A MULTIDISCIPLINARY TECHNIQUE FOR THE EVALUATION OF LESS LETHAL WEAPONS (VOLUME II)

DRAFT REPORT
APRIL 1974

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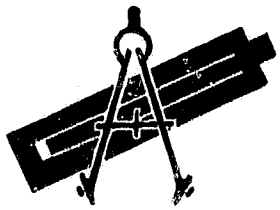

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A MULTIDISCIPLINARY TECHNIQUE FOR THE EVALUATION OF LESS LETHAL WEAPONS

VOLUME II

Effectiveness of the .38 Caliber Weapon System

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ABSTRACT

The primary objective of the overall task was to establish a methodology/technique for determining standardized effectiveness measures for candidate less lethal weapons that utilize kinetic-energy damage mechanisms. The methodology/technique has been developed and is presented in Volume I of this report.

This Volume (II) utilizes the aforementioned evaluation technique and applies the evaluation model to the .38 caliber weapon system. The effectiveness of the .38 caliber weapon system can serve as a basis for comparison of other so-called less lethal weapons for those scenarios where such weapons might have application.

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FOREWORD

The work described in this report was performed under Task Plan I of the LEAA/LWL Interagency Agreement No. LEAA-J-IAA-014-2. Mr. Lester Shubin and Mr. Marc A. Nerenstone were the LEAA Program Monitors for this task. Mr. Donald O. Egner was the USALWL Project Officer.

The work is reported in two volumes. The first volume contains the general evaluation methodology/technique, while this second volume describes the application of the technique to the .38 caliber weapon system. Although this weapon system is not generally thought of as being applicable in the less lethal role, some of the justifications for its consideration in this report are as follows:

o Preliminary studies have shown that under many circumstances woundings with the .38 caliber have not been fatal.

o The .38 caliber weapon system can provide a common basis for relative comparisons with other "less lethal" weapon systems.

o The .38 caliber weapon system is familiar to all police and law enforcement agencies.

The work described in this report is pioneer in nature and thus subject to considerable change in the immediate future. Comments, data and other information which could improve the methodology described in Volume I and applied herein are welcome and should be forwarded to the Project Monitor, Less Lethal Weapons Evaluations Program, National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, 633 Indiana Avenue, NW, Washington, DC 20530.

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Miami Police Department
Seven Baltimore Area Hospitals.

Mr. John Sarvis, Munitions Branch, USALWL, is credited with spearheading the effort to obtain the basic ballistic performance (velocity/accuracy) and time-stress accuracy test data of the .38 caliber weapon system.

Mr. Donald Campbell, Research Analysis Office, USALWL, directed the statistical analysis of the man-weapon test data.

SUMMARY

A general concept for the evaluation of less lethal weapons was presented in Volume I of this report. The present volume (II) is concerned with analyzing the effectiveness and safety characteristics of the .38 caliber weapon system in a less lethal role. Since no stringent criteria have been developed to distinguish the lethal weapons from the less lethal weapons, it is somewhat justifiable at present to consider the .38 caliber weapon system as an element of the set of less lethal weapons.

Assessment of the peripheral elements of the overall evaluation technique determined that only a few modifications would be required to examine the effectiveness of the .38 caliber weapon system. There were no apparent geometric limitations, so both point and area (line) targets could be addressed. On the other hand, the format of existing human physiological data [obtained from local (Baltimore) hospital files and medical examiner records] was not suitable for computer usage (the model, described in Volume I, is partially computerized). Additionally, some minor modifications to the input format for the civil scenarios were required.

It was noted, in review, that the model for evaluating the effectiveness of less lethal weapons necessitated the following quantifications:

- o the effect of displaying the weapon
- o the effect of threatening to use the weapon
- o the effect of actual weapon use.

