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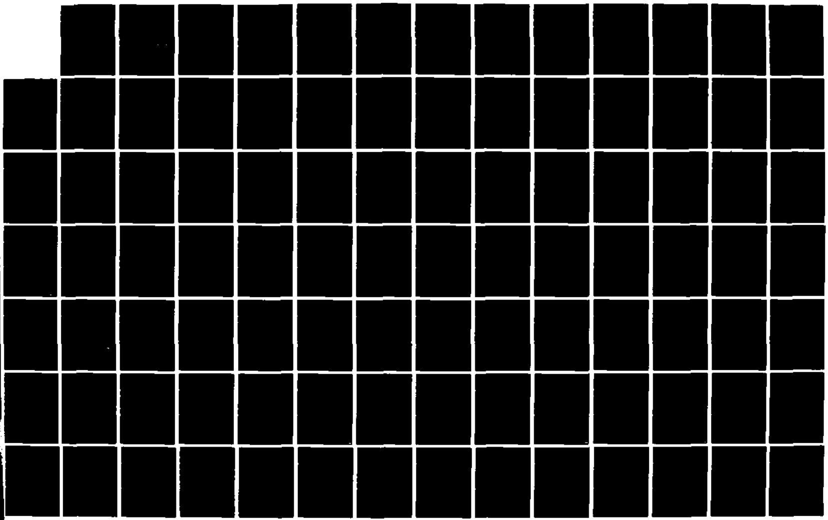

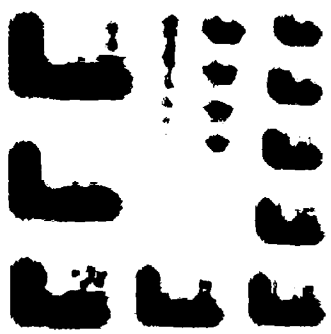

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The study explores alternative procedures to assist the US Army Medical Research Development Command with decisions concerning the allocation of R&D resources to projects, with specific concentration on projects concerned with improvements in Combat Casualty Care. A generic description of medical system processes within selected combat scenarios is used to analyze the impact of medical research and development on the number of casualties returned to duty during the combat—

(continued on reverse)

Block 20. (Continued)

period. The analysis demonstrates a methodology for linking medical R & D to military payoff. A separate volume of this report, "Volume II, Technical Annex," presents the major analytical formulations and computer program used during the course of the study.

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1.0 INTRODUCTION

This report presents the results of a six-month project to examine the feasibility of relating medical research and development to potential military payoff. These results were developed by Vector Research, Incorporated, (VRI) for the US Army Medical Research and Development Command under Contract Number DAMD17-78-C-8025. In addition to this report, a technical annex was developed which describes major analytical formulations and computer programs used during the project. The technical annex is bound in separate volume under the same report title.[1]

1.1 Outline of Report

The report is organized into four chapters -- this introductory chapter, a chapter which discusses the methodology developed in the study, a chapter which demonstrates an application of the methodology, and a chapter which describes the study observations and conclusions. The introductory chapter discusses the study background, purpose, and scope and presents a summary of the study findings. The study methodology described in the second chapter provides a conceptual framework for estimating the military payoff of R&D improvements to medical system capability. The specific payoff measures chosen are those which reflect an improvement in combat fighting strength by increasing the numbers of casualties returned to duty during conflict. Then using this conceptual structure, the third chapter presents a demonstration of this methodology by using historical combat casualty data.

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[1]See [Doyle *et al.*, 1978] in the bibliography of this report for a specific reference.

The fourth chapter presents observations and conclusions based on the demonstration results of the third chapter. The report concludes with an appendix which presents an overview of the data used in the demonstration of the methodology.

1.2 Background

The US Army Medical Research and Development Command (USAMRDC) conducts research directed toward improving the capability of the Army's medical system. One of USAMRDC's research mission areas -- Mission Area II -- is concerned with improving the capability of the field medical system to manage combat casualties. That is, research in this mission area influences the capability of the medical system to discover, resuscitate, treat, and evacuate soldiers who are wounded by enemy action, injured during combat, or diseased. One military objective of this research is to reduce the amount of time required to return to duty those casualties with mild to moderate conditions. Thus, a measure of the potential effectiveness of research conducted under this mission area is its impact on combat casualty recovery time.

Since the availability of R&D resources is limited, one of the primary concerns of the USAMRDC research program is the priority of research projects in Mission Area II. A major consideration of such a prioritization is the degree to which an individual research project or a group of research projects appears to have potential to impact on the rate at which casualties are returned to duty. The problem addressed by this study is to examine the [illegible]

to estimates of [illegible]

[illegible]

1.3 Purpose

The purpose of the study [illegible]

of demonstration [illegible]

to develop a [illegible]

development [illegible]

in returning [illegible]

structure could be [illegible]

a preliminary [illegible]

1.4 Scope

To develop and demonstrate [illegible]

resource constraints of the study [illegible]

The study scope was, therefore, [illegible]

the type of medical research [illegible]

scenario used in the analysis, [illegible]

considered for potential [illegible]

dimensions are specified in the [illegible]

First, it was decided to examine [illegible]

search mission areas -- Mission Area [illegible]

Sole consideration of research [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

on the number of casualties returned in these classes. Despite the difficulty with the casualty classification scheme, this data was useful to demonstrate the range of R&D impact if it were capable of achieving certain outcomes. In addition, the demonstration of the methodology using this data illustrated the mechanics of relating medical research and development to return-to-duty performance; thus supporting the above conclusion.

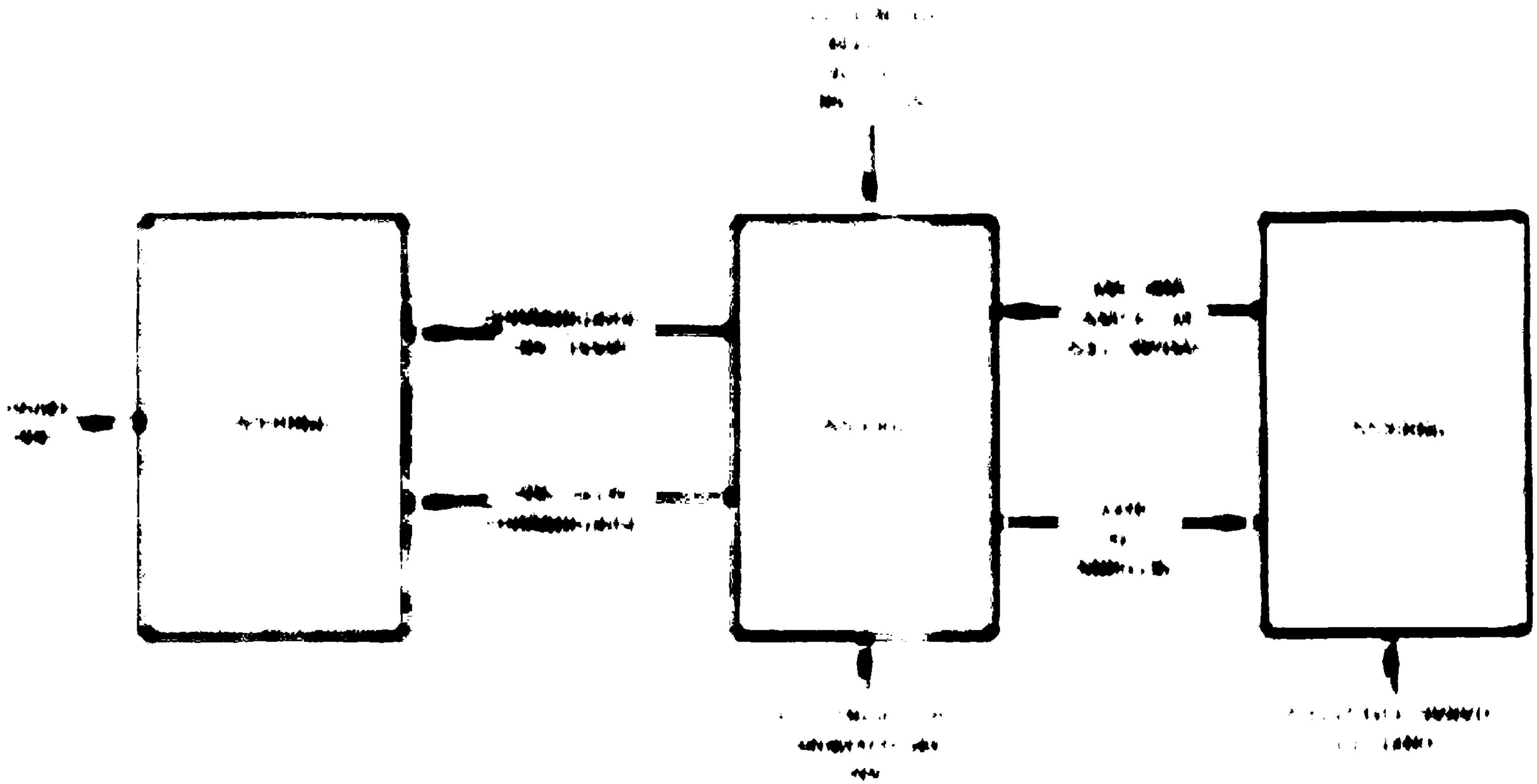
The methodology developed in the study requires further refinement to be useful to USAMRDC in justifying or improving the allocation of resources to R&D programs. One such refinement is the integration of the methodology into the USAMRDC programmatic and research project structure. The demonstration provides an example of how this integration might be visualized and illustrates a general technique for reorienting the content of combat casualty information so that it might be more useful to research planning activities. Another suggested improvement to the methodology is the incorporation of information concerning the uncertainty of R&D outcomes and the cost of R&D. With these and other less extensive improvements, the methodology could assist with the development and evaluation of alternative R&D resource allocation strategies.

[illegible]

The methodology [illegible] work for organizing and [illegible] medical R&D impact on the [illegible] ology is a conceptual [illegible] medical R&D and the [illegible] It addresses only [illegible] a medical R&D resource [illegible] strategy requires [illegible] payoff (i.e., that [illegible] technological [illegible] implementation of [illegible]

The conceptual methodology [illegible] information flows, [illegible] information [illegible] results employed by the methodology [illegible] methodology. The [illegible] results from the [illegible] Finally, the performance measures [illegible] of measuring the [illegible]

This chapter [illegible] It is organized into [illegible] of the methodological framework. [illegible] that in the above discussion, [illegible] and performance measures.



[illegible] Information Flows

Exhibit 2-1 illustrates the principal information flows through the conceptual framework for the methodology. The framework contains eight sets of information flows: three are inputs to process boxes; four are intermediate results (outputs from one process which become inputs to another process); and one is the desired output from the methodology (R&D impact).

A discussion of these flows is facilitated by proceeding from the left side to the right side of Exhibit 2-1. Specifically, the characteristics of the conflict and the number of medical system returns to duty are inputs to the process that estimates the number of casualties by class[1] and day. This estimate is then combined either with information on the baseline medical system capability, or with estimates of R&D improvements in this capability in a second process to produce the corresponding estimate of medical system performance, a calculation of the number of returns-to-duty. Finally, a third process compares the estimates of medical system performance in the absence of R&D improvements (the baseline performance) with the performance anticipated after the implementation of R&D improvements to estimate the potential impact of medical research and development.

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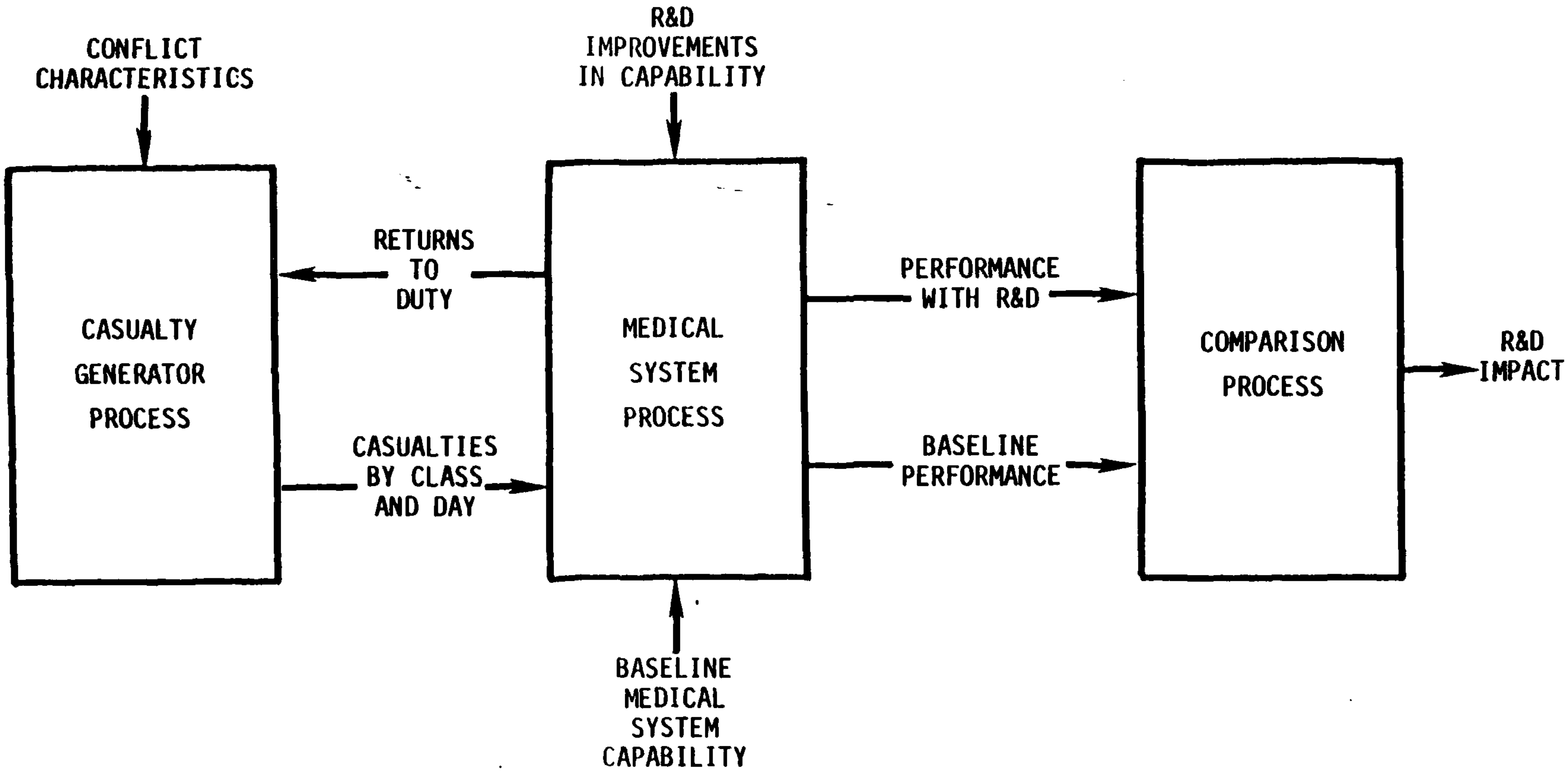
[1] The term casualty class is used throughout the text of this report to indicate a particular type of wound, injury, or psychological trauma. For example, one class might be burn casualties, and another might be soldiers suffering from anxiety reactions.

EXHIBIT 2-2: CONCEPTUAL FRAMEWORK FOR METHODOLOGY
(GENERIC PROCESSES)



Use of these conceptual information flows in an actual study requires definition of flow parameters and estimation of parameter values. The specification of the types of data and level of detail contained in each information flow definition is dependent on the specific structure and content employed in the three processes. The structure of the processes is dependent, in turn, on the specific questions being addressed and the availability of data. An example set of such definitions and interdependencies is provided in the study demonstration (chapter 3.0).

2.2 Generic Processes

The methodological framework consists of three generic processes -- the casualty generator process, the medical system process, and the comparison process (see exhibit 2-2). They are data producers; within the context of the methodology this data becomes information. That is, each process accepts a subset of the information flows described above inputs and produces another set of these information elements as outputs. This section discusses the three processes, the functions they perform, and the alternative ways that might be chosen to perform these functions.

