. occupational injuries and illness in 1993 as our primary data source for calculating clinic costs.[2]

In this chapter, we present the basic cost model equation used to calculate the clinic costs. We present the equation first, define each of the terms in the equation, discuss each of the terms in detail, and then present other useful clinic related information. We conclude the chapter with an example calculation.

EQUATION

The equation for clinic costs is

$$C_c = P_e \times N_s \times N_{ps} \times S_k \times \left[V_e + \left(I_i \times N_c\right)\right] \times F_c, \qquad \text{[Eq. 4-1]}$$

where

- C_c = cost of clinic visits;
- P_e = probability of exposure per year, based on the determined HP category;
- N_s = number of systems—the total number of individual items of materiel, equipment, or weapon systems in the Army inventory;
- N_{ps} = number of persons per system;
- S_k = HS factor based on the determined HS category;
- V_e = visit constant as result of exposure;
- I_i = incidence of injury or illness based on the determined risk level for the individual item of materiel;
- N_c = number of visits by injured or ill personnel based on the determined HS category; and

[1] See Note 2, Chapter 1.

[2] See Notes 6–9, Chapter 3.

F_c = average fee per clinic visit.

DATA ELEMENTS

Hazard Probability (P_e)

DEFINITION

HP (P_e) represents the likelihood of exposure per year, based on the determined HP category from Table 3-1.

OBJECTIVE

We developed this data element to quantify probability.

SOURCE

We developed the data element using a panel of occupational health experts.

DERIVATION AND LIMITATION

Derivation

An in-house panel of occupational health experts developed this data element. We developed numerical values that quantified the intent of the probability description. Once in agreement on the numerical values, we validated them using USACHPPM practicing health hazard assessment experts.

Limitation

The determination of this data element was subjective. We need to further validate these HP values by performing research and including more occupational health and safety experts in our evaluation.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from a form named fdataHazProb in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Exposure Probabilities button. The values can then be modified.

Number of Systems (N_s)

DEFINITION

The number of systems refers to the total number of individual items of materiel, equipment, or weapon systems in the Army inventory, or planned for inclusion in the inventory.

OBJECTIVE

We developed this element to determine the total number of people associated with a system.

SOURCE

Obtain this information from the program manager for the system being evaluated or use the Army Readiness Equipment Module.

DERIVATION AND LIMITATION

Derivation

Program managers report this data element, or we can extract it from the Army Readiness Equipment Module.

Limitation

The data obtained from the system program manager should be reliable. It may vary in the long term depending on the system program budgeting and the number of systems actually fielded. The data from the Army Readiness Equipment Module is also reliable for determining similar systems in the inventory.

LOCATION IN THE AUTOMATED COST MODULE

This value must be entered manually for each hazard cost calculated. To enter the number of systems, choose Cost Avoidance Calculator from the Main Menu. The Cost Avoidance Calculator Menu will appear. Enter the number in the No. Systems window.

Number of Persons Per System (N_{ps})

DEFINITION

The number of persons per system refers to the crew size for the system or item being evaluated.

OBJECTIVE

We developed this element to determine the total number of people associated with a system or item.

SOURCE

Obtain this information from the program manager for the system being evaluated.

DERIVATION AND LIMITATION

Derivation

Program managers report this data. We did not derive the data.

Limitation

The manpower requirements data obtained from the system program manager should be reliable.

DATA LOCATION IN THE AUTOMATED COST MODULE

This value must be entered manually for each hazard cost calculated. To enter the number of people per system, choose the Cost Avoidance Calculator from the Main Menu. The Cost Avoidance Calculator will appear. Enter the number in the No. People window.

Hazard Severity (S_k)

DEFINITION

HS is a relative score of the severity of the medical effects caused by exposure to the hazard based on the determined HS category from Table 3-2.

OBJECTIVE

We developed this data element to quantify severity.

SOURCE

We developed the data element using a panel of occupational health experts.

Derivation and Limitation

Derivation

An in-house panel of occupational health experts developed this data element. We developed numerical values that quantified the intent of the severity description. Once in agreement on the numerical values, we validated them using USACHPPM practicing health hazard assessment experts.

Limitation

The determination of this data element was subjective. We assumed a logarithmic relationship among the four severity categories. However, we need to pursue the development of "true" HS values.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataHazSev in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Hazard Severity button. The values can then be modified.

Visit Constant Factor (V_e)

Definition

The visit constant (V_e) equals 0.75 based on exposure to a health hazard that results in illness or injury.

Objective

We developed this data element to provide a reasonable value for the number of clinic visits that would occur as a result of being injured or ill.

Source

We developed the data element using a panel of occupational health experts.

Derivation and Limitation

Derivation

An in-house panel of occupational health experts developed this data element, which is subjective. We determined a value of 0.75 for the factor. We assumed that if an exposure event occurs, 75 percent of all persons exposed to the hazard will visit the clinic for an examination to determine whether any injury has occurred.

Limitation

The determination of this data element was subjective. We need to pursue development of "true" visit constant factors.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from the form named fdataConstants in the cost avoidance calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

Incidence of Illness or Injury (I_i)

DEFINITION

We developed the incidence of injury or illness factor from an incidence rate for illness and injury. We based the factor on the determined risk level for the individual item of materiel (Table 3-6).

OBJECTIVE

We developed this data element to provide a numerical value that we could use to estimate the number of persons injured or ill as a result of exposure to a hazard.

SOURCE

U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1993,* Washington, DC, December 1994.

DERIVATION AND LIMITATION

Derivation

We developed this data element from industry-wide illness and injury incidence rates. We analyzed each of the categories of military systems to determine the appropriate industry illness and injury incidence rate to apply to each system category (Table 3-4). We selected incidence of illness and injury data from the Bureau of Labor Statistics data that are representative of the range of illness and injury rates within the Army.

We selected industries with a high (0.12), medium (0.095), and low (0.067) incidence of illness and injury. For example

- the construction industry, which represents high-risk occupations (12.2 injuries or illnesses per 100 full-time workers per year),
- the transportation industry, which represents occupations with medium risk (9.5 injuries or illnesses per 100 full-time workers per year), and
- the service industry, which represents occupations with low risk (6.7 injuries or illnesses per 100 full-time workers per year).

Limitation

The data used was not Army data. To correlate Army systems to industry categories, we based our analysis on our experience and limited Army illness and injury data. We also tapped the experience of a group of senior medical health risk assessors who had worked with these systems. We cannot currently determine the percentage of these injuries and illnesses that are really due to materiel incidents. This needs to occur through follow-up efforts. Because we determined an overall mean incidence factor, individual hazard illness and injury calculations for a given HP and HS are equal.

DATA LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from the form named fdataIncidenceValues in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Incidence Values button. The values can then be modified.

Number of Visits (N_c)

DEFINITION

This data element refers to the number of expected visits by injured or ill personnel based on the determined HS category (Table 3-10).

OBJECTIVE

We developed this data element to obtain values for the number of clinic visits by injured or ill persons.

SOURCE

We developed the data element using a panel of occupational health experts.

DERIVATION AND LIMITATION

Derivation

An internal and external panel of occupational health experts developed these four data element values, one for each severity category. The HS category determines the seriousness of the medical outcomes that could occur. As the severity increases, the number of clinic visits increases. We assigned the number of visits based on the HS category and the potential medical outcomes.

Limitation

The determination of this data element was subjective. We developed values for the four severity categories; however, we need to develop an incidence rate for clinic visits using Army data when it becomes available to improve these values.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from the form named fdataHazSev in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Hazard Severity button. The values can then be modified.

Clinic Service Fee (F_c)

DEFINITION

The average fee per clinic visit equals $122 based on the mean value for various types of clinic service visit fees.

OBJECTIVE

We developed this data element to determine the average cost of a clinic visit.

SOURCE

"Medical and Dental Reimbursement Rates for Fiscal Year 1996," *Federal Register,* Volume 60, Number 195, 10 October 1996, pp. 52,655–52,659.

DATA ELEMENT DERIVATION AND LIMITATION

Derivation

We developed this data element by linking potential medical outcomes with various types of clinic services. We summed the fees for each of the selected clinic services, used the mean fee determined in the cost calculations, and found that the average fee was $122 per clinic visit.

Limitation

The value developed was for a combination of all hazards. Calculation of clinic costs for specific hazards with the same HP and HS will be the same. For calculating hazard specific costs, this introduces a potential error. We would expect to see visits in different types of clinics depending on specific hazard exposure and resultant medical effects. This would result in variable clinic fees. For calculating overall hazard costs, this does not present a problem. We need improved Army clinic visit data when it becomes available.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

OTHER OUTPUTS

In addition to the yearly and life-cycle clinic costs, we can estimate

- the number of persons injured or ill and
- the number of clinic visits.

Number of Persons Injured or Ill (N_i)

We determine the number of persons injured or ill (N_i) by using Equation 4-2:

$$N_i = P_e \times N_s \times N_{ps} \times S_k \times I_i, \qquad \text{[Eq. 4-2]}$$

where

N_i = number of persons injured or ill;

P_e = probability of exposure per year, based on the determined HP category;

N_s = number of systems—the total number of individual items of materiel, equipment, or weapon systems in the Army inventory;

N_{ps} = number of persons per system or crew size for system or item;

S_k = HS factor based on the determined HS category; and

I_i = incidence of injury or illness based on the determined risk level for the individual materiel item.

Number of Clinic Visits (N_v)

We determine the number of clinic visits (N_v) by using Equation 4-3:

$$N_v = P_e \times N_s \times N_{ps} \times S_k \times \left[V_e + \left(I_i \times N_c\right)\right], \qquad \text{[Eq. 4-3]}$$

where

N_v = total number of clinic visits;

P_e = probability of exposure per year, based on the determined HP category;

N_s = number of systems—the total number of individual items of materiel, equipment, or weapon systems in the Army inventory;

N_{ps} = number of persons per system or crew size for system or item;

S_k = HS factor based on the determined HS category;

V_e = visit constant factor as result of exposure;

I_i = incidence of injury or illness factor based on the determined risk level for the individual item of materiel; and

N_c = number of visits by injured or ill personnel based on the determined HS category.

These outputs may be useful to physicians, environmental engineers, environmental scientists, and other health care professionals as a basis for assessing the strengths and weaknesses of preventive health care. The measures may also be useful in trend analyses to identify which types of systems are more hazardous to operate and create the greatest burden on the health care system. This allows corrective actions to be focused on the most hazardous systems currently in the inventory and preventive actions on similar types of systems in development.

Medical treatment facility commanders may use the illness and injury data to tailor their treatment capability to meet the demand. Preventive medicine program managers may use the outputs to evaluate the effectiveness of their program.

EXAMPLE CALCULATION

We will use the example we introduced in the Summary section of Chapter 3. We will address only the weapons combustion product hazard. For this hazard, the system has a RAC of 1, a HS category of I, and a HP of A. We will calculate yearly clinic costs, the number of people injured or ill, and the number of clinic visits. Our known variables are

P_e = 0.9,

N_s = 7,400,

N_{ps} = 4,

S_k = 1,

V_e = 0.75 visit per person,

I_i = 0.122,

N_c = 5 visits per person, and

F_c = \$122 per visit.

Using Equation 4-1, we see that total clinic costs (C_c) are approximately \$4,420,000 per year:

$$C_c = P_e \times N_s \times N_{ps} \times S_k \times \left[V_e + \left(I_i \times N_c\right)\right] \times F_c$$

$$= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons per system} \times 1$$

$$\times\, 0.75 \text{ visits per person} + 5 \text{ visits per person}$$

$$\times\, \$122/\text{visit},$$

$$= \$4{,}420{,}108/\text{year}.$$

Using Equation 4-2, we see that the number of people injured or ill (N_i) is approximately 3,250 persons per year:

$$N_i = P_e \times N_s \times N_{ps} \times S_k \times I_i$$

$$= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons per system}$$

$$\times\, 1 \times 0.122$$

$$= 3{,}250 \text{ persons per year}.$$

Finally, using Equation 4-3, we see that the total number of clinic visits per year (N_v) is approximately 36,230:.

$$N_v = P_e \times N_s \times N_{ps} \times S_k \times \left[V_e + \left(I_i \times N_c\right)\right]$$

$$= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons per system} \times 1$$

$$\times [0.75 \text{ visits per person} + (0.122 \times 5 \text{ visits per person})],$$

$$= 36{,}230 \text{ clinic visits per year.}$$

SUMMARY

In this chapter we

- discussed the model component for clinic costs,
- defined the equations to estimate clinic costs,
- defined each data element and its data objective,
- described the data sources for each data element,
- described the data element locations in the automated cost module,
- discussed other useful information, and
- performed an example calculation.

In the next chapter, we will discuss the model component for hospitalization costs.

Chapter 5
Estimating Hospitalization Costs

INTRODUCTION

We attribute hospitalization costs to inpatient hospital stays by persons exposed to a hazard that resulted in illness or injury.[1] We used the hospitalization data from the USACHPPM *Medical Surveillance Monthly Report,* April 1995,[2] and "CHAMPUS DRG Weights for Fiscal Year 1996" published in the *Federal Register.*[3]

In this chapter, we present the basic equation from the cost model used to calculate the hospitalization costs. We present the equation first, define each of the terms in the equation, discuss each of the terms in detail, and then present other useful hospitalization related information. We conclude the chapter with an example calculation.

EQUATION

The equation for hospitalization costs is

$$C_h = P_e \times N_s \times N_{ps} \times S_k \times I_h \times \left[\sum \left(D_{hd} \times D_{ho}\right)\right] \times F_h, \quad \text{[Eq. 5-1]}$$

where

C_h = cost of hospitalization;

P_e = probability of exposure per year, based on the determined HP category;

N_s = number of systems—the total number individual items of materiel, equipment, or weapon systems in the Army inventory;

N_{ps} = number of persons per system;

S_k = HS factor based on the determined HS category;

I_h = incidence of hospitalization based on the determined risk level for the individual item of materiel;

[1] See Notes 3 and 4, Chapter 1.

[2] See Notes 1–5, Chapter 3.

[3] See Note 3, Chapter 1.

D_{hd} = factor for the average number of days in hospital per person based on historical hospital stay distribution;

D_{ho} = factor for the hospitalization population distribution for average number of days in hospital; and

F_h = average fee per hospital day.

DATA ELEMENTS

Hazard Probability (P_e)

Refer to Chapter 4 for this previously discussed common data element.

Number of Systems (N_s)

Refer to Chapter 4 for this previously discussed common data element.

Number of Persons per System (N_{ps})

Refer to Chapter 4 for this previously discussed common data element.

Hazard Severity (S_k)

Refer to Chapter 4 for this previously discussed common data element.

Incidence of Hospitalization (I_h)

DEFINITION

We developed the incidence of hospitalization factor from an incidence rate for Army hospitalization. We based the factor on the determined risk level for the individual item of materiel (Table 3-7).

OBJECTIVE

We developed this data element to provide a numerical value that we could use to estimate the number of persons hospitalized as a result of exposure to a hazard that resulted in illness or injury.

SOURCES

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S1, Active Duty Hospitalizations, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S2, Active Duty Hospitalization Rates, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S3, Total Active Duty Hospital Sickdays, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S4, Non-Effective Rates, Active Duty Hospitalization, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, Memorandum to Gary M. Bratt, Logistics Management Institute, *Active Duty Army Hospitalizations 1994,* Aberdeen Proving Ground, MD, 1994.

Derivation and Limitation

Derivation

We developed this data element using incidence rates for hospitalization from USACHPPM medical surveillance data (Appendix H). We analyzed each of the military system categories to determine the appropriate incidence of hospitalization rate to apply to each system category. We selected incidence rates for ICD-9 categories that linked to the nine health hazards, summed these values, and determined the mean incidence value. One standard deviation plus or minus provided the high and low incidence rates. We assumed a direct relationship to the industry categories for calculation purposes. We calculated hospitalization factors for high- (0.013), medium- (0.007), and low-risk systems (0.0006).

Limitation

The data used was actual Army data. We cannot currently determine the percentage of these hospitalizations that are really due to materiel incidents. This needs to occur through follow-up efforts. Because we determined an overall mean for all health hazards, individual hazard-related hospitalizations are the same for a given HP and HS.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataIncidenceValues in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Incidence Values button. The values can then be modified.

Hospitalization Length of Stay Factors (D_{hd})

DEFINITION

The hospitalization lengths of stay factors are average length of stay factors developed from combined categories of hospitalization length of stay duration. (Table 3-11).

OBJECTIVE

We developed this data element to determine an average hospitalization length of stay in four categories. Using four categories of days in the hospital provides for a future capability to discriminate between hospital stay times (bed days) and correlates directly with the hospitalization population distribution.

SOURCE

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S1, Active Duty Hospitalizations, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S2, Active Duty Hospitalization Rates, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S3, Total Active Duty Hospital Sickdays, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S4, Non-Effective Rates, Active Duty Hospitalization, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, Memorandum to Gary M. Bratt, Logistics Management Institute, *Active Duty Army Hospitalizations 1994,* Aberdeen Proving Ground, MD, 1994.

Derivation and Limitation

Derivation

We based this data element on the average number of days in the hospital factor (D_{hd}) from historical hospital length of stay data. We determined numerical factors for the four categories of days in the hospital. Three represent the midpoints of the range of days in each category (i.e., 1 day for <2 days, 3.5 days for 2–5 days, and 18 days for 6–30 days). For the >30 days category, we selected a conservative value of 30 days.

Limitation

The data used were actual Army data. We do not know how much overlap exists between bed days, convalescent sick days, or medical hold days. Recently received data suggests that overlap is minimal. Hospitalization data should concern bed days only. *Note: We did not count hospitalization in the lost time category. We need to include both clinic visits and hospitalization in the lost time category.*

Location in the Automated Cost Module

This data element can be accessed from a form named fdataDistribMultipliers in the Cost Avoidance Calculator. The elements are under the Constant (Dho_n) Category and the D_x Multiplier column.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Distribution Values button. The values can then be modified.

Hospitalization Population Distribution Factors (D_{ho})

Definition

The factor for hospitalization population distribution provides the percentage of persons hospitalized in each of four selected hospital length of stay categories. It varies based on the determined risk level for the individual item of materiel (Table 3-14).

Objective

We developed this data element to

- determine the percentage of persons within each hospital length of stay category and

- estimate the hospitalization length of stay as a result of persons being exposed to a hazard that resulted in illness or injury.

This distribution approach, when combined with the length of stay, provides a future capability to discriminate between hospital length of stay categories.

SOURCE

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S1, Active Duty Hospitalizations, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S2, Active Duty Hospitalization Rates, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S3, Total Active Duty Hospital Sickdays, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, "Table S4, Non-Effective Rates, Active Duty Hospitalization, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, Memorandum to Gary M. Bratt, Logistics Management Institute, *Active Duty Army Hospitalizations 1994,* Aberdeen Proving Ground, MD, 1994.

DERIVATION AND LIMITATION

Derivation

We developed distribution tables because event outcomes in a general population are not the same. We obtained actual hospitalization data for the specific diagnostic categories for 1 day, 2 days, 3–5 days, 6–10 days, 11–20 days, 21–30 days, and 31 or more days hospitalization.[4] We then combined the data into four categories. We based the factor for the hospitalization population distribution (D_{ho}) on historical data for the percentage of persons hospitalized for four selected hospital length of stay distribution categories. We determined numerical values for the four hospitalization population distribution factors within each risk category based on the historical data (Appendix J). The high-and low-risk

[4] See Note 5, Chapter 3.

category factors within each length of stay category represent normalized values of the medium (mean) values plus or minus one standard deviation.

Limitation

The Army data is reliable. We determined an overall mean population distribution for all health hazards. Individual hazard-specific population distributions may vary.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from a form named fdataDistribMultipliers in the Cost Avoidance Calculator. The elements are under the Constant (Dho_n) Category, and the D_y Multiplier column.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Distribution Values button. The values can then be modified.

Hospital Fee (F_h)

DEFINITION

The hospital fee variable (F_h) equals $1,669 per day, based on various types of hospital diagnosis related groups and the classification of the disease.

OBJECTIVE

We developed this data element to determine the average daily cost for hospitalization.

SOURCES

"CHAMPUS DRG Weights for Fiscal Year 1996," Table 2, CHAMPUS Weights and Threshold Summary, *Federal Register,* Volume 60, Number 207, 26 October 1995, pp. 54,851–54,862.

Walter Reed Army Medical Center (WRAMC), Third Party Collection Program, Memorandum to Gary M. Bratt, Logistics Management Institute, *Determining Cost of WRAMC Care,* Washington, DC, 4 December 1995.

Derivation and Limitation

Derivation

We developed this data element by initially correlating selected illness or injury diagnoses classifications with the health hazard categories.[5] We summed the DRG weighting factors from the table and determined the overall mean DRG weight. We summed the arithmetic mean length of stays for these same categories and determined an overall arithmetic mean length of stay. We obtained the cost per case factor from a large Army hospital. We determined the cost per case factor based on the overall arithmetic mean length of stays for hospitals. We then obtained the daily hospital fee by dividing the hospital cost per case factor by the overall mean length of stay (Appendix N). We found the average hospital fee was $1,669 per day.[6]

Limitation

The differences in the sizes of both hospitals and clinics can result in variable hospital costs. We minimized extreme cost variations by averaging historical data for many types of hospital and clinical services. However, we need to pursue obtaining the "true" hospital and clinic costs. Individual hazard-specific hospitalization outputs may vary.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The value can then be modified.

Other Outputs

In addition to the yearly and life-cycle hospitalization costs, we can estimate

- the number of persons hospitalized and
- the number of hospital days.

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[5] See Notes 1–5, Chapter 3.

[6] See Note 4, Chapter 1.