In prior less lethal weapons evaluation work, the effect of "display" and "threat" had largely been discounted; however, when considering the .38 caliber weapon system, the elements which may be appropriately applied to it have been stated previously by others: "the physical appearance which the officer presents, coupled with the holstered pistol, is impressive," and it is known that a portion of confrontees indulging in illegal acts submit on a warning shot[1]. For the civil scenarios considered in this report, probability of

effects for "display" and "threat" for the .38 caliber weapon system were generated by the Methods Group. These estimates, presented in Section II, agree closely with some published data[1],[2], especially in the category of "threat of weapon use."

In the animal test series, damage assessment was made for each specific target organ, including the extremities; however, due to the criteria established for evaluating blunt-trauma impacts, all damage assessments were Level 5.

Specific data banks for probability of undesirable and desirable effects (both physiological and nonphysiological) for the .38 caliber weapon system were generated by the Medical and Methods Groups. The Medical Group, when rendering estimates of probabilities of effect, took into consideration noncritical wounds (those not involving critical organs) to the chest and

abdominal cavities*. Moreover, the Methods Group established the definition of a nonphysiologically undesirable effect.

For the final steps in the evaluation, the scenario was chosen (The Suspect Fleeing on Foot), specific weapon characteristics were identified, terminal effects were calculated, hit probabilities were computed (using the mathematical model described in Volume I) and pertinent data were extracted from the generalized data bank. Results were as follows:

- the probability of a physiologically desirable effect = .343
- the probability of a nonphysiologically desirable effect = .174
- the probability of a physiologically undesirable effect = .347
- the probability of a nonphysiologically undesirable effect = 0.

It should be noted in conclusion that the general evaluation procedure is incomplete but further effort is probably not warranted until sufficient input data, e.g., operational accuracy, is available. However, certain features of the evaluation, such as completion of the data bank on desirable effects for all applicable scenarios, can be accomplished if additional funds become available.

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*These judgments were based on the Medical Group's experience and expertise.

I. INTRODUCTION

Under Task Plan I, a provisional evaluation methodology was developed for determining the effectiveness and safety characteristics of a class of less lethal weapons and was described in Volume I of this report. For the most part, this methodology keyed upon kinetic-energy, blunt-trauma-producing damage mechanisms. A limited amount of medical data for this class of weapons was developed and scenarios (situations) were formulated for weapon analyses.

It can be inferred that, since the .38 caliber weapon system is in common use (as indicated by survey results in Appendix B), an assessment of its less lethal characteristics under representative civil scenarios can serve as a baseline against which other less lethal weaponry can be measured. The objective of the phase of Task Plan I described in this volume (II) was to utilize the evaluation methodology in order to determine the less lethal weapon effectiveness and safety characteristics of the .38 caliber weapon system. Specifically, this required the development of a data bank by quantifying damage mechanism outputs and estimating probabilities of less lethal incapacitation and undesirable damage for the .38 caliber weapon system.

In addition to the generalized data bank, information relating to the .38 caliber weapon system itself was required. In this regard, the following information has been included either as appendices to this report or cited as references:

A. History and Characteristics of the .38 Caliber Weapon/Ammunition [Appendix A - informal LWL Research Analysis Office (RAO) memorandum]

B. Sample Survey of Revolvers and Ammunition Used by Law Enforcement Agencies (Appendix B - informal RAO memorandum)

C. Statistical Analysis of Man-Weapon Test Data Relating to Basic and Time-Stress Tests of the .38 Caliber Special (Appendix C - informal RAO memorandum, based on tests reported in LWL Technical Note No. 73-01[3])

D. Accuracy Data for the .22, .38 and .45 Caliber Weapon Systems (Appendix D - informal RAO Memorandum)

E. Statistical Analysis and Summary of .38 Caliber Shooting Incidents in the Baltimore Area (Appendix E - informal RAO Memorandum)

F. Analysis of Tissue Damage in Experimental Animals Resulting from the Impact and Penetration of a .38 Caliber Bullet (AAI Engineering Report (ER) 7330[4], prepared by AAI Corporation in conjunction with Hazelton Laboratories for LWL under Contract No. DAAD05-72-C-0292; tests performed in November 1972)

G. Analysis of Shooting Incidents, Dade County, FL (R. S. Zelina, AAI Corporation, Visit Notes, Miami Police Department, 11 October 1972[5]).