2.2.1 Casualty Generator Process

The role of the casualty generator process is to produce a casualty stream, the numbers of casualties in each casualty class for each day of the conflict [illegible]

of the conflict [illegible]

medical system [illegible]

feedback information [illegible]

The selection of [illegible]

the particular [illegible]

question. [illegible]

[illegible]

Another [illegible]

techniques to estimate the [illegible]

[illegible]

generally [illegible] the number of [illegible]

from actual [illegible]

by such a method [illegible]

tion of the [illegible]

casualty generator, the number of [illegible]

---

[1]Described in subsection [illegible]

[2]Few, if any, existing [illegible] characterization of [illegible] of refinement of [illegible] Factors Study [illegible] approaches to estimating [illegible] The results of this study [illegible] would have to be [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

2.3 *Effectiveness Measures*

There are a number of measures that could be used to describe the return-to-duty effectiveness of the medical system. Effectiveness measures could be used which describe: (1) the performance level of the medical system to return casualties to duty, (2) the medical system cost of achieving a particular level of performance, or (3) some combination of these two. During the development and demonstration of the above methodological structure, most of the emphasis was placed on the first of the above types, i.e., measures which describe the return-to-duty performance of the medical system.[1] Consequently, the following discussion primarily concentrates on measures of this type. However, it should be noted that medical R&D directed toward improving combat casualty management can impact on the medical system resource requirements (i.e., costs) as well as increase the number of casualties returned to duty. Thus, the ultimate effectiveness measure should be one which includes both cost and performance considerations.

Four measures of the return to duty performance of the medical system were examined during the study. The first measure was a simple count of the number of casualties returned to duty during the conflict period. The major advantage to this measure lies in its simplicity. The obvious disadvantage of the measure is that it gives the medical system as much credit for returning a soldier on the first day of the conflict as it would if

---

[1]This emphasis was the consequence of the study scope which adopted the operational objective for Mission Area II; i.e., one with a single goal of increasing return-to-duty rate.

he were returned on the last day. Thus, the measure does not provide a realistic assessment of the medical system's contribution to the fighting strength during the conflict.

The second measure, the number of noneffective man-days during the conflict period,[1] obviates this shortcoming by counting the number of man-days lost to combat (i.e., spent in the medical system). This is a negative measure from the combat perspective, since the effectiveness value increased as the value of the measure decreases. The measure is often used as a component in medical system planning since it provides an assessment of system workload. However, when employed within the context of the methodology discussed above, it has the potential drawback that its value may not always change in the appropriate direction with changes in return-to-duty effectiveness. For example, if the medical system became capable of rapidly returning a certain class of casualties, these returned casualties would then be at risk to becoming casualties in different classes, which could have much longer recovery times than those in the original class. Such an occurence is, however, remote thus the major disadvantage of this measure is its orientation to medical workload rather than combat strength.

The third measure examined was the number of active-duty man-days during the conflict period. This measure has intuitive appeal from a combat perspective since it provides a direct measure of combat strength. The disadvantage of this measure is that its value is dependent on the

---

[1]The total number of man-days that combat casualties spend in the medical system. Other types of noneffective days attributed to non-medical causes (e.g., desertion) are not included.

characteristics of combat. That is, the time that a casualty returned to duty will contribute to the fighting force for the remainder of the conflict period is dependent on whether he is re-injured or killed in combat. The risk of becoming such a casualty is, in turn, dependent on the methods employed in the combat casualty generator process (e.g., a combat model). This measurement of medical system performance could, therefore, be dramatically influenced by the assumptions concerning combat and non-battle injury rates. A preferred alternative to this measure would be one which examines the combat results directly (e.g., FEBA movement) as a consequence of casualty returns. Such an alternative was not examined in this study since it was beyond the study scope.

The final measure examined was essentially the complement to the effective man-days. Referred to here as potential restored man-days, this measure credits the medical system for return [illegible] es-timating the number of potential days each casualty could contribute to the fighting strength were he not vulnerable to subsequent attrition. The disadvantage to this measure is that it overestimates the number of man-days restored by the medical system. The advantage is that it measures effectiveness from the combat perspective and is not sensitive to combat assumptions regarding the vulnerability of returned casualties. For these reasons, the potential restored man-day measure was chosen for use in the demonstration described in the next chapter.

It should finally be noted that the absolute value of all of the above measures is dependent on both the size of the force under consideration and the duration of the conflict period. However, the values of

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

previous chapter. In this section each of the demonstration processes is discussed separately in terms of its assumptions, inputs, and outputs.

3.1.1 Demonstration Casualty Generator Process

The casualty generator produces estimates of the total number of nonbattle injured (NBI), wounded-in-action (WIA), and psychological casualties[1] for each day of the conflict analysis period. The casualty generator decomposes the casualty stream into the number of casualties in each class for each day of the conflict period. This section discusses the underlying assumptions, the inputs, the mathematical structure of the process, and the output of the demonstration casualty generator.

Four assumptions formed the foundation of the casualty generator used in this demonstration. These were specific cases of an assumption of a [illegible] conflict. First, the number of casualties [illegible] was assumed to be a fixed percentage of the [illegible] at the beginning of that day.[2] Second, the number of KIAs on any day was assumed to be a fixed percentage of the casualties-plus-KIAs on

[1] [illegible]

[2] [illegible]

[illegible]

that day. Third, the [illegible] was assumed to be invariant [illegible] casualties returned to duty [illegible] do the other members of the [illegible] tions (i.e., a fixed casualty [illegible] nerability of active duty personnel [illegible] or quantifiable estimate [illegible] regarding fixed percentages [illegible] they were felt to be sufficient for the [illegible]

Five inputs were required by the [illegible] initial size fighting force, [illegible] analysis period, (3) the [illegible] the proportion of casualties [illegible] probability distribution [illegible] casualty class. The inputs and the [illegible] described in the following paragraphs.

A division force of [illegible] of fifteen days were inputs to the casualty [illegible] analysis period was selected for [illegible] of sufficient length for the [illegible]

---

[1]For example, the percentage of [illegible] of the fighting was assumed to be the same as [illegible] the fighting.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

data from the 1973 Israeli war, data from the 1971 Indo-Pakistani war,[1] the MEDMET data from the Vietnam war,[2] the data developed during the TOMSS study,[3] and the data developed as part of the MEDPLN study.[4] Of these, the MEDPLN data describing the Vietnam casualties were selected. There were several factors influencing this decision. The MEDPLN data classified casualties in terms of primary diagnoses found in inpatient medical records. Consequently, casualties with multiple types of injuries were counted only once. The data were based on a relatively large sample of casualty records.[5] Further, such samples were available from both Korean and Vietnam wars using a consistent classification scheme. The number of casualty classes pertaining to WIAs, NBIs, and psychological casualties was somewhat more manageable than provided by several other sources. Finally, the MEDPLN study data provided distributions of the convalescence times[6] for inpatients in each of the MEDPLN casualty classes.[7]

The MEDPLN data was not without limitations; there were four factors which made it less than ideal for the demonstration. First, casualties

---

[1] See [Banerjee and Chandekar, 1973].

[2] See [Sacco, 1975].

[3] See [US Army, 1977].

[4] See [McSiffece, 1975].

[5] See the description of the MEDPLN data base development, *ibid* page G-21.

[6] The period of convalescence is the time between the admission to and release from the medical system.

[7] For the demonstration, it was necessary that the convalescence time distribution and the information describing the distribution of casualties across classes use the same casualty classification scheme.

were classified according to the AHS casualty classes which are primarily based on the anatomical location of the injury, but lump together various types of injury. Consequently, the casualty classes were often extremely heterogeneous, increasing the difficulty of estimating the potential impact of R&D has on these classes. Second, the data reflects the distribution of casualties over classes for the entire Vietnam war or Korean war, thus, averaging the combat and noncombat situation. The resultant distributions are not necessarily representative of those anticipated in the initial phase of future conflict in Europe. Third, again due to the data being collected during various conditions, the distributions of convalescence times do not reflect a single medical system, but rather the average performance of the medical system under various degrees of overloading and underloading, etc. Finally, the data did not contain any information about outpatients. Consequently, the numbers produced using this data in chapter 3.0 are simply illustrative of the kinds of information that can be produced and are used only to demonstrate the methodology. These values should not be used other than for demonstration purposes.

A refinement was required of the MEDPLN data for the fifth input (the probability distribution describing the fraction of casualties in each casualty class), since the MEDPLN data described only inpatients, and since outpatients were also being considered in the demonstration. Subjective estimates of the proportion of outpatients in each class were incorporated into the MEDPLN data to produce the distribution of injuries over classes for inpatients and outpatients combined.

Using these five inputs, plus information concerning the number of medical system returns to duty, the casualty generator provided an estimate of the number of casualties on each day and proportionally distributed these casualties over the MEDPLN casualty classes. The mathematical equation[1] used to compute the number of casualties by class and by day is given in exhibit 3-1.

3.1.2 Demonstration Medical System Process

The analytic representation of the medical system process was called the medical system model. The medical system model developed in the demonstration provided feedback to the casualty generator process (the number of returns by day), and estimated the appropriate performance measure (the number of potential restored man-days). This section describes the characteristics of the medical system model in both the absence (baseline) and presence of R&D improvement. The baseline case is discussed first in terms of the assumptions, inputs, mathematical structure, and outputs of the medical systems model. This is followed by a description of the methods used to incorporate R&D impact into the model structure.

---

[1]Volume II of this report -- *The Technical Annex* -- describes in greater detail the analytical methods used to make these computations.

[illegible]

[illegible]

$$C_{j,k} = PC_k \cdot [illegible] \cdot \left[[illegible] + \sum [illegible] \right]$$

where

$C_{j,k}$ = the number of [illegible].

PC_k = the probability that a [illegible].

.04[illegible] = the multiplier to get the number [illegible] (4 [illegible]/day).

[illegible] = the number of [illegible] (= 15,000 • [illegible]).

RE^{*}_{j} = the number of [illegible]

[1]This is the medical system feedback to the casualty [illegible] in subsection 3.1.2.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

EXHIBIT 3-2: EXAMPLE CONVALESCENCE TIME DISTRIBUTION

FOR CASUALTY CLASS K

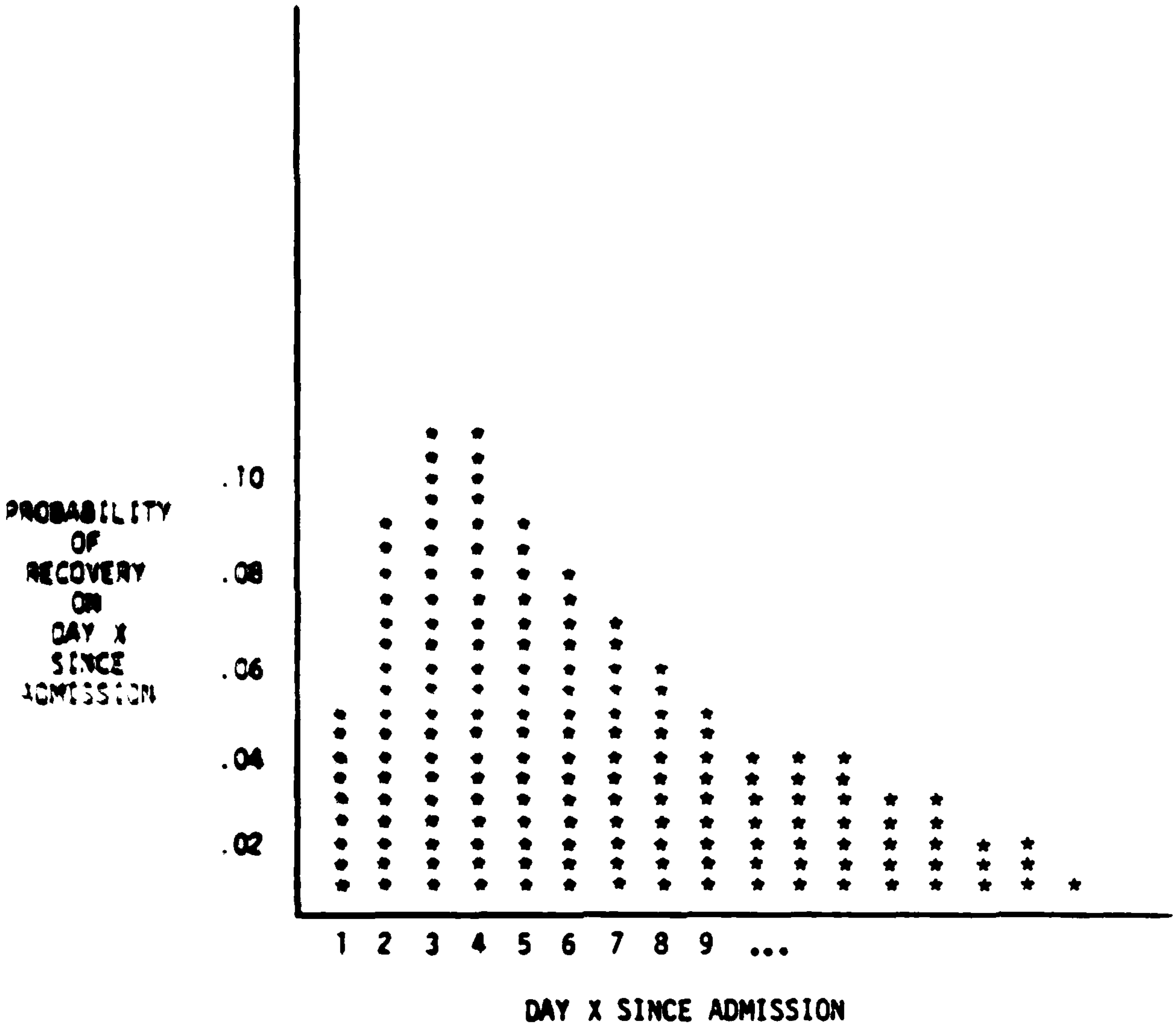


EXHIBIT 3-3: MEDICAL SYSTEM RETURNS FORMULA

$$RET_j = \sum_{\substack{\text{classes} \\ k}} \left[C_{j,k} \cdot (1 - PI_k) + \sum_{i=1}^{j-1} C_{j-i,k} \cdot PI_k \cdot PR_k \cdot f_k\,[t=i] \right]$$

where

RET_j = the number of returns by the end of day j,

$C_{j,k}$ = the number of casualties in class k on day j,

PI_k = the probability that a casualty in class k is an inpatient,

PR_k = the probability than an inpatient in class k recovers

$f_k[t=i]$ = the probability that an inpatient in class k who recovers, convalesces in exactly i days.

EXHIBIT 3-4: PERFORMANCE MEASURE FORMULA

$$\text{PRMD} = \sum_{\substack{\text{classes}\\ k}} \sum_{j=1}^{15} \left[C_{j,k} \cdot (1 - PI_k) \cdot (R_j - TO_k) + \sum_{n=j}^{15} \left\{ C_{i,k} \cdot PI_k \cdot PR_k \cdot f_k[t = n - j + 1] \cdot (15 - n + 1) \right\} \right]$$

where

PRMD = the number of potential restored man-days,

$C_{j,k}$ = the number of casualties in class k on day j,

PI_k = the probability that a casualty in class k is an inpatient,

R_j = the number of days remaining in the conflict period on day j,

TO_k = the average treatment time for outpatients in class k,

PR_k = the probability that an inpatient in class k recovers,

$f_k[t=n-j+1]$ = the probability that an inpatient in k who recovers convalescences in exactly n-j+1 days.

Incorporation of R&D Impacts

The incorporation of R&D impacts [illegible] required a representation of the [illegible] in system capability [illegible] three were incorporated [illegible] (1) a reduction in the average outpatient treatment [illegible] duction in the inpatient convalescence times and [illegible] the proportion of casualties that [illegible] three potential R&D impacts were [illegible] to the baseline medical system model. [illegible] fication depended on the type and extent of the R&D impact being represented.

Of the five baseline inputs to the medical system model [illegible] not modified. The input from the casualty generation (the number of casualties by day and class) was automatically adjusted by the feedback loop which described the number of patients [illegible] system. The probability that an inpatient in a particular [illegible] dies in the hospital was also held constant.