Number of Persons Hospitalized (N_{ph})

Using Equation 5-2, we determine the number of persons hospitalized (N_{ph}):

$$N_{ph} = P_e \times N_s \times N_{ps} \times S_k \times I_h, \qquad \text{[Eq. 5-2]}$$

where

- N_{ph} = number of persons hospitalized;
- P_e = probability of exposure per year, based on the determined HP category;
- N_s = number of systems—the total number individual items of materiel, equipment, or weapon systems in the Army inventory;
- N_{ps} = number of persons per system;
- S_k = HS factor based on the determined HS category; and
- I_h = incidence of hospitalization based on the determined risk level for the individual item of materiel.

Number of Hospital Days (N_h)

Using Equation 5-3, we determine the number of hospital days (N_h):

$$N_h = P_e \times N_s \times N_{ps} \times S_k \times I_h \times \sum \left(D_{hd} \times D_{ho}\right), \qquad \text{[Eq. 5-3]}$$

where

- N_h = total number of hospital days;
- P_e = probability of exposure per year, based on the determined HP category;
- N_s = number of systems—the total number individual items of materiel, equipment, or weapon systems in the Army inventory;
- N_{ps} = number of persons per system;
- S_k = HS factor based on the determined HS category;
- I_h = incidence of hospitalization based on the determined risk level for the individual item of materiel;
- D_{hd} = factor for the average number of days in hospital per person based on historical hospital stay distribution; and
- D_{ho} = factor for the hospitalization population distribution for average number of days in hospital.

These hospitalization component outputs may be useful to physicians, environmental engineers, environmental scientists, and other health care professionals as a basis for assessing the strengths and weaknesses of preventive health care. The outputs may also be useful in trend analyses to identify the system health hazards that are creating the greatest burden on the health care system. This allows corrective actions to be focused on the most hazardous systems currently in the inventory and preventive actions on similar types of systems in development.

Medical treatment facility commanders may use the data to assess performance and how well prevention activities are incorporated within the health care system. We could also use the data to tailor treatment capability to meet the demand. Preventive medicine program managers may use the measures to evaluate the effectiveness of their program.

EXAMPLE CALCULATION

We continue here with our system example from Chapter 3. Remember, the weapons combustion product hazard for the system had a RAC of 1, an HS Category of I, and an HP of A. We will calculate hospitalization costs, the number of people hospitalized, and the number of hospital days. Our known variables are

- P_e = 0.9;
- N_s = 7,400 systems;
- N_{ps} = 4 persons per system;
- S_k = 1;
- I_h = 0.013;
- D_{hd} = 1 day per person for <2 days, 3.5 days per person for 2–5 days, 18 days per person for 6–30 days, and 30 days per person for >30 days;
- D_{ho} = 0.4 for <2 days, 0.35 for 2–5 days, 0.17 for 6–30 days, and 0.08 for >30 days; and
- F_h = \$1,669 per day.

Using Equation 5-1, we find the total hospitalization costs per year (C_h):

$$C_h = P_e \times N_s \times N_{ps} \times S_k \times I_h \times \left[\sum \left(D_{hd} \times D_{ho}\right)\right] \times F_h$$

$$= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons per system} \times 1 \times 0.013$$
$$\times [(1 \text{ day per person} \times 0.40) + (3.5 \text{ days per person} \times 0.35)$$
$$+ (18 \text{ days per person} \times 0.17) + (1 \text{ day per person} \times 0.08)]$$
$$\times \$1{,}669 \text{ per day}$$
$$= \$4{,}095{,}187 \text{ per year.}$$

Using Equation 5-2, we find the number of people hospitalized per year (N_{ph}):

$$N_{ph} = P_e \times N_s \times N_{ps} \times S_k \times I_h$$

$$= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons per system} \times 1 \times 0.013$$

$$= 346 \text{ persons per year.}$$

Finally, using Equation 5-3, we find the total number of hospital days per year (N_h):

$$N_h = P_e \times N_s \times N_{ps} \times S_k \times I_h \times \sum \left(D_{hd} \times D_{ho} \right)$$

$$\begin{aligned} &= 0.9 \times 7400 \text{ systems} \times 4 \text{ persons per system} \times 1 \times 0.013 \\ &\quad \times [(1 \text{ day per person} \times 0.40) \\ &\quad + (3.5 \text{ days per person} \times 0.35) \\ &\quad + (18 \text{ days per person} \times 0.17) \\ &\quad + (1 \text{ day per person} \times 0.08)] \\ &= 2{,}454 \text{ days per year} \end{aligned}$$

SUMMARY

In this chapter we

- discussed the model component for hospitalization costs,
- defined the equations to estimate hospitalization costs,
- defined each data element and its data objective,
- described the data sources for each data element,
- described the data element locations in the automated cost module,
- discussed other useful information, and
- performed an example calculation.

In the next chapter, we will discuss the model component for lost time costs.

Chapter 6
Estimating Lost Time Costs

INTRODUCTION

We attribute lost time costs to time away from the job by persons exposed to a hazard that resulted in illness or injury.[1] We used the lost time data from the Bureau of Labor Statistics. We included data from

- *Results of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1993* and[2]
- tabular data on the percentage distribution of nonfatal occupational injuries and illnesses involving days away from work for 1992.[3]

In this chapter, we present the basic equation used to calculate lost time costs. We present the equation first, define each of the terms in the equation, discuss each of the terms in detail, and then present other useful lost time related information. We conclude the chapter with an example calculation.

EQUATION

The equation for lost time costs is

$$C_l = P_e \times N_s \times N_{ps} \times S_k \times I_l \times \left[\sum \left(D_{ld} \times D_{lt}\right)\right] \times W_d \times B_f , \quad \text{[Eq. 6-1]}$$

where

C_l = cost of days of lost time;

P_e = probability of exposure per year, based on the determined HP category;

N_s = number of systems—the total number individual items of materiel, equipment, or weapon systems in the Army inventory;

N_{ps} = number of persons per system;

S_k = HS factor based on the determined HS category;

[1] See Note 5, Chapter 1.

[2] See Note 6, Chapter 3.

[3] See Notes 7–9, Chapter 3.

I_l = incidence of lost time based on the determined risk level for the individual materiel item;

D_{ld} = number of lost workdays per person based on historical lost workday distribution;

D_{lt} = lost time population distribution based on average lost workday distribution;

W_d = average wage per day; and

B_f = wage fringe benefit factor.

DATA ELEMENTS

Hazard Probability (P_e)

Refer to Chapter 4 for this previously discussed common data element.

Number of Systems (N_s)

Refer to Chapter 4 for this previously discussed common data element.

Number of Persons per System (N_{ps})

Refer to Chapter 4 for this previously discussed common data element.

Hazard Severity (S_k)

Refer to Chapter 4 for this previously discussed common data element.

Incidence of Lost Time (I_l)

DEFINITION

We developed the incidence of lost time factor from an incidence rate for illness and injury involving lost time. We based the factor on the determined risk level for the individual item of materiel (Table 3-8).

OBJECTIVE

We developed this data element to estimate the number of persons losing time as a result of exposure to a hazard that resulted in illness or injury.

SOURCE

U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1993,* Washington, DC, December 1994.

DERIVATION AND LIMITATION

Derivation

We developed this data element from industry-wide illness and injury incidence rates involving lost time. We analyzed each of the categories of military systems to determine the appropriate industry lost time incidence rates to apply to each system category (Table 3-8). This was similar to what we did with the incidence rates for illness and injury and of hospitalization. We selected *single* incidence rates for each selected industry category from the Bureau of Labor Statistics data. We considered the data representative of the range of lost time rates within the Army for hazards associated with materiel systems. We selected industries with high (0.055), medium (0.054), and low (0.028) incidences of injury and illness with lost time. For example, the

- construction industry represents high-risk occupations (55 persons lose time per 1,000 per year),
- transportation industry represents occupations with medium risk (54 persons lose time per 1,000 per year), and
- service industry represents occupations with low risk (28 persons lose time per 1,000 per year).

Limitation

The data were not from the Army; however, they are reliable. We based our analysis on our experience and limited Army illness and injury lost time data. We also tapped the experience of a group of senior medical health risk assessors who had worked with these systems to correlate Army systems to industry categories. We cannot currently determine the percentage of these injuries and illnesses involving lost time that is really due to materiel incidents. This needs to occur through follow-up efforts. Because we determined an overall mean for all health hazards, individual hazard related illnesses and injuries with lost time are the same for a given HP and HS.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from the form named fdataIncidenceValues in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Incidence Values button. The values can then be modified.

Duration of Lost Time Factors (D_{ld})

Definition

The duration of lost time factors are average lost time factors developed from combined categories of lost work days (Table 3-12).

Objective

We developed this data element to provide a numerical value for an average duration of lost time in four duration of lost time categories. Using four categories of lost work days provides for a future capability to discriminate between lost work days and correlates directly with the lost time population distribution.

Source

U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1993,* Washington, DC, December 1994.

Derivation and Limitation

Derivation

We based the factor for the average number of days of lost time (D_{ld}) on historical distribution data for lost workdays. This approach provides a future capability to discriminate between selected lost day categories and correlates directly with the lost time population distribution. For this model component, we determined numerical values for the four categories of lost time in the same manner as the hospital factors. Three represent the midpoints of each category (i.e., 1 day for <2 days, 3.5 days for 2–5 days, and 18 days for 6–30 days). Because the historical data available only listed the lost time as >30 days, we selected a conservative value of 30 days for this category.

Limitation

The data were not from the Army; however, they are reliable. We do not know how much overlap exists with hospitalization. Recently received hospitalization bed day data suggests that overlap is minimal. *Note: We did not count hospitalization in the lost time category. However, we need to include both clinic visits and hospitalization in the lost time category in future versions of the Cost Avoidance Calculator.*

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from a form named fdataDistribMultipliers in the cost avoidance calculator. The elements are under the Constant (Dld_n) Category, and the *Dx* Multiplier column.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Distribution Values button. The values can then be modified.

Lost Time Population Distribution Factors (D_{lt})

DEFINITION

The population distribution factor for lost time provides the percentage of persons losing time in each of four selected duration of lost time categories. It varies based on the determined risk level for the individual item of materiel (Table 3-15).

OBJECTIVE

We developed this data element to

- determine the percentage of persons for each duration of lost time category and
- estimate the lost time as a result of persons being exposed to a hazard that resulted in illness or injury with lost time.

This distribution approach, when combined with the factor for the average number of days of lost time, provides for a future capability to discriminate between lost workday categories.

SOURCES

U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1993,* Washington, DC, December 1994.

U.S. Department of Labor, Bureau of Labor Statistics, tabular data on the percentage distribution of nonfatal occupational injuries and illnesses involving days away from work for 1992, Washington, DC, December 1994.

Derivation and Limitation

Derivation

Because events in a general population are not the same, we developed distribution tables for use in the calculations. We obtained actual lost time data for the nature of injury or event for 1 day, 2 days, 3–5 days, 6–10 days, 11–20 days, 21–30 days, and 31 or more days lost time.[4] We then combined the data into four categories. We determined the factors for lost time population distribution (D_{lt}) based on historical data for the percentage of persons losing time for each risk category (Appendix K). The high- and low-risk categories within each length of lost time category represent the normalized values of the medium (mean) values plus or minus one standard deviation.

Limitation

The data are not from the Army; however, they are reliable. We determined an overall mean population distribution for all health hazards. Individual hazard-specific population distributions may vary.

Location in the Automated Cost Module

This data element can be accessed from a form named fdataDistribMultipliers in the Cost Avoidance Calculator. The elements are under the Constant (Dld_n) Category, and the *Dy* Multiplier column.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Distribution Values button. The values can then be modified.

Average Wage (W_d)

Definition

The average wage per day (W_d) equals $53.97 and is based on the salaries and number of persons drawing each salary for a selected group of personnel.

Objective

We developed this data element to determine the average daily cost for lost time.

Source

"The 1996 Army Times Pay Chart," *U.S. Army Times*, 20 November 1995.

[4] See Notes 8 and 9, Chapter 3.

DERIVATION AND LIMITATION

Derivation

We determined the wage per day from the FY96 military pay chart.[5] We selected grade levels from the officer, warrant officer, and enlisted categories. We made these selections based on the potential for being involved with the systems (Appendix O). We calculated an average wage based on the 6 years of service rates and the number of personnel within each grade. We determined the salary rate to be $53.97.

Limitation

The wage calculated is reasonable. We could determine a more accurate value for specific systems by including only those military occupational specialties and pay grades for each type of system. However, it is not worth the effort. This is an area to pursue in the future. Individual hazard-specific wages may vary.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button from the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

Fringe Benefit (B_f)

DEFINITION

The fringe benefit factor equals 1.41 and is a standard factor within the government used for programming personnel budget requirements.

OBJECTIVE

We developed this data element to determine the daily wage related indirect costs for lost time.

SOURCE

Internal USACHPPM fringe benefit factor for programming personnel costs.

[5] See Note 5, Chapter 1.

Derivation and Limitation

Derivation

This is a subjective data element. We did not derive the fringe benefit factor 1.41 but selected it based on USACHPPM program management experience. We used the factor for programming personnel costs.

Limitation

The determination of this data element was subjective. We consider the factor representative of other corporate benefit factors.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataConstants in the cost avoidance calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

Other Outputs

In addition to the yearly and life-cycle lost time costs, we can estimate

- the number of persons losing time and
- the number of lost workdays.

Number of Persons Losing Time (N_{pl})

Using Equation 6-2, we determine the number of persons losing time (N_{pl}):

$$N_{pl} = P_e \times N_s \times N_{ps} \times S_k \times I_l, \qquad \text{[Eq. 6-2]}$$

where

N_{pl} = total number of persons losing time;

P_e = probability of exposure per year, based on the determined hazard probability category;

N_s = number of systems—the total number individual items of materiel, equipment, or weapon systems in the Army inventory;

N_{ps} = number of persons per system;

S_k = HS factor based on the determined HS category; and

I_l = incidence of lost time based on the determined risk level for the individual materiel item.

Number of Lost Workdays (N_l)

Using Equation 5-3, we determine the number of lost workdays (N_l):

$$N_l = P_e \times N_s \times N_{ps} \times S_k \times I_l \times \sum(D_{ld} \times D_{lt}),$$ [Eq. 6-3]

where

N_l = total number of days lost workdays;

P_e = probability of exposure per year, based on the determined hazard probability category;

N_s = number of systems—the total number individual items of materiel, equipment, or weapon systems in the Army inventory;

N_{ps} = number of persons per system;

S_k = HS factor based on the determined HS category;

I_l = incidence of lost time based on the determined risk level for the individual materiel item;

D_{ld} = number of lost workdays per person based on historical lost workday distribution; and

D_{lt} = lost time population distribution based on average lost workday distribution.

These lost time outputs may be useful to physicians, environmental engineers, environmental scientists, and other health care professionals as a basis for assessing the strengths and weaknesses of preventive health care. Preventive medicine program managers may use the outputs to evaluate the effectiveness of their program. They may also be useful in trend analyses to identify system-specific health hazards that degrade unit readiness and create the greatest burden on the health care system.

Program managers and unit commanders may use the data to assess the impact on unit readiness if a fielded system is without hazard abatement. The lost time data may be the most important data from a unit commander's perspective. Having soldiers away from the job decreases readiness. Should the length of time away from the job be significant, it may be necessary to acquire and train replacement personnel.

EXAMPLE CALCULATION

We continue here with our previous system example. Remember, the weapons combustion product hazard for the system was assigned a RAC of 1, an HS category of I, and an HP of A. We will calculate lost time costs, the number of people losing time, and the number of lost workdays. Our known variables are

P_e = 0.9;

N_s = 7,400 systems;

N_{ps} = 4 persons per system;

S_k = 1;

I_l = 0.055;

D_{ld} = 1 day per person for <2 days, 3.5 days per person for 2–5days, 18 days per person for 6–30 days, and 30 days per person for >30 days;

D_{lt} = 0.4 for <2 days, 0.35 for 2–5 days, 0.17 for 6–30 days, and 0.08 for >30 days;

w_d = \$53.97 per day; and

B_f = 1.41.

Using Equation 6-1, we determine total lost time costs per year (C_l):

$$C_l = P_e \times N_s \times N_{ps} \times S_k \times I_l \times \left[\sum \left(D_{ld} \times D_{lt}\right)\right] \times W_d \times B_f$$

$$\begin{aligned} &= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons per system} \times 1 \times 0.055 \\ &\quad \times [(1 \text{ day per person} \times 0.22) + (3.5 \text{ days per person} \times 0.30) \\ &\quad + (18 \text{ days per person} \times 0.29) + (1 \text{ day per person} \times 0.20)] \\ &\quad \times \$53.97/\text{day} \times 1.41 \\ &= \$1{,}392{,}614/\text{year}. \end{aligned}$$

Using Equation 6-2, we determine the number of people losing time (N_{pl}):

$$N_{pl} = P_e \times N_s \times N_{ps} \times S_k \times I_l$$

$$\begin{aligned} &= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons per system} \times 1 \times 0.055 \\ &= 1{,}465 \text{ persons/year.} \end{aligned}$$

Finally, using Equation 6-3, we determine the total number of lost workdays per year (N_l):

$$N_l = P_e \times N_s \times N_{ps} \times S_k \times I_l \times \sum \left(D_{ld} \times D_{lt} \right)$$

$$= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons per system} \times 1 \times 0.055$$

$$\times [(1 \text{ day per person} \times 0.22) + (3.5 \text{ days per person} \times 0.30)$$

$$+ (18 \text{ days per person} \times 0.29) + (1 \text{ day per person} \times 0.20)],$$

$$= 18{,}300 \text{ days/year.}$$

SUMMARY

In this chapter we

- discussed the model component for lost time costs,
- defined the equations to estimate lost time costs,
- defined each data element and its data objective,
- described the data sources for each data element,
- described the data element locations in the automated cost module,
- discussed other useful information, and
- performed an example calculation.

In the next chapter, we will discuss the model component for disability costs.

Chapter 7

Estimating Disability Costs

INTRODUCTION

We attribute disability costs to active-duty temporary and permanent disability compensation and VA disability compensation by persons exposed to a hazard that resulted in illness or injury.[1] We used the active duty disability data from a report by the Armed Forces Epidemiological Board Injury Prevention and Control Work Group.[2] We used veterans disability data from the VA National Center for Veteran Analysis and Statistics, Demographics Division.[3]

In this chapter, we present the basic equation from the cost model used to calculate disability costs. We present the equation first, define each of the terms in the equation, discuss each of the terms in detail, and then present other useful disability related information. We conclude the chapter with an example calculation.

EQUATION

The equation for lost time costs (Equation 7-1) is

$$
\begin{aligned}
C_{di} = {} & P_e \times N_s \times N_{ps} \times S_k \times \{[I_v \times T_v \times \sum (D_v \times B_v) \times 12 \text{ months / year}] \\
& + [(I_t \times B_t) + (I_p \times B_p)]\}
\end{aligned}
$$

[Eq.7-1]

where

C_{di} = cost of disabilities;

P_e = probability of exposure per year, based on the determined HP category;

N_s = number of systems—the total number individual items of materiel, equipment, or weapon systems in the Army inventory;

N_{ps} = number of persons per system;

S_k = HS factor based on the determined HS category;

[1] See Notes 6–8, Chapter 1.

[2] See Note 6, Chapter 1.

[3] See Notes 10–14, Chapter 3.

I_v = incidence of VA disability based on the determined risk level for the individual item of materiel, equipment, or weapon system;

T_v = VA disability adjustment factor for delayed disability;

D_v = VA disability population factor based on historical rate of disability distribution;

B_v = VA disability compensation per month per rate of disability;

I_t = incidence of active-duty temporary disability;

B_t = active-duty temporary disability compensation per year;

I_p = incidence of active-duty permanent disability; and

B_p = active-duty permanent disability compensation per year.

DATA ELEMENTS

Hazard Probability (P_e)

Refer to Chapter 4 for this previously discussed common data element.

Number of Systems (N_s)

Refer to Chapter 4 for this previously discussed common data element.

Number of Persons per System (N_{ps})

Refer to Chapter 4 for this previously discussed common data element.

Hazard Severity (S_k)

Refer to Chapter 4 for this previously discussed common data element.

Incidence of VA Disability (I_v)

DEFINITION

We developed the VA disability incidence factor from incidence rates for VA disabilities involving injury or illness. We based the factor on the determined risk level for the individual item of materiel (Table 3-9).

OBJECTIVE

We developed this data element to estimate the number of persons who become disabled as a result of exposure to a hazard that resulted in illness or injury.

Sources

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Grand Total Report as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Persian Gulf War Report as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Specific Diagnosis, Major-Disability Compensation, Total Service Connected as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Numerical Index of Disabilities," 38 CFR, Chapter 1, Appendix B to Part 4, *Pensions, Bonuses and Veteran's Relief,* Washington, DC, July 1994.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Alphabetical Index of Disabilities," 38 CFR, Chapter 1, Appendix C to Part 4, *Pensions, Bonuses and Veteran's Relief,* Washington, DC, July 1994.

Derivation and Limitation

Derivation

We developed this data element from the VA National Center for Veteran Analysis and Statistics data involving disability compensation by class of major disability by combined degree. We analyzed each of the categories of military systems to determine the appropriate incidence of VA disability to apply to each system category (Table 3-9), just as we did with the incidence of illness and injury. We selected classifications of illness or injury diagnoses that linked to the nine categories of health hazards. We summed these values and determined the mean incidence value (Appendix I). The high- and low-risk category levels represent the medium (mean) value plus or minus one standard deviation. Because the value for low risk was a negative number, we selected the statistical minimum for the low risk category. We assumed a direct relationship to the industry categories for calculation purposes. We calculated disability incidence factors for high- (0.032), medium- (0.012), and low-risk systems (0.00005).

Limitation

We used the VA National Center for Veteran Analysis and Statistics data. The data are reliable. We cannot currently determine the percentage of these disabilities that are really due to materiel incidents. This needs to occur through follow-up efforts. Because we determined an overall mean for all health hazards, individual hazard disabilities are the same for a given HP and HS.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from the form named fdataIncidenceValues in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Incidence Values button. The values can then be modified.