The synthesis of an evaluation technique for less lethal weapons is not an easy task, and it cannot be claimed at this point that the objective has

been realized. As the effort progressed during 1972 and 1973, a confidence developed (and is still prevalent) among the personnel involved in the project that the work being accomplished is both significant and useful. It is recognized, however, that additional work is necessary in order to refine both the data collection effort and the logic of the evaluation scheme. It is further realized that this refinement must be accomplished before the technique of the evaluation will be acceptable to both the users of the product information and those agencies claiming to understand what comprises an ideal evaluation.

Many questionable areas remain in this evaluation of the .38 caliber weapon system with regard to its role as a less lethal weapon. These questionable areas are a consequence of both the incompleteness of the evaluation and the "shotgun approach" used to conduct the evaluation. However, since at this time an examination of the unresolved areas would greatly delay the availability of this report, it therefore seems reasonable to present the report in terms of the "shotgun approach" that was used.

Many parallel activities were conducted during this first year's effort. There was a great deal to be learned, and much data was unavailable where it had been previously assumed that data existed. There were questions to be answered, such as: What was the origin of the .38 caliber weapon system?, or, Was the .38 caliber weapon system the predominant system used by law enforcement personnel? To answer the former question, a short history of the .38 caliber weapon was assembled (refer to Appendix A), and in answer to the latter question, a brief study was conducted through interviews and researching popular literature, in particular "Guns and Ammo" magazine (refer to Appendix B).

It was assumed, prior to this task, that considerable data existed in Army reports on the subject of .38 caliber wound ballistics. It now appears that this assumption was incorrect. Two separate activities were initiated, therefore, to obtain some basic data on .38 caliber woundings. One activity involved the examination of operational data (from hospital files and medical examiner records) on .38 caliber woundings and deaths in the Baltimore

area. The second activity entailed the conduction of a series of controlled tests against 18 animals (swine and baboons). It is recognized that these efforts cannot be considered to either encompass all possible study/test conditions or reveal startling new information. The resulting data, however, unequivocably validate the "critical organ" concept in wounding.

One of the major variables in all weapons or devices is "operational accuracy"--this is the accuracy under actual-use conditions--and it is suspected that this accuracy is quite different from any target range-type accuracy. Again, in the absence of reliable data on either stressed or unstressed accuracy firings, a test series was conducted to obtain this information. The tests were not exhaustive, but they did provide some previously unavailable basic accuracy information on the .38 caliber weapon system.

This Volume II report, therefore, is basically a presentation of the aforementioned isolated studies and tests. The actual value of the report will depend upon the specific users of the information, and the "grossness" that these users will accept when comparing the .38 caliber weapon system results with the results of future less lethal weapon systems evaluations.

II. TECHNICAL APPROACH

As presented in Volume I, and Figure 1 herein, a less lethal weapon evaluation is comprised of several areas in which basic data are utilized to provide the "quantitative flow." In this section five key areas are discussed, and the nature of the basic data used in each area is described. The areas are: weapon system performance characteristics, scenarios, physiological data, nonphysiological data, and the exercise of the mathematical model.

A. Weapon System Performance Characteristics

Since the effort presented in this volume represents only a trial application of the newly established methodology, it was decided to utilize only one weapon/ammunition combination. The weapon selected was a .38 caliber Smith and Wesson revolver with a four-inch barrel*, and the ammunition used was the Remington .38 caliber special with a 158-grain round-nose lead bullet.