The three medical system model inputs that were modified to reflect potential R&D impact were: (1) the average outpatient treatment times, (2) the distributions of inpatient convalescence times, and (3) the inpatient/outpatient ratios. All three of these inputs were varied parametrically to examine the impact on the ability of the medical

---

[1]The two ways excluded from the demonstration were: (1) a reduction in the number of casualties that die in the medical system and (2) an improvement in the ability to return partially recovered casualties to duty. The first was excluded since it was considered unlikely that a significant decrease in this mortality rate would significantly influence the return to duty effectiveness during a fifteen day conflict analysis period. The second was excluded because of a general lack of data on the use of partially recovered casualties.

[illegible]

[illegible]

[illegible]

Without this shift, [illegible] less than the [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

unharmed personnel[1] by the [illegible] day of [illegible]
Of the remaining 4,350 personnel on day [illegible]
1,050 are killed-in-action and [illegible]

The demonstration medical system model [illegible]
of the total casualties. Therefore, the [illegible]
be viewed as the medical system [illegible]
realization of some of this opportunity [illegible]
the baseline medical system. [illegible]
systems model, the casualties returned to duty [illegible]
of the active duty force on day [illegible]
Since the casualties returned by the medical system [illegible]
to being killed in action, the number [illegible]
increased (i.e., from [illegible])

3.2.2 [illegible]

The capability [illegible]
to duty not only influences the size of the [illegible]
but also establishes a backdrop against which [illegible]
judged. Further, the "region of opportunity" for [illegible]
dotted region in exhibit 3-6 (i.e., the casualties that [illegible]
medical system and were not returned [illegible]
the performance level for the baseline [illegible]

---

[1]The term unharmed refers to personnel [illegible]
battle injured or a psychological casualty [illegible]

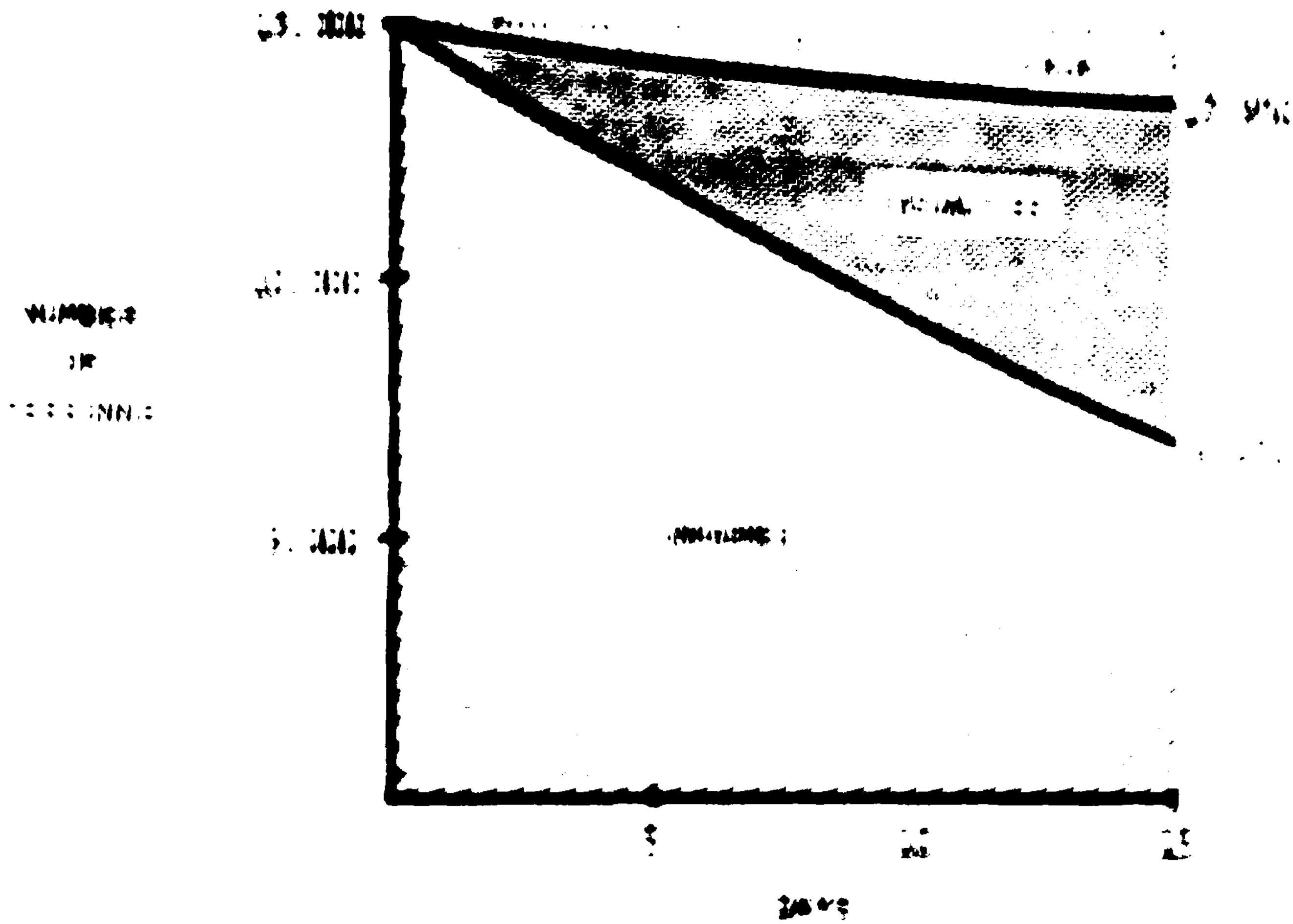
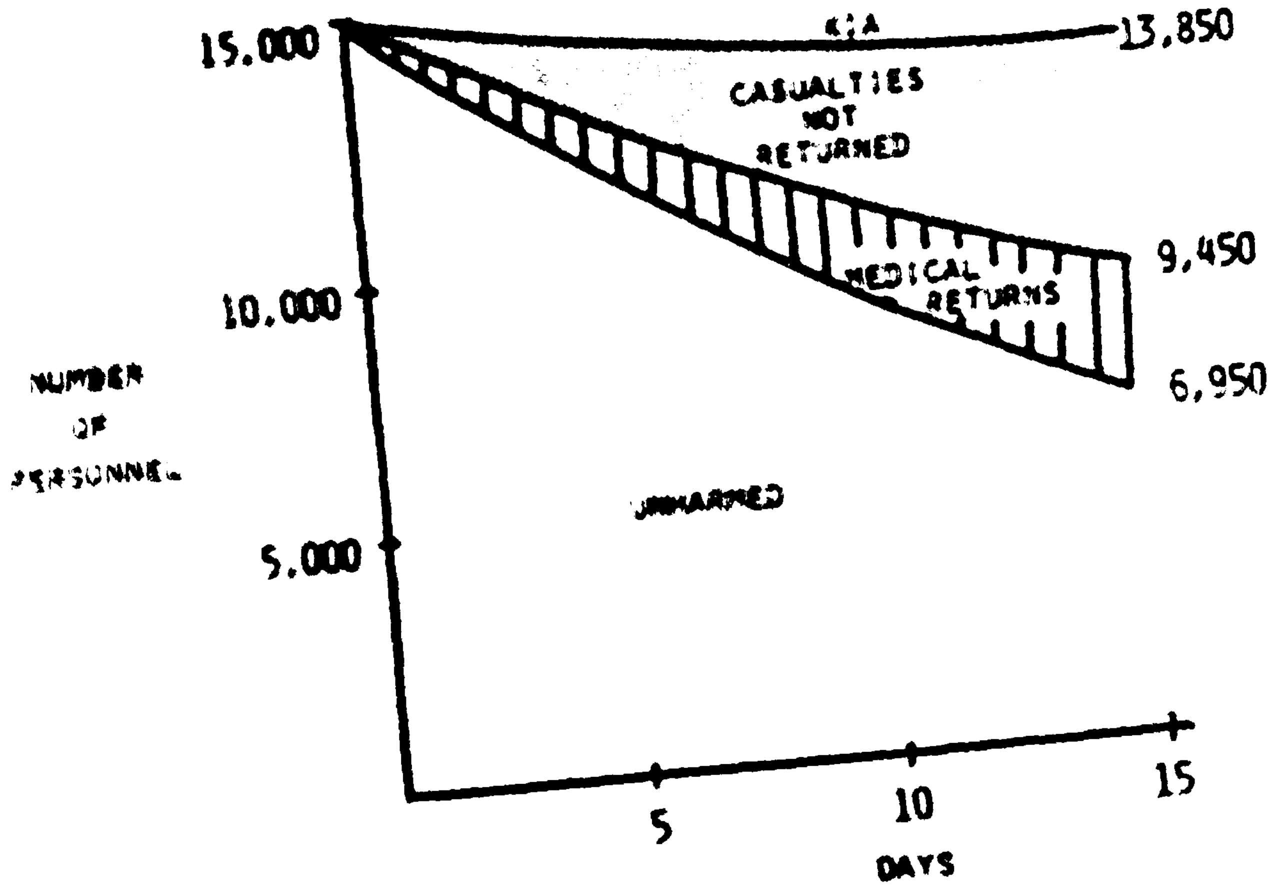


EXHIBIT 3-6. DEMONSTRATION CASUALTY STREAMS WITH BASELINE MEDICAL SYSTEM RETURNS TO DUTY



against which potential R&D improvements are judged and defines the maximum amount of this improvement for a particular casualty stream.

For example, the potential impact of R&D on the performance of a degraded medical system could be significantly greater than its impact on the performance of a nondegraded system. There are at least three causes for this increase in potential R&D impact. First, since the degraded medical system would probably return casualties to duty more slowly, more patient man-days are exposed to the potential R&D improvement. Second, of the patient man-days exposed to R&D, some would likely be casualties with less severe injuries who normally would be returned by a nondegraded medical system. Return-to-duty rates of these casualties might more readily respond to R&D improvements, particularly those intended to alleviate some of the problems causing the degradation of the system (e.g., those that improve the productivity of medical personnel or materiel or reduce the storage requirements for whole blood. The third cause results from the measurement of impact relative to baseline performance. The same increase in potential restored man-days would result in a greater percent improvement over the baseline performance as this performance diminished (i.e., degraded).

The baseline performance shown in exhibit 3-6 represents approximately 22,000 potential restored man-days (i.e., the number of potential restored man-days required to produce the striped area designated in the exhibit as medical returns). This baseline return-to-duty performance can be further decomposed into the return-to-duty contribution of each casualty class.

In all, there were twenty-seven MEDPLN casualty classes used in the analysis. Eleven of these casualty classes contributed over ninety percent of the 22,000 potential restored man-days (PRMD). Exhibit 3-7 shows the individual contribution of each of these eleven casualty classes to the total baseline PRMD. The contribution of the most significant class, lacerations and contusions,[1] is shown on the bottom of the bar graph with the remaining classes stacked on top of this class in order of PRMD significance.

Three characteristics essentially determine the relative significance of one casualty class versus another seen in the exhibit. First is the relative frequency of the casualties in that class, second is the estimated inpatient/outpatient ratio for that class, and third is the distribution of inpatient recovery times.[2] The most significant casualty classes are those which were prevalent in the Vietnam War[3] and were likely to be outpatients or experience a rapid recovery time in the hospital if hospitalized. The least significant classes are those that were infrequent, had no outpatients, and required lengthy hospitalization prior to recovery.

3.2.3 Parametric Analysis of Three Types of R&D Impact

A major component of the demonstration was a *parametric* analysis of the degree to which R&D might increase the baseline return to duty performance. The analysis was *parametric* in form since it addressed questions concerning the potential impact on return to duty performance if R&D were capable of improving the level of medical system capability to a specified level. The analysis did not address the question of whether R&D could achieve such an improvement in system capability. As noted previously, the three types of R&D improvements examined were:

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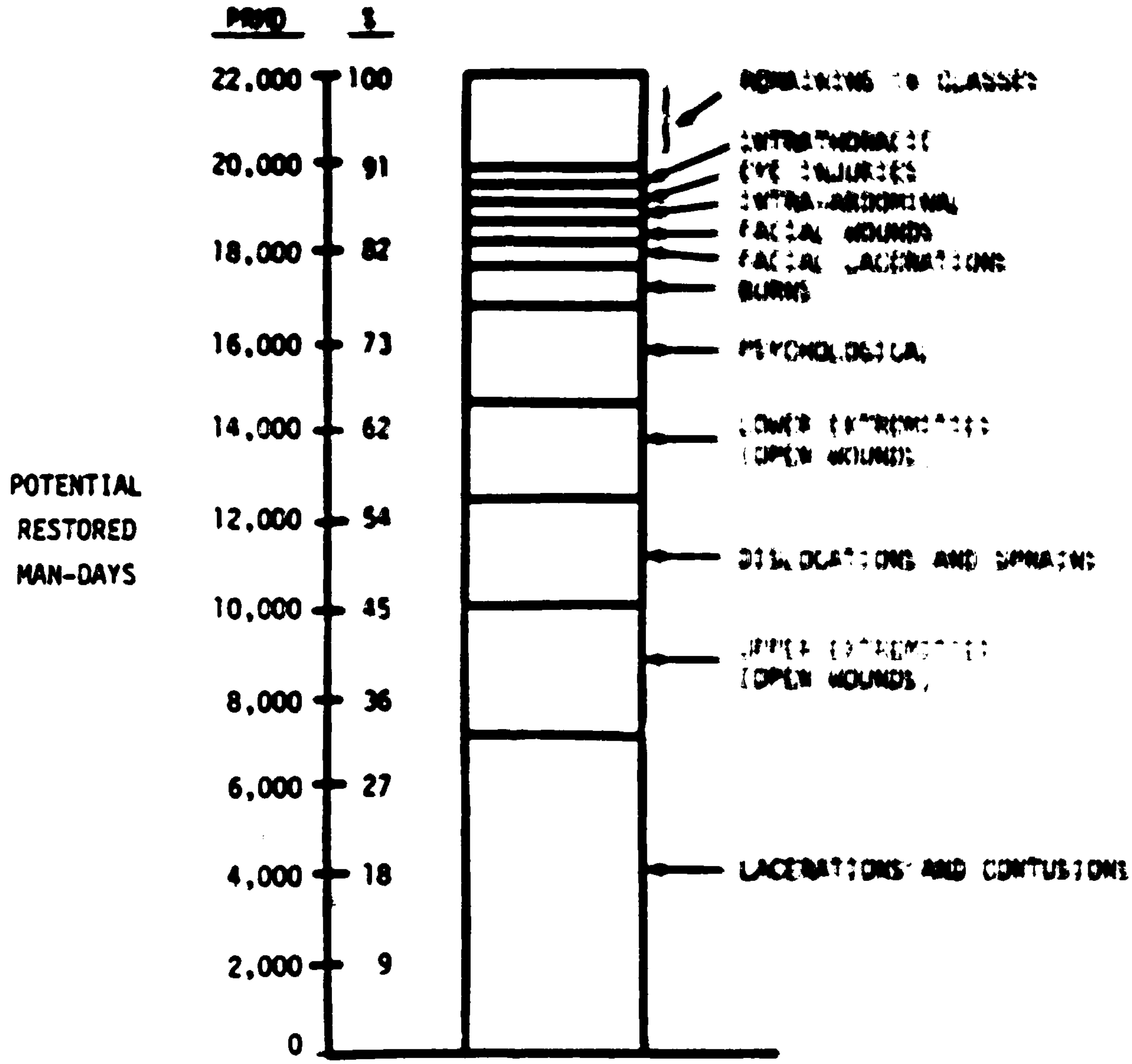
[1]A more detailed description of this and other casualty classes used in the analysis is provided in appendix A.

[2]Data describing these three characteristics is provided in appendix A.

[3]As noted previously, the particular data sets chosen for this demonstration were those developed from the Vietnam War experience.

EXHIBIT 3-7: CONTRIBUTION OF CASUALTY CLASSES TO BASELINE MEDICAL SYSTEM PERFORMANCE



[illegible]

[illegible] reduction [illegible] outpatient [illegible] [illegible] patient recovery [illegible] [illegible] [illegible] followed.

[illegible] If the average outpatient [illegible] [illegible] impact since the average outpatient [illegible] prior to this reduction [illegible] the increase in the number of [illegible] percent increase [illegible] about 20 percent of [illegible] infeasible that [illegible] would reduce the average [illegible] patients to zero [illegible]. Thus, there [illegible] reduction [illegible] [illegible] shown in this exhibit [illegible] of the [illegible] are [illegible].