Incidence of Active-Duty Temporary Disability (I_t)

DEFINITION

We developed the incidence factor for active-duty temporary disability from active duty military temporary disability data.

OBJECTIVE

We developed this data element to estimate the number of persons who become disabled as a result of exposure to a hazard that resulted in illness or injury.

SOURCE

COL Bruce Jones, MD, and Barbara Hansen, Ph.D., et al., "Injuries in the Military: A Hidden Epidemic," unpublished, a report for the Armed Forces Epidemiological Board, Injury Prevention and Control Work Group, November 1996.

DERIVATION AND LIMITATION

Derivation

We determined an incidence rate for active-duty temporary disability (I_t) from a report by the Armed Forces Epidemiological Board Injury Prevention and Control Work Group on illness and injury.[4] The report provided us basic active-duty temporary disability incidence and compensation data. For this incidence rate, we determined a single incidence only because of the limited data presented in the report. The services evaluate approximately 2% of service members for disability

[4] See Note 6, Chapter 1.

annually. Of the persons evaluated the services discharge or classify permanently disabled approximately 60%. This provides an incidence of 12 persons per 1,000 persons. We then determined the ratio of temporary retired persons divided by permanently retired persons. This ratio multiplied by the overall incidence results in an active-duty temporary disability incidence rate of 1 person disabled per 1,000 soldiers per year. This relates to a factor of 0.001 (Appendix Q).

Limitation

The data are reliable. The report provided limited active-duty disability information that was sufficient to allow determination of a temporary incidence factor. We cannot currently determine the percentage of these temporary disabilities that are really due to materiel incidents. This needs to occur through follow-up efforts. Because we determined an overall mean for all health hazards, individual hazard disabilities are the same for a given HP and HS.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

Incidence of Active-Duty Permanent Disability (I_p)

Definition

We developed the incidence factor for active-duty permanent disability from active duty military permanent disability.

Objective

We developed this data element to estimate the number of persons who become disabled as a result of exposure to a hazard that resulted in illness or injury.

Source

COL Bruce Jones, MD, and Barbara Hansen, Ph.D., et al., "Injuries in the Military: A Hidden Epidemic," unpublished, a report for the Armed Forces Epidemiological Board, Injury Prevention and Control Work Group, November 1996.

Derivation and Limitation

Derivation

We selected an incidence rate for active-duty permanent disability (I_p) from the report by the Armed Forces Epidemiological Board Injury Work Group on illness and injury.[5] The report provided us basic information on active-duty permanent disability. For this incidence rate, we selected a single incidence only because of the limited data presented in the report. The services evaluate approximately 2% of service members for disability annually. Of the persons evaluated the services discharge or classify permanently disabled approximately 60%. This provides an incidence of 12 persons per 1,000 persons. We then determined the ratio of temporary retired persons divided by permanently retired persons. Subtracting this ratio from 1 and multiplying by the overall results in an active-duty temporary disability incidence rate of 11 persons disabled per 1,000 soldiers per year. This relates to a factor of 0.011 (Appendix R).

Limitation

The data are reliable. The report provided limited active-duty disability information that was sufficient to allow determination of a permanent incidence factor. We cannot currently determine the percentage of these permanent disabilities that are really due to materiel incidents. Because we determined an overall mean for all health hazards, individual hazard disabilities are the same for a given HP and HS.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Next, click on the "Constant Values" button. The values can then be modified.

VA Disability Population Distribution Factor (D_v)

Definition

The population distribution factor for VA disability provides the percentage of persons disabled in each of four selected degrees of disability distribution categories. It varies based on the determined risk level for the individual item of materiel (Table 3-16).

[5] See Note 6, Chapter 1.

OBJECTIVE

We developed this data element to

- determine the percentage of persons for each degree of disability category and
- estimate the number of persons who become disabled as a result of exposure to a hazard that resulted in illness or injury.

The four categories allow for the future capability to discriminate between degree of disability costs.

SOURCE

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Grand Total Report as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Persian Gulf War Report as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Specific Diagnosis, Major-Disability Compensation, Total Service Connected as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Numerical Index of Disabilities," 38 CFR, Chapter 1, Appendix B to Part 4, *Pensions, Bonuses and Veteran's Relief*, Washington, DC, July 1994.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Alphabetical Index of Disabilities," 38 CFR, Chapter 1, Appendix C to Part 4, *Pensions, Bonuses and Veteran's Relief*, Washington, DC, July 1994.

DERIVATION AND LIMITATION

Derivation

We developed distribution tables because event outcomes in a general population are not the same. We obtained actual disability data for the specific diagnostic categories for disabilities in 10% increments.[6] We combined the data into four degrees of disability distribution categories. We based the factor for the disability population distribution (D_v) on historical data for the percentage of persons disabled for these categories, which were 10%, 20%–50%, 60%–90%, and 100%. We determined four distribution factors for each risk category (Appendix L). The high- and low-risk category levels represent the normalized values of the medium (mean) values plus or minus one standard deviation.

Limitations

The Army and VA data are reliable. We determined an overall mean for all health hazards. Individual hazard-specific population distributions may vary.

Location in the Automated Cost Module

This data element can be accessed from a form named fdataDistribMultipliers in the Cost Avoidance Calculator. The elements are under the Constant (Dva_n) Category, and the *Dy* Multiplier column.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Distribution Values button. The values can then be modified.

VA Disability Compensation Factor (B_v)

Definition

The VA disability compensation factor provides monthly compensation data for a selected degree of disability categories (Table 3-18). The VA pays disability compensation in 10% disability increments.

Objective

We developed this data element to determine the monthly costs for selected degrees of disability. The approach, when combined with the VA disability population distribution factor for degree of disability, provides a future capability to discriminate between degree of disability costs.

Sources

U.S. Department of Veterans Affairs, *Veterans Benefits, Fast Fact 1, Disability Compensation,* Washington, DC, 1994.

U.S. Department of Veterans Affairs, *Federal Benefits for Veterans and Dependents,* Washington, DC, 1994 edition.

[6] See Note 5, Chapter 1.

Derivation and Limitation

Derivation

We based the VA disability compensation (B_V) factor on historical data for selected degree of disability categories.[7] We determined values for the four VA disability compensation factors by degree of disability population distribution factors (Appendix P). When appropriate, we summed the monthly compensation values for each degree of disability category. We then determined the mean value for each category. We determined B_v factors of $91 for the 10% category, $340.25 for the 20%–50% category, $915.50 for the 60%–90% category, and $1,865 for the 100% category.

Limitation

We used VA data, which are reliable. The VA adjusts the monthly compensation values on a yearly basis. Because we determined an overall mean for all health hazards, individual hazard disabilities are the same for a given HP and HS.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

Active-Duty Temporary Disability Compensation Factor (B_t)

Definition

The active-duty temporary disability compensation factor (B_t) equals $9,242 per person per year based on historical compensation for active-duty temporary disability.

Objective

We developed this element to estimate the yearly costs for temporary disability while on active duty.

[7] See Notes 7 and 8, Chapter 1.

SOURCE

COL Bruce Jones, MD, and Barbara Hansen, Ph.D., et al., "Injuries in the Military: A Hidden Epidemic," unpublished, a report for the Armed Forces Epidemiological Board, Injury Prevention and Control Work Group, November 1996.

DERIVATION AND LIMITATION

Derivation

We based the active-duty temporary disability compensation factor (B_t) on 1990 historical compensation costs for permanent and temporary disability in the three military services (Appendix Q). We used a 15% adjustment factor to account for compensation costs in 1996. We divided the total temporary disability costs by the number of temporarily disabled persons and multiplied by the adjustment factor. We assumed that the temporary disability list numbers would remain constant—that is, persons removed from the list are replaced by another person. We found the average active-duty temporary disability compensation to be $9,242 per year per person.

Limitation

The data are somewhat subjective; however, they are reliable. The report provided limited compensation and active-duty disability information sufficient to determine temporary disability compensation factors.[8] We did not correlate the factor with health hazards.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

Active-Duty Permanent Disability Compensation Factor (B_p)

DEFINITION

The active-duty permanent disability compensation factor (B_p) equals $12,862 per person per year based on historical compensation data for active-duty permanent disability.

[8] See Note 6, Chapter 1.

OBJECTIVE

We developed this data element to estimate the yearly costs for permanent disability incurred while on active duty.

SOURCE

COL Bruce Jones, MD, and Barbara Hansen, Ph.D., et al., "Injuries in the Military: A Hidden Epidemic," unpublished, a report for the Armed Forces Epidemiological Board, Injury Prevention and Control Work Group, November 1996.

DERIVATION AND LIMITATION

Derivation

We based the active-duty permanent disability compensation factor (B_p) on 1990 historical compensation costs for permanent and temporary disability in the three military services (Appendix R). We used a 15% adjustment factor to account for compensation costs in 1996. We divided the total permanent disability costs by the number of permanently disabled persons and multiplied by the adjustment factor. We assumed that the permanent disability list numbers would remain constant. We found the average active-duty permanent disability compensation to be $12,864 per year per person.

Limitation

The data are somewhat subjective; however, they are reliable. The report provided limited compensation and active-duty disability information that was sufficient to allow selection of permanent incidence and compensation factors.[9] We did not correlate the factor with health hazards.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

[9] See Note 6, Chapter 1.

VA Disability Adjustment Factor (T_v)

Definition

The VA disability adjustment factor (T_v) reduces the VA disability population. Eligible veterans may receive VA disability after leaving military service.

Objective

We developed this data element to estimate the number of persons who are eligible for a VA disability because of exposure to a hazard that resulted in illness or injury.

Source

We developed this data element using a panel of occupational health experts.

Derivation and Limitation

Derivation

An in-house panel of occupational health experts developed this data element. VA disability compensation usually occurs after leaving military service. The VA disability adjustment factor (T_v) reduces the VA disability population. We would likely see disabilities compensated by the VA only later in the life of a system. We assumed that for a system with an operational life of 20 years, we would expect VA disabilities at 15 years. Considering this assumption, we calculated a VA disability adjustment factor of 0.25 (5 years/20 years).

Limitation

The determination of this data element was very subjective. The pursuit and development of a "true" adjustment factor for VA disability is desirable.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

OTHER OUTPUTS

In addition to the yearly and life-cycle disability costs, we can estimate the number of persons disabled (N_{pd}).

We determine the number of persons disabled (N_{pd}) by using Equation 7-2:

$$N_{pd} = P_e \times N_s \times N_{ps} \times S_k \times \left[\left(T_v \times I_v + I_t + I_p\right)\right], \quad \text{[Eq. 7-2]}$$

where

N_{pd} = total number of persons disabled;

P_e = probability of exposure per year, based on the determined hazard probability category;

N_s = number of systems—the total number individual items of materiel, equipment, or weapon systems in the Army inventory;

N_{ps} = number of persons per system;

S_k = HS factor based on the determined HS category;

T_v = VA disability adjustment factor for delayed disability;

I_v = incidence of VA disability based on the determined risk level for the individual materiel item;

I_t = incidence of active-duty temporary disability; and

I_p = incidence of active-duty permanent disability.

As with other outputs previously discussed, disability outputs may be useful to physicians, environmental engineers, environmental scientists, and other health care professionals as an indicator for assessing the strengths and weaknesses of preventive health care. The outputs may be useful for determining when disabilities occur in a soldier's career. They may also be useful in trend analyses to identify the system health hazards that create the greatest burden on the health care system. This, along with the other measures discussed in previous chapters, allows corrective actions to be focused on the most hazardous systems currently in the inventory and preventive actions on similar types of systems in development.

Medical treatment facility commanders may use the data to assess performance and how well prevention activities are incorporated within the health care system. They may also use the data for trend analyses to assess the future burden on Army and VA health care systems.

Preventive medicine program managers may use this output to evaluate the effectiveness of their programs.

EXAMPLE CALCULATION

We continue here with our previous system example. Remember, the weapons combustion product hazard for the system was assigned a RAC of 1, an HS Category of I, and an HP of A. We will calculate disability costs and the number of people disabled. Our known variables are

P_e = 0.9;

N_s = 7,400 systems;

N_{ps} = 4 persons per system;

S_k = 1;

I_v = 0.032;

T_v = 0.25;

D_v = 0.44 for 10% disability, 0.42 for disability between 20% and 50%, 0.10 for disability between 60% and 90%, and 0.04 for a disability of 100%; B_v = $91.00 per month per person for a 10% disability, $340.25 per month per person for a disability between 20% and 50%, $915.50 per month per person for a disability between 60% and 90%, and $1,865.00 per month per person for a disability of 100%;

I_t = 0.001;

B_t = $9,242 per year per person;

I_p = 0.011; and

B_p = $12,864 per year per person.

Using Equation 7-1, we determine total disability costs (C_{di}):

$$\begin{aligned}
C_{di} &= P_e \times N_s \times N_{ps} \times S_k \times \Big\{\Big[I_v \times T_v \times \sum \left(D_v \times B_v\right) \\
&\quad \times 12 \text{ months/year}\Big] + \Big[\left(I_t \times B_t\right) + \left(I_p \times B_p\right)\Big]\Big\} \\
&= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons/year exposed} \times 1 \\
&\quad \times \Big\{\Big[0.032 \times 0.25 \times \big(0.44 \times \$91/\text{ month/person} \\
&\quad + 0.42 \times \$340.25/\text{ month/person} \\
&\quad + 0.1 \times \$915.50/\text{month/person} \\
&\quad + 0.04 \times \$1{,}865/\text{month/person}\big) \times 12 \text{ month /year}\Big] \\
&\quad + \Big[\left(0.001 \times \$9{,}242/\text{year/person}\right) \\
&\quad + \left(0.011 \times \$12{,}864/\text{year/person}\right)\Big]\Big\} \\
&= \$4{,}908{,}663/\text{year}.
\end{aligned}$$

Using Equation 7-2, we determine the number of people disabled (N_{pd}):

$$
\begin{aligned}
N_{pd} &= P_e \times N_s \times N_{ps} \times S_k \times \left[\left(T_v \times I_v \right) + \left(I_t + I_p \right) \right], \\
&= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons / year exposed} \times 1 \\
&\quad \times \left[(0.25 \times 0.032) + (0.001 + 0.011) \right], \\
&= 533 \text{ persons /year.}
\end{aligned}
$$

SUMMARY

In this chapter we

- discussed the model component for disability costs,
- defined the equations to estimate disability costs,
- defined each data element and its data objective,
- described the data sources for each data element,
- described the data element locations in the automated cost module,
- discussed other useful information, and
- performed an example calculation.

In the next chapter, we will discuss the model components for rehabilitation costs.

Chapter 8
Estimating Rehabilitation Costs

INTRODUCTION

We attribute rehabilitation costs to rehabilitation benefits for persons exposed to a hazard that resulted in illness or injury.[1] We used the rehabilitation data from VA as our primary data source for calculating rehabilitation costs.[2]

In this chapter, we present the basic equation from the cost model used to calculate disability costs. We present the equation first, define each of the terms in the equation, discuss each of the terms in detail, and present other outputs. We conclude the chapter with an example calculation.

EQUATION

The equation for lost time costs (Equation 8-1) is

$$C_r = P_e \times N_s \times N_{ps} \times S_k \times I_v \times T_v \times \sum D_r \times Q_r \times B_r , \qquad \text{[Eq. 8-1]}$$

where

C_r = cost of rehabilitation;

P_e = probability of exposure per year, based on the determined HP category;

N_s = number of systems—the total number individual items of materiel, equipment, or weapon systems in the Army inventory;

N_{ps} = number of persons per system, or crew size for a system or item;

S_k = HS factor based on the determined HS;

I_v = incidence of VA disability based on the determined risk level for the individual item of materiel;

T_v = VA disability adjustment factor for delayed disability;

D_r = eligible VA disability population factor based on rate of disability distribution equal to or greater than 20 percent;

Q_r = VA rehabilitation qualification factor; and

B_r = VA rehabilitation benefit per year per person.

[1] See Notes 7 and 8, Chapter 1.

[2] See Notes 7, 8, and 10, Chapter 1.

DATA ELEMENTS

Hazard Probability (P_e)

Refer to Chapter 4 for this previously discussed common data element.

Number of Systems (N_s)

Refer to Chapter 4 for this previously discussed common data element.

Number of Persons per System (N_{ps})

Refer to Chapter 4 for this previously discussed common data element.

Hazard Severity (S_k)

Refer to Chapter 4 for this previously discussed common data element.

Incidence of VA Disability (I_v)

DEFINITION

We developed the VA disability incidence factor from incidence rates for VA disabilities involving injury or illness. We based the factor on the determined risk level for the individual item of materiel (Table 3-9).

OBJECTIVE

We developed this data element to estimate the number of persons who become disabled as a result of exposure to a hazard that resulted in illness or injury.

SOURCES

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Grand Total Report as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Persian Gulf War Report as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Specific Diagnosis,*

Major-Disability Compensation, Total Service Connected as of March 1995, Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Numerical Index of Disabilities," 38 CFR, Chapter 1, Appendix B to Part 4, *Pensions, Bonuses and Veteran's Relief,* Washington, DC, July 1994.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Alphabetical Index of Disabilities," 38 CFR, Chapter 1, Appendix C to Part 4, *Pensions, Bonuses and Veteran's Relief,* Washington, DC, July 1994.

Derivation and Limitation

Derivation

We developed this data element from the VA National Center for Veteran Analysis and Statistics data involving disability compensation by class of major disability by combined degree. We analyzed each of the categories of military systems to determine the appropriate incidence of VA disability to apply to each system category (Table 3-9), just as we did with the incidence of illness and injury. We selected classification of illness or injury diagnoses that linked to the nine categories of health hazards. We summed these values and determined the mean incidence value (Appendix I). The high- and low-risk category levels represent the medium (mean) value plus or minus one standard deviation. Because the low-risk value was a negative number, we selected the statistical minimum for the low-risk category. We assumed a direct relationship to the industry categories for calculation purposes. We calculated disability incidence factors for high- (0.032), medium- (0.012), and low-risk systems (0.00005).

Limitation

We used the VA National Center for Veteran Analysis and Statistics data. The data are reliable. We cannot currently determine the percentage of these disabilities that are really due to materiel incidents. This needs to occur through follow-up efforts. Because we determined an overall mean for all health hazards, individual hazard disabilities are the same for a given HP and HS.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataIncidenceValues in the cost avoidance calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Incidence Values button. The values can then be modified.

VA Disability Adjustment Factor (T_v)

Definition

The VA disability adjustment factor (T_v) reduces the VA disability population. Eligible veterans may receive VA disability after leaving military service.

Objective

We developed this data element to estimate the number of persons who are eligible for a VA disability because of exposure to a hazard that resulted in illness or injury.

Source

We developed this data element using a panel of occupational health experts.

Derivation and Limitation

Derivation

An in-house panel of occupational health experts developed this data element. VA disability compensation usually occurs after leaving military service. The VA disability adjustment factor (T_v) reduces the VA disability population. We would likely see disabilities compensated by the VA only later in the life of a system. We assumed that for a system with an operational life of 20 years, we would expect VA disabilities at 15 years. Considering this assumption, we calculated a VA disability adjustment factor of 0.25 (5 years/20 years).

Limitation

The determination of this data element was subjective. The pursuit and development of a "true" adjustment factor for VA disability is desirable.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataConstants in the cost avoidance calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

Eligible VA Disability Population Distribution Factor (D_r)

DEFINITION

The eligible population distribution factor for VA rehabilitation provides the percentage of persons eligible for rehabilitation services. There are three selected degrees of disability distribution categories. It varies based on the determined risk level for the individual item of materiel (Table 3-17).

OBJECTIVE

We developed this data element to

- determine the percentage of rehabilitation eligible persons for each degree of disability category and
- estimate the number of rehabilitation cases resulting from exposure to a hazard that resulted in illness or injury.

This distribution approach provides a future capability to discriminate between categories of rehabilitation costs.

SOURCES

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Grand Total Report as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Persian Gulf War Report as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Specific Diagnosis, Major-Disability Compensation, Total Service Connected as of March 1995,* Washington, DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Numerical Index of Disabilities," 38 CFR, Chapter 1, Appendix B to Part 4, *Pensions, Bonuses and Veteran's Relief,* Washington, DC, July 1994.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Alphabetical Index of Disabilities," 38 CFR, Chapter 1, Appendix C to Part 4, *Pensions, Bonuses and Veteran's Relief,* Washington, DC, July 1994.

DERIVATION AND LIMITATION

Derivation

We developed distribution tables because event outcomes in a general population are not the same. We obtained actual disability data for the specific diagnostic categories for disabilities in 10 percent increments.[3] We combined the data into four degrees of disability distribution categories. We selected the factor for the eligible VA disability population distribution (D_r) based on historical data for the percentage of persons disabled for three selected disability distribution categories. These categories were 20%–50%, 60%–90%, and 100%. We determined three distribution factors for each risk category. Only people with a disability of 20% or more are eligible for rehabilitation. The factor for the 10% category was 0. The high- and low-risk category levels represent the normalized values of the medium (mean) values plus or minus one standard deviation. The values in Table 3-17 are the same as those listed in Table 3-16, except for the 10% category.

Limitation

The VA data are reliable. We determined an overall mean for all health hazards. Individual hazard-specific population distributions may vary.

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from a form named fdataDistribMultipliers in the cost avoidance calculator. The elements are under the Constant (Drh_n) Category and the Dy Multiplier column.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Distribution Values button. The values can then be modified.

VA Qualification Factor for Rehabilitation (Q_r)

DEFINITION

The VA qualification factor (Q_r) for rehabilitation determines the qualified population from the VA rehabilitation eligible population.

[3] See Notes 10–12, Chapter 3.

Objective

We developed this data element to estimate the number of persons who qualify for VA rehabilitation services.

Source

We developed this data element using a panel of occupational health experts.

Derivation and Limitation

Derivation

An in-house panel of occupational health experts developed this data element. We assumed the qualification factor for rehabilitation (Q_r) to be 0.05. We selected this value based on an estimate of the percentage of people who may apply for and be accepted for rehabilitation benefits.