Weapon systems evaluations are generally characterized by at least three types of data: reliability, accuracy, and terminal effects (impact parameters). In this initial evaluation the subject of reliability has not been considered--the assumption has been made that the device functions approximately as intended and presents no hazard to the user. The accuracy data has been addressed in two ways: (1) tests were conducted and analyzed to determine man/weapon system accuracy (Appendix C)**, and (2) a comparison of accuracy was made with other familiar weapon systems, viz., the .22 caliber and the .45 caliber (Appendix D). The third characteristic, terminal effects, was examined in two parts: first, a series of firings against test animals, and second, an investigation of human medical data. For the first part of this particular phase of the weapon performance evaluation, the terminal effects or impact conditions were held constant; in other words, all targets were the same distance from the muzzle and no attempt was made to vary the impact velocity/energy*** at the target by, for example, varying the range; for the second part of this phase, impact conditions (e.g., ranges) were unknown.

As noted in the introduction, one of the relatively weak parts of a weapon system evaluation is "operational accuracy" information. Whenever an attempt is made to obtain accuracy data, there is a tendency to fall back to unrealistic match-type firing tests. The best way, however, to obtain operational-type firing accuracy appears to be through expensive simulated firings or by controlled time-stress firings, and this latter technique was used for the .38 caliber accuracy data found in this report[3].

One of the factors assumed in operational accuracy is a degradation which occurs under time-stress. Analysis of the controlled time-stress firings

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*Information presented in Appendix B influenced this selection.

**The accuracy data used in subsequent calculations are based upon the data in Appendix C.

***The only variations in impact velocity/energy were those common to any weapon/ammunition combination, such as 755 fps vs 758 fps or 200 ft-lb vs 202 ft-lb.