Exhibit 3-8 [illegible] the [illegible] impact of the [illegible] time for all issue [illegible] fourteen days. The [illegible] impact of [illegible] is [illegible] substantially more than found in reducing the outpatient [illegible] time. The magnitude of the impact for a fourteen day [illegible] time is six times greater than the [illegible] found when the average outpatient treatment time was reduced to zero. Even a more [illegible] four-

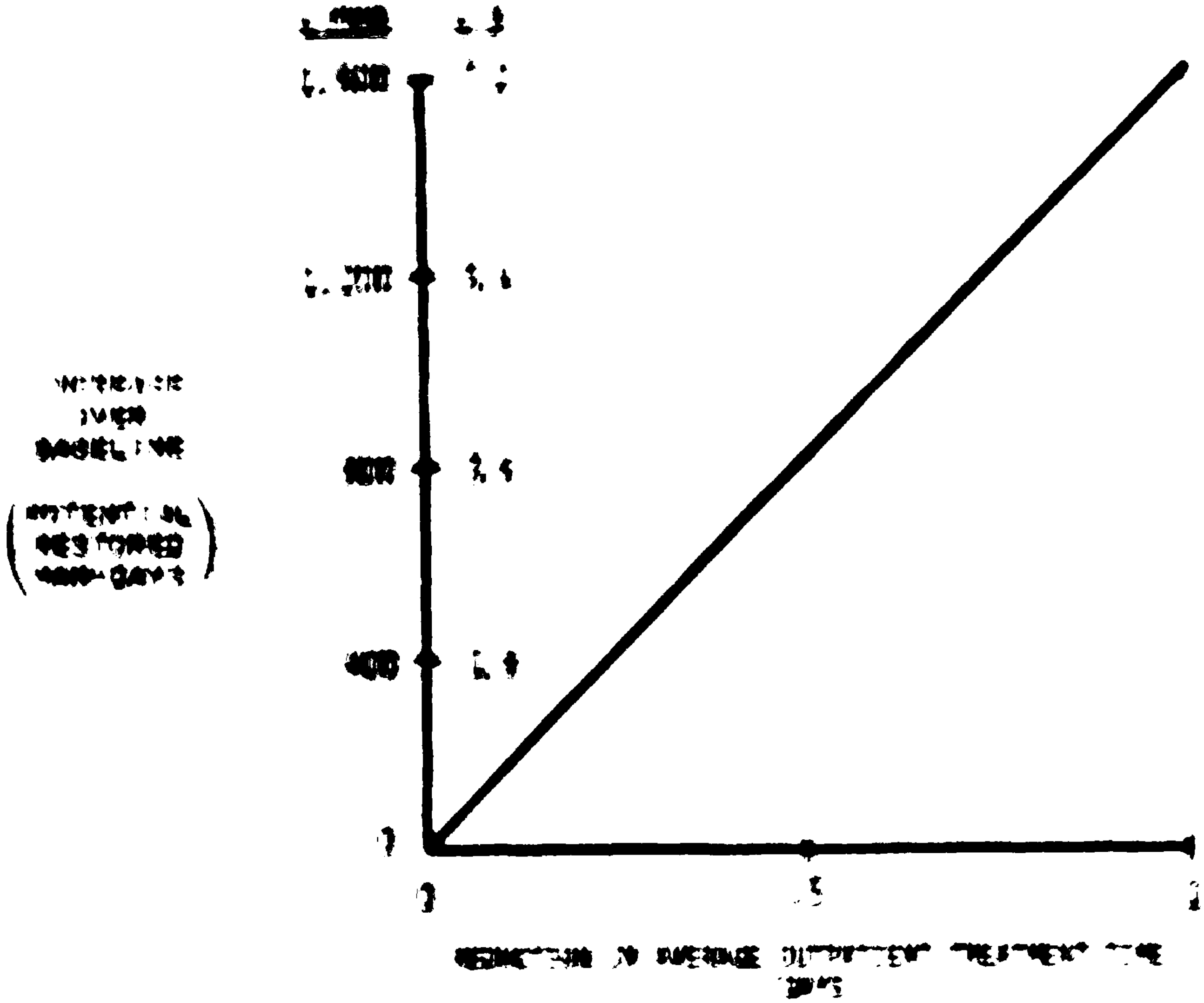
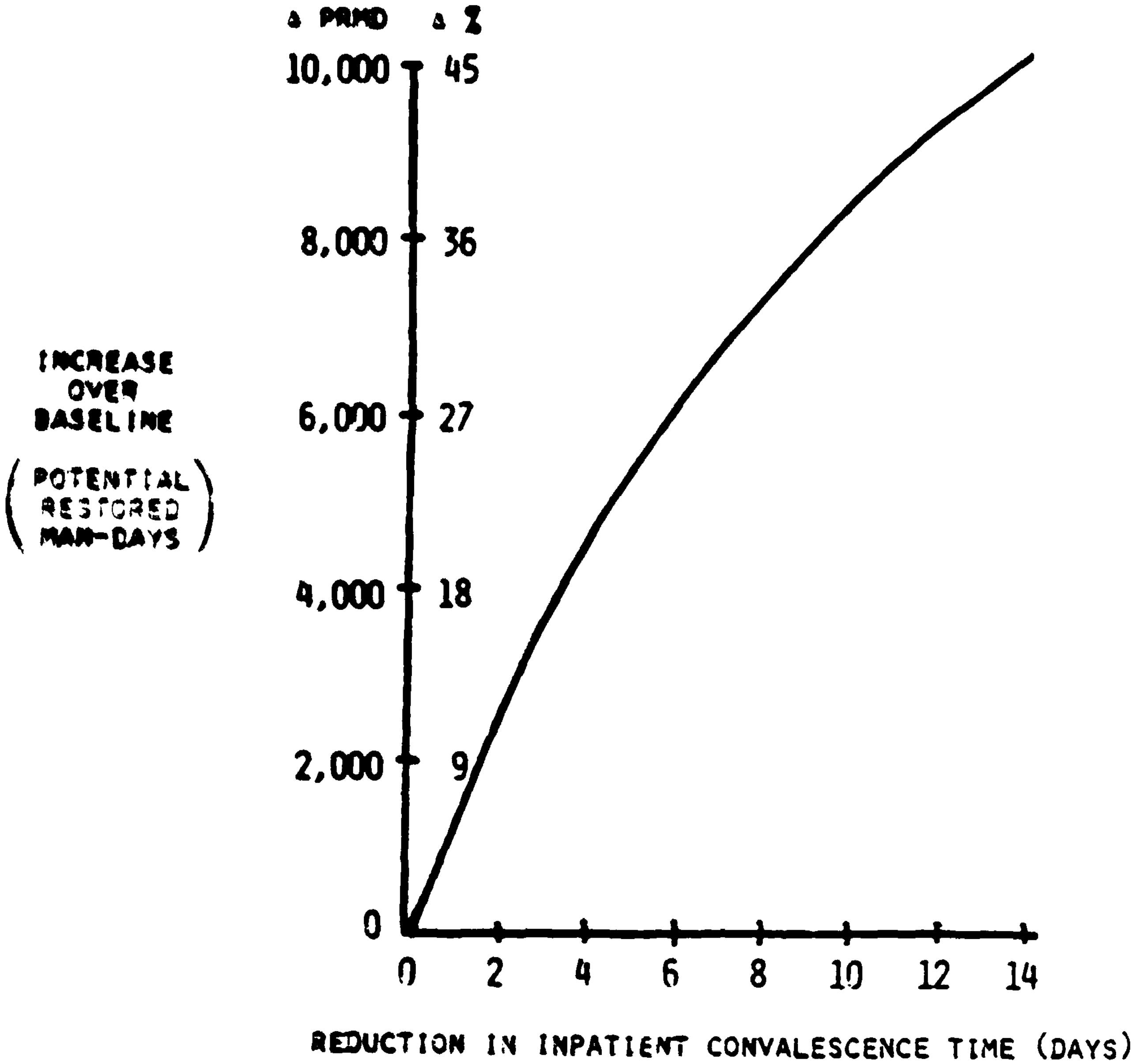

800
400
0

EXHIBIT 3-9: POTENTIAL R&D IMPACT
(PARAMETRIC REDUCTION IN INPATIENT RECOVERY TIME)



day reduction in inpatient convalescence time results in an increase of about 4,600 potential restored man-days -- nearly three times the maximum number shown in exhibit 3-8.

The reduction in the number of casualties requiring hospitalization is represented by converting inpatients to outpatients and reducing the convalescence time for the remaining inpatients. The greatest impact with this type of R&D occurs when the outpatient time is reduced along with the conversion of inpatients to outpatients. Thus, exhibit 3-10 compares the relative magnitude of such a combined impact to the other impacts presented above. In this exhibit, the impacts of reducing outpatient treatment times and the transformation of inpatients to outpatients are both presented under their most favorable conditions. Even so, the major portion of the R&D impact appears to come from reducing the inpatient convalescence times. This situation is even more evident when it is noted that the probability of being able to eliminate the outpatient treatment time is remote, expecially when inpatients are also being transformed to outpatients. Therefore, the remainder of the demonstration analysis will consider reduction in inpatient convalescence times to be the only type of R&D impact of interest.

3.2.4 Parametric Reduction in Inpatient Convalescence Times

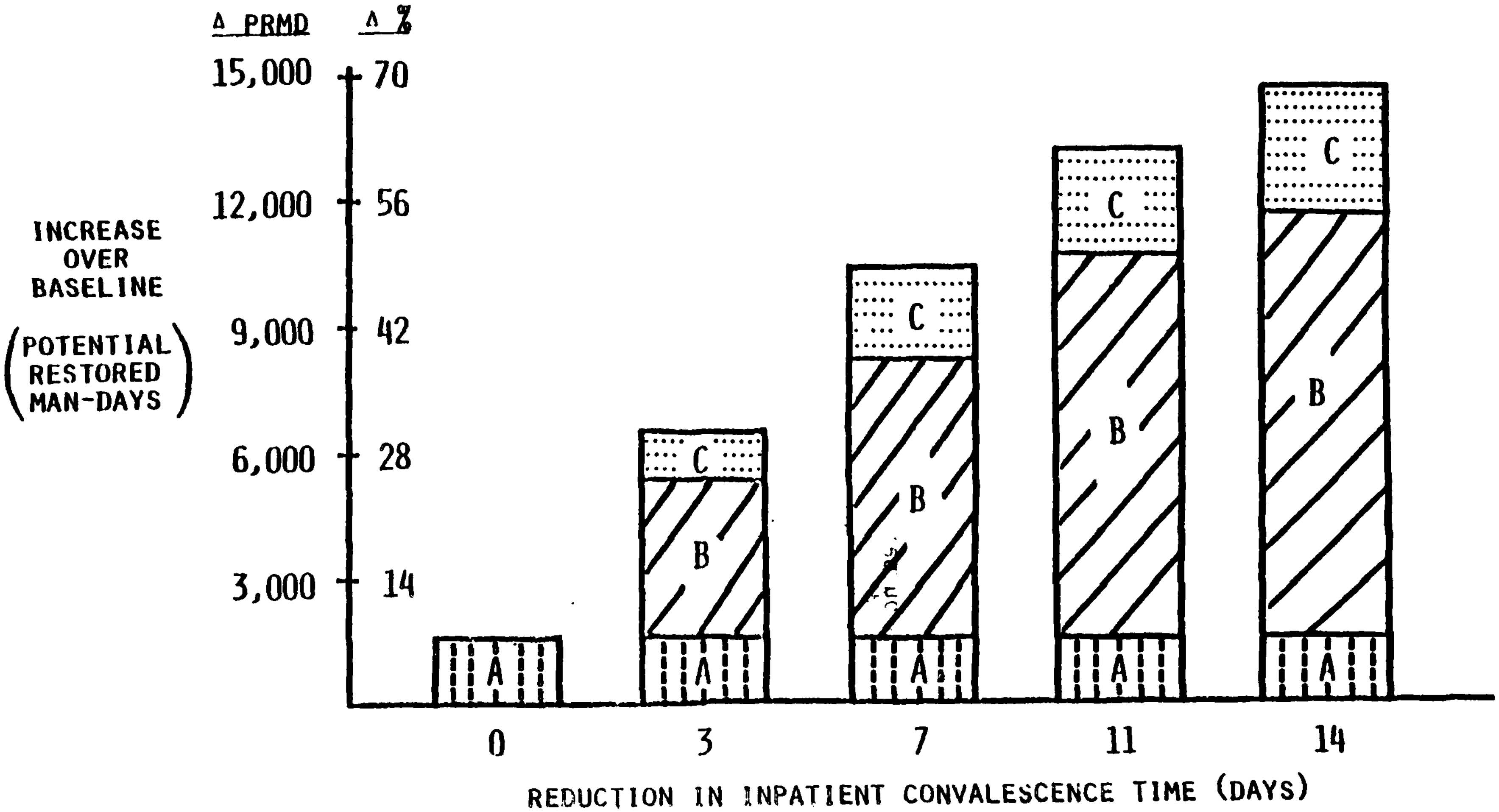
The impact on returns to duty performance of reducing the inpatient convalescence time for all patients was demonstrated in the previous subsection (see exhibit 3-9). A 14-day reduction in convalescence was found to increase the number of potential restored man-days by 10,000, an increase of about 45 percent over the baseline performance. If each of the 27 casualty classes contributed equally to this increase,

EXHIBIT 3-10: THREE COMPONENTS OF R&D IMPACT

A: MAXIMUM IMPACT OF REDUCING AVERAGE OUTPATIENT TREATMENT TIME

B: IMPACT OF REDUCING INPATIENT CONVALESCENCE TIMES

C: COMBINED IMPACT OF TRANSFORMING INPATIENTS TO OUTPATIENTS AND REDUCING THE AVERAGE OUTPATIENT TREATMENT TIME.



each would account for approximately 370 potential restored man-days (i.e., the average increase per class). As anticipated from the decomposition of the baseline performance into the individual casualty class contributions, there was significant inequality in the impact contribution of different classes.

Exhibit 3-11 illustrates the degree to which the reduction in the convalescence time of certain casualty classes[1] accounted for much of the impact on return to duty performance. In fact, only seven of the 27 casualty classes exceeded the average impact level (shown by the dashed line). Furthermore, the total contribution of these seven classes accounts for over 70 percent of the impact found for all 27 classes.

The results in exhibit 3-11 also indicate that the seven significant casualty classes appear to cluster in groups. The particular grouping however, depends upon the selection of a common value for the reduction in convalescence time. In addition, the order ranking of these casualty classes changes slightly with the selection of any common value for a reduction in convalescence time and changes significantly if the reduction in convalescence time is varied from one casualty class to the next. This latter case appears to be more likely since R&D directed toward one type of casualty will probably achieve a reduction in convalescence which is different than that achieved for another class. Thus, the next logical question confronting the demonstration was to examine the feasibility of R&D achieving a particular reduction for an individual casualty class.