Limitation

The determination of this data element was subjective. The pursuit and development of a "true" disability qualification factor is desirable. The qualification factor selected may be low; for example, the Baltimore VA region estimated its acceptance rate for the VA rehabilitation program to be greater than 20%. However, the value is adequate for use in this model.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

VA Rehabilitation Benefit Factor (B_r)

Definition

The VA rehabilitation benefit factor (B_r) equals $12,000 per person per year. It is a subjective data element.

Objective

We developed this data element to estimate the costs for persons receiving rehabilitation services.

SOURCES

We developed this data element using a panel of occupational health experts and the following additional sources:

- U.S. Department of Veterans Affairs, *Veterans Benefits, Fast Fact 1, Disability Compensation,* Washington, DC, 1994
- U.S. Department of Veterans Affairs, *Federal Benefits for Veterans and Dependents,* Washington, DC, 1994 edition
- U.S. Department of Veterans Affairs. *Veterans Benefits, Fast Fact 5, Vocational Rehabilitation (Chapter 31)*, Washington, DC, 1994.

DERIVATION AND LIMITATION

Derivation

We estimated the rehabilitation benefit factor (B_r) to be $12,000 per year per person.

Limitation

The determination of this data element was subjective. The pursuit and development of a "true" disability adjustment factor is desirable. Rehabilitation benefits may vary per person, but we considered $12,000 to be a reasonable estimate. Other benefits may be available for eligible disabled persons, but we did not consider these other benefits.[4]

LOCATION IN THE AUTOMATED COST MODULE

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Constant Values button. The values can then be modified.

OTHER OUTPUTS

In addition to the yearly and life-cycle rehabilitation costs, we can estimate the number of rehabilitation cases.

[4] See Notes 8 and 10, Chapter 1.

Using Equation 8-2, we determine the number of rehabilitation cases (N_r):

$$N_r = N_e \times S_k \times I_v \times T_v \times \sum D_r \times Q_r, \qquad \text{[Eq. 8-2]}$$

where

N_r = total number of rehabilitation cases;

S_k = HS factor based on the determined HS;

I_v = incidence of VA disability based on the determined risk level for the individual materiel item;

T_v = VA disability adjustment factor for delayed disability;

D_r = eligible VA disability population based on rate of disability distribution equal to or greater than 20%; and

Q_r = VA rehabilitation qualification factor.

As with other outputs previously discussed, rehabilitation outputs may be useful to physicians, environmental engineers, environmental scientists, and other health care professionals to indicate the strengths and weaknesses of preventive health care. The outputs can be useful in determining what types of disabilities require rehabilitation. They may also be useful in trend analyses to identify the system health hazards creating the greatest burden on the health care system. These outputs, along with the others discussed in previous chapters, allow corrective actions to be focused on the most hazardous systems currently in the inventory and preventive actions on similar types of systems in development.

Medical treatment facility commanders may use the data to assess performance and how well prevention activities are incorporated within the health care system. They may also use the data for trend analyses to assess the future burden on Army and VA health care systems.

Preventive medicine program managers may use this output to evaluate the effectiveness of their programs.

EXAMPLE CALCULATION

We continue here with our previous system example. The system was assigned a RAC of 1, an HS category of I, and an HP of A. We will calculate rehabilitation costs and the number of people rehabilitated. Our known variables are

N_e = 26,640 persons per year exposed;

P_e = 0.9;

N_s = 7,400 systems;

N_{ps} = 4 persons per system;

S_k = 1;

I_v = 0.032;

T_v = 0.25;

D_v = 0.42 for disability between 20% and 50%, 0.10 for disability between 60% and 90%, and 0.04 for a disability of 100%;

Q_r = 0.05; and

B_r = \$12,000 per year per person.

Using Equation 8-1, we determine total rehabilitation costs (C_r):

$$\begin{aligned} C_r &= P_e \times N_s \times N_{ps} \times S_k \times I_v \times T_v \times \sum D_v \times Q_r \times B_r \\ &= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons/system/year exposed} \times 1 \times 0.032 \times 0.25 \\ &\quad \times [0.42 + 0.1 + 0.04] \times 0.05 \times \$12{,}000\text{/person}, \\ &= \$71{,}608\text{/year}. \end{aligned}$$

Using Equation 8-2, we determine the number of rehabilitation cases:

$$\begin{aligned} N_r &= P_e \times N_s \times N_{ps} \times S_k \times I_v \times T_v \sum D_v \times Q_r \\ &= 0.9 \times 7{,}400 \text{ systems} \times 4 \text{ persons/system /year exposed} \times 1 \times 0.032 \times 0.25 \\ &\quad \times [0.42 + 0.1 + 0.04] \times 0.05 \\ &= 6 \text{ cases / year}. \end{aligned}$$

SUMMARY

In this chapter, we

- discussed the model component for rehabilitation costs,
- defined the equations to estimate rehabilitation costs,
- defined each data element and its data objective,
- described the data sources for each data element,
- described the data element locations in the automated cost module,
- discussed other useful information, and
- performed an example calculation.

In the next chapter, we will discuss the model component for death costs.

Chapter 9

Estimating Death Costs

INTRODUCTION

We attribute death costs to payment of insurance proceeds and the cost of casualty assistance, honor guard, burial, family, and other expenses as a result of the death of persons exposed to a hazard that resulted in illness or injury complications. We used a report by the Armed Forces Epidemiological Board Injury Prevention and Control Work Group[1] and the death benefit paid by the Serviceman's Group Life Insurance as our primary sources of death data.

In this chapter, we present the basic equation from the cost model used to calculate death costs. We present the equation first, define each of the terms in the equation, discuss each of the terms in detail, and then present other useful death related information. We conclude the chapter with an example calculation.

EQUATION

The equation for death costs (Equation 9-1) is as follows:

$$C_{de} = N_{de} \times B_{de}, \qquad \text{[Eq. 9-1]}$$

where

C_{de} = cost of death,

N_{de} = number of deaths per year, and

B_{de} = death benefit and expenses.

DATA ELEMENTS

Death Benefit and Expenses (B_{de})

DEFINITION

The death benefit and expenses factor (B_{de}) equals $200,000. It encompasses costs paid by insurance policies plus expenses relating to casualty assistance, honor

[1] See Note 6, Chapter 1.

guard, funeral and burial, family, and other related expenses as a result of the death of persons exposed to a hazard that resulted in illness or injury complications.

Objective

We developed this data element to determine death benefit costs and expenses related to an item or system.

Source

We developed this data element using a panel of occupational health experts.

Derivation and Limitation

Derivation

We determined a subjective value of $200,000 for the death benefit and expenses factor. Our cost of death includes costs paid by insurance policies plus expenses relating to casualty assistance, honor guard, funeral and burial, family, and other related expenses. Serviceman's Group Life Insurance can pay a beneficiary up to $200,000 for the death of a soldier.

Limitation

This data element is subjective because there is great variability in calculating the cost of a person's death. Values presented in the literature have varied from $100,000 to over $1,000,000. Other expenses incurred by the Army can be substantial. As previously discussed, we did not consider training and personnel replacement costs. It is another area deserving further research to establish a "true" death benefit and expenses value.

Location in the Automated Cost Module

This data element can be accessed from the form named fdataConstants in the Cost Avoidance Calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Next, click on the Constant Values button. The values can then be modified.

Number of Deaths (N_{de})

DEFINITION

The number of deaths factor (N_{de}) is the number of deaths per year that we can expect to occur because of exposure to hazards associated with a system or item being evaluated. We based the factor on the determined HS category (Table 3-19).

OBJECTIVE

We developed the element to determine the number of deaths associated with a system or item.

SOURCE

We developed this data element using a panel of occupational health experts.

DERIVATION AND LIMITATION

Derivation

We determined a value of 1 death for HS category I and a value of zero for all other HS categories. We assumed that only rare circumstances would allow more than 1 death per year related to a materiel system before an immediate resolution occurred. The report by the Armed Forces Epidemiological Board Injury Prevention and Control Work Group showed that overall there was approximately 1 death per 1,000 clinic visits. While this number is appropriate from an overall injury perspective, the results obtained when applied to our example were not believable.[2]

Limitation

This data element is subjective. We assumed that a potential for death existed only in the catastrophic HS category. We need to pursue the development of "true" factors for numbers of death.

LOCATION IN AUTOMATED COST MODULE

This data element can be accessed from the form named fdataHazSev in the cost avoidance calculator.

To view or edit this data element, click on the View Parameters button in the Main Menu. The Parameter Menu will appear. Click on the Hazard Severity button. The values can then be modified.

[2] See Note 6, Chapter 1.

Other Outputs

In addition to the yearly and life-cycle death costs, we can estimate the number of deaths (N_{de}). Currently, we assume the number of deaths equals 1 for HS category I and zero for all other HS categories. As previously discussed, this area requires further research.

As with other outputs previously discussed, death outputs may be useful to physicians, environmental engineers, environmental scientists, and other health care professionals as indicators of the strengths and weaknesses of preventive health care. The outputs can be useful in trend analyses to identify the system health hazards that are creating the greatest burden on the health care system. These outputs, along with the others discussed in previous chapters, allow corrective actions to be focused on the most hazardous systems currently in the inventory and preventive actions on similar types of systems in development.

Medical treatment facility commanders may use the data to assess performance and how well prevention activities are being incorporated within the health care system. They may also use the data for trend analyses to assess the future burden on Army and VA health care systems.

Preventive medicine program managers may use these outputs to evaluate the effectiveness of their program.

Example Calculation

We continue here with our previous system example. Remember, health hazard assessors assigned a RAC of 1, an HS of category I, and an HP of A for the weapons combustion product hazard for the system. We will calculate the death costs. Our known variables are

N_{de} = 1 death per year for a catastrophic HS category and

B_{de} = \$200,000 per death.

Using Equation 9-1, we determine death costs (C_{de}):

$$\begin{aligned} C_{de} &= N_{de} \times B_{de}, \\ &= 1\ death/year \times \$200{,}000/death, \\ &= \$200{,}000/year. \end{aligned}$$

SUMMARY

In this chapter, we

- discussed the model component for death costs,
- defined the equation to estimate death costs,
- defined each data element and its data objective,
- described the data sources for each data element,
- described the data element locations in the automated cost module,
- discussed other useful information, and
- performed an example calculation.

In the next chapter, we present a complete cost summary of our system with multiple hazards.

Chapter 10

Cost Summary for a System with Multiple Health Hazards

RECAP OF THE MODEL

In this chapter, we summarize the total medical costs for all hazards identified for our example system. Additionally, we provide cost breakdown reports from the automated model in Appendix S. We discuss those hazards in Chapter 3. In subsequent chapters, we explain the individual cost components and provide sample calculations for each of the components for a single hazard. We show the previously discussed model framework in Figure 1-2.

In this chapter, we also present the equations and data elements, summarize the component outputs, and discuss how to use the cost and other output information.

COST EQUATIONS

Cost Component Equations

In Chapter 2, we presented the general formula for calculating health related costs. The model in equation form is as follows:

Hazard costs/year = clinic costs/year + hospitalization costs/year + lost time costs/year + disability costs/year + rehabilitation costs/year + death costs/year.

In Chapter 3, we discussed the equations (Table 2-2) we developed for estimating costs that incorporated HS and HP. The equations included costs per year for clinic services, hospitalization, lost time, disability, rehabilitation, and death.

Data Elements

We discussed in Chapter 3 how we used industry-wide incidence rates and factors to quantify health hazard costs based on the six cost components—our model framework. We listed the data elements and values in Table 3-20 along with a brief description.

Total Costs

In this section, we calculate the total medical costs for all hazards identified for our example system.

Use of the Model for a System with Multiple Hazards

While earlier example calculations addressed only a single hazard, most materiel systems present more than one. To calculate total medical costs for a system with multiple health hazards, we sum the individual component costs for each individual hazard. We identified 10 health hazards with our example system. Table 3-21 lists the hazards and their assigned risk indices.

Cost Summary

Costs incurred over the operational life of the system as a result of unabated health hazards are significant—in this case, greater than $345 million. Lost time, disability, rehabilitation, and death costs of $150 million, along with clinic and hospitalization costs of $195 million, affect both readiness and the health care system. Table 10-1 summarizes the model component life-cycle costs for each of the 10 unabated health hazards for our example system. The table lists the hazards by the magnitude of their potential costs. Health hazard intervention and other preventive medicine measures can reduce these costs.

Table 10-1. Life-Cycle Costs of Unabated Health Hazards for the System

	Costs ($000)						
Hazards by rank	Clinic	Hospital	Lost time	Disability	Rehabilitation	Death	Total
Weapons combustion products	88,402	81,904	27,852	98,173	1,432	4,000	301,763
Fire extinguishing agents	1,612	1,820	619	2,182	32	0	6,265
Impulse noise	1,612	1,820	619	2,182	32	0	6,265
Steady-state noise	1,612	1,820	619	2,182	32	0	6,265
Cold stress	1,612	1,820	619	2,182	32	0	6,265
Heat stress	1,612	1,820	619	2,182	32	0	6,265
Oxygen deficiency (ventilation)	1,612	1,820	619	2,182	32	0	6,265
Nonionizing radiation	1,612	1,820	619	2,182	32	0	6,265
Carbon dioxide	81	91	31	109	2	0	314
Ionizing radiation	8	9	3	11	0	0	31
Total	99,775	94,744	32,219	113,567	1,658	4,000	345,963

Program managers, health hazard assessors, medical treatment facility commanders, and other preventive medicine personnel can use the information in Table 10-1:

- Program managers can easily see which health hazards require immediate attention and priority abatement. They can also see that the magnitude of the costs from unabated hazards could have a severe impact on readiness.
- Health hazard assessors can demonstrate the value of their work and where to avoid needless medical costs. They can see where they have to focus their attention concerning health hazard control education.
- Health care system practitioners can see impacts by medical cost category. This may assist medical treatment facility commanders in determining necessary resource reallocation within their medical treatment facility.
- Preventive medicine personnel can use information in the table to assist commanders in determining health promotion and preventive education measures requirements. The information can indicate where they should focus efforts to reduce medical costs and the burden on the health care system. They can also use this information to evaluate the effectiveness of their programs in reducing medical costs—a reduction in medical costs is a measure of success.

While the current approach may not address hazard-specific differences in medical cost categories, the model is still a useful tool. However, an improved model capable of estimating hazard-specific costs is desirable. Such improvements would provide more detailed information on hazard-specific medical outcomes and impacts on specific hospital and clinic services. Additionally, one could determine the types of injuries and illnesses occurring, and the hazards that create the most potential for lost time and disability. This improvement will require the research and development of individual hazard-specific variables for use in the model. Additionally, the model will require some revision.

Individual Component Output Summary

The medical cost data clearly show that unabated health hazards can have a significant impact on readiness and the health care system over the operational life of our system. The individual component outputs give a detailed picture of these impacts. Table 10-2 summarizes the yearly individual component output data for each of the 10 unabated health hazards for our system. The table lists the hazards by the magnitude of their impact on readiness and the health care system.

Yearly, we can expect 3,758 injured or ill persons, 1,698 persons losing time at work, 618 disabled persons, and 402 hospitalized persons. This has a tremendous impact on available manpower. Lost workdays account for a total of 21,171 days per year. This directly impacts unit readiness. Yearly, we can expect 40,893 clinic visits and 2,842 hospital days as a result of exposure to health hazards resulting in illness and injury. This can present a great burden on the health care system. Health hazard intervention and other preventive medicine measures can reduce these costs.

Table 10-2. Individual Component Outputs by Hazard—Yearly Basis

Hazard	Component outputs								
	Clinic visits	Persons injured/ill	Persons hospitalized	Hospital days	Persons losing time	Lost work-days	Persons disabled	Rehabili-tation cases	Deaths
Weapons combustion products	36,230	3,250	346	2,454	1,465	18,300	533	7	1
Fire extin-guishing agents	661	72	8	55	33	407	12	0	0
Impulse noise	661	72	8	55	33	407	12	0	0
Steady-state noise	661	72	8	55	33	407	12	0	0
Cold stress	661	72	8	55	33	407	12	0	0
Heat stress	661	72	8	55	33	407	12	0	0
Oxygen deficiency ventilation	661	72	8	55	33	407	12	0	0
Nonionizing radiation	661	72	8	55	33	407	12	0	0
Carbon dioxide	33	4	0	3	2	20	1	0	0
Ionizing radiation	3	0	0	0	0	2	0	0	0
Total	40,893	3,758	402	2,842	1,698	21,171	618	7	1

Program managers can easily see the magnitude of injuries and lost workdays due to unabated hazards that will lessen readiness. Health hazard assessors can identify preventable injuries and illnesses, lost time, and disabilities. They can also see where they need to focus their attention concerning health hazard control education. As with the medical cost information, health care system practitioners can see the impacts on clinic visits and hospital stays. This may assist medical activity commanders in determining resource reallocations among their clinical and preventive medicine services. Information such as that in Table 10-2 can also allow preventive medicine personnel to assist commanders in determining health promotion and preventive education measures requirements. As with medical costs, they can use this information to evaluate the effectiveness of their programs, because a reduction in these output values is an indicator of success.

As we discussed in earlier chapters, improving the data elements and addressing specific hazards will provide more detailed information on hazard-specific medical outcomes. This should provide more information about the impacts on specific hospital and clinic services, the types of injuries and illnesses occurring, and the hazards with the most potential for injury, lost time, and disability.

While the current version of the model provides valuable information, improvements are needed. We provide summary conclusions for the model data elements in the next and final chapter.

Chapter 11
Conclusions

In this report we provided the documentation of the process, data elements, and data sources that we used to develop the cost model. Specifically, we provided

- an overview of the cost estimating process,
- the documentation necessary to understand the selection or development of each data element,
- the sources of data used to provide input to the model, and
- the equations used to estimate each cost.

It is our hope that by using this documentation report, medical assessors and others involved in the risk management process will have a starting point for

- understanding our cost estimating process,
- understanding our data elements and their sources, and
- suggesting improvements and revisions of the cost model data elements.

Appendix A
Assigning Risk Assessment Codes

Overview

The process of assigning RACs can be subjective and variable depending upon the individual assessment of the person assigning the code. Therefore, we have developed an approach to standardizing the process and limiting the variability between individual assessors. The two major factors used to determine the risk are HS and HP. Each of these factors is divided into two major components, and these components are then assigned numerical scores. The scores are then summed to obtain a total score for the HS and HP factors. These total scores are used to enter the matrix and select the appropriate RAC.

Determining the Hazard Severity

The HS factor is divided into two components: exposure severity and medical outcome severity. Each of the components are assigned a numerical value, and these numerical values are summed to determine the HS score. The HS scores are divided into four categories, I through IV. The HS score reflects the magnitude of the exposure to physical, chemical, or biological agents and the potential medical effects of exposure. The steps used to assign the scores follow.

1. Use Table A-1 to assign the exposure severity score.

Table A-1. Determining the Exposure Severity Code

Is an alternate route of exposure possible ?	Always < AL	Occasionally > AL Always < STD	Always > AL But ≤ STD	Always > STD
No	0	3	5	7
Yes	1–2	4	6	8

Notes: AL = DoD component threshold that triggers surveillance actions. This is also called the action level. STD = DoD exposure limit, such as the threshold limit value and permissible exposure limit.

2. Use Table A-2 to assign the medical effects severity score.

Table A-2. Determining the Medical Effects Severity Score

Condition	Score
No medical effect, such as nuisance noise and nuisance odor.	0
Temporary reversible illness requiring supportive treatment, such as eye irritation and sore throat.	1–2
Temporary reversible illness with a variable, but limited period of disability, such as metal fume fever.	3–4
Permanent, nonsevere illness or loss of capacity, such as permanent hearing loss.	5–6
Permanent, severe, disabling, irreversible illness or death, such as asbestosis and lung cancer.	7–8

3. Sum the numerical scores obtained from Tables A-1 and A-2 to obtain the total score for the health HS factor. The total score is then converted to a severity code using Table A-3.

Table A-3. Health HS Total Score

Total score	Severity code
13–16	I
9–12	II
5–8	III
0–4	IV

DETERMINING THE HAZARD PROBABILITY

The HP factor is divided into two major components: exposure duration and number of people exposed to the hazard. Each of the components are assigned a numerical value, and these numerical values are summed to determine the HP score. The HP score is divided into four categories, like the HS score. The four categories are designated A through D. The HP score reflects the duration of the exposure and the number of people exposed to the hazard. The steps used to assign the score follow.

1. Determine the exposure duration score using the information presented in Table A-4.

Table A-4. Determining the Exposure Duration Score

Type of exposure	1–8 hours per week	> 8 hours per week, not continuous	Continuous exposure, fully weekly work shift
Irregular, intermittent	1–2	4–6	Not applicable
Regular, periodic	2–3	5–7	8

2. Determine the score for the number of people exposed using the information presented in Table A-5.

Table A-5. Determining the Number of Exposed Personnel Score

Number of exposed personnel	Points
< 5	1–2
5–9	3–4
10–49	5–6
> 49	7–8

3. Sum the scores for the exposure duration and number of people exposed from Tables A-4 and A-5 to obtain the total score for the HP factor. Assign the code for the for the HP factor based upon the information presented in Table A-6.

Table A-6. Hazard Probability Codes

Total points	HP code
14–16	A
10–13	B
5–9	C
3–5	D
< 3	E

Assigning the Risk Assessment Code

The RAC is assigned based upon the codes assigned to the HS and HP components of the risk. Table A-7 shows the matrix used to assign the RAC.

Table A-7. Assigning the Risk Assessment Code

	HP				
HS	A	B	C	D	E
I	1	1	1	2	3
II	1	1	2	3	4
III	2	3	3	4	5
IV	3	5	5	5	5

Appendix B
Health Hazard and International Classification of Disease Category Link

Table B-1 provides the links we established between the nine health hazards and the ICD-9 categories. The links were made subjectively. If an expected medical outcome for a specific health hazard was possible, then those ICD-9 categories were linked with that health hazard.