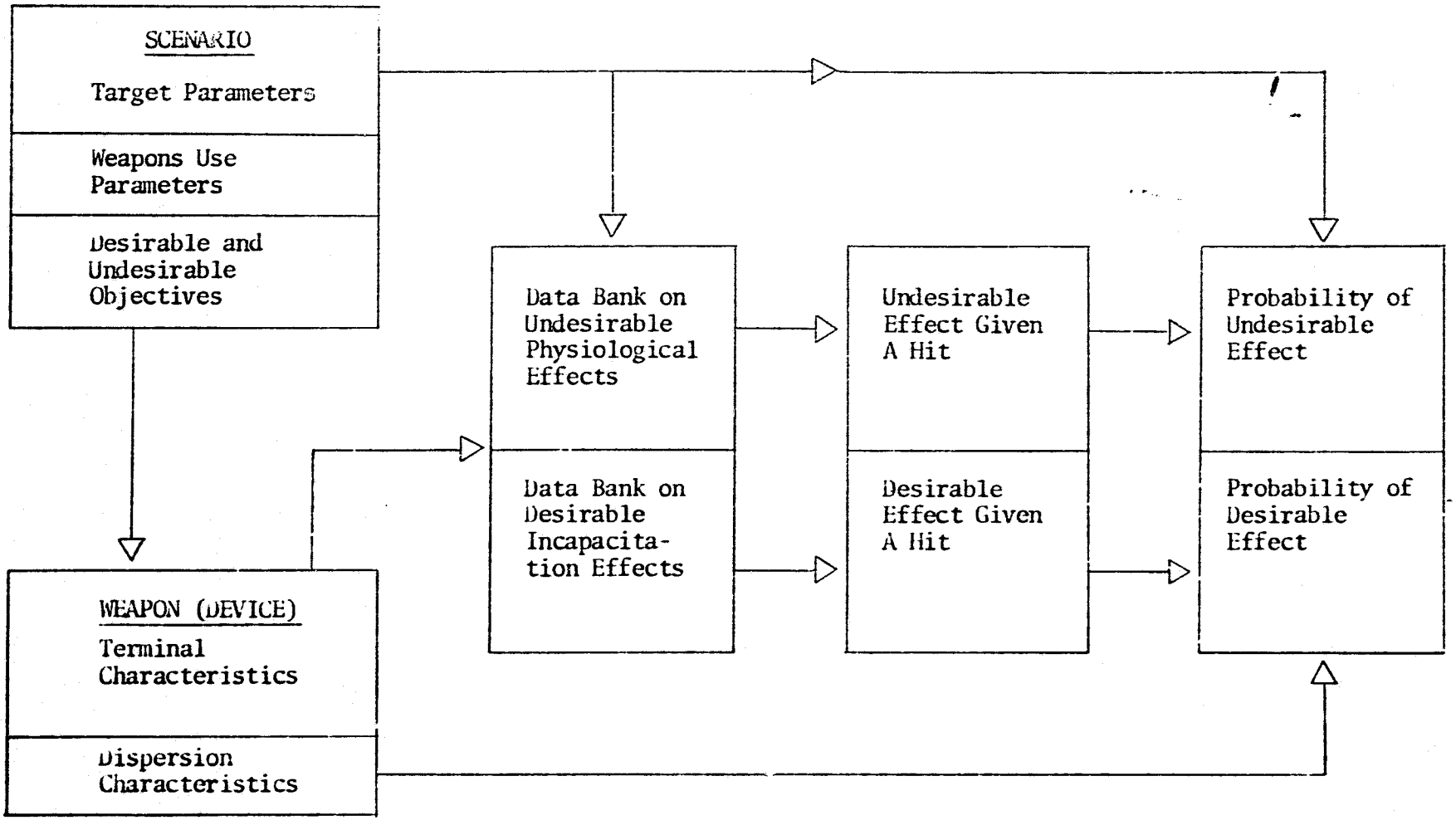

FIGURE 1. A General Concept of An Evaluation Procedure for Less Lethal Weapons

(Appendix C) conducted for this study is based upon 10- and 20-second limits for firing five-round groups*. For these firings, although the accuracy degradation is noticeable under time-stress, it is not overwhelming.

Other factors which may contribute to operational accuracy are individual differences in proficiency, motivation, emotional level, decision-making ability, target motion, and unusual target presentation. Although all these stress factors should be investigated, time and funding have precluded their consideration for this report.

An interesting "fallout" from this data is a phenomenon peculiar to handgunshooting, viz., the angular accuracy seems to improve with range. Since the accuracy information in this report has been developed from man-silhouettes without a marked bull's-eye (or point-target), and since the intended aim-point is the center-of-mass, it appears that the shooter is not challenged to fire as accurately as possible at short ranges against a large target.

It is felt that this information could be used by a well-trained and well-disciplined police group. When, for example, ranges are very short and the policeman's life is threatened, it appears that there would be an advantage in aiming at the head rather than the trunk of the target. In the section on physiological effects it is shown that head wounds cause a much quicker loss of function in the targeted person than do trunk wounds, even when the trunk wounds involve a critical organ such as the heart or liver. (There is also the possibility that noncritical head wounds could induce unconsciousness, thus bringing on an immediate loss of function and reduction of the threat to the police involved.) As another example, when ranges are very short and the policeman's life is not threatened, there would appear to be an advantage in aiming at noncritical areas, such as the extremities--the physiological effects data show that extremity wounds alone are not generally serious. As a third example, if there is a decision to fire, extremity wounds may be just as effective as trunk wounds in achieving the objectives of the police and yet not nearly as hazardous to the targeted subject or to bystanders.

Finally, the three-to-four mil accuracy potential of the .38 caliber weapon system will undoubtedly influence any future weapons comparisons. Blunt-trauma devices, for example, will have difficulty when competing for accuracy with the .38 caliber weapon system. Also, in many situations the accuracy of the .38 caliber, together with selectivity and discipline, provides a potentially more flexible reponse than blunt-trauma weapons.

B. Scenarios

The four basic civil scenarios considered in the overall program are described in Volume I, Appendix C, of this report. By title they are:

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*The police who participated in the .38 caliber accuracy tests conducted by LWL were well experienced shooters (some were or had been members of marksmanship teams.