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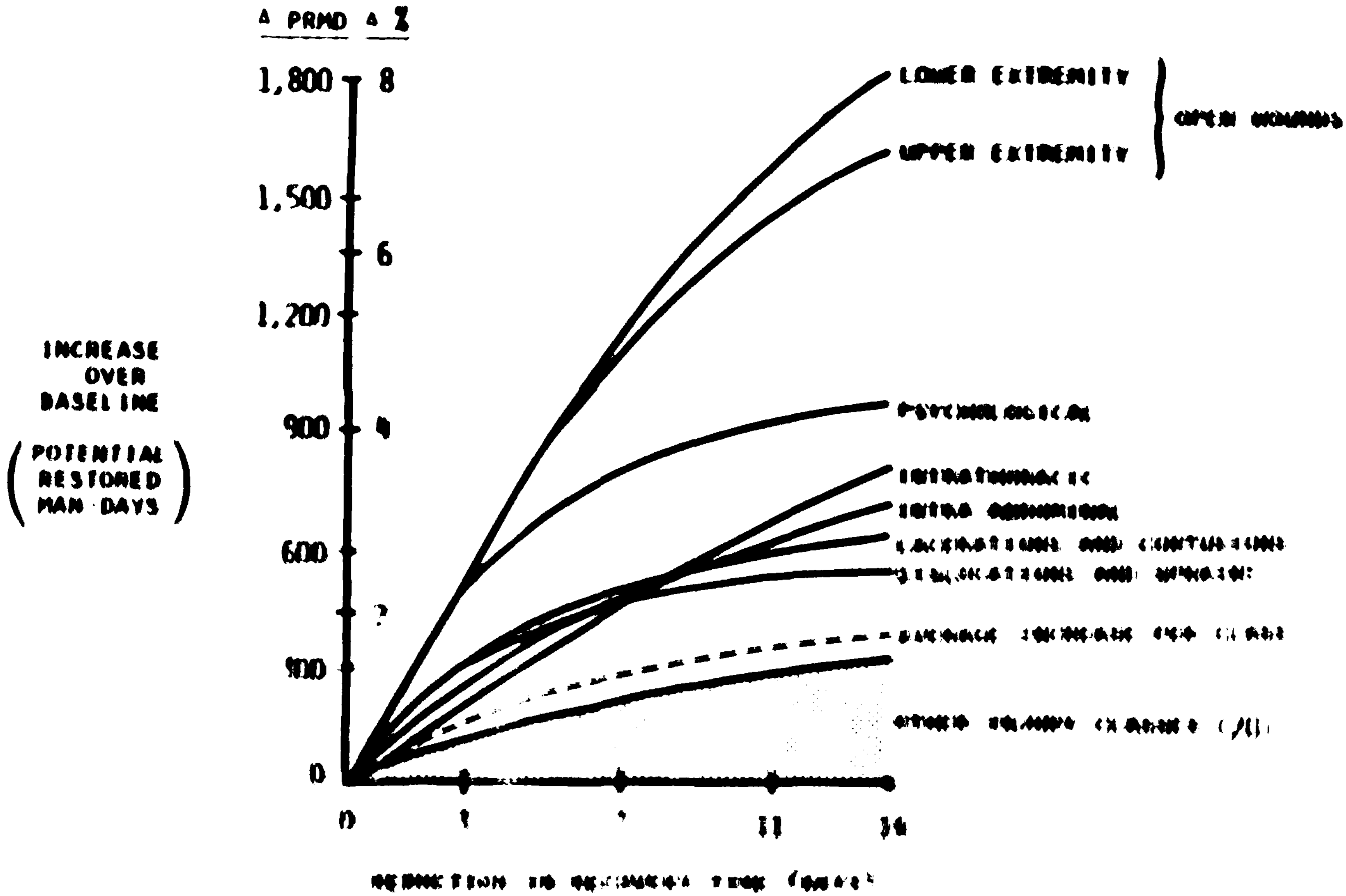
[1]A more detailed description of the casualty classes used in the demonstration is provided in Appendix A.

EXHIBIT 3-11: R&D IMPACT BY CASUALTY CLASS



[illegible]

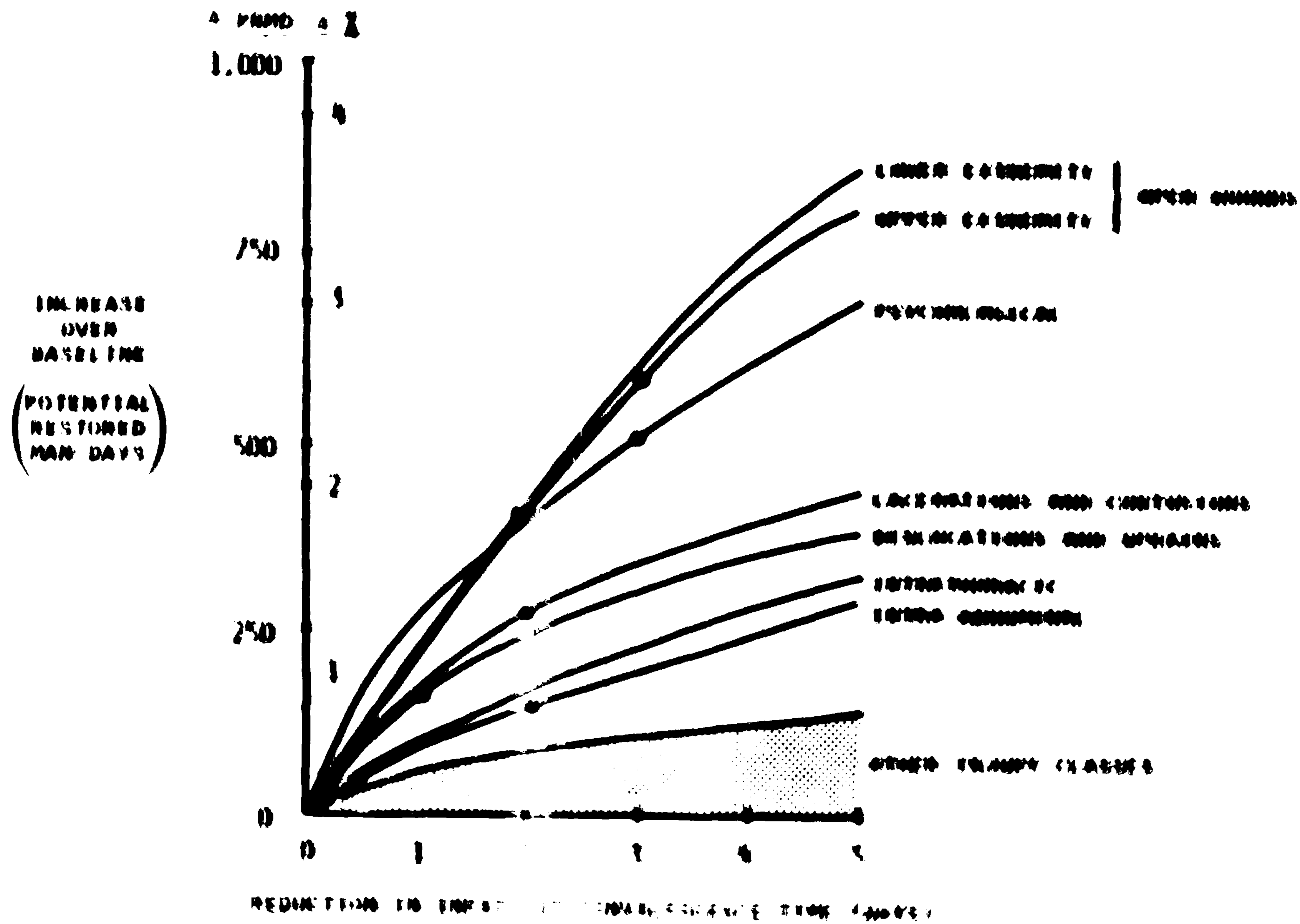
[illegible]

[illegible]

The second exercise was not as [illegible] as the first. [illegible] attempted to estimate the reduction in inpatient recovery time for each class achievable through research and development. [illegible] be- tween this hypothetical R&D and existing R&D projects were not established. An illustration of the type of estimates produced by this exercise is provided in exhibit 3-12. The exhibit shows the point estimates (large dots) of the R&D impact for each of the seven casualty classes presented previously. The point estimates shown are relatively conservative since they are based on an assessment of the R&D impact in the short term and they are somewhat tenuous due to the difficulties in understanding the composition of the MEDPLN classes. Even though [illegible] the total short-term R&D impact of all the point estimates is roughly [illegible] percent (-2,500 potential restored man-days).

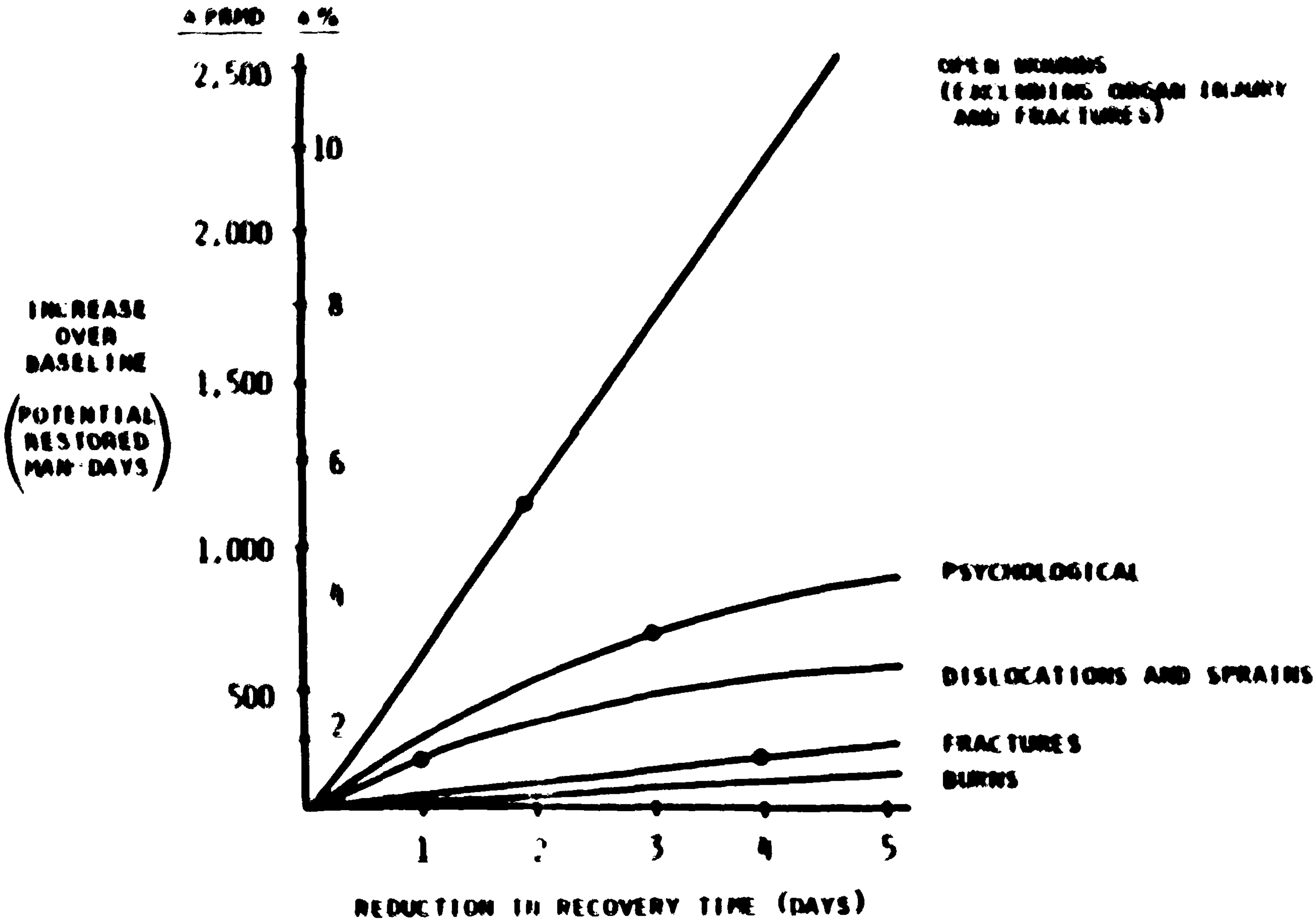
During these exercises it was also noted that the categorization of [illegible] For example, research influencing open wounds of the lower extremities should also be applicable to open wounds elsewhere in the body. Thus, an attempt was made to regroup the casualty classes into a potentially more useful set. Exhibit 3-13 illustrates the consequences of this regroup- ing into "generic" injury types and the estimated short-term R&D impact. The point estimates shown for these generic injury types were developed by averaging the estimated impacts for the casualty classes which comprise each generic group and rounding to the nearest day.

EXHIBIT 5-12 [illegible]



1,000
750
500
250
0
4
3
2
1
INCREASE OVER BASELINE
(POTENTIAL RESTORED MAN DAYS)
0
1
3
4
5

EXHIBIT 3-13 ESTIMATED R&D IMPACT FOR GENERIC INJURY TYPES



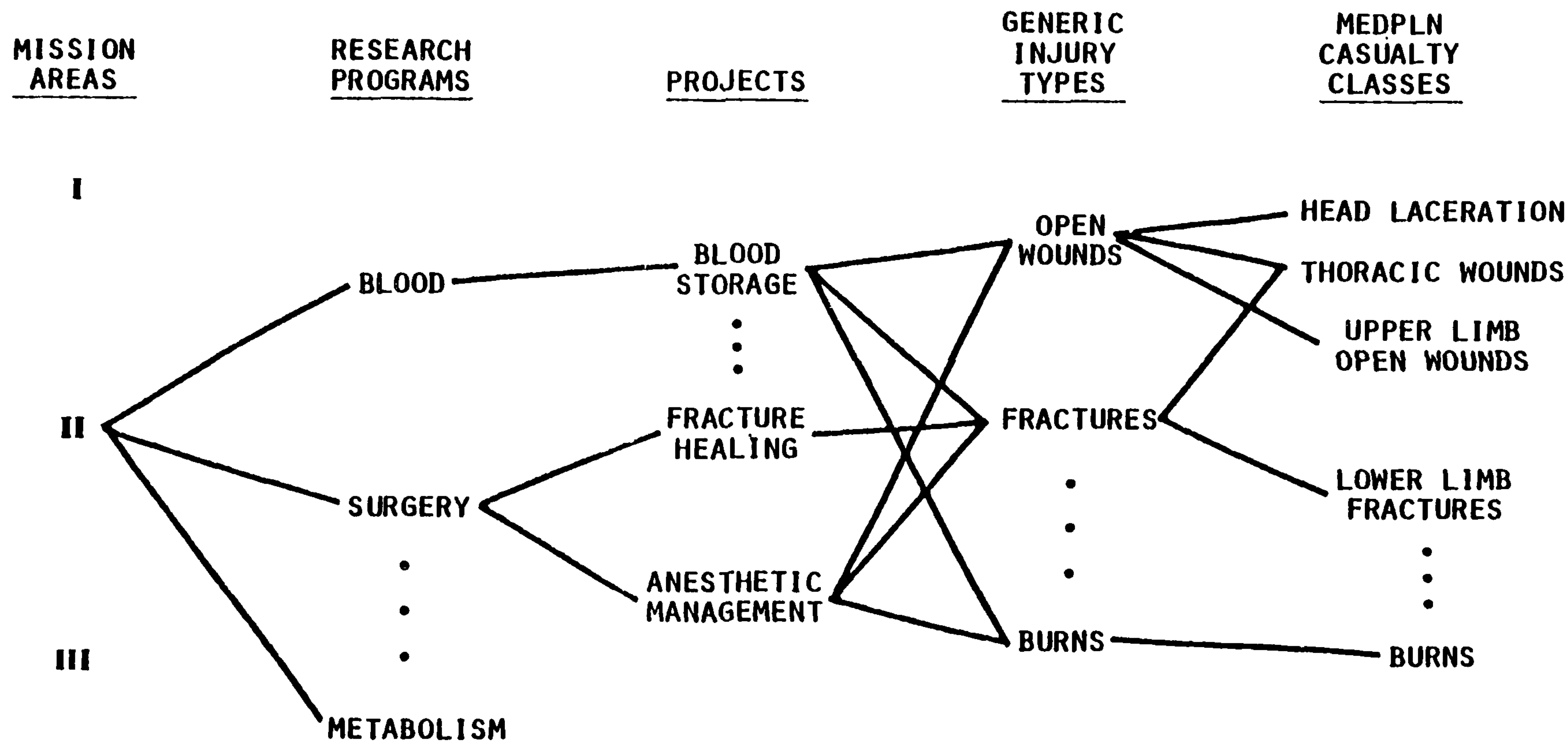
3.3 *Demonstration of Linkage Between USAMRDC R&D Programs and Methodology*

The demonstration results represented R&D improvements by shifts in the distributions of times to return wounded and injured personnel to duty, where these personnel have been categorized into selected MEDPLN casualty classes. If the methods exercised in this demonstration are to be of use to USAMRDC in justifying or improving the allocation of resources to R&D programs, these programs must be related to some extent to the performance of the combat medical system, so as to obtain a measure, quantitative or qualitative, of the payoff for R&D investments. This section provides an example of how this linkage might be traced for research at USAMRDC.

Exhibit 3-14 is a *relevance diagram*, showing VRI's understanding of the potential impact of some selected Mission Area II research on the management of combat casualties. The diagram is similar to the SPIDER charts used in DARCOM to relate R&D work units concerned with the development of equipment to the potential impact of that equipment on a future battlefield. Like the SPIDER charts, the relevance diagram relates R&D to either a direct materiel or procedural product of the research or to its likely contributions to future materiel or procedures. Here, the R&D is concerned with the medical materiel and procedures, and its impact is indicated in terms of the return to duty of combat casualties belonging to MEDPLN casualty classes.