Table B-1. Health Hazard and ICD-9 Category Link

Health hazards	ICD-9 category
Biological substances	
Pathological organisms	Infectious and parasitic diseases
	Diseases of the digestive system
	Diseases of the skin and subcutaneous tissue
	Diseases, not fully coded
Sanitation	Infectious and parasitic diseases
	Diseases of the digestive system
	Diseases of the skin and subcutaneous tissue
	Diseases, not fully coded
Blast overpressure	Injury and poisoning
	Injury, not fully coded
Chemical substances	Diseases of the respiratory system
	Symptoms, signs, and ill-defined conditions
	Diseases of the skin and subcutaneous tissue
	Diseases of the genitourinary system
	Neoplasms
	Injury and poisoning
Noise	
Impulse	Injury, not fully coded
Steady state	Injury, not fully coded
Oxygen deficiency	Diseases of the respiratory system
	Diseases of the circulatory system
	Diseases of the nervous system and sense organs
Radiation	
Ionizing	Diseases of the blood and blood forming organs
	Diseases of the genitourinary system
	Endocrine, nutrition, and metabolic disease

Table B-1. Health Hazard and ICD-9 Category Link (Continued)

Health hazards	ICD-9 category
	Neoplasms
Laser	Diseases of the blood and blood forming organs
	Diseases of the genitourinary system
	Endocrine, nutrition, and metabolic disease
	Neoplasms
Microwave	Diseases of the blood and blood forming organs
	Diseases of the genitourinary system
	Endocrine, nutrition, and metabolic disease
	Neoplasms
Shock	
Acceleration	Diseases of the musculoskeletal system and connective tissue
	Injury, not fully coded
Deceleration	Diseases of the musculoskeletal system and connective tissue
	Injury, not fully coded
Temperature extremes	
Cold	Diseases of the musculoskeletal system and connective tissue
	Injury and poisoning
	Diseases of the respiratory system
	Diseases of the skin and subcutaneous tissue
	Symptoms, signs, and ill-defined conditions
	Diseases of the genitourinary system
	Diseases of the circulatory system
Heat	Diseases of the musculoskeletal system and connective tissue
	Injury and poisoning
	Diseases of the respiratory system
	Diseases of the skin and subcutaneous tissue
	Symptoms, signs, and ill-defined conditions
	Diseases of the genitourinary system
	Diseases of the circulatory system
Trauma	
Blunt	Injury and poisoning
	Injury, not fully coded
Sharp	Injury and poisoning
	Injury, not fully coded
Musculoskeletal	Injury and poisoning
	Injury, not fully coded

Table B-1. Health Hazard and ICD-9 Category Link (Continued)

Health hazards	ICD-9 category
Vibration	
Segmental	Injury and poisoning
	Injury, not fully coded
	Disease of the musculoskeletal system and connective tissue
Whole body	Injury and poisoning
	Injury, not fully coded
	Disease of the musculoskeletal system and connective tissue

Appendix C
Health Hazard and Department of Labor Disease or Injury Category Link

Table C-1 provides the links we established between the nine health hazards and the DOL disease or injury categories. The links were made subjectively. If an expected medical outcome for a specific health hazard was possible, then those disease or injury categories were linked with that health hazard.

Table C-1. Health Hazard and DOL Disease or Injury Category Link

Health hazard	Disease/injury category
Biological substances	
Pathological organisms	Infectious and parasitic diseases
Sanitation	Infectious diseases peculiar to the intestines
Blast overpressure	Internal injuries to organs and blood vessels of the trunk
Chemical substances	Exposure to caustic, noxious, or allergic substances
Noise	
Impulse	Exposure to noise in single incident
Steady state	Exposure to noise over time
Oxygen deficiency	Oxygen deficiency, NEC
Radiation	
Ionizing	Exposure to radiation, NEC
Laser	Exposure to radiation, NEC
Microwave	Exposure to radiation, NEC
Shock	
Acceleration	Sudden start or stop, NEC
Deceleration	Sudden start or stop, NEC
Temperature extremes	
Cold	Exposure to environmental cold
Heat	Exposure to environmental heat
Trauma	
Blunt	Multiple traumatic injuries and disorders
Musculoskeletal	Traumatic injuries, bones, nerves, spine
Sharp	Punctures, except bites
Vibration	
Segmental	Repetitive use of tools
Whole body	Rubbed, abraded, or jarred by vehicle or mobile equipment vibration

Note: NEC - Not elsewhere classified

Appendix D
Health Hazard and Department of Veterans Affairs Diagnostic Category Link

Table D-1 provides the links we established between the nine health hazards and the VA diagnostic categories. The links were made subjectively. If an expected medical outcome for a specific health hazard was possible, then those diagnostic categories were linked with that health hazard.

Table D-1. Health Hazard and VA Diagnostic Category Link

Health hazard	Diagnostic category
Biological substances	
Pathological	Nontuberculosis diseases
	Digestive system
	Skin
Sanitation	Trachea and bronchia
	Digestive system
	Skin
Blast overpressure	Lungs and pleura
Chemical substances	Lungs and pleura
	Skin
	Trachea and bronchia
	Genitourinary system
Noise	
Impulse	Hearing, smell, and taste
Steady state	Hearing, smell, and taste
Oxygen deficiency	Lungs and pleura
Radiation	
Ionizing	Genitourinary system
	Skin
	Eye and visual acuity
	Digestive system
Laser	Genitourinary system
	Skin
	Eye and visual acuity
	Digestive system
Microwave	Genitourinary system
	Skin
	Eye and visual acuity

Table D-1. Health Hazard and VA Diagnostic Category Link (Continued)

Health hazard	Diagnostic category
	Digestive system
Shock	
Acceleration	Bones and joints
	Other impairment, bones and joints
	Muscle injuries
Deceleration	Bones and joints
	Other impairment, bones and joints
	Muscle injuries
Temperature extremes	
Cold	Skin
Heat	Skin
	Genitourinary system
Trauma	
Blunt	Other impairment, bones and joints
Musculoskeletal	Bones and joints
Sharp	Bones and joints
Vibration	
Segmental	Other impairment, bones and joints
Whole body	Muscle injuries

Appendix E
Potential Clinical Services Visited as a Result of Health Hazard Exposure

Clinical Services

We selected the listed clinical services subjectively. If an expected medical outcome could possibly result in a visit to a medical treatment facility for a specific health hazard exposure, then we included that clinic service. These services are as follows:

- Internal medicine
- Allergy
- Endocrinology
- Gastroenterology
- Nephrology
- Nutrition
- Oncology
- Dermatology
- Infectious disease
- Physical medicine
- General surgery
- Cardiovascular/thoracic surgery
- Neurosurgery
- Ophthalmology
- Orthopedics
- Chiropractic
- Medical examination
- Optometry
- Audiology
- Community health
- Occupational health

- Immediate care
- Emergency care
- Flight medicine
- Underseas medicine
- Physical therapy
- Occupational therapy
- Neuromuscularskeletal screening.

SOURCES

"CHAMPUS DRG Weights for Fiscal Year 1996," Table 2, CHAMPUS Weights and Threshold Summary, *Federal Register,* Volume 60, Number 207, 26 October 1995, pp. 54,851–54,862.

"Medical and Dental Reimbursement Rates for Fiscal Year 1996," *Federal Register,* Volume 60, Number 195, 10 October 1996, pp. 52,655–52,659.

Appendix F
Health Hazard and Diagnostic Related Groups Link

Table F-1 provides the links we established between the nine health hazards and the DRGs. The links were made subjectively. If an expected medical diagnosis for a specific health hazard was possible, then those DRGs were linked with that health hazard.

Table F-1. Health Hazard and DRG Links

Health hazard	DRG	DRG Number
Biological substances		
Pathological organisms	Chest pain	143
	Other digestive system	171
	Esophagus, gastrointestinal, and miscellaneous digestive disorders	183
	Other digestive system diagnoses	189
	Other skin, subcutaneous tissue, and breast procedures	270
	Major skin disorders	273
	Minor skin disorders	284
	Fever of unknown origin	420
	Other infectious and parasitic disease diagnoses	423
	Other injury, poisoning, and toxic effect diagnoses	455
Sanitation	Chest pain	143
	Other digestive system	171
	Esophagus, gastrointestinal, and miscellaneous digestive disorders	183
	Other digestive system diagnoses	189
	Other skin, subcutaneous tissue, and breast procedures	270
	Major skin disorders	273
	Minor skin disorders	284
	Fever of unknown origin	420
	Other infectious and parasitic disease diagnoses	423
	Other injury, poisoning, and toxic effect diagnoses	455
Blast overpressure	Other ear, nose, mouth, and throat disorders	74
	Major chest trauma	84
	Chest pain	143
	Other injury, poisoning, and toxic effect diagnoses	455

Table F-1. Health Hazard and DRG Links (Continued)

Health hazard	DRG	DRG Number
	Signs and symptoms	464
Chemical substances	Nervous system neoplasms	11
	Respiratory infections and inflammations	80
	Respiratory neoplasms	82
	Respiratory signs and symptoms	100
	Other respiratory system diagnoses	102
	Chest pain	143
	Other skin, subcutaneous tissue, and breast procedures	270
	Major skin disorders	273
	Minor skin disorders	284
	Other kidney and urinary tract procedures	315
	Kidney and urinary tract infections	321
	Kidney and urinary tract signs and symptoms	326
	Other kidney and urinary tract disorders	332
	Other male reproductive system diagnoses	352
	Other female reproductive system procedures	365
	Lymphoma and non-acute leukemia	404
	Other injury, poisoning, and toxic effect diagnoses	455
	Signs and symptoms	464
Noise		
Impulse	Miscellaneous ear, nose, mouth, and throat procedures	55
	Other ear, nose, mouth, and throat procedures	63
	Other ear, nose, mouth, and throat procedures	74
	Other operating room procedures for injuries	443
Steady-state	Miscellaneous ear, nose, mouth, and throat procedures	55
	Other ear, nose, mouth and throat procedures	63
	Other ear, nose. Mouth and throat procedures	74
	Other operating room procedures for injuries	443
Oxygen deficiency	Nervous system neoplasms	11
	Degenerative nervous system disorders	12
	Nonspecific cerebrovascular disorders	17
	Nervous system infection	20
	Other disorders of nervous system	35
	Respiratory infections and inflammation	80
	Respiratory signs and symptoms	100
	Other respiratory system diagnoses	102

Table F-1. Health Hazard and DRG Links (Continued)

Health hazard	DRG	DRG Number
	Other circulatory system operating room procedures	120
	Other circulatory system diagnoses	145
Radiation energy		
Ionizing	Nervous system neoplasms	11
	Respiratory neoplasms	82
	Peripheral vascular disorders	131
	Pancreas, liver, and shunt procedures	192
	Hepatobiliary diagnostic procedures for malignancy	199
	Other hepatobiliary or pancreas operating room procedures	201
	Disorders of the liver	206
	Other endocrine, nutrition, and metabolic operating room procedures	293
	Nutritional and miscellaneous metabolic disorders	297
	Endocrine disorders	301
	Other kidney and urinary tract operating room procedures	315
	Kidney and urinary tract infections	321
	Kidney and urinary tract signs and symptoms	326
	Other kidney and urinary tract disorders	332
	Other male reproductive system diagnoses	352
	Other female reproductive system procedures	365
	Lymphoma and non-acute leukemia	404
Laser	Retinal procedures	36
	Extraocular procedures	41
	Intraocular procedures	42
	Other disorders of the eye	47
	Respiratory neoplasms	82
	Pancreas, liver, and shunt procedures	192
	Other endocrine, nutrition, and metabolic operating room procedures	293
	Nutritional and miscellaneous metabolic disorders	297
	Endocrine disorders	301
	Lymphoma and non-acute leukemia	404
Microwave	Retinal procedures	36
	Extraocular procedures	41
	Intraocular procedures	42
	Other disorders of the eye	47
	Respiratory neoplasms	82

Table F-1. Health Hazard and DRG Links (Continued)

Health hazard	DRG	DRG Number
	Pancreas, liver, and shunt procedures	192
	Other endocrine, nutrition, and metabolic operating room procedures	293
	Nutritional and miscellaneous metabolic disorders	297
	Endocrine disorders	301
	Lymphoma and non-acute leukemia	404
Shock		
Acceleration/Deceleration	Back and neck procedures	215
	Lower extremity procedures	219
	Knee procedures	222
	Shoulder, elbow, or forearm procedures	224
	Soft tissue procedures	227
	Other musculoskeletal system and connective tissue operating room procedures	234
	Sprains, strains, and dislocations of hip, pelvis, or thigh	237
	Connective tissue disorders	241
	Signs and symptoms of musculoskeletal system and connective tissues	247
	Other musculoskeletal system and connective tissue diagnoses	256
	Other operating room procedures for injuries	443
	Signs and symptoms	464
Temperature extremes		
Cold	Respiratory signs and symptoms	100
	Other respiratory system diagnoses	102
	Other circulatory system operating room procedures	120
	Chest pain	143
	Other circulatory system diagnoses	145
	Connective tissue disorders	241
	Major skin disorders	273
	Minor skin disorders	284
	Kidney and urinary tract infections	321
	Kidney and urinary tract signs and symptoms	326
	Other kidney and urinary tract diagnoses	332
	Other operating room procedures for injuries	443
	Other injury, poisoning, and toxic effect diagnoses	455
	Signs and symptoms	464
Heat	Chest pain	143
	Other circulatory system diagnoses	145

Table F-1. Health Hazard and DRG Links (Continued)

Health hazard	DRG	DRG Number
	Connective tissue disorders	241
	Major skin disorders	273
	Minor skin disorders	284
	Kidney and urinary tract infections	321
	Kidney and urinary tract signs and symptoms	326
	Other kidney and urinary tract diagnoses	332
	Other operating room procedures for injuries	443
	Other injury, poisoning, and toxic effect diagnoses	455
	Signs and symptoms	464
Trauma		
Blunt	Medical back problems	243
	Other operating room procedures for injuries	443
	Traumatic injury	445
	Other injury, poisoning, and toxic effects	455
	Other operating room procedures for multiple significant trauma	486
Musculoskeletal	Other musculoskeletal system and connective tissue operating room procedures	234
	Sprains, strains, and dislocations of hip, pelvis, thigh	237
	Connective tissue disorders	241
	Medical back problems	243
	Signs and symptoms of musculoskeletal system and connective tissues	247
	Other musculoskeletal system and connective tissue diagnoses	256
	Other operating room procedures for injuries	443
	Traumatic injury	445
	Other injury, poisoning, and toxic effects	455
	Other operating room procedures for multiple significant trauma	486
Sharp	Medical back problems	243
	Wound debridements for injuries	440
	Other operating room procedures for injuries	443
	Traumatic injury	445
	Other injury, poisoning, and toxic effects	455
	Other operating room procedures for multiple significant trauma	486
Vibration		
Segmental	Carpal tunnel release	6
	Medical back problems	243

Table F-1. Health Hazard and DRG Links (Continued)

Health hazard	DRG	DRG Number
Whole body	Hand procedures for injuries	441
	Other operating room procedures for injuries	443
	Other injury, poisoning, and toxic effects	455
	Medical back problems	243
	Other operating room procedures for injuries	443
	Other injury, poisoning, and toxic effects	455

Source: Headquarters, Department of the Army, Army Regulation 40-10, Health Hazard Assessment Program in Support of the Army Materiel Acquisition Decision Process, 1991.

Walter Reed Army Medical Center (WRAMC), Washington, DC, Third Party Collection Program, Memorandum, *Determining Cost of WRAMC Care,* 4 December 1995.

"CHAMPUS DRG Weights for Fiscal Year 1996," Table 2, CHAMPUS Weights and Threshold Summary, *Federal Register*, Volume 60, Number 207, 26 October 1995, pages 54,851–54,862.

"Medical and Dental Reimbursement Rates for Fiscal Year 1996," *Federal Register*, Volume 60, Number 195, 10 October 1996, pages 52,655–52,659.

Appendix G
Nonfatal Occupational Injury and Illness Incidence Rates for Selected Industry Divisions

Table G-1 contains the industry divisions and the incidence rates for illness and injury.

Table G-1. Nonfatal Occupational Injury and Illness Incidence Rates per 100 Full-Time Workers, by Industry Division, 1993

Industry division	Total cases	Lost workday cases[b]
Construction	12.2	5.5
Transportation	9.5	5.4
Services	6.7	2.8

Source: *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1993*, "Table 1, Nonfatal Occupational Injury and Illness Incidence Rates per 100 Full-Time Workers, by Industry Division, 1993," 1994.

[a] The incidence rates represent the number of injuries and illnesses per 100 full-time workers and were calculated as (number of injuries and illness divided by total hours worked by all employees during the calendar year) times 200,000 hours.

[b] Lost workdays include cases involving restricted work activity only in addition to days-away-from-work cases with or without restricted work activity.

Appendix H
Hospitalization Incidence Factor (I_h) Calculations

Remember that we linked selected ICD-9 categories with our health hazards. The top portion of Table H-1 provides the ICD-9 categories we selected along with their incidence rates per 1,000 persons. The lower portion of Table H-1 provides the calculations we performed to determine the high, medium, and low incidence rates for hospitalization incidence and the resultant incidence factor (I_h).

We summed the incidence rates for ICD-9 categories and then determined the mean. One population standard deviation plus or minus provided the high and low incidence rates. We assumed a direct relationship to the industry categories for calculation purposes.

Table H-1. Hospitalization Incidence Factor (I_h) Calculations

ICD-9 category	Incidence rate (per 1,000 persons)	Incidence factor[a]
Infectious and parasitic diseases	5.000	
Neoplasms	3.100	
Endocrine, nutritional, and metabolic diseases	0.900	
Diseases of the blood and blood-forming organs	0.300	
Diseases of the nervous system and sense organs	3.800	
Diseases of the circulatory system	3.800	
Diseases of the respiratory system	9.300	
Diseases of the digestive system	15.200	
Diseases of the genitourinary system		
Diseases of the skin and subcutaneous tissue	2.700	
Diseases of the musculoskeletal system and connective tissue	23.600	
Symptoms, signs, and ill-defined conditions	4.800	
Injury and poisoning	12.800	
Disease, not fully coded	11.600	
Injury, not fully coded	0.400	
Calculation of statistical information		
Average	6.927	
Max	23.600	
Min	0.300	
Sample standard deviation	6.501	
Population standard deviation	6.280	
Average + 1 standard deviation	13.207	
Average–1 standard deviation	0.646	
Incidence factor for hospitalization		
High (average + 1 population standard deviation)		0.013
Medium (average)		0.007
Low (average – 1 population standard deviation)		0.0006

Source: U.S. Army Center for Health Promotion and Preventive Medicine, "Table S2, Active Duty Hospitalization Rates, United States Army, 1994, by ICD-9 Category," *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

[a] Incidence factors are rounded.

Appendix I
Disability Incidence Factor (I_v) Calculations

Remember that we linked selected VA diagnostic categories with our health hazards. The top portion of Table I-1 provides the diagnostic categories we selected along with their number of persons disabled and the incidence of disability. The lower portion of Table I-1 provides the calculations we performed to determine the high, medium, and low incidence rates for hospitalization incidence and the resultant incidence factor (I_v).

We summed the incidence of disability values for the diagnostic categories and then determined the mean. One population standard deviation plus or minus provided the high and low incidence rates. The lower standard deviation was negative, so we assigned a number that approached zero (statistical minimum). We assumed a direct relationship to the industry categories for calculation purposes.

Table I-1. Disability Incidence Factor (I_V) Calculations

Disability diagnostic category	Number disabled	Incidence of disability	Incidence factor[a]
Bones and Joints	14399	0.0206	
Other impairment, bones and joints	52255	0.0749	
Muscle injuries	1183	0.0016	
Eye and visual acuity	1782	0.0025	
Ear, smell, and taste	4946	0.0070	
Trachea and bronchi	3186	0.0045	
Lungs and pleura	35	5.0220	
Nontuberculosis disease	480	0.0006	
Digestive system	4115	0.0059	
Genitourinary system	1607	0.0023	
Skin	3869	0.0055	
Calculation of statistical information			
Total army active duty (697,000)			
Average		0.0114	
Sample standard deviation		0.0220	
Population standard deviation		0.0210	
Average +1 standard deviation		0.0322	
Average–1 standard deviation		–0.009	
Incidence factor for disability			
High (average + 1 population standard deviation)			0.032
Medium (average)			0.012
Low (average–1 population standard deviation)			.00005

Source: U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree, Persian Gulf War Report as of March 1995*, Washington, DC, undated.

[a] The incidence factors are rounded.

Appendix J
Hospitalization Population Distribution Factors (D_{ho}) Case Distribution

CASE DISTRIBUTION

Table J-1 contains the case distribution for the ICD-9 categories we linked with the nine health hazards.

Table J-1. Case Distribution by Length of Stay in Hospital for ICD-9 Categories

	Length of stay in hospital (days)								
ICD-9 category[a]	Total cases	0	1	2	3–5	6–10	11–20	21–30	>30
Infectious and parasitic diseases	3,056	52	689	821	885	364	138	44	63
Neoplasms	1,981	106	868	150	296	173	125	59	204
Endocrine, nutritional, and metabolic disease	562	44	125	91	132	53	68	17	32
Diseases of the blood and blood-forming organs	210	24	44	25	64	19	17	7	10
Diseases of the nervous system and sense organs	2,378	328	941	228	320	155	150	71	185
Diseases of the circulatory system	2,391	192	657	398	446	302	180	67	149
Diseases of the respiratory system	5,711	458	1,707	1,204	1,507	363	331	52	89
Diseases of the digestive system	9,355	257	4,946	1,362	1,280	512	428	274	296
Diseases of the genitourinary system	4,106	175	1,865	525	869	305	176	64	127
Diseases of the skin and subcutaneous tissue	1,633	91	509	229	483	171	71	28	51
Diseases of the musculoskeletal system and connective tissue	14,675	3,127	6,035	1,295	1,639	788	511	300	980
Symptoms, signs, and ill-defined conditions	3,041	245	1,223	528	514	249	158	42	82
Injury and poisoning	7,866	253	2,620	1,183	1,609	880	536	215	570
Disease, not fully coded	545	33	135	61	77	57	44	20	118
Injury, not fully coded	30	3	4	4	10	5	0	2	2

Sources: U.S. Army Center for Health Promotion and Preventive Medicine, Table S1, Active Duty Hospitalizations, United States Army, 1994, by ICD-9 Category, *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, Table S2, Active Duty Hospitalizations, United States Army, 1994, by ICD-9 Category, *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, Table S3, Total Active Duty Hospital Sick Days, United States Army, 1994, by ICD-9 Category, *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, Table S4, Non-Effective Rates, Active Duty Hospitalizations, United States Army, 1994, by ICD-9 Category, *Medical Surveillance Monthly Report,* Aberdeen Proving Ground, MD, April 1995.