- o Scenario I - The One-on-One Situation
- o Scenario II - The Barricade and Hostage Situation
- o Scenario III - The Suspect Fleeing on Foot
- o Scenario IV - The Dispersal of a Crowd

In examining these various scenarios for this .38 caliber evaluation the following determinations were made:

o The One-on-One Situation required some modifications*, after which it was considered the most applicable scenario in terms of evaluating desirable effects.

o The Barricade and Hostage Situation was considered not applicable for the evaluation of the .38 caliber weapon system--primarily because of accuracy/range relations involved and the unlikely line-of-sight conditions required for this system.

o The Suspect Fleeing on Foot scenario required no modifications but was considered most applicable in terms of evaluating undesirable effects.

o The Dispersal of a Crowd scenario also required no modifications; however, it was considered applicable, with some reservations, for evaluating the desirable effects of the .38 caliber weapon system.

It should be recognized that the evaluation of the .38 caliber weapon system as a less lethal weapon system presents certain problems. For example, if the scenarios are modified to make the situation credible (i.e., realistic situations wherein the .38 caliber weapon system would be used by the police), then the less lethal consideration may tend to be obscured. Also, if the .38 caliber weapon system is evaluated as a less lethal weapon system, it is necessary to include situations where the use of the .38 caliber would be socially unacceptable--this latter problem can be seen when examining Scenarios III and IV. In Scenario III, the Suspect Fleeing on Foot, the target is the back of an unarmed suspect--an obviously controversial situation; in

Scenario IV, the Dispersal of a Crowd, shooting into the crowd is a part of the conditions examined--another obviously controversial situation.

The nature of the data required to define various scenario conditions is another important consideration in the evaluation of the .38 caliber weapon system, or any other weapon system, for that matter. These data include: (1) time after wounding until a person is incapacitated, (2) time after wounding that a person is incapacitated, and (3) the probability of crowd members dispersing when fired upon, even though they are not hit. It is

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*The main modification to Scenario I involves Variation C(I) (see Volume I, page 57) in which the suspect is armed with a knife and the policeman's immediate objective is changed from subduing the suspect for 30 seconds until he can be handcuffed, to disabling the suspect before he can harm the policeman.

also important to note that each scenario specifies the weapon use concept and the geometrical arrangement of the situation (i.e., ranges from firer to target, spatial distribution of targets, etc.). Additionally, each scenario provides a constant basis for evaluation and specifies the desirable and undesirable effects (physiological and nonphysiological) for any weapon/device under evaluation.

Much of the aforementioned scenario information is combined with weapon performance information (aiming and ballistic errors, etc.) to determine the probability of a hit. The remaining information (particularly the effects information) is then combined with the probability of hit, to determine the probability of achieving an effect.

Thus, in summary, it can be said that the scenario is the hub of the evaluation around which all the other evaluation elements revolve.

C. Physiological Data*

At the time that the decision was made to utilize the evaluation of the .38 caliber weapon system as a baseline with which to compare less lethal weapons, there was no obvious source of statistical wounding data for this weapon system for either organ tissue disruption or an individual's ability to function after being wounded. There had been a great deal of study by the military on the general subject of wound ballistics; however, no information had been gathered specifically on .38 caliber wound ballistics. Since a major concern of this program was to understand the total process of evaluation, including tests to obtain data when no data was available, two separate investigations were conducted to obtain data on physiological effects of the .38 caliber weapon system.

One investigation involved firings at test animals[2]. In these test firings two shots each were fired at the following target areas/animals**.

1. Heart (swine)
2. Lungs (swine)

3. Liver (swine)
4. Kidney (swine)
5. Thigh (swine)
6. Left temple (baboon)

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*As it is used in this report, the term "physiological data (or physiological effects)" describes, in objective medical terms, resultant changes in the body.