The exhibit contains five columns -- mission areas, research programs, projects, generic injury types, and MEDPLN casualty classes. The first three columns organize a sample subset of USAMRDC research. As it shows,

EXHIBIT 3-14: EXAMPLE RELEVANCE DIAGRAM FOR USAMRDC PROGRAMS



a mission area can require several research programs to carry out its goals, and research programs consist of several individual projects (i.e., work units or clusters of related work units). Conversely, it shows that these projects and programs do not exist in isolation; they exist because they support the objectives of the research programs and mission areas to which they belong. This hierarchical relationship is helpful to understanding *why* programs and projects are pursued.

The first column of the relevance diagram lists the four mission areas of USAMRDC. This demonstration project has been concerned only with the impact of Mission Area 2 research, and hence only programs from this mission area are shown in the diagram. The example research programs in the second column are organized by areas of biological science and, to some degree, by the nature of the desired end product, medical procedures or materiel. In some cases, these programs correspond to organizations within USAMRDC, because existing organizations are to some extent aligned along areas of knowledge. For example, the Blood Research Division within the LAIR[1] Department of Surgery conducts much of the research on blood storage and blood substitutes. Also, the Surgical Metabolism Division within that department conducts much of the research on metabolic support. Such a division of programs along organizational lines does not hold for all research, and research on related topics can occur in different departments and divisions, just as different areas of biological science are investigated within a single organization. Consequently, a clearer picture of the relationship among projects results by aggregating them according to

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[1]The Letterman Army Institute of Research is one of the USAMRDC research laboratories.

the research programs supporting [illegible]. The [illegible] shown in the exhibit is [illegible], but the [illegible] is [illegible] of this approach.

The third column [illegible] of projects [illegible] work units or clusters of closely related work units. The [illegible] them to the programs of the second column [illegible] programs concerning [illegible] surgery [illegible]. For example, there are several projects concerning [illegible] research program. [illegible] for projects related to the program of research [illegible] surgery. [illegible] example projects is based on [illegible] understanding of [illegible] as determined from conversations with [illegible] selected Research and Development [illegible] Summaries [illegible].

The fourth column lists examples of generic injury types [illegible] aggregations of types of wounds that [illegible] to a greater extent than [illegible] type Open Wounds includes several [illegible] for treatment -- such as the classes of [illegible] Thoracic Wounds and Upper Limb Wounds in the [illegible] column. As the [illegible] the diagram show the MEDPLN casualty classes can also be related to more than one generic injury type. For example, the class Thoracic Wounds [illegible] Open Wounds and Fractures. This is one reason that the generic types are useful constructs in the diagram.

The potential medical and military impact of a project would be investigated by tracing from the project, in the third column, through the relevant

[illegible]

[illegible]

The [illegible] phenomenon [illegible] the example [illegible] programs [illegible] projects pur-suing the same objective [illegible] the same R&D program. For example, [illegible] and [illegible] substitutes are parallel approaches to meet a single [illegible] need. Such an apparent redundancy in efforts may be more easy to defend when the [illegible] for parallel projects can be linked to estimates of [illegible] power.[22] The reason is that parallel projects may be mutually supporting, i.e., that an advance in one area is necessary to achieve the payoff estimated for implementing an advance in another area. For example, it may be necessary to understand the storage properties of a blood substitute to determine the potential degradation in its ability to support life in field medical operations.

Another reason for parallel projects is the risk associated with individual projects. Since technological advances are impossible without the acceptance of some degree of risk, there is always the chance that an R&D effort will fail, or will not produce the level of improvement anticipated. If the uncertainty in an approach is high enough, and if the problem is of sufficient importance, it may be worthwhile to pursue different scientific approaches to solving the problem, thus increasing the chances of at least one approach succeeding. Different approaches must be available, however, as must the funds and research resources to pursue the parallel approaches.

If parallel approaches are feasible, some measure of the uncertainty inherent in each approach would help both in making allocation decisions and in justifying the decision once it was made. Even if parallel approaches are not involved, risk information can be useful, for example, when an increased budget is required to reduce the risk of a project's failure, or when an increased risk of failure is accepted in order to free funds for other uses. Experience has shown that researchers often can quantify their understanding of the uncertainty inherent in the projects they are pursuing.[1] (It has also shown that researchers can often cite

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[1]Methods for obtaining quantitative estimates of this uncertainty are discussed in [Bonder, 1977].

specific evidence, such as preliminary experimental results, to support their estimates.) Because many researchers are knowledgable in the field of statistics, or at least comfortable in dealing with probabilities, eliciting information about the uncertainties in the outcome of a research project is often accomplished simply with an informal interview. However, when researchers find it difficult to quantify these uncertainties, more formal techniques are used to elicit the information via questionnaires, graphic aids, and comparisons with events whose probabilities are known. Whatever the technique, these subjective estimates can be refined by pooling the estimates of different researchers, by submitting them to review by managers, co-workers, and other experts, and by giving the original estimators an opportunity to revise their estimates based on feedback from this review.

Other kinds of information, in addition to uncertainty, can be useful in the context of a relevance diagram. These include research costs, the costs of the developed materiel, compatibility with existing organizations and procedures, development times, the existence of alternative solutions, the magnitude of anticipated improvements, and the need for these improvements. The design of resource allocation strategies for medical research and development would integrate these types of information with that illustrated in this demonstration study (i.e., the linkage between R&D and the return-to-duty performance of the medical system).

4.0 OBSERVATIONS AND CONCLUSIONS

This chapter summarizes the study observations and conclusions and is organized into two sections. The first section describes the observations developed during the demonstration of the methodology. The second section presents the study conclusion and discusses areas for further study.

4.1 Demonstration Observations

The previous chapter demonstrated an example application of the methodology using a specific collection of historical data and a set of somewhat arbitrary assumptions. Even though the intent of this demonstration was primarily illustrative in nature, some of the observed results appear to provide some preliminary insights. In addition, the validity of the observations was further supported by the insensitivity of some of the demonstration results to input data and assumptions. The following paragraphs briefly describe four major demonstration observations and the conditions to which their validity appears to be sensitive.

The first observation was that there was greater potential for R&D impact when inpatient recovery time is reduced than when outpatient treatment time is reduced. The observed difference in the return-to-duty impact between these two improvements may be, in part, attributable to the relatively small fraction of casualties that were outpatients (~ 20 percent) in the demonstration. It should be noted, however, that increases in this fraction will not necessarily result in comparable increases in the R&D impact for reductions in the average outpatient treatment time. An increase in the fraction of casualties that are outpatients increases the baseline return-to-duty performance of the medical system. The impact of R&D is measured relative to the baseline performance. Consequently, the range of R&D impact for increasing outpatient returns-to-duty should increase with more outpatient casualties, but the amount of this increase relative to the baseline will clearly be less significant. Finally, it is questionable whether R&D can reduce the average treatment time for outpatients to a value substantially less than one day. Therefore, the potential impact derived from an R&D reduction in the time to return outpatients to duty appears to be limited.[1]

The parametric examination of an R&D reduction in inpatient recovery times indicated that most of the impact on the return-to-duty effectiveness is concentrated in a few casualty classes. Specifically, seven casualty classes[2] accounted for 72 percent of the total impact estimated for all casualty classes (i.e., the 27 used in the analysis). The predominance of these seven classes was relatively insensitive to changes in the amount that the inpatient convalescence time was reduced.[3] Furthermore, only minor variation in the significance of these classes was witnessed when

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[1]If, however, performance of the medical system is significantly degraded then it may not be capable of returning casualties with minor injuries in the assumed average of one day. Left untreated, these minor injuries could ultimately reduce the effectiveness of soldier performance. Therefore, the potential for R&D in outpatient care may be greater with degradation of the medical system.

[2]These classes were: (1) lower extremity open wounds, (2) upper extremity open wounds, (3) psychological casualties, (4) intrathoracic wounds, (5) intra-abdominal wounds, (6) lacerations and contusions, and (7) dislocations and sprains. Further definition of these and other casualty classes is provided in appendix A.

[3]The percent of the total impact accounted for by these classes differed by less than two percent when the reduction in convalescence time was varied from one to 14 days.

alternative historical data bases were used (i.e., those describing the medical system experience of the Korean, Vietnam, and 1973 Israel wars).[1] Thus, this second observation from the demonstration suggests that medical research and development should be concentrated on a few types of injury which have the greatest potential impact on return-to-duty effectiveness.

An attempt to estimate the degree to which R&D could improve the return to duty for these more significant casualty classes revealed that the MEDPLN casualty classification scheme was not well suited to this task. Two reasons were noted for this lack of suitability. First, the types of injury in individual casualty classes were not sufficiently homogeneous from a medical treatment perspective. For example, the category of [illegible] abdominal wounds included injury to the liver, spleen, kidney and other intra-abdominal organs as well as multiple unspecified open wounds of the face, neck, and trunk. Second, the definition of the types of injury as categorized in many individual casualty classes was relatively vague and imprecise. For example, from the description of the category [illegible] it was difficult to determine whether it included all injuries to the neck or simply those involving muscle, nerve, and tendons (e.g., excluding injury to trachea and spinal column). These limitations of the classification scheme hampered the ability to relate R&D projects to casualty classes and, hence, estimate potential R&D impact.

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[1]The MEDPLN Study provided Korean and Vietnam data on the distribution of injuries across casualty class and the inpatient convalescence time distribution for these casualty classes. Data was also available from the 1973 Israeli War describing the distribution of injuries across casualty class. This entire collection of data was used to produce six different data sets to reflect the historical variation in medical system experience.

Finally, it was observed that data systems as well as [illegible] are needed to support medical R&D [illegible]. [illegible] the [illegible] of future combat provide only [illegible] estimates of the numbers of casualties sustained in these scenarios and do not attempt to estimate the types of casualties experienced in different combat situations. The casualty types of new conventional munitions and the [illegible] of chemical agents and nuclear weapons suggest that the mix of casualty types may be [illegible] different than experienced in [illegible] the Vietnam and Korean conflicts. Consequently, empirical data from [illegible] studies and recent military conflicts, e.g., the 1973 [illegible] and the 1978 [illegible] occupation of Lebanon, should be integrated into existing combat models to provide potentially more realistic characterization of the combat casualties in future conflicts. In addition, there exists [illegible] in describing the potential [illegible] effectiveness of the U.S. medical system [illegible] research and development. [illegible] effectiveness [illegible] ably well documented for the Vietnam war, a medical system situation which many consider inappropriate in [illegible] of future conflict, e.g., a general abundance of medical resources, a lack of medical installation vulnerability, and a capability to air-evacuate a large proportion of the combat casualties. Since the impact of research and development on this effectiveness may depend on the degree to which the medical system capability is degraded, i.e., falls short of the Vietnam experience, additional information is necessary to estimate the likelihood of system degradation and the influence of this degradation on the return-to-duty rate in future conflicts.

4.2 Study Conclusion and Areas for Further Study

The purpose of this study was to examine the feasibility of relating medical research and development to military payoff. Focusing on one aspect of military payoff, the return-to-duty effectiveness of the medical system, the study demonstrated a methodology which estimates the potential military impact of medical R&D. Based on available data, this demonstration indicated specific levels of R&D impact measured by an increase in the number of potential restored man-days. The set of input data and assumptions used in the demonstration may have biased these estimates (i.e., another set of inputs might have produced different results). However, with an appropriate set of data and assumptions, the methodology appears to provide a feasible means of relating medical R&D to military payoff.

The parametric estimates of R&D impact developed during the demonstration could be made more realistic by improving the combat casualty data base and the model used to represent medical system performance. The more important improvements to the combat casualty data base appear to be:

(1) development of a casualty classification scheme which is oriented to the type of problems addressed by medical research and development and

(2) estimation of the number and type of casualties (using the above scheme) sustained by forward area combat maneuver units (e.g., division, brigade and battalion size units) in short (one to two weeks) intense combat engagements.

A more realistic portrayal of the capability of the medical system in a conflict is needed. The importance of such an assessment is enhanced by the dependence of the potential R&D payoff on the base line system performance. For example, the potential R&D impact on a degraded medical system is significantly greater in both absolute and relative measures than the impact of the same level of R&D on a non-degraded system. The more important improvements to the representation (model) of medical system performance appear to be:

(1) representation of the factors which determine the time to treat and return non-hospitalized patients to duty (e.g., aidman supplies, workload, etc.);

(2) representation of the factors that influence evacuation of a casualty for admission to a hospital (e.g., air superiority, type of casualty, availability of transport, the medical resources at the unit);

(3) representation of the factors that influence the convalescence time in a hospital (e.g., availability of critical skills, supplies, casualty mix, etc.).

Although the above improvements are desirable from the standpoint of improving the estimates of R&D impacts, the integration of the methodology into a structure which illustrates the relevance of programs to estimates of military payoff is potentially more useful. Such an integration would provide a more global perspective of the payoff for one or more of the organizational elements of the research program in order to produce a more realistic "relevance diagram" than that developed during the study. The development of this diagram would, in fact, provide the primary foundation for the "[illegible]" casualty classification scheme noted above. It would also indicate the degree to which improvements in the model of medical system performance are needed.

Upon completion of the relevance diagram and incorporation of appropriate improvements to the casualty stream and medical system models, two further refinements are needed to facilitate the use of the methodology in research planning activities. First, procedures should be developed to incorporate the concepts of technological risk (uncertainty) into the methodology. These procedures would permit investigation of the potential payoff of research programs with uncertain outcomes. Second, a method should be developed to assess the level of technological risk associated with individual programs or work units. The methods developed might be similar to those applied in materiel research and development programs (Bonder, 19[illegible]). These methods employ a systematic procedure for developing quantitative estimates of R&D outcomes from the subjective estimates of research staff.

APPENDIX A: DEMONSTRATION DATA

This appendix presents the data used in the demonstration and describes the process by which it was assembled. The data used in the demonstration consisted of the distribution of injuries over casualty classes, and the distributions of convalescence times. The source of the data used to estimate these distributions was the MEDPLN study. The appendix is organized into two sections: (1) the data base for the distribution of injuries over casualty classes, and (2) the data base for the convalescence distributions. Each section is divided into two subsections: (1) the MEDPLN data base, and (2) the demonstration data base. At the end of the appendix are two exhibits. Exhibit A-1 provides a description of each of the demonstration casualty classes. Exhibit A-2 provides a summary of the demonstration data bases for the injury distribution and the convalescence distributions.

A.1 Distribution of Injuries over Casualty Classes

A.1.1 MEDPLN Data Base

The data source used in the demonstration was the US Army Medical Planning Factors Study (MEDPLN) file "Vietnam All-Division/Non-Divisional Summary". The raw data used to compile the file was 246,000 individual admission records covering the period 1 July 1967 to 31 December 1968. Duplicate, carded-for-record-only, and DOA records were discarded. Records not specifying which diagnosis was the primary cause of admission were discarded. All of the remaining records pertaining to WIA admissions were used to compile the summary. A data sampling procedure was used for NBI, psychological and disease admissions. "However, in all cases, the resulting sample size was large enough to insure statistical confidence in the resulting distribution."[1] The original records expressed the diagnosis with the Department of Defense Disease and Injury Codes (DDDIC). The Academy of Health Sciences (AHS) prepared a mapping of these code numbers into 60 casualty classes. These 60 AHS classes were then mapped into the 75 MEDPLN classes by dividing the injuries in certain classes into severe and mild groups based on WWII severe/mild distributions.

A.1.2 Demonstration Data Base

Only casualty classes pertaining to WIAs, NBIs, and psychological admissions were of interest in the demonstration. These classes accounted for 40 of the 75 MEDPLN classes. The severe/mild distinctions introduced by the MEDPLN processing did not appear to be helpful to the demonstration, but rather appeared capable of obfuscating the results. Therefore, severe and mild classes corresponding to the same DDDIC numbers were recombined according to the inverse of the procedure by which they were divided. This reduced the number of relevant classes from 40 to 27.

As noted in the third chapter of the report, it was necessary to make subjective estimates of the percentages of outpatients in each class in order to obtain the probability of a casualty occurring in each class. These subjective estimates were made by a group of analysts and USAMRDC physicians.