U.S. Army Center for Health Promotion and Preventive Medicine, Memorandum to Gary M. Bratt, Logistics Management Institute, *Active Duty Army Hospitalizations 1994*, Aberdeen Proving Ground, MD, April 1994.

[a] The ICD-9 categories listed are those that linked to the nine health hazard categories.

Case Percentage Distribution

In Table J-2, we show the case distribution on a percentage basis.

Table J-2. Case Percentage Distribution by Length of Stay in Hospital for ICD-9 Categories

ICD-9 category[a]	Total cases	Length of stay in hospital (days)							
		0	1	2	3–5	6–10	11–20	21–30	>30
Infectious and parasitic diseases	3,056	1.70	22.54	26.86	28.95	11.91	4.51	1.43	2.06
Neoplasms	1,981	5.35	43.81	7.57	14.94	8.73	6.30	2.97	10.29
Endocrine, nutritional, and metabolic disease	562	7.82	22.24	16.19	23.48	9.43	12.09	3.02	5.69
Diseases of the blood and blood-forming organs	210	11.42	20.95	11.90	30.47	9.04	8.09	3.33	4.76
Diseases of the nervous system and sense organs	2,378	13.79	39.57	9.58	13.45	6.51	6.30	2.98	7.77
Diseases of the circulatory system	2,391	8.03	27.47	16.64	18.65	12.63	7.52	2.80	6.23
Diseases of the respiratory system	5,711	8.01	29.88	21.08	26.38	6.35	5.79	0.91	1.55
Diseases of the digestive system	9,355	2.74	52.87	14.55	13.68	5.47	4.57	2.92	3.16
Diseases of the genitourinary system	4,106	4.26	45.42	12.78	21.16	7.42	4.28	1.55	3.09
Diseases of the skin and subcutaneous tissue	1,633	5.57	31.16	14.02	29.57	10.47	4.34	1.71	3.12
Diseases of the musculoskeletal system and connective tissue	14,675	21.30	41.12	8.82	11.16	5.36	3.48	2.04	6.67
Symptoms, signs, and ill-defined conditions	3,041	8.05	40.21	17.36	16.90	8.18	5.19	1.38	2.69
Injury and poisoning	7,866	3.21	33.30	15.03	20.45	11.18	6.81	2.73	7.24
Disease, not fully coded	545	6.05	24.77	11.19	14.12	10.45	8.07	3.66	21.65
Injury, not fully coded	30	10	13.33	13.33	33.33	16.66	0	6.66	6.66

[a] The ICD-9 categories listed are those that linked to the nine health hazard categories.

Consolidated Case Percentage Distribution

This table shows the consolidation of the cases (on a percentage basis) into the four categories we chose for length of stay in the hospital. We assumed that for any hospitalization and lost time there would be a relative distribution of outcomes within these four categories. We considered this approach reasonable because when an adverse exposure occurs, one would not expect the population involved to all incur the same amount of hospitalization time.

Table J-3. Consolidated Case Percentage Distribution by Length of Stay in Hospital for ICD-9 Categories

ICD-9 Category[a]	Length of stay in hospital (days)			
	<2	2–5	6–30	>30
Infectious and parasitic diseases	24.24	55.82	17.86	2.06
Neoplasms	49.16	22.51	18.02	10.29
Endocrine, nutritional, and metabolic disease	30.07	39.36	24.55	5.69
Diseases of the blood and blood-forming organs	32.38	42.38	20.47	4.76
Diseases of the nervous system and sense organs	53.36	23.04	15.81	7.77
Diseases of the circulatory system	35.50	35.29	22.9	6.23
Diseases of the respiratory system	37.90	47.46	13.06	1.55
Diseases of the digestive system	55.61	28.24	12.97	3.16
Diseases of the genitourinary system	49.68	33.95	13.27	3.09
Diseases of the skin and subcutaneous tissue	36.74	43.60	16.53	3.12
Diseases of the musculoskeletal system and connective tissue	62.43	19.99	10.89	6.67
Symptoms, signs, and ill-defined conditions	48.27	34.26	14.76	2.69
Injury and poisoning	36.52	35.49	20.73	7.24
Disease, not fully coded	30.82	25.32	22.20	21.65
Injury, not fully coded	23.33	46.66	23.33	6.66

[a] The ICD-9 categories listed are those that linked to the nine health hazard categories.

STATISTICAL INFORMATION

In this table, we provide various statistical information for the data in table J-3. We calculated these statistics using an automated spreadsheet.

Table J-4. Statistical Information for Hospitalization Population Distribution by Length of Stay in Hospital

Statistic calculated	Length of stay in hospital (days)			
	< 2	2–5	6–30	> 30
Sum	606.08	533.74	267.46	92.70
Standard deviation sample	11.90	10.47	4.36	4.93
Standard deviation population	11.49	10.11	4.21	4.76
Median	36.74	35.29	17.86	5.69
Maximum	62.43	55.82	24.55	21.65
Minimum	23.33	19.99	10.89	1.55
Average	40.40	35.58	17.83	6.18
Average deviation	10.14	8.28	3.66	3.10
Average + 1 population standard deviation	51.90	45.70	22.04	10.94
Average–1 population standard deviation	28.90	25.46	13.61	1.41

PERCENTAGE POPULATION DISTRIBUTION

This table provides the mean value and the mean value plus or minus one standard deviation on a percentage basis for each of the four consolidated categories we chose for length of stay in the hospital by appropriate system risk category. These values are within categories and are not normalized across the categories for a specific system risk category.

Table J-5. Percentage Population Distribution for Hospitalization by Length of Stay in Hospital (Not Normalized)

System risk category	Length of stay in hospital (days)				
	< 2	2–5	6–30	> 30	Total
High (+ 1 population standard deviation)	51.90	45.70	22.04	10.94	130.60
Medium (mean)	40.40	35.58	17.83	6.18	100.00
Low (–1 population standard deviation)	28.90	25.46	13.61	1.41	69.39

FACTORS FOR HOSPITALIZATION POPULATION

This table provides the factor values for the mean and the mean plus or minus one standard deviation for each of the four consolidated categories we chose for length of stay in the hospital by appropriate system risk category. These values are within categories and are normalized across the categories for a specific system risk category. (Note: The summation of factor values within each row totals to 1 for each system risk category.)

Table J-6. Factors for Hospitalization Population (D_{ho}) by Length of Stay in Hospital for System Risk Categories (Normalized)

System risk category	Length of stay in hospital (days)				
	< 2	2–5	6–30	> 30	Total
High (+ 1 population standard deviation)	0.40	0.35	0.17	0.08	1
Medium (mean)	0.40	0.36	0.18	0.06	1
Low (–1 population standard deviation)	0.42	0.37	0.20	0.02	1

SAMPLE POPULATION

This table shows the population distribution of a sample of 100 persons within each length of stay in hospital category for the system risk categories.

Table J-7. Sample Population Distribution by Length of Stay in Hospital for System Risk Categories

System risk category	Length of stay in hospital (days)			
	< 2	2–5	6–30	> 30
High (+ 1 population standard deviation)	40	35	17	8
Medium (average)	40	36	18	6
Low (–1 population standard deviation)	42	37	20	2

Appendix K
Lost Time Population Distribution Factors (D_{lt})

Case Percentage Distribution

Table K-1 contains the case distribution on a percentage basis for the U.S. Department of Labor illness or injury diagnostic categories we linked with the nine health hazards. The distribution was extracted from Tables 21, 22, and 23 of the U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on U.S. Occupational Injuries, Illnesses in 1992.*

Table K-1. Case Percentage Distribution by Length of Lost Time for Nature or Event of Illness or Injury Categories

Nature or event of illness or injury[a]	Total cases	Lost time (days)						
		1	2	3–5	6–10	11–20	21–30	>30
Traumatic injuries bones, nerves, spine	183,500	7.4	6.3	12.3	11.3	13.2	10.9	38.7
Punctures except bites	31,300	28.9	21.6	20.8	12.8	6.5	3.6	5.8
Multiple traumatic injuries and disorders	67,500	14.1	13.5	18.6	12.8	11.5	6.3	23.1
Internal injuries to organs/blood vessels of trunk	300	2.2	4.5	8.4	5.9	16.5	18.7	43.7
Infectious and parasitic diseases	3,200	13	15.5	16.1	25.5	21.2	3.4	5.3
Infectious diseases peculiar to intestines	400	21	25.3	10.8	23.8	10.8	1	7.3
Rubbed, abraded, or jarred by vehicle/equipment vibration	1,700	6.3	9.7	24.4	12.3	12.7	5.9	28.7
Repetitive use of tools	16,200	7.8	6.1	12.5	10.4	14.2	9.8	39.3
Exposure to environmental heat	1,600	26.8	27.9	29.1	7.5	3	2.6	3
Exposure to environmental cold	300	20.4	13.2	30.6	12.7	15.5	2.6	5.1
Exposure to caustic, noxious, or allergic substances	56,100	32.2	19.9	20.5	11.3	7.6	3.1	5.4
Exposure to noise over time	200	20.4	7.4	15.1	16.8	24.2	5	11.2
Exposure to noise in single incident	100	35.4	10.9	15.1	4.8	16.9	9.4	7.6
Exposure to radiation, NEC	200	51.4	21.9	23.4	1.7	0	0	1.6
Oxygen deficiency, NEC	100	20.8	14	14	40.6	0	0	10.6
Sudden start or stop, NEC	1,400	12.2	14.9	23.1	13.9	10.2	5	20.6

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on US Occupational Injuries, Illnesses in 1992*, "Table 23, Percent Distribution of Nonfatal Occupational Injuries and Illnesses Involving Days Away from Work by Source of Injury or Illness and Number of Days Away from Work," 1992, Washington, DC, December 1993.

U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on US Occupational Injuries, Illnesses in 1992*, "Table 24, Percent Distribution of Nonfatal Occupational Injuries and Illnesses Involving Days Away from Work by Event or Exposure Leading to Injury or Illness and Number of Days Away from Work," 1992, Washington, DC, December 1993.

U.S. Department of Labor, Bureau of Labor Statistics, *Results of Bureau of Labor Statistics Survey on US Occupational Injuries, Illnesses in 1992*, "Table 21, Percent Distribution of Nonfatal Occupational Injuries and Illnesses Involving Days Away from Work by Nature of Injury or Illness and Number of Days Away from Work," 1992, Washington, DC, December 1993.

[a] The nature or event of illness or injury categories are those that linked to the nine health hazard categories.

Note: NEC - Not elsewhere classified

CONSOLIDATED CASE PERCENTAGE DISTRIBUTION

This table shows the consolidation of the cases (on a percentage basis) into the four categories we chose for lost time. We assumed that for any lost time there would be a relative distribution of outcomes within these four categories. We considered this approach reasonable because when an adverse exposure occurs, one would not expect the population involved to all incur the same amount of lost time.

Table K-2. Consolidated Case Percentage Distribution by Length of Lost Time for Nature or Event of Illness or Injury Categories

Nature or event of illness or injury	Lost time (days)			
	<2	2–5	6–30	>30
Traumatic injuries bones, nerves, spine	7.4	18.6	35.4	38.7
Punctures except bites	28.9	42.4	22.9	5.8
Multiple traumatic injuries and disorders	14.1	32.1	30.6	23.1
Internal injuries to organs/blood vessels of trunk	2.2	12.9	41.1	43.7
Infectious and parasitic diseases	13	31.6	50.1	5.3
Infectious diseases peculiar to intestines	21	36.1	35.6	7.3
Rubbed, abraded, or jarred by vehicle/equipment vibration	6.3	34.1	30.9	28.7
Repetitive use of tools	7.8	18.6	34.4	39.3
Exposure to environmental heat	26.8	57	13.1	3
Exposure to environmental cold	20.4	43.8	30.8	5.1
Exposure to caustic, noxious, or allergic substances	32.4	40.4	22	5.4
Exposure to noise over time	20.4	22.5	46	11.2
Exposure to noise in single incident	35.4	26	31.1	7.6
Exposure to radiation, NEC	51.4	45.3	1.7	1.6
Oxygen deficiency, NEC	20.8	28	40.6	10.6
Sudden start or stop, NEC	12.2	38	29.1	20.6

Note: NEC - Not elsewhere classified

STATISTICAL INFORMATION

In this table, we provide various statistical information for the data in Table K-2. We calculated these statistics using an automated spreadsheet.

Table K-3. Calculation of Statistical Information for Lost Time Population Distribution by Length of Lost Time

Statistics Calculated	Length of lost time (days)			
	<2	2–5	6–30	>30
Average	20.0	32.9	30.9	16.1
Sum	320.3	527.4	495.4	257
Standard deviation sample	12.7	11.6	12.0	14.3
Standard deviation population	12.3	11.2	11.6	13.9
Median	20.4	33.1	31	9.1
Maximum	51.4	57	50.1	43.7
Minimum	2.2	12.9	1.7	1.6
Average	20.0	32.9	30.9	16.1
Average deviation	9.6	9.1	8.3	12.2
Average + 1 population standard deviation	32.4	44.2	42.5	29.9
Average–1 population standard deviation	7.6	21.7	19.3	2.2

PERCENTAGE POPULATION DISTRIBUTION

This table provides the mean value and the mean value plus or minus one standard deviation on a percentage basis for each of the four consolidated categories we chose for lost time by appropriate system risk category. These values are within categories and are not normalized across the categories for a specific system risk category.

Table K-4. Percentage Population Distribution for Lost Time by Days of Lost Time for System Risk Categories (Not Normalized)

System risk category	Length of lost time (days)				Total
	<2	2–5	6–30	>30	
High (+ 1 population standard deviation)	32.40	44.22	42.59	29.94	149.17
Medium	20.02	32.96	30.96	16.06	100.01
Low (–1 population standard deviation)	7.634	21.70	19.32	2.18	50.84

FACTORS FOR LOST TIME POPULATION DISTRIBUTION

This table provides the factor values for the mean and the mean plus or minus one standard deviation for each of the four consolidated categories we chose for lost time by appropriate system risk category. These values are within categories and are normalized across the categories for a specific system risk category. (Note: The summation of factor values within each row totals to 1 for each system risk category.

Table K-5. Factors for Lost Time Population Distribution (D_{lt}) by Days of Lost Time for System Risk Categories (Normalized)

System risk category	Length of lost time (days)				Total
	<2	2–5	6–30	>30	
High (+ 1 population standard deviation)	0.22	0.30	0.29	0.20	1.00
Medium	0.20	0.33	0.31	0.16	1.00
Low (–1 population standard deviation)	0.15	0.43	0.38	0.04	1.00

SAMPLE POPULATION DISTRIBUTION

This table shows the population distribution of a sample of 100 persons within each lost time category for the system risk categories.

Table K-6. Sample Population Distribution by Length of Stay in Hospital for System Risk Categories

System risk category	Length of lost time (days)				Total
	<2	2–5	6–30	>30	
High (+ 1 population standard deviation)	22	30	29	20	100
Medium	20	33	31	16	100
Low (–1 population standard deviation)	15	43	38	4	99

Appendix L

Disability Population Distribution Factors (D_v) Calculation

CASE DISTRIBUTION

Table L-1 contains the case distribution for the VA disability diagnosis categories we linked w Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major L*

Table L-1. Case Distribution by De

Disability diagnosis category[a]	Diagnosis code	0%	10%	20%	30
Bones and joints	50	105	81,238	44,023	23,5
Other impairments bones and joints	20	119	278,885	141,600	62,5
Muscle injuries	53	5	51,577	37,337	29,3
Eye and visual acuity	60	53	12,231	4,383	12,6
Hearing, smell, and taste	61, 62	51	57,337	20,411	9,1
Trachea and bronchi	66	4	21,208	3,207	10,3
Lungs and pleura	67	17,431	1,274	588	6,1
Nontuberculosis diseases	68	47	5,346	2,422	4,4
Digestive system	72, 73	196	50,572	29,584	10,9
Genitourinary system	75	1,451	14,374	4,404	6,7
Skin	78	80	94,051	13,645	15,3
Total		19,542	668,093	301,604	191,1

Source: U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Divisi DC, undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Com undated.

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, Com

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Nun

U.S. Department of Veterans Affairs, National Center for Veteran Analysis and Statistics, Demographics Division, "Alph

[a] The disability diagnosis categories listed are those that linked to the nine health hazard categories.

ıtion Factors (D_v) Calculations

for the VA disability diagnosis categories we linked with the nine health hazards. The distribution was extracted from the \
ıputer List, *Disability Compensation, Class of Major Disability by Combined Degree, Grand Total Report as of March 199.*

Table L-1. Case Distribution by Degree of Disability for VA Disability Diagnosis Categories

0%	10%	20%	30%	40%	50%	60%	70%
105	81,238	44,023	23,551	15,921	7,034	8,651	4,212
119	278,885	141,600	62,526	45,902	17,678	22,018	8,893
5	51,577	37,337	29,334	23,831	12,683	9,583	4,961
53	12,231	4,383	12,641	7,938	3,263	2,444	1,655
51	57,337	20,411	9,138	8,582	3,651	3,419	1,074
4	21,208	3,207	10,307	2,940	825	5,027	982
17,431	1,274	588	6,159	632	652	702	493
47	5,346	2,422	4,410	3,342	1,508	2,023	882
196	50,572	29,584	10,912	16,708	3,076	5,102	1,518
1,451	14,374	4,404	6,779	2,687	891	1,823	643
80	94,051	13,645	15,366	4,596	3,234	1,788	1,118
19,542	668,093	301,604	191,123	133,079	54,495	62,580	26,431

ıl Center for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combinec*

for Veteran Analysis and Statistics, Demographics Division, Computer List, *Disability Compensation, Class of Major Disability by Combined Degree.*

for Veteran Analysis and Statistics, Demographics Division, Computer List, *Specific Diagnosis, Major-Disability Compensation, Total Service Conne*
for Veteran Analysis and Statistics, Demographics Division, "Numerical Index of Disabilities," 38 CFR, Chapter 1, Appendix B to Part 4, *Pensions, B*
for Veteran Analysis and Statistics, Demographics Division, "Alphabetical Index of Disabilities," 38 CFR, Chapter 1, Appendix C to Part 4, *Pensions,*
hat linked to the nine health hazard categories.

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e nine health hazards. The distribution was extracted from the VA National Center for Veteran Analysis and *lity by Combined Degree, Grand Total Report as of March 1995*, Washington, DC, undated.

of Disability for VA Disability Diagnosis Categories

40%	50%	60%	70%	80%	90%	100%	Total
15,921	7,034	8,651	4,212	2,677	1,362	3,855	192,629
45,902	17,678	22,018	8,893	5,280	1,968	4,628	589,497
23,831	12,683	9,583	4,961	2,601	1,077	643	173,632
7,938	3,263	2,444	1,655	931	673	3,440	49,652
8,582	3,651	3,419	1,074	1,772	537	2,020	107,992
2,940	825	5,027	982	514	148	1,625	46,787
632	652	702	493	802	72	651	29,456
3,342	1,508	2,023	882	615	153	1,077	21,825
16,708	3,076	5,102	1,518	864	307	3,946	122,785
2,687	891	1,823	643	543	192	2,257	36,044
4,596	3,234	1,788	1,118	745	398	613	135,634
133,079	54,495	62,580	26,431	17,344	6,887	24,755	1,505,933

omputer List, *Disability Compensation, Class of Major Disability by Combined Degree, Grand Total Report as of March 1995*, Washington,

List, *Disability Compensation, Class of Major Disability by Combined Degree, Persian Gulf War Report as of March 1995*, Washington, DC,

List, *Specific Diagnosis, Major-Disability Compensation, Total Service Connected as of March 1995*, Washington, DC, undated.
l Index of Disabilities," 38 CFR, Chapter 1, Appendix B to Part 4, *Pensions, Bonuses and Veteran's Relief*, Washington, DC, July 1994.
cal Index of Disabilities," 38 CFR, Chapter 1, Appendix C to Part 4, *Pensions, Bonuses and Veteran's Relief*, Washington, DC, July 1994.