**The rationale for choice of animals can be found on page 21, Volume I, of this report.

7. Anterior head (baboon)

8. Posterior head (baboon).

The results of these tests produced no real surprises--all animals with wounds to critical organs died, and all animals with wounds to noncritical areas (the thigh shots) survived. It was noted, however, that a number of the deaths were probably due in part to the size of the test animals; that is, shots to the liver and kidney which resulted in fatalities to the test animals may not have caused death in full-size humans.

Since the original popular concept of less lethal devices involved the question of a weapon literally being lethal, an additional investigation oriented toward "lethal vs less lethal data" was made. This second investigation involved a survey of .38 caliber shootings in the city of Baltimore during a nine-month period in 1971 and 1972. (Details of this investigation are given in Appendix E.) Although there are only a total of 56 cases in the survey, certain indications appear sufficiently evident to warrant drawing some conclusions. First of all, 32 victims, or 57% of the persons wounded, survived. Survival did not seem to depend on how often the person was shot--of the fatalities, 62% were shot only once, and of the nonfatalities, 59% were shot only once. None of the survivors was shot in either the heart or the lung and only two were shot in the head (but the bullet lodged extracranially). Sixty-two percent of the survivors had wounds of the extremities, whereas only 25% of the fatalities had wounds of the extremities. Of these 25%, all were shot more than once, with another wound located other than the extremity. It is important to note, therefore, that the data indicated at least three levels of seriousness in .38 caliber wounding, viz., head, heart and lung wounds were almost always fatal; neck, liver and kidney wounds were sometimes fatal; extremity wounds alone were never fatal.

In regard to the first investigation, the test firings against animals, the Medical Group reviewed the basic data for the purpose of assessing probability of desirable and undesirable effects. This effort is a key part of the evaluation procedure and involves two activities. The first activity

entails grading the wounds for the various organs, according to previously established grading criteria (Appendix J, Volume I). This procedure is basically nonjudgmental and serves presently as a check on the level of probabilities assigned for the various test shots. The second activity involves the assigning of probability levels, and it is also divided into two parts, viz., the determination of the probability of an undesirable effect given a hit ($P_{UE/H}$) and the determination of the probability of a desirable effect given a hit ($P_{DE/H}$). This second activity is presently judgmental, but produces information critical to the evaluation, namely, quantitative values (probabilities) which measure the hazard and the effect of an impact. The quantitative assessment of undesirable effect of the .38 caliber weapon by the Medical Group was simply that $P_{UE/H} = 1.00$ for <u>any</u> impact on the body*.

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*It was determined by the Medical Group that the physiologically undesirable effects would be the same for all scenarios considered.

This assessment is based upon the following criterion:

> Undesirable effect is that anatomical and/or functional effect which persists longer than 24 hours and prevents an individual from performing routine daily tasks and/or produces permanent impairment as defined by the American Medical Association (AMA) ratings.

(It should be understood that the probability of 1.00 does not indicate absolute certainty but simply that 1.00 is a better estimate of the probability of an undesirable effect than .95, for example.)

The second part of the judgmental assignment of probabilities involves the desirable effect. However, when desirable effects are considered, the criteria for a desirable effect must be obtained from the scenario under consideration. For ease of evaluation, the Medical Group chose to examine the Suspect Fleeing on Foot, Scenario III, in which the specific desirable effect is that the suspect should be intercepted before proceeding 100 meters or that the suspect should be completely stopped within 30 seconds. Table I relates the target effects parameter to the physiological damage level for the .38 caliber weapon system tests described in Appendix J, Volume I.

Physiologically undesirable and desirable effects probability estimates (P_{UE}, P_{DE})* are presented in Table II for Scenario III, the Suspect Fleeing on Foot. Estimates for impacts to the extremities and noncritical wounds to the chest and abdominal cavity are given in Tables III and IV, respectively.

For Scenario I, the One-on-One Situation, Variation C(I)**, group members postulated that onset time was the crucial parameter. Therefore, estimates of onset times for this scenario are given in Table V below.