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[1]MEDPLN Final Report, G-98

Exhibit A-1 presents a description of the 27 demonstration casualty classes. The title of each class is given, followed by a description of the injuries contained in that class, followed by the number(s) of the MEDPLN class(es) which correspond to the demonstration casualty class.

A.2 Convalescence Distributions

A.2.1 MEDPLN Data Base

The source for the demonstration convalescence distributions was also the MEDPLN file "Vietnam All-Division/Non-Divisional Summary". These distributions covered the first 60 days in the medical system. Distributions for the 75 MEDPLN classes were created from the distributions for the 60 AHS classes in a manner concordant with the mapping of the 60 AHS classes into the 75 MEDPLN classes. The distribution of an AHS injury class which was divided into severe and mild MEDPLN classes was divided into two distributions. The first few days of the AHS class distribution (enough to correspond to the appropriate percentage of casualties) was used as the convalescence distribution of the mild class. The remainder was used as the distribution of the severe class.

A.2.2 Demonstration Data Base

Only the first 30 days of the distributions were used in the study. The distributions of the severe and mild classes corresponding to the same DDDIC codes were concatenated to provide the demonstration distributions.

Exhibit A-2 presents a summary of the major data elements used in the demonstration. One page is devoted to each class giving: (1) the title of the class, (2) the approximate probability that a casualty will be in the class, (3) the estimated probability that a casualty in the class is an inpatient, (4) the approximate probability that an inpatient in the class will recover, (5) and the distribution of convalescence times for inpatients in that class. The format of Exhibit A-2 is presented below.

EXHIBIT A-2: STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

[number of days since admission]

[probability that an inpatient who recovers is released after DAY days in the medical system]

DAY	P(t=DAY)	CONVALESCENCE TIME HISTOGRAM
1	0.2199	**
2	0.1269	***
3	0.0883	*****************************
4	0.0501	*****************
5	0.0381	************
6	0.0407	*************
7	0.0311	**********
8	0.0311	**********
9	0.0277	*********
10	0.0208	*******
11	0.0130	***
12	0.0121	***
13	0.0103	***
14	0.0113	***
15	0.0112	***
16	0.0078	**
17	0.0095	**
18	0.0070	**
19	0.0060	*
20	0.0035	*
21	0.0017	
22	0.0069	**
23	0.0087	**
24	0.0026	
25	0.0034	*
26	0.0026	
27	0.0035	*
28	0.0043	*
29	0.0026	

79.9300 % OF RETURNS-TO-DUTY REPRESENTED

[percentage of inpatients who return to duty in the first 29 days after admission]

[title of casualty class]

PC = [probability of an injury in that class]

PI = [probability of being an inpatient]

PR = [probability of an inpatient recovering]

[all above probabilities are expressed in percents]

EXHIBIT A-[illegible] DEMONSTRATION CASUALTY CLASS DESCRIPTIONS

<u>Head Fracture, Compound</u>. Multiple skull fractures, skull fractures involving open wounds, infection, delayed healing or foreign bodies (MEDPLN #1).

<u>Head Fracture, Simple</u>. Skull fractures without open wounds, delayed healing, infection, or foreign bodies (MEDPLN #2).

<u>Head Wound, Penetrating</u>. Multiple open wounds of head, wounds involving head and limbs or trunk (MEDPLN #3).

<u>Head Wound, Incised</u>. Open wounds of scalp (MEDPLN #4).

<u>Concussion</u>. Concussions (MEDPLN #5 and #6).

<u>Facial Fractures, Compound</u>. Facial fractures (MEDPLN #7 and #8).

<u>Facial Fractures, Simple</u>. No further definition was provided for this class (MEDPLN #9).

<u>Facial Wound</u>. Multiple and unspecified wounds of face excluding broken nose (MEDPLN #10 and #11).

<u>Facial Lacerations</u>. Multiple open wounds of face and other locations excluding neck and trunk (MEDPLN #12 and #13).

<u>Eye and Orbit</u>. Open wounds of eye and orbit, avulsion of eyeball (MEDPLN #14 and #15).

<u>Neck Wound</u>. Open wound of neck (MEDPLN #16 and #17).

<u>Upper Extremity Fractures, Compound</u>. Fractures of the upper extremities involving open wounds, infections, delayed healings, or foreign bodies. (MEDPLN #22 and #23)

<u>Upper Extremity Fractures, Simple</u>. Fractures of the upper extremities not involving open wounds, infections, delayed healings, or foreign bodies (MEDPLN #24)

<u>Upper Extremity Open Wounds</u>. Open wounds of upper extremities including those involving nerves, tendons and traumatic amputations. (MEDPLN #25 and #26)

EXHIBIT A-1: DEMONSTRATION CASUALTY CLASS DESCRIPTIONS

(concluded)

Lower Extremity Fractures, Compound: fractures of the lower extremities involving open wounds, infections, delayed healings, or foreign bodies. (MEDPLN #27 and #29)

Lower Extremity Fractures, Simple: fractures of the lower extremities not involving open wounds, infections, delayed healings, or foreign bodies. (MEDPLN #29 and #30)

Lower Extremity Open Wounds: open wounds of lower extremities including those involving nerves, tendons and traumatic amputations. (MEDPLN #31 and #32)

Dislocations and Sprains: All dislocations and sprains. Also fractures and dislocations of vertebra column without cord involvement, fractures of ribs, sternum, and larynx, multiple and ill-defined fractures of trunk, multiple fractures involving extremities and ribs or sternum. (MEDPLN #33)

Intrathoracic: injury to heart, lung or other unspecified intrathoracic organs. (MEDPLN #36 and #37)

Thoracic Open Wound: open wound of chest. (MEDPLN #38)

Intra-abdominal: injury to gastrointestinal tract, liver, kidney, spleen, pelvic organs or other intra-abdominal organs. Multiple injuries involving intrathoracic and intra-abdominal organs. Multiple unspecified open wounds of face, neck and trunk. (MEDPLN #39 and #40)

Burns: 1°, 2° and 3° burns (MEDPLN #45)

Lacerations and Contusions: Superficial injury to or contusion of any part or multiple parts of body. Contusion and hematoma of scalp. (MEDPLN #46)

Genitourinary Wounds: genitourinary wounds (MEDPLN #47)

Spinal Injuries: cord compression, herniated intervertebra disk, tumors and cord involvement. (MEDPLN #50)

Psychosis: psychosis (MEDPLN #73)

Psychological: excluding psychosis. Including anxiety reaction, situational maladjustment, character disorders, drug overdose, and drug abuse. (MEDPLN #74)

EXHIBIT A-2: STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0	
2	0.0034	*
3	0.0018	
4	0.0043	*
5	0.0	
6	0.0017	
7	0.0026	
8	0.0034	*
9	0.0026	
10	0.0035	*
11	0.0017	
12	0.0008	
13	0.0009	
14	0.0034	*
15	0.0	
16	0.0009	
17	0.0009	
18	0.0	
19	0.0043	*
20	0.0034	*
21	0.0026	
22	0.0035	*
23	0.0017	
24	0.0017	
25	0.0017	
26	0.0	
27	0.0	
28	0.0	
29	0.0026	

5.3400 % OF RETURNS-TO-DUTY REPRESENTED

HEAD FRACTURE, COMPOUND

PC = 0.9%

PI = 100%

PR = 93%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0	
2	0.0238	*******
3	0.0079	**
4	0.0159	****
5	0.0	
6	0.0159	****
7	0.0159	****
8	0.0079	**
9	0.0079	**
10	0.0080	**
11	0.0158	****
12	0.0	
13	0.0318	**********
14	0.0238	*******
15	0.0	
16	0.0159	****
17	0.0158	****
18	0.0	
19	0.0	
20	0.0080	**
21	0.0	
22	0.0	
23	0.0079	**
24	0.0	
25	0.0080	**
26	0.0	
27	0.0079	**
28	0.0159	****
29	0.0	

HEAD FRACTURE, SIMPLE

PC = 0.1%

PI = 100%

PR = 82%

25.4000 % OF RETURNS-TO-DUTY REPRESENTED

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0601	******************
2	0.0565	****************
3	0.0342	**********
4	0.0530	***************
5	0.0412	************
6	0.0495	**************
7	0.0353	**********
8	0.0365	**********
9	0.0189	*****
10	0.0223	******
11	0.0271	********
12	0.0248	*******
13	0.0165	****
14	0.0188	*****
15	0.0212	******
16	0.0212	******
17	0.0212	******
18	0.0094	**
19	0.0106	***
20	0.0118	***
21	0.0200	*****
22	0.0083	**
23	0.0118	***
24	0.0117	***
25	0.0118	***
26	0.0106	***
27	0.0153	****
28	0.0071	**
29	0.0071	**

[illegible] 3000 % [illegible] RETURNS-TO-DUTY REPRESENTED

HEAD WOUND, PENETRATING

PC = 0.7%

PI = 100%

PR = 93%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

Convalescence Time Histogram

DAY	f[t=DAY]
1	0.2109
2	0.1265
3	0.0883
4	0.0501
5	0.0381
6	0.0407
7	0.0311
8	0.0311
9	0.0277
10	0.0208
11	0.0130
12	0.0124
13	0.0103
14	0.0111
15	0.0112
16	0.0078
17	0.0095
18	0.0070
19	0.0060
20	[illegible]
21	0.0017
22	0.0069
23	0.0087
24	0.0026
25	0.0013
26	0.0026
27	0.0013
28	0.0063
29	0.0026

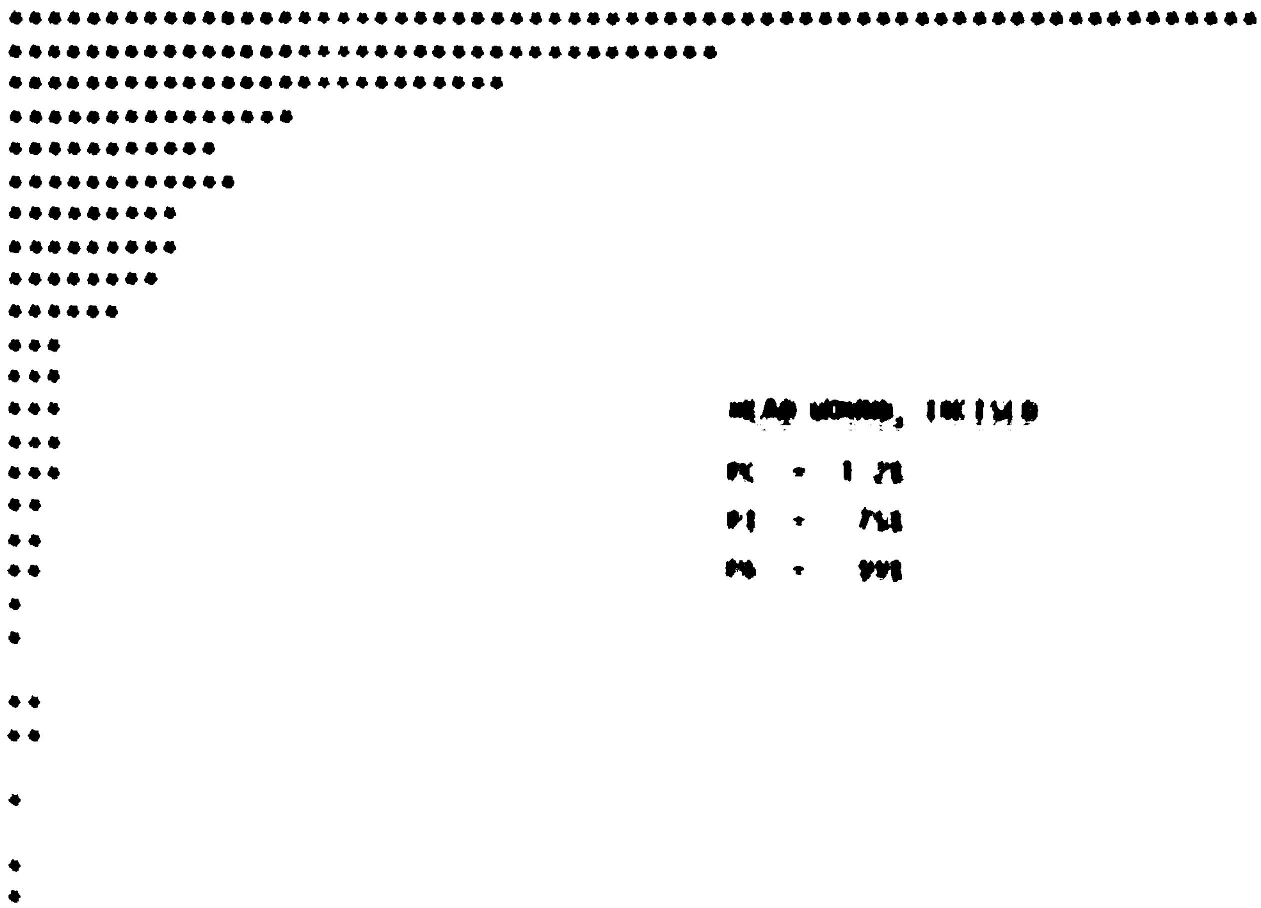

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMOBILIZATION CASUALTY CLASS

DAY	f(t-DAY)	Convalescence Time Histogram
1	0.2629	**
2	0.2007	**
3	0.1054	*******************************
4	0.0511	***************
5	0.0522	***************
6	0.0371	***********
7	0.0302	*********
8	0.0311	*********
9	0.0100	**
10	0.0144	****
11	0.0106	***
12	0.0053	*
13	0.0116	***
14	0.0021	
15	0.0043	*
16	0.0084	**
17	0.0043	*
18	0.0063	*
19	0.0043	*
20	0.0010	
21	0.0021	
22	0.0064	*
23	0.0011	
24	0.0053	*
25	0.0021	
26	0.0010	
27	0.0074	**
28	0.0022	
29	0.0	

CONCENTRATION

PC = [illegible]

PI = [illegible]

PN = [illegible]

88.8900 % OF RETURNS-TO-DUTY REPRESENTED

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

FACIAL FRACTURES, COMPOUND

PC = 1.0%

PI = 100%

PR = 99%

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0177	*****
2	0.0133	***
3	0.0162	****
4	0.0126	***
5	0.0148	****
6	0.0133	***
7	0.0103	***
8	0.0133	***
9	0.0126	***
10	0.0110	***
11	0.0118	***
12	0.0119	***
13	0.0066	*
14	0.0104	***
15	0.0110	***
16	0.0104	***
17	0.0066	*
18	0.0044	*
19	0.0037	*
20	0.0082	**
21	0.0051	*
22	0.0037	*
23	0.0082	**
24	0.0088	**
25	0.0104	***
26	0.0044	*
27	0.0007	
28	0.0030	
29	0.0029	

26.7300 % OF RETURNS-TO-DUTY REPRESENTED

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

FACIAL FRACTURES, SIMPLE

PC = 0.0%

PI = 90%

PR = 0%

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0210	******
2	0.0370	***********
3	0.0170	*****
4	0.0170	*****
5	0.0310	*********
6	0.0310	*********
7	0.0070	**
8	0.0070	**
9	0.0240	*******
10	0.0370	***********
11	0.0110	***
12	0.0100	**
13	0.0100	**
14	0.0110	***
15	0.0100	**
16	0.0070	**
17	0.0030	
18	0.0140	****
19	0.0170	*****
20	0.0100	**
21	0.0100	**
22	0.0040	*
23	0.0070	**
24	0.0100	**
25	0.0070	**
26	0.0140	****
27	0.0100	**
28	0.0100	**
29	0.0170	*****

42.1000 % OF RETURNS-TO-DUTY REPRESENTED

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t-DAY]	Convalescence Time Histogram
1	0.1749	**
2	0.1254	*************************************
3	0.0818	************************
4	0.0648	*******************
5	0.0691	********************
6	0.0659	*******************
7	0.0420	************
8	0.0386	***********
9	0.0257	*******
10	0.0332	*********
11	0.0210	******
12	0.0135	****
13	0.0187	*****
14	0.0147	****
15	0.0107	***
16	0.0076	**
17	0.0093	**
18	0.0074	**
19	0.0056	*
20	0.0040	*
21	0.0062	*
22	0.0034	*
23	0.0057	*
24	0.0050	*
25	0.0051	*
26	0.0040	*
27	0.0005	
28	0.0034	*
29	0.0040	*