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CONSOLIDATED CASE DISTRIBUTION

In Table L-2 we show the consolidation of the cases into the four categories we chose for degre four categories. We considered this approach reasonable because when an adverse exposure oc

Table L-2. Consolidated Case Distribution

Disability diagnosis category	Diagnosis code	< 10%	2(
Bones and joints	50	81,343	
Other impairments bones and joints	20	279,004	2
Muscle injuries	53	51,582	
Eye and visual acuity	60	12,284	
Hearing, smell, and taste	61, 62	57,388	
Trachea and bronchi	66	21,212	
Lungs and pleura	67	18,705	
Nontuberculosis diseases	68	5,393	
Digestive system	72, 73	50,768	
Genitourinary system	75	15,825	
Skin	78	94,131	
Total		687,635	6

CONSOLIDATED CASE PERCENTAGE DISTRIBUTION

This table shows the consolidation of the cases (on a percentage basis) into the four categories

Table L-3. Consolidated Case Percentage Distrib

Disability diagnosis category	Diagnosis code	< 10%
Bones and joints	50	0.42228
Other impairments bones and joints	20	0.47329
Muscle injuries	53	0.29708
Eye and visual acuity	60	0.2474
Hearing, smell, and taste	61, 62	0.53141
Trachea and bronchi	66	0.45337
Lungs and pleura	67	0.63501
Nontuberculosis diseases	68	0.2471
Digestive system	72, 73	0.41347
Genitourinary system	75	0.43905
Skin	78	0.69401

N

he cases into the four categories we chose for degree of disability. We assumed that for any disability, there would be a relati
h reasonable because when an adverse exposure occurs, one would not expect the population involved to all incur the same (

Table L-2. Consolidated Case Distribution by Degree of Disability for VA Disability Diagnosis Categories

osis de	< 10%	20%–50%	60%–90%	100%
)	81,343	90,529	16,902	3,855
)	279,004	267,706	38,159	4,628
3	51,582	103,185	18,222	643
)	12,284	28,225	5,703	3,440
62	57,388	41,782	6,802	2,020
;	21,212	17,279	6,671	1,625
	18,705	8,031	2,069	651
.	5,393	11,682	3,673	1,077
73	50,768	60,280	7,791	3,946
	15,825	14,761	3,201	2,257
	94,131	36,841	4,049	613
	687,635	680,301	113,242	24,755

DISTRIBUTION

es (on a percentage basis) into the four categories we chose for degree of disability.

Table L-3. Consolidated Case Percentage Distribution by Degree of Disability for VA Disability Diagnosis Categories

	Diagnosis	Degree of disability		
ory	code	< 10%	20%–50%	60%–90%
	50	0.42228	0.4699656	0.087744
oints	20	0.47329	0.4541261	0.064731
	53	0.29708	0.5942741	0.104946
	60	0.2474	0.5684565	0.114859
	61, 62	0.53141	0.386899	0.062986
	66	0.45337	0.369312	0.142582
	67	0.63501	0.2726439	0.07024
	68	0.2471	0.5352577	0.168293
	72, 73	0.41347	0.4909394	0.063452
	75	0.43905	0.4095272	0.088808
	78	0.69401	0.2716207	0.029852

lity. We assumed that for any disability, there would be a relative distribution of outcomes within these
/ould not expect the population involved to all incur the same degree of disability.

of Disability for VA Disability Diagnosis Categories

	60%–90%	100%	Total
	16,902	3,855	192,629
	38,159	4,628	589,497
	18,222	643	173,632
	5,703	3,440	49,652
	6,802	2,020	107,992
	6,671	1,625	46,787
	2,069	651	29,456
	3,673	1,077	21,825
	7,791	3,946	122,785
	3,201	2,257	36,044
	4,049	613	135,634
	113,242	24,755	1,505,933

ɔr degree of disability.

·egree of Disability for VA Disability Diagnosis Categories

Degree of disability		
20%–50%	60%–90%	100%
0.4699656	0.087744	0.0200126
0.4541261	0.064731	0.0078508
0.5942741	0.104946	0.0037032
0.5684565	0.114859	0.0692822
0.386899	0.062986	0.0187051
0.369312	0.142582	0.0347319
0.2726439	0.07024	0.0221008
0.5352577	0.168293	0.0493471
0.4909394	0.063452	0.0321375
0.4095272	0.088808	0.0626179
0.2716207	0.029852	0.0045195

(3)

STATISTICAL INFORMATION

In this table, we provide various statistical information for the data in Table L-3. We calculated

Table L-4. Calculation of Statistical Informati

Statistical calculations	10%	
Sum	4.85347	
Standard deviation sample	0.1442	
Standard deviation population	0.13749	
Median	0.43905	
Maximum	0.69401	
Minimum	0.2471	
Average	0.44122	
Average deviation	0.10563	
Average + 1 standard deviation	0.57871	
Average – 1 standard deviation	0.30374	

FACTORS FOR DISABILITY POPULATION DISTRIBUTION

This table provides the factor values for the mean and the mean plus or minus one standard dev category. These values are within categories and are normalized across the categories for a spec

Table L-5. Factors for Disability Population Distribu

System risk category	< 10%	
High (+ 1 standard deviation)	0.44495	
Medium	0.44122	
Low (– 1 standard deviation)	0.4343	

A

r the data in Table L-3. We calculated these statistics using an automated spreadsheet.

-4. Calculation of Statistical Information for Disability Population Distribution by Degree of Disability

Degree of disability			
%	20%–50%	60%–90%	
347	4.8230224	0.998496	
42	0.1086952	0.039771	
749	0.1036368	0.03792	
305	0.4541261	0.087744	
401	0.5942741	0.168293	
71	0.2716207	0.029852	
122	0.4384566	0.090772	
563	0.0876873	0.030471	
371	0.5420934	0.128692	
374	0.3348198	0.052852	

RIBUTION

mean plus or minus one standard deviation for each of the four consolidated categories we chose for degree of disability by alized across the categories for a specific system risk category.

rs for Disability Population Distribution by Degree of Disability for System Risk Categories (Not Normalized)

Degree of disability			
< 10%	20%–50%	60%–90%	100%
0.44495	0.4167929	0.098946	0.039316
0.44122	0.4384566	0.090772	0.0295462
0.4343	0.4787448	0.075571	0.0113772

statistics using an automated spreadsheet.

Disability Population Distribution by Degree of Disability

Degree of disability		
0%	60%–90%	100%
224	0.998496	0.3250085
952	0.039771	0.0226431
368	0.03792	0.0215894
261	0.087744	0.0221008
741	0.168293	0.0692822
207	0.029852	0.0037032
566	0.090772	0.0295462
373	0.030471	0.0182519
934	0.128692	0.0511356
198	0.052852	0.0079569

r each of the four consolidated categories we chose for degree of disability by appropriate system risk
m risk category.

egree of Disability for System Risk Categories (Not Normalized)

Degree of disability		
–50%	60%–90%	100%
67929	0.098946	0.039316
34566	0.090772	0.0295462
37448	0.075571	0.0113772

3

SAMPLE POPULATION DISTRIBUTION

This table shows the population distribution of a sample of 100 persons within each degree of

Table L-6. Sample Population Distr

System risk categories		< 10%
High (+ 1 standard deviation)		44
Medium		44
Low (– 1 standard deviation)		43

1

'ION

ıtion of a sample of 100 persons within each degree of disability category for the system risk categories.

Table L-6. Sample Population Distribution by Degree of Disability for System Risk Categories

	Degree of Disability		
ȝories	< 10%	20% to 50%	60% to 90%
ation)	44	42	10
	44	44	9
tion)	43	48	8

(2)

y category for the system risk categories.

y Degree of Disability for System Risk Categories

Degree of Disability		
% to 50%	60% to 90%	100%
42	10	4
44	9	3
48	8	1

3

Appendix M
Clinic Visit Fee Factor (F_c) Calculation

Table M-1 lists the clinical services we subjectively selected with their rate per visit. We selected those clinic service types that linked to potential medical outcomes as a result of exposure to the nine health hazards. OSD revises and publishes this information yearly. It contained a listing of FY96 outpatient rates for various types of clinic services. We used the "other" category rates because they contained no subsidized costs.

We summed the individual rates per visit and divided by the total number of clinical services to determine the mean clinic visit fee factor (F_c) of $122 per visit.

Table M-1. Clinic Visit Fee Factor (F_c) Calculation

Medical expense and performance reporting system code	Clinical service	Rate/visit
BAA	Internal medicine	$163
BAB	Allergy	$56
BAF	Endocrinology	$152
BAG	Gastroenterology	$190
BAJ	Nephrology	$230
BAL	Nutrition	$51
BAM	Oncology	$157
BAO	Rheumatology	$147
BAP	Dermatology	$100
BAQ	Infectious disease	$139
BAR	Physical medicine	$132
BBA	General surgery	$193
BBB	Cardiovascular/thoracic surgery	$183
BBC	Nuerosurgery	$228
BBD	Ophthalmology	$131
BEA	Orthopedic	$163
BEZ	Chiropractic clinic	$49
BHB	Medical examination	$93
BHC	Optometry	$71
BHD	Audiology clinic	$57
BHF	Community health	$80
BHG	Occupational health	$84
BHI	Immediate care clinic	$139
BIA	Emergency care clinic	$163
BJA	Flight medicine	$151
BKA	Underseas medicine clinic	$65
BLA	Physical therapy	$49
BLB	Occupational therapy	$96
BLC	Nueromuscularskeletal screening	$37
	Mean clinic cost factor (F_c)	$122
	Count	29

Source: "Medical and Dental Reimbursement Rates for Fiscal Year 1996," *Federal Register,* Volume 60, Number 195, 10 October 1996, pp. 52,655–52,659.

"CHAMPUS DRG Weights for Fiscal Year 1996," Table 2, CHAMPUS Weights and Threshold Summary, *Federal Register,* Volume 60, Number 207, 26 October 1995, pp. 54,851–54,862.

Walter Reed Army Medical Center (WRAMC), Third Party Collection Program, Memorandum to Gary M. Bratt, Logistics Management Institute, *Determining Cost of WRAMC Care,* Washington, DC, 4 December 1995.

Appendix N

Hospitalization Fee Factor (F_h) Calculation

The table lists the DRGs we subjectively selected with their CHAMPUS weight and arithmetic mean length of stay (LOS). We selected those DRGs that linked to potential medical outcomes as a result of exposure to the nine health hazards. OSD revises and publishes this information yearly. It contained a listing of FY96 CHAMPUS DRG weights as well as the arithmetic and geometric average lengths of stay for all CHAMPUS DRGs.

We used a weighting factor for a large hospital. We determined the mean hospitalization fee factor (F_h) by multiplying the mean CHAMPUS weight by the WRAMC weighting factor, $6,504, and dividing by the mean LOS. We estimated the mean hospitalization fee factor (F_h) to be $1,669 per day.

Table N-1. Hospitalization Fee Factor (F_h) *Calculation*

DRG number	CHAMPUS weight	Mean LOS	DRG
6	0.8124	4	Carpal tunnel release
11	0.8643	4.4	Nervous system neoplasms
12	1.7772	13.3	Degenerative nervous system disorders
17	0.7104	4.8	Nonspecific cerebrovascular disorders
20	2.9769	11.2	Nervous system infection
35	0.7239	4.3	Other disorders of nervous system
36	0.8324	1.7	Retinal procedures
41	0.7172	2.2	Extraocular
42	0.732	1.9	Intraocular procedures
47	0.4133	2.5	Other disorders of the eye
55	1.0312	2.8	Miscellaneous ear, nose, mouth, and throat procedures
63	1.3142	2.4	Other ear, nose, mouth, and throat procedures
73	0.6098	3.4	Other ear, nose, mouth, and throat diagnoses
80	1.1504	5.5	Respiratory infections and inflammations
82	1.5579	7	Respiratory neoplasms
84	0.7418	2.7	Major chest trauma
100	0.521	2	Respiratory signs and symptoms
102	0.5617	2.7	Other respiratory system diagnoses
120	2.2233	7.5	Other circulatory system or procedures
131	0.7144	4.9	Peripheral vascular disorders
143	0.4826	1.9	Chest pain

Table N-1. Hospitalization Fee Factor (F_h) Calculation (Continued)

DRG number	CHAMPUS weight	Mean LOS	DRG
145	0.762	2.7	Other circulatory system diagnoses
171	1.015	3.6	Other digestive system
183	0.5473	2.7	Esophagus, gastrointestinal, and miscellaneous digestive disorders
189	0.5934	3.8	Other digestive system diagnoses
192	1.7636	6.9	Pancreas, liver, and shunt procedures
199	3.5448	10.2	Hepatobiliary diagnostic procedure for malignancy
201	5.3906	17.4	Other hepatobiliary or pancreas operating room procedures
206	0.7014	3.8	Disorders of the liver
215	1.2403	2.8	Back and neck procedures
219	1.0947	3.1	Lower extremity procedures
222	1.1148	2.1	Knee procedures
224	0.8402	1.9	Shoulder, elbow, or forearm procedures
227	0.8634	2.4	Soft tissue procedures
234	1.3744	3.8	Other musculoskeletal system and connective tissue operating room procedures
237	0.5657	3.2	Sprains, strains, and dislocations of hip, pelvis, thigh
241	0.6978	4	Connective tissue disorders
243	0.6188	3.9	Medical back problems
247	0.6545	3.8	Signs and symptoms of musculoskeletal system and connective tissue
256	0.5939	2.9	Other musculoskeletal system and connective tissue diagnoses
270	0.7568	2.8	Other skin, subcutaneous tissue, and breast procedures
273	0.638	3.7	Major skin disorders
284	0.4042	3	Minor skin disorders
293	0.9688	3.9	Other endocrine, nutrition, and metabolic or procedures
297	0.5349	3	Nutritional and miscellanous metabolic disorders
301	0.5963	3.1	Endocrine disorders
315	2.0094	6.3	Other kidney and urinary tract procedures
321	0.5903	3.4	Kidney and urinary tract infections
326	0.2959	2.2	Kidney and urinary tract signs and symptoms
332	0.5808	2.3	Other kidney and urinary tract disorders
352	0.5932	4.2	Other male reproductive system diagnoses
365	1.2739	3.8	Other female reproductive system diagnoses
404	1.0991	4.2	Lymphoma and nonacute leukemia

Table N-1. Hospitalization Fee Factor (F_h) Calculation (Continued)

DRG number	CHAMPUS weight	Mean LOS	DRG
420	0.6545	3.7	Fever of unknown origin
423	1.8956	7.7	Other infectious and parasitic disease diagnoses
440	2.079	8.1	Wound debridements for injuries
441	1.0864	3.3	Hand procedures for injuries
443	0.9935	2.8	Other operating room procedures for injuries
445	0.5071	3	Traumatic injury
455	0.3355	1.3	Other injury, poisoning, and toxic effect diagnoses
464	0.4593	2	Signs and symptoms
486	4.553	10.5	Other operating room procedures for multiple significant trauma
Total	68.3504	266.4	WRAMC cost per case: $6,504
Average	1.102425806	4.2967742	
Standard deviation	0.941517386	2.9684664	
Count	62	62	
Average + 1 standard deviation	20.43943192		
Average–1 standard deviation	0.16090842		
		UCL—mean	1.37683646
		LCL—mean	0.82801515

Note: Standard deviation refers to population standard deviation. UCL - Upper confidence limit, LCL - Lover confidence limit.

Sources: "Medical and Dental Reimbursement Rates for Fiscal Year 1996," *Federal Register,* Volume 60, Number 195, 10 October 1996, pp. 52,655–52,659.

"CHAMPUS DRG Weights for Fiscal Year 1996," Table 2, CHAMPUS Weights and Threshold Summary, *Federal Register,* Volume 60, Number 207, 26 October 1995, pp. 54,851–54,862.

Walter Reed Army Medical Center (WRAMC), Third Party Collection Program, Memorandum to Gary M. Bratt, Logistics Management Institute, *Determining Cost of WRAMC Care,* Washington, DC, 4 December 1995.

Appendix O
Average Wage Factor (W_d) Calculation

Table O-1 provides the salaries and numbers of persons drawing that wage we selected. We selected the 6 years of service point as the basis for subjectively determining an average wage factor (W_d). We determined the factor by summing the wages per day for the selected groups and dividing by the sum of all eligible persons. We found the average wage factor (W_d) to be $53.97 per day.

Table O-1.Average Wage Factor (W_d)

Rank	Years of service = 6[a]	Number persons	Wage ($/day)[b]	Total wage ($/day)	Eligible persons
Commissioned Officers					
0-10[c]	$7,397.10				
0-9	$6,637.50				
0-8	$6,048.30				
0-7	$5,318.70				
0-6	$4,135.50	3,602	$135.96	$489,733.84	
0-5	$3,546.90	9,241	$116.61	$1,077,596.81	
0-4	$3,150.90	14,011	$103.59	$1,451,416.76	
0-3	$3,066.90	24,926	$100.83	$2,513,278.34	
0-2	$2,671.50	8,559	$87.83	$751,738.14	
0-1	$2,107.50	9,573	$69.29	$663,290.88	69,912
Warrant Officers					
W-4	$2,586.90	1,425	$85.05	$121,194.49	
W-3	$2,277.90	3,016	$74.89	$225,867.83	
W-2	$2,107.50	5,637	$69.29	$390,574.60	
W-1	$1,941.90	1,875	$63.84	$119,706.16	11,953
Enlisted Members					
E-7	$1,840.20	39,856	$60.50	$2,411,277.08	
E-6	$1,622.70	59,220	$53.35	$3,159,330.21	
E-5	$1,471.80	80,377	$48.39	$3,889,277.87	
E-4	$1,354.20	127,774	$44.52	$5,688,708.52	
E-3	$1,161.90	50,679	$38.20	$1,935,910.03	
E-2	$980.70	29,923	$32.24	$964,783.10	
E-1	$874.80	20,008	$28.76	$575,441.04	407,837
			Totals	$26,429,125.72	489,702
			Average wage/day	$53.97	

Source: "The 1996 Army Times Pay Chart," *U.S. Army Times*, 20 November 1995.

[a] The 6 years of service value was used to select values.

[b] Wage per day = (monthly salary x 12 months per year)/365 days per year.

[c] Basic pay is limited to $9,016.80 per month. Figures for O-10 in the chart show what pay would be without the cap.

Appendix P
VA Disability Compensation Factor (B_v) and Average Degree of Disability Calculation

Table P-1 provides the calculations for the VA disability compensation factor.

Table P-1. VA Disability Compensation Factor (B_v)

% disabled combined category	Calculated category compensation factor (B_v)
10%	$91.00
20%–50%	$340.25
60%–90%	$914.50
100%	$1,865.00

Source: U.S. Department of Veterans Affairs, *Federal Benefits for Veterans and Dependents*, Washington, DC, 1996.

Note: The compensation factor is calculated by adding the compensation disability rates for each disability category with the combined category and dividing by the number of disability categories in that combined category. $91 is the 1996 10% compensation rate. $174 is the 1996 20% compensation rate. $266 is the 1996 30% compensation rate. $380 is the 1996 40% compensation rate. $541 is the 1996 50% compensation rate. $681 is the 1996 60% compensation rate. $860 is the 1996 70% compensation rate. $996 is the 1996 80% compensation rate. $1,121 is the 1996 90% compensation rate. $1,865 is the 1996 100% compensation rate.

Table P-2 provides the calculations and results for the VA average degree of disability.

Table P-2. Calculation of Average Degree of Disability

Degree of disability category	Average degree of disability	Calculation
10%	0.1	10%/1 = 10%, 10%/100% = 0.1
20%–50%	0.35	(20% + 30% + 40% + 50%)/4 = 35%, 35%/100% = 0.35
60%–90%	0.75	(60% + 70% + 80% + 90%)/4 = 75%, 75%/100% = 0.75
100%	1	100%/1 = 100%, 100%/100% = 1

Appendix Q
Factors for Active Duty Temporary Disability (I_t) and Temporary Disability Compensation (B_t) Calculations

This appendix provides the calculations for the factor for active-duty temporary disability (I_t) and temporary disability compensation (B_t). Approximately 2% of service members are evaluated for disability annually. Of these service members, 60% are discharged or permanently disabled. Table Q-1 lists the costs of compensation for permanent and temporary disability in the three services. We do not know the breakout of the various military disability degrees.

Table Q-1. Factors for Active-Duty Temporary Disability (I_t) and Temporary Disability Compensation (B_t)

Category	Total on retirement list[a]	Costs/year/person for 1990	Costs/year/person for 1996[b]	Other calculations
PDRL	122,744	$11,186	$11,186 x 1.15 = $12,864	
TDRL	11,393	$8,037	$8,037 x 1.15 = $9,242	
Percentage discharged or permanently disabled each year				2% x 0.6 = 1.2% 0.02 x 0.6 = 0.012
Percentage of temporary disabilities each year				11,393/122,744 x 0.012 x 100% = 0.1%
Factor for temporary disability (I_t)				0.1%/100% = 0.001
Factor for temporary disability compensation (B_t)			$9,242	

Source: COL Bruce Jones, MD, and Barbara Hansen, Ph.D., et al., "Injuries in the Military: A Hidden Epidemic," unpublished, a report for the Armed Forces Epidemiological Board, Injury Prevention and Control Work Group, November 1996.

Note: PDRL = Permanently Disability Retired List; TDRL = Temporary Disability Retired List.

[a] The total number of permanently retired personnel is cumulative over time. The total number of temporarily retired personnel is constant over time.

[b] A 15% increase in payments was assumed because of inflation

Appendix R
Factors for Active Duty Permanent Disability (I_p) and Permanent Disability Compensation (B_p) Calculations

This appendix provides the calculations for the factor for active duty permanent disability (I_p) and permanent disability compensation (B_p). Approximately 2% of service members are evaluated for disability annually. Of these service members, 60% are discharged or permanently disabled. Table R-1 lists the costs of compensation for permanent and temporary disability in the three services. We do not know the breakout of the various military disability degrees.

Table R-1 Factors for Active Duty Permanent Disability (I_p) and Permanent Disability Compensation (B_p)

Category	Total on retirement list[a]	Costs/year/person for 1990	Costs/year/person for 1996[b]	Other calculations
PDRL	122,744	$11,186	$11,186 x 1.15 = $12,864	
TDRL	11,393	$8,037	$8,037 x 1.15 = $9,242	
Percentage discharged or permanently disabled each year				2% x .6 = 1.2% 0.02 x 0.6 = 0.012
Percentage of permanent disabilities each year				1–(11,393/122,744) x 0.012 x 100% = 1.1%
Factor for permanent disability (I_p)				1.1%/100% = 0.011
Factor for permanent disability compensation (B_p)			$12,864	

Source: COL Bruce Jones, MD, and Barbara Hansen, Ph.D., et al., "Injuries in the Military: A Hidden Epidemic," unpublished, a report for the Armed Forces Epidemiological Board, Injury Prevention and Control Work Group, November 1996.

Note: PDRL = Permanently Disability Retired List; TDRL = Temporary Disability Retired List.

[a] The total number of permanently retired personnel is cumulative over time. The total number of temporarily retired personnel is constant over time.

[b] A 15% increase in payments was assumed because of inflation.

Appendix S
Health Hazard Assessment Cost Avoidance Breakdown Reports

Tables S-1 through S-11 contain cost component summary values. The cost component calculations used to obtain these are performed by the Cost Avoidance Calculator—the automated cost module we developed for the USACHPPM. The tables are similar in layout to the cost avoidance breakdowns—standard reports generated by the automated cost module. They represent the project total and the 10 hazards identified from our previous system example. (Table 10-3 provides the hazards and risks assigned by the health hazard assessors.) The Cost Avoidance Calculator requires the estimation of a residual risk for the hazard. The costs avoided are calculated by subtracting the costs avoided for the residual risk from the costs avoided for the current risk.

The tables are

- Table S-1. Costs Avoided for Total Project,
- Table S-2. Costs Avoided for Chemical Substances—Weapons Combustion Products (HS 1, HP A, RAC 1),
- Table S-3. Costs Avoided for Chemical Substances—Fire Extinguishing Agents (HS 2, HP C, RAC 2),
- Table S-4. Costs Avoided for Chemical Substances—Carbon Dioxide (HS 2, HP D, RAC 3),
- Table S-5. Costs Avoided for Acoustical Energy—Impulse Noise (HS 2, HP C, RAC 2),
- Table S-6. Costs Avoided for Acoustical Energy—Steady State Noise (HS 2, HP C, RAC 2),
- Table S-7. Costs Avoided for Temperature Extremes—Cold Stress (HS 2, HP C, RAC 2),
- Table S-8. Costs Avoided for Temperature Extremes—Heat Stress (HS 2, HP C, RAC 2),
- Table S-9. Costs Avoided for Oxygen Deficiency—Oxygen Deficiency (Ventilation) (HS 2, HP C, RAC 2),

- Table S-10. Costs Avoided for Radiation Energy—Nonionizing Radiation (HS 2, HP C, RAC 2), and
- Table S-11. Costs Avoided for Radiation Energy—Ionizing Radiation (HS 2, HP E, RAC 4).

Table S-1. Costs Avoided for Total Project

Project total	Current	Residual	Avoided[a]
Number of persons exposed	68,406	296	68,110
Number of persons injured/ill	3,760	0	3,760
Number of persons losing time	1,695	0	1,695
Number of persons hospitalized	401	0	401
Number of persons disabled	616	0	616
Number of persons requiring rehabilitation	7	0	7
Number of clinic visits	40,891	0	40,891
Number of lost days	21,169	0	21,169
Number of hospital days	2,838	0	2,838
Number of deaths	1	0	1
Cost of clinic visits	$4,988,756	$31	$4,988,724
Cost of lost time	$1,610,945	$15	$1,610,930
Cost of hospitalization	$4,737,222	$46	$4,737,176
Cost of disability	$5,678,232	$55	$5,678,178
Cost of rehabilitation	$82,835	$1	$82,834
Cost of deaths	$200,000	$0	$200,000
Total hazard cost for 1 year	$17,297,990	$148	$17,297,842
Total hazard cost for 20 years	$345,959,798	$2,956	$345,956,842

[a] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Table S-2. Costs Avoided for Chemical Substances—Weapons Combustion Products (HS 1, HP A, RAC 1)

Risk code[a]	1A, 1	4E, 5	
Category	Current	Residual	Avoided[b]
Number of persons exposed	26,640	30	26,610
Number of persons injured/ill	3,250	0	3,250
Number of persons losing time	1,465	0	1,465
Number of persons hospitalized	346	0	346
Number of persons disabled	533	0	533
Number of persons requiring rehabilitation	6	0	6
Number of clinic visits	36,230	0	36,230
Number of lost days	18,300	0	18,300
Number of hospital days	2,454	0	2,454
Number of deaths	1	0	1
Cost of clinic visits	$4,420,109	$3	$4,420,106
Cost of lost time	$1,392,614	$2	$1,392,613
Cost of hospitalization	$4,095,187	$5	$4,095,183
Cost of disability	$4,908,663	$5	$4,908,658
Cost of rehabilitation	$71,608	$3	$71,608
Cost of deaths	$200,000	$3	$200,000
Total hazard cost for 1 year	$15,088,182	$15	$15,088,167
Total hazard cost for 20 years	$301,763,634	$296	$301,763,339

[a] The risk code sequence is HS, HP, and RAC (i.e., 4E, 5). In the cost calculator, the HS categories are the Arabic numerals 1, 2, 3, and 4, while in the report, they are the Roman numerals I, II, III, and IV.

[b] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Table S-3. Costs Avoided for Chemical Substances—Fire Extinguishing Agents (HS 2, HP C, RAC 2)

Risk code[a]	1A, 1	4E, 5	
Category	Current	Residual	Avoided[b]
Number of persons exposed	5,920	30	5,890
Number of persons injured/ill	72	0	72
Number of persons losing time	33	0	33
Number of persons hospitalized	8	0	8
Number of persons disabled	12	0	12
Number of persons requiring rehabilitation	0	0	0
Number of clinic visits	661	0	661
Number of lost days	407	0	407
Number of hospital days	55	0	55
Number of deaths	0	0	0
Cost of clinic visits	$80,602	$3	$80,599
Cost of lost time	$30,947	$2	$30,945
Cost of hospitalization	$91,004	$5	$91,000
Cost of disability	$109,081	$5	$109,076
Cost of rehabilitation	$1,591	$0	$1,591
Cost of deaths	$0	$0	$0
Total hazard cost for 1 year	$313,226	$15	$313,211
Total hazard cost for 20 years	$6,264,517	$296	$6,264,221

[a] The risk code sequence is HS, HP, and RAC (i.e., 4E, 5). In the cost calculator, the HS categories are the Arabic numerals 1, 2, 3, and 4, while in the report, they are the Roman numerals I, II, III, and IV.

[b] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Table S-4. Costs Avoided for Chemical Substances—Carbon Dioxide (HS 2, HP D, RAC 3)

Risk code[a]	1A, 1	4E, 5	
Category	Current	Residual	Avoided[b]
Number of persons exposed	296	30	266
Number of persons injured/ill	4	0	4
Number of persons losing time	2	0	2
Number of persons hospitalized	0	0	0
Number of persons disabled	1	0	1
Number of persons requiring rehabilitation	0	0	0
Number of clinic visits	33	0	33
Number of lost days	20	0	20
Number of hospital days	3	0	3
Number of deaths	0	0	0
Cost of clinic visits	$4,030	$3	$4,027
Cost of lost time	$1,547	$2	$1,546
Cost of hospitalization	$4,550	$5	$4,546
Cost of disability	$5,454	$5	$5,449
Cost of rehabilitation	$80	$0	$79
Cost of deaths	$0	$0	$0
Total hazard cost for 1 year	$15,661	$15	$15,647
Total hazard cost for 20 years	$313,226	$296	$312,930

[a] The risk code sequence is HS, HP, and RAC (i.e., 4E, 5). In the cost calculator, the HS categories are the Arabic numerals 1, 2, 3, and 4, while in the report, they are the Roman numerals I, II, III, and IV.

[b] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Table S-5. Costs Avoided for Acoustical Energy—Impulse Noise (HS 2, HP C, RAC 2)

Risk code[a]	1A, 1	4E, 5	
Category	Current	Residual	Avoided[b]
Number of persons exposed	5,920	30	5,890
Number of persons injured/ill	72	0	72
Number of persons losing time	33	0	33
Number of persons hospitalized	8	0	8
Number of persons disabled	12	0	12
Number of persons requiring rehabilitation	0	0	0
Number of clinic visits	661	0	661
Number of lost days	407	0	407
Number of hospital days	55	0	55
Number of deaths	0	0	0
Cost of clinic visits	$80,602	$3	$80,599
Cost of lost time	$30,947	$2	$30,945
Cost of hospitalization	$91,004	$5	$91,00
Cost of disability	$109,081	$5	$109,076
Cost of rehabilitation	$1,591	$0	$1,591
Cost of deaths	$0	$0	$0
Total hazard cost for 1 year	$313,226	$15	$313,211
Total hazard cost for 20 years	$6,264,517	$296	$6,264,211

[a] The risk code sequence is HS, HP, and RAC (i.e., 4E, 5). In the cost calculator, the HS categories are the Arabic numerals 1, 2, 3, and 4, while in the report, they are the Roman numerals I, II, III, and IV.

[b] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Table S-6. Costs Avoided for Acoustical Energy—Steady State Noise (HS 2, HP C, RAC 2)

Risk code[a]	1A, 1	4E, 5	
Category	Current	Residual	Avoided[b]
Number of persons exposed	5,920	30	5,890
Number of persons injured/ill	72	0	72
Number of persons losing time	33	0	33
Number of persons hospitalized	8	0	8
Number of persons disabled	12	0	12
Number of persons requiring rehabilitation	0	0	0
Number of clinic visits	661	0	661
Number of lost days	407	0	407
Number of hospital days	55	0	55
Number of deaths	0	0	0
Cost of clinic visits	$80,602	$3	$80,599
Cost of lost time	$30,947	$2	$30,945
Cost of hospitalization	$91,004	$5	$91,000
Cost of disability	$109,081	$5	$109,076
Cost of rehabilitation	$1,591	$0	$1,591
Cost of deaths	$0	$0	$0
Total hazard cost for 1 year	$313,226	$15	$313,211
Total hazard cost for 20 years	$6,264,517	$296	$6,264,221

[a] The risk code sequence is HS, HP, and RAC (i.e., 4E, 5). In the cost calculator, the HS categories are the Arabic numerals 1, 2, 3, and 4, while in the report, they are the Roman numerals I, II, III, and IV.

[b] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Table S-7. Costs Avoided for Temperature Extremes—Cold Stress (HS 2, HP C, RAC 2)

Risk code[a]	1A, 1	4E, 5	
Category	Current	Residual	Avoided[b]
Number of persons exposed	5,920	30	5,890
Number of persons injured/ill	72	0	72
Number of persons losing time	33	0	33
Number of persons hospitalized	8	0	8
Number of persons disabled	12	0	12
Number of persons requiring rehabilitation	0	0	0
Number of clinic visits	661	0	661
Number of lost days	407	0	407
Number of hospital days	55	0	55
Number of deaths	0	0	0
Cost of clinic visits	$80,602	$3	$80,599
Cost of lost time	$30,947	$2	$30,945
Cost of hospitalization	$91,004	$5	$91,000
Cost of disability	$109,081	$5	$109,076
Cost of rehabilitation	$1,591	$0	$1,591
Cost of deaths	$0	$0	$0
Total hazard cost for 1 year	$313,226	$15	$313,211
Total hazard cost for 20 years	$6,264,517	$296	$6,264,221

[a] The risk code sequence is HS, HP, and RAC (i.e., 4E, 5). In the cost calculator, the HS categories are the Arabic numerals 1, 2, 3, and 4, while in the report, they are the Roman numerals I, II, III, and IV.

[b] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Table S-8. Costs Avoided for Temperature Extremes—Heat Stress (HS 2, HP C, RAC 2)

Risk code[a]	1A, 1	4E, 5	
Category	Current	Residual	Avoided[b]
Number of persons exposed	5,920	30	5,890
Number of persons injured/ill	72	0	72
Number of persons losing time	33	0	33
Number of persons hospitalized	8	0	8
Number of persons disabled	12	0	12
Number of persons requiring rehabilitation	0	0	0
Number of clinic visits	661	0	661
Number of lost days	407	0	407
Number of hospital days	55	0	55
Number of deaths	0	0	0
Cost of clinic visits	$80,602	$3	$80,599
Cost of lost time	$30,947	$2	$30,945
Cost of hospitalization	$91,004	$5	$91,000
Cost of disability	$109,081	$5	$109,076
Cost of rehabilitation	$1,591	$0	$1,591
Cost of deaths	$0	$0	$0
Total hazard cost for 1 year	$313,226	$15	$313,211
Total hazard cost for 20 years	$6,264,517	$296	$6,264,221

[a] The risk code sequence is HS, HP, and RAC (i.e., 4E, 5). In the cost calculator, the HS categories are the Arabic numerals 1, 2, 3, and 4, while in the report, they are the Roman numerals I, II, III, and IV.

[b] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Table S-9. Costs Avoided for Oxygen Deficiency—Oxygen Deficiency (Ventilation) (HS 2, HP C, RAC 2)

Risk code[a]	1A, 1	4E, 5	
Category	Current	Residual	Avoided[b]
Number of persons exposed	5,920	30	5,890
Number of persons injured/ill	72	0	72
Number of persons losing time	33	0	33
Number of persons hospitalized	8	0	8
Number of persons disabled	12	0	12
Number of persons requiring rehabilitation	0	0	0
Number of clinic visits	661	0	661
Number of lost days	407	0	407
Number of hospital days	55	0	55
Number of deaths	0	0	0
Cost of clinic visits	$80,602	$3	$80,599
Cost of lost time	$30,947	$2	$30,945
Cost of hospitalization	$91,004	$5	$91,000
Cost of disability	$109,081	$5	$109,076
Cost of rehabilitation	$1,591	$0	$1,591
Cost of deaths	$0	$0	$0
Total hazard cost for 1 year	$313,226	$15	$313,211
Total hazard cost for 20 years	$6,264,517	$296	$6,264,221

[a] The risk code sequence is HS, HP, and RAC (i.e., 4E, 5). In the cost calculator, the HS categories are the Arabic numerals 1, 2, 3, and 4, while in the report, they are the Roman numerals I, II, III, and IV.

[b] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Table S-10. Costs Avoided for Radiation Energy—Nonionizing Radiation (HS 2, HP C, RAC 2)

Risk code[a]	1A, 1	4E, 5	
Category	Current	Residual	Avoided[b]
Number of persons exposed	5,920	30	5,890
Number of persons injured/ill	72	0	72
Number of persons losing time	33	0	33
Number of persons hospitalized	8	0	8
Number of persons disabled	12	0	12
Number of persons requiring rehabilitation	0	0	0
Number of clinic visits	661	0	661
Number of lost days	407	0	407
Number of hospital days	55	0	55
Number of deaths	0	0	0
Cost of clinic visits	$80,602	$3	$80,599
Cost of lost time	$30,947	$2	$30,945
Cost of hospitalization	$91,004	$5	$91,000
Cost of disability	$109,081	$5	$109,076
Cost of rehabilitation	$1,591	$0	$1,591
Cost of deaths	$0	$0	$0
Total hazard cost for 1 year	$313,226	$15	$313,211
Total hazard cost for 20 years	$6,264,517	$296	$6,264,221

[a] The risk code sequence is HS, HP, and RAC (i.e., 4E, 5). In the cost calculator, the HS categories are the Arabic numerals 1, 2, 3, and 4, while in the report, they are the Roman numerals I, II, III, and IV.

[b] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Table S-11. Costs Avoided for Radiation Energy—Ionizing Radiation (HS 2, HP E, RAC 4)

Risk code[a]	1A, 1	4E, 5	
Category	Current	Residual	Avoided[b]
Number of persons exposed	30	30	0
Number of persons injured/ill	0	0	0
Number of persons losing time	0	0	0
Number of persons hospitalized	0	0	0
Number of persons disabled	0	0	0
Number of persons requiring rehabilitation	0	0	0
Number of clinic visits	3	0	3
Number of lost days	2	0	2
Number of hospital days	0	0	0
Number of deaths	0	0	0
Cost of clinic visits	$403	$3	$400
Cost of lost time	$155	$2	$153
Cost of hospitalization	$455	$5	$450
Cost of disability	$545	$5	$540
Cost of rehabilitation	$8	$0	$8
Cost of deaths	$0	$0	$0
Total hazard cost for 1 year	$1,566	$15	$1,551
Total hazard cost for 20 years	$31,323	$296	$31,027

[a] The risk code sequence is HS, HP, and RAC (i.e., 4E, 5). In the cost calculator, the HS categories are the Arabic numerals 1, 2, 3, and 4, while in the report, they are the Roman numerals I, II, III, and IV.

[b] Because of rounding, these numbers may not add up in the chart and may vary from the those presented in the report.

Appendix T
Abbreviations

HHA	health hazard assessment
HP	hazard probability
HS	hazard severity
ICD	International Classification of Diseases
MANPRINT	manpower and personnel integration
RAC	risk assessment code
SIC	standard industrial classification
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine

Appendix U
Glossary

clinic costs component—component of the model that estimates costs attributed to outpatient visits to the medical clinic or medical treatment facility by persons exposed to a hazard that resulted in illness or injury.

clinic costs component output—outputs that can be estimated other than costs. The specific outputs are the number of clinic visits and the number of persons who are injured or ill.

common variables—specific variables used in the estimate of costs in five of the six model components: clinic, hospitalization, lost time, disability, and rehabilitation. The specific variables are the number of persons exposed (N_e) and the hazard severity factor (S_k).

component-unique variables—specific variables that are unique to each model component and are used to determine component costs. They include incidence and distribution rates for lost time, hospitalization, disability, etc.

cost avoidance—medical costs not incurred because of health hazard intervention and prevention activities.

disability costs component—component of the model that estimates costs attributed to active-duty temporary and permanent disability compensation, and VA disability compensation, for persons exposed to a hazard that resulted in illness or injury.

disability costs component output—outputs that can be estimated other than costs. The specific output is the number of persons who are disabled.

hazard costs per year—costs of hazard per year based on hospitalization, lost time, disability, rehabilitation, and death costs.

hazard probability—the likelihood that a hazard will occur. It reflects the duration of exposure and the number of exposed personnel. There are five categories for hazard probability, designated A through E:

- **A, frequent**—likely to occur habitually for a specific individual item; will occur continuously for a fleet or inventory.

- **B, probable**—will occur several times in the life of a specific individual item; will occur frequently for a fleet or inventory.

- **C, occasional**—likely to occur sometime in the life of a specific individual item; will occur several times for a fleet or inventory.
- **D, remote**—unlikely but possible to occur sometime in the life of a specific individual item; unlikely but can reasonably be expected to occur for a fleet or inventory.
- **E, improbable**—so unlikely it can be assumed an occurrence may not be experienced in the life of a specific individual item; unlikely to occur but possible for a fleet or inventory.

hazard severity—an assessment of the potential consequence. It is used to address degree of bodily injury, illness, performance degradation, or bodily system damage that could occur. It reflects the magnitude of exposure to a hazard and the medical effects of the exposure. It is assessed prior to the implementation of recommendations to eliminate or minimize the hazard. There are four health hazard categories, designated I through IV:

- **I, catastrophic**—hazard may cause death or total loss of a bodily system.
- **II, critical**—hazard may cause severe bodily injury, severe occupational illness, or major damage to a bodily system.
- **III, marginal**—hazard may cause minor bodily injury, minor occupational illness, or minor damage to a bodily system.
- **IV, negligible**—hazard would cause less than minor bodily injury, minor occupational illness, or minor bodily system damage.

health hazard—an existing or likely condition, inherent to the operation or use of materiel, that can cause death, injury, acute or chronic illness, disability, or reduced job performance of personnel by exposure to acoustical energy, biological substances, chemical substances, oxygen deficiency, radiation energy, shock, temperature extremes, trauma, and vibration.

health hazard assessment—the application of biomedical knowledge and principles to document and quantitatively determine the health hazards of systems. This assessment identifies, evaluates, and recommends solutions to control the risks to the health and effectiveness of personnel who test, use, or service Army materiel systems. It includes the evaluation of hazard severity, hazard probability, risk assessment, and operational constraints; the identification of required precautions and protective devices; and the identification of training requirements.

health risk—combines the probability of exposure to a hazard and the severity of the potential consequences.

hospitalization costs component—component of the model that estimates costs attributed to inpatient hospital stays by persons exposed to a hazard that resulted in illness or injury.

hospitalization costs component output—outputs that can be estimated other than costs. The specific outputs are the number of persons who are hospitalized and the number of hospital days.

incidence rates—rate of injury or illness in a group over a period of time.

lost time costs component—component of the model that estimates costs attributed to time away from the job by persons exposed to a hazard that resulted in illness or injury.

lost time costs component output—outputs that can be estimated other than costs. The specific outputs are the number of persons losing time away from the job and the number of lost workdays.

manpower and personnel integration—the process of integrating the full range of manpower, personnel training, human engineering, health hazard, system safety, and soldier survivability to improve individual performance and total system performance throughout the entire system development and acquisition process.

materiel—all items necessary to equip, operate, maintain, and support military activities, including ships, tanks, self-propelled weapons, aircraft, and related spares, repair parts, and support equipment, but excluding real property, installations, and utilities.

rehabilitation costs component—component of the model that estimates costs attributed to rehabilitation benefits received by eligible persons drawing VA disability compensation who were exposed to a hazard that resulted in illness or injury.

rehabilitation costs component output—outputs that can be estimated other than costs. The specific output is the number of rehabilitation cases.

total medical costs—the sum of each cost component (clinic, hospitalization, lost time, disability, rehabilitation, and death).

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13. ABSTRACT *(Maximum 200 words)*

We developed a model to estimate the costs associated with the failure to abate or control health hazards in Army materiel systems. An earlier LMI report, AR 515R1 Estimating Costs for Army Materiel Health Hazards in March 1997 described the model. Health hazard assessors are using the cost model to estimate the potential costs incurred if materiel program managers fail to implement the recommendations for abatement and control of identified health hazards. This report provides the documentation of the process, data elements, and data sources that we used to develop the cost model. Specifically, it provides: an overview of the cost estimating process; the documentation necessary to understand the selection or development of each data element; the sources of data used to provide input to the model, and the equations used to estimate each cost. We believe this documentation will provide medical assessors and others involved in the risk management process a starting point for: understanding our cost estimating process; understanding our data elements and their sources, and suggesting improvements and revisions of the cost model data elements.

14. SUBJECT TERMS

medical costs, health hazards, Army material, cost model, risk assessment code, risk management, lost time

15. NUMBER OF PAGES

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