FACIAL WOUND

PC = 1.5%

PI = 93%

PR = 98%

87.1200 % OF RETURNS-TO-DUTY REPRESENTED

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0592	*****************
2	0.0386	***********
3	0.0387	***********
4	0.0368	***********
5	0.0391	***********
6	0.0339	**********
7	0.0256	*******
8	0.0227	******
9	0.0223	******
10	0.0223	******
11	0.0123	***
12	0.0175	*****
13	0.0215	******
14	0.0168	*****
15	0.0175	*****
16	0.0193	*****
17	0.0145	****
18	0.0186	*****
19	0.0201	******
20	0.0126	***
21	0.0112	***
22	0.0138	****
23	0.0145	****
24	0.0122	***
25	0.0078	**
26	0.0060	*
27	0.0078	**
28	0.0071	**
29	0.0081	**

59.8400 % OF RETURNS-TO-DUTY REPRESENTED

FACIAL LACERATIONS

PC - 2.4%

PI - 82%

PR - 99%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t-DAY]	Convalescence Time Histogram
1	0.0693	********************
2	0.0577	*****************
3	0.0305	*********
4	0.0348	**********
5	0.0287	********
6	0.0207	******
7	0.0176	*****
8	0.0137	****
9	0.0119	***
10	0.0097	**
11	0.0071	**
12	0.0062	*
13	0.0070	**
14	0.0040	*
15	0.0048	*
16	0.0027	
17	0.0066	*
18	0.0048	*
19	0.0036	*
20	0.0026	
21	0.0040	*
22	0.0013	
23	0.0018	
24	0.0022	
25	0.0009	
26	0.0017	
27	0.0031	
28	0.0009	
29	0.0017	

36.1600 % OF RETURNS-TO-DUTY REPRESENTED

EYE AND ORBIT

PC = 2.1%

PI = 80%

PR = 99%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0699	********************
2	0.0586	*****************
3	0.0484	**************
4	0.0587	*****************
5	0.0473	**************
6	0.0383	***********
7	0.0440	*************
8	0.0495	**************
9	0.0350	**********
10	0.0304	*********
11	0.0214	******
12	0.0204	******
13	0.0191	*****
14	0.0192	*****
15	0.0135	****
16	0.0225	******
17	0.0147	****
18	0.0203	******
19	0.0101	***
20	0.0113	***
21	0.0101	***
22	0.0068	**
23	0.0079	**
24	0.0090	**
25	0.0023	
26	0.0101	***
27	0.0066	*
28	0.0053	*
29	0.0092	**

71.9900 % OF RETURNS-TO-DUTY REPRESENTED

NECK WOUND

PC = 0.8%

PI = 83%

PR = 96%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0017	
2	0.0022	
3	0.0045	*
4	0.0031	
5	0.0034	*
6	0.0031	
7	0.0035	*
8	0.0055	*
9	0.0048	*
10	0.0027	
11	0.0040	*
12	0.0039	*
13	0.0023	
14	0.0028	
15	0.0025	
16	0.0045	*
17	0.0027	
18	0.0013	
19	0.0025	
20	0.0021	
21	0.0017	
22	0.0025	
23	0.0028	
24	0.0022	
25	0.0032	
26	0.0025	
27	0.0038	*
28	0.0028	
29	0.0019	

8.6500 % OF RETURNS-TO-DUTY REPRESENTED

UPPER EXTREMITY FRACTURES, COMPOUND

PC = 4.5%

PI = 100%

PR = 99%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0618	******************
2	0.0519	***************
3	0.0608	******************
4	0.0314	*********
5	0.0166	****
6	0.0216	******
7	0.0147	****
8	0.0098	**
9	0.0108	***
10	0.0049	*
11	0.0059	*
12	0.0108	***
13	0.0039	*
14	0.0039	*
15	0.0049	*
16	0.0039	*
17	0.0059	*
18	0.0040	*
19	0.0058	*
20	0.0049	*
21	0.0020	
22	0.0	
23	0.0039	*
24	0.0010	
25	0.0010	
26	0.0019	
27	0.0079	**
28	0.0029	
29	0.0030	

36.1800 % OF RETURNS-TO-DUTY REPRESENTED

UPPER EXTREMITY FRACTURES, SIMPLE

PC = 1.0%

PI = 75%

PR = 99%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0561	****************
2	0.0409	************
3	0.0415	************
4	0.0423	************
5	0.0384	***********
6	0.0331	*********
7	0.0248	*******
8	0.0214	******
9	0.0210	******
10	0.0191	*****
11	0.0174	*****
12	0.0185	*****
13	0.0198	*****
14	0.0197	*****
15	0.0172	*****
16	0.0190	*****
17	0.0158	****
18	0.0161	****
19	0.0142	****
20	0.0147	****
21	0.0129	***
22	0.0114	***
23	0.0100	**
24	0.0103	***
25	0.0085	**
26	0.0093	**
27	0.0091	**
28	0.0077	**
29	0.0075	**

59.7700 % OF RETURN-TO-DUTY REPRESENTED

UPPER EXTREMITY OPEN WOUND

PC = 13%

PI = 80%

PR = 99%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

LOWER EXTREMITY FRACTURES, COMPOUND

PC = 6.6%

PI = 100%

PR = 99%

DAY	f[t=DAY]
1	0.0003
2	0.0008
3	0.0013
4	0.0012
5	0.0009
6	0.0010
7	0.0015
8	0.0015
9	0.0020
10	0.0019
11	0.0010
12	0.0019
13	0.0016
14	0.0004
15	0.0022
16	0.0013
17	0.0018
18	0.0024
19	0.0018
20	0.0013
21	0.0015
22	0.0015
23	0.0014
24	0.0022
25	0.0012
26	0.0024
27	0.0009
28	0.0021
29	0.0028

4.4100 % OF RETURN-TO-DUTY REPRESENTED

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0312	*********
2	0.0294	********
3	0.0353	**********
4	0.0262	*******
5	0.0216	******
6	0.0124	***
7	0.0109	***
8	0.0024	
9	0.0037	*
10	0.0045	*
11	0.0041	*
12	0.0028	
13	0.0037	*
14	0.0032	
15	0.0023	
16	0.0027	
17	0.0037	*
18	0.0009	
19	0.0014	
20	0.0019	
21	0.0004	
22	0.0010	
23	0.0018	
24	0.0004	
25	0.0019	
26	0.0004	
27	0.0005	
28	0.0013	
29	0.0010	

21.3000 % OF RETURNS-TO-DUTY REPRESENTED

LOWER EXTREMITY FRACTURES, SIMPLE

PC = 1.9%

PI = 83%

PR = 99%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0433	************
2	0.0418	************
3	0.0376	***********
4	0.0380	***********
5	0.0345	**********
6	0.0326	*********
7	0.0266	*******
8	0.0240	*******
9	0.0194	*****
10	0.0184	*****
11	0.0151	****
12	0.0166	****
13	0.0177	*****
14	0.0214	******
15	0.0199	*****
16	0.0159	****
17	0.0183	*****
18	0.0163	****
19	0.0153	****
20	0.0143	****
21	0.0138	****
22	0.0129	***
23	0.0128	***
24	0.0121	***
25	0.0101	***
26	0.0105	***
27	0.0095	**
28	0.0093	**
29	0.0087	**

58.6700 % OF RETURNS-TO-DUTY REPRESENTED

LOWER EXTREMITY OPEN WOUNDS

PC = 13%

PI = 87%

PR = 99%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0856	*************************
2	0.0967	*****************************
3	0.0702	*********************
4	0.0446	*************
5	0.0305	*********
6	0.0232	******
7	0.0164	****
8	0.0151	****
9	0.0082	**
10	0.0097	**
11	0.0065	*
12	0.0078	**
13	0.0054	*
14	0.0050	*
15	0.0064	*
16	0.0044	*
17	0.0034	*
18	0.0030	
19	0.0034	*
20	0.0031	
21	0.0027	
22	0.0032	
23	0.0034	*
24	0.0025	
25	0.0030	
26	0.0021	
27	0.0021	
28	0.0019	
29	0.0018	

47.1300 OF RETURNS-TO-DUTY REPRES:N D

DISLOCATIONS AND SPRAINS

PC = 9.2%

PI = 75%

PR = 99%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0169	*****
2	0.0183	*****
3	0.0143	****
4	0.0181	*****
5	0.0200	*****
6	0.0181	*****
7	0.0160	****
8	0.0147	****
9	0.0134	****
10	0.0114	***
11	0.0125	***
12	0.0151	****
13	0.0158	****
14	0.0176	*****
15	0.0179	*****
16	0.0155	****
17	0.0154	****
18	0.0152	****
19	0.0147	****
20	0.0181	*****
21	0.0136	****
22	0.0148	****
23	0.0159	****
[illegible]	0.0140	****
[illegible]	0.0132	***
[illegible]	0.0133	***
[illegible]	0.0111	***
[illegible]	0.0102	***
[illegible]	0.0105	***

INTRATHORACIC

PC - 6.6%

PI - 98%

PR - 97%

% [illegible] RETURNS TO-DUTY REPRESENTED

AD-A123 458 TECHNICAL ASSISTANCE TO USAMRDC IN DEVELOPING RESOURCE ALLOCATION METHODO..(U) VECTOR RESEARCH INC ANN ARBOR MI T DOYLE ET AL. JUL 78 VRI-MRDC-1-AR78-1-VOL-1 2/2

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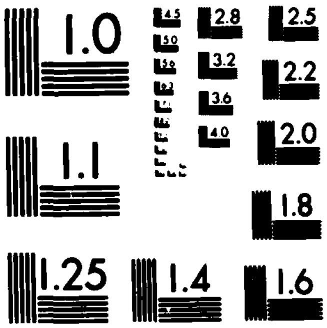

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0601	******************
2	0.0406	************
3	0.0439	*************
4	0.0536	****************
5	0.0528	***************
6	0.0325	*********
7	0.0398	***********
8	0.0276	********
9	0.0228	******
10	0.0252	*******
11	0.0300	*********
12	0.0244	*******
13	0.0374	***********
14	0.0308	*********
15	0.0252	*******
16	0.0276	********
17	0.0244	*******
18	0.0244	*******
19	0.0146	****
20	0.0146	****
21	0.0171	*****
22	0.0113	***
23	0.0114	***
24	0.0065	*
25	0.0057	*
26	0.0130	***
27	0.0089	**
28	0.0073	**
29	0.0090	**

74.2500 % OF RETURNS-TO-DUTY REPRESENTED

THORACIC OPEN WOUND

PC = 1.0%

PI = 100%

PR = 94%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0416	************
2	0.0394	***********
3	0.0322	*********
4	0.0360	**********
5	0.0295	********
6	0.0281	********
7	0.0284	********
8	0.0191	*****
9	0.0192	*****
10	0.0138	****
11	0.0194	*****
12	0.0165	****
13	0.0226	******
14	0.0158	****
15	0.0223	******
16	0.0156	****
17	0.0164	****
18	0.0159	****
19	0.0171	*****
20	0.0138	****
21	0.0133	***
22	0.0098	**
23	0.0124	***
24	0.0097	**
25	0.0094	**
26	0.0096	**
27	0.0084	**
28	0.0078	**
29	0.0099	**

INTRA-ABDOMINAL

PC = 4.6%

PI = 100%

PR = 95%

55.3000 % OF RETURNS-TO-DUTY REPRESENTED

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.1148	**********************************
2	0.0839	*************************
3	0.0526	***************
4	0.0267	********
5	0.0242	*******
6	0.0190	*****
7	0.0172	*****
8	0.0161	****
9	0.0169	*****
10	0.0161	****
11	0.0119	***
12	0.0109	***
13	0.0084	**
14	0.0102	***
15	0.0067	**
16	0.0109	***
17	0.0073	**
18	0.0088	**
19	0.0056	*
20	0.0064	*
21	0.0035	*
22	0.0087	**
23	0.0035	*
24	0.0029	
25	0.0052	*
26	0.0039	*
27	0.0028	
28	0.0017	
29	0.0032	

BURNS

PC = 3.0%

PI = 75%

PR = 95%

51.0000 % OF RETURNS-TO-DUTY REPRESENTED

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.2330	***
2	0.1876	***
3	0.1305	*************************************
4	0.0840	************************
5	0.0625	*****************
6	0.0422	************
7	0.0330	*********
8	0.0306	*********
9	0.0184	*****
10	0.0127	***
11	0.0131	***
12	0.0076	**
13	0.0086	**
14	0.0100	**
15	0.0101	***
16	0.0057	*
17	0.0035	*
18	0.0035	*
19	0.0037	*
20	0.0039	*
21	0.0042	*
22	0.0035	*
23	0.0011	
24	0.0026	
25	0.0026	
26	0.0024	
27	0.0026	
28	0.0018	
29	0.0006	

LACERATIONS AND CONTUSIONS

PC = 14%

PI = 25%

PR = 100%

92.5600 % OF RETURNS-TO-DUTY REPRESENTED

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0030	
2	0.0083	**
3	0.0102	***
4	0.0059	*
5	0.0076	**
6	0.0037	*
7	0.0038	*
8	0.0032	
9	0.0033	
10	0.0043	*
11	0.0016	
12	0.0053	*
13	0.0022	
14	0.0022	
15	0.0021	
16	0.0032	
17	0.0033	
18	0.0005	
19	0.0011	
20	0.0016	
21	0.0016	
22	0.0032	
23	0.0043	*
24	0.0038	*
25	0.0016	
26	0.0022	
27	0.0032	
28	0.0016	
29	0.0005	

9.8400 % OF RETURNS-TO-DUTY REPRESENTED

GENITOURINARY WOUNDS

PC = 1.7%

PI = 100%

PR = 81%

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0029	
2	0.0115	***
3	0.0086	**
4	0.0077	**
5	0.0047	*
6	0.0020	
7	0.0067	**
8	0.0067	**
9	0.0067	**
10	0.0076	**
11	0.0019	
12	0.0087	**
13	0.0048	*
14	0.0057	*
15	0.0029	
16	0.0029	
17	0.0028	
18	0.0010	
19	0.0009	
20	0.0058	*
21	0.0019	
22	0.0	
23	0.0048	*
24	0.0019	
25	0.0019	
26	0.0010	
27	0.0009	
28	0.0010	
29	0.0019	

SPINAL INJURIES

PC = 0.8%

PI = 100%

PR = 95%

11.7800 % OF RETURNS-TO-DUTY REPRESENTED

EXHIBIT A-2 (continued)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.0244	*******
2	0.0231	******
3	0.0165	****
4	0.0128	***
5	0.0146	****
6	0.0171	*****
7	0.0176	*****
8	0.0067	**
9	0.0153	****
10	0.0073	**
11	0.0073	**
12	0.0073	**
13	0.0073	**
14	0.0061	*
15	0.0061	*
16	0.0031	
17	0.0036	*
18	0.0037	*
19	0.0036	*
20	0.0031	
21	0.0036	*
22	0.0013	
23	0.0036	*
24	0.0037	*
25	0.0012	
26	0.0006	
27	0.0030	
28	0.0007	
29	0.0030	

22.7300 % OF RETURNS-TO-DUTY REPRESENTED

PSYCHOSIS

PC = 1.2%

PI = 100%

PR = 100%

EXHIBIT A-2 (concluded)

STATISTICAL DESCRIPTION OF DEMONSTRATION CASUALTY CLASS

DAY	f[t=DAY]	Convalescence Time Histogram
1	0.2022	**
2	0.1554	**
3	0.1000	******************************
4	0.0797	***********************
5	0.0541	****************
6	0.0456	*************
7	0.0370	***********
8	0.0281	********
9	0.0191	*****
10	0.0171	*****
11	0.0141	****
12	0.0111	***
13	0.0119	***
14	0.0082	**
15	0.0051	*
16	0.0057	*
17	0.0055	*
18	0.0044	*
19	0.0046	*
20	0.0050	*
21	0.0038	*
22	0.0049	*
23	0.0037	*
24	0.0027	
25	0.0038	*
26	0.0038	*
27	0.0029	
28	0.0033	
29	0.0033	

PSYCHOLOGICAL

PC = 6.4%

PI = 95%

PR = 99%

84.6100 % OF RETURNS-TO-DUTY REPRESENTED

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