The physiological effects data is the most critical information concerning the hazards to those subjected to the weapon. It is therefore extremely desirable that the physiological effects data be organized so that it is quantitatively useful, i.e., such that one can proceed from a quantifiable weapon/

projectile impact (dose) to a quantifiable physiological change. (Table I is an example of how these data should be organized.) The weakness, however, is the inability of the evaluator to quantify the tissue and organ damage resulting from the .38 caliber bullet's impact to the body. [For example, testing to date, although limited, indicates marked damage and death[2], however, it is known from a search of hospital files relating to gunshot wounds that not all persons die when impacted with a .38 caliber bullet. (Although actual distances were unknown, it is assumed that the shootings occurred at relatively short ranges.)]

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*It should be noted that these estimates are essentially independent of the emotional state of the subject hit, and thus are medical judgments of the ability of the human body to function after having received various types of wounds.

**See footnote on page 7.

TABLE I

PHYSIOLOGICAL DATA, .38 CALIBER

Target Area	Average Impact Energy (ft-lb)*	Physiological Damage Level	Number of Tests
Heart	187	5	2
Kidney	186	5	4
Lung	185	5	2
Liver	183	5	2
Thigh	184	5	2
Head	187	5	6

*These energies are calculated impact energies and do not represent energies imparted to the various organs as the bullet passed through them (through and through, or exit, wounds were observed in every case). It appeared that the projectile still had a considerable amount of energy after exiting the animal (based on projectile deformation after it impacted the bullet trap).

TABLE II

PROBABILITY ESTIMATES FOR PHYSIOLOGICAL EFFECTS - SUSPECT FLEEING ON FOOT, CIVIL SCENARIO III

Organ or Body Area	Damage Level D_L	P_{DE}	P_{UE}
Heart	5	1.00	1.00
Kidney	5	1.00	1.00
Lung	5	1.00	1.00
Liver	5	1.00	1.00
Thigh	5	1.00	1.00
Head	5	1.00	1.00

TABLE III

PROBABILITY ESTIMATES FOR PHYSIOLOGICAL EFFECTS FOR VARIOUS IMPACTS TO THE EXTREMITIES - SUSPECT FLEEING ON FOOT, CIVIL SCENARIO III

Impact	Description	P_{DE}	P_{UE}
1	One arm hit, no bone or nerve hit but Grade 5 damage to the skin and/or muscle with no major nerve or blood vessel severed.	0.25	1.00
2	As in 1 above except major nerve hit	1.00	1.00
3	As in 1 above except major blood vessel hit	0.50	1.00
4	As in 1 above except bone hit	1.00	1.00

TABLE IV

PROBABILITY ESTIMATES FOR PHYSIOLOGICAL EFFECTS FOR NONCRITICAL WOUNDS TO THE CHEST AND ABDOMINAL CAVITIES - SUSPECT FLEEING ON FOOT, CIVIL SCENARIO III

Impact Zone	P_{DE}	P_{UE}
Chest	0.30	1.00
Abdomen	0.30	1.00

TABLE V

ONSET TIMES FOR ONE-ON-ONE SITUATION, VARIATION C(I)*, CIVIL SCENARIO I

Impacted Area	Onset Time (sec)
Head or Cervical Reticular Cord	<1
Heart, Lung, Kidney, etc.	>5
Femur (Thigh)	--
Extremity Handling Weapon (Up to Shoulder)	<1
Solar Plexus	--

*Suspect assumed to have knife.

The minutes of the Medical Group meeting at which many of the above determinations were made are included as Appendix F. The reader may refer to this appendix for assumptions, relevant discussion and rationale for the probability estimates which were rendered.

D. Nonphysiological Data

The area of nonphysiological (or "other") effects is the most difficult area in the evaluation of blunt-trauma devices, and perhaps even more so when evaluating a weapon system such as the .38 caliber which uses a penetrating projectile. In order to achieve "other" effects, some desirable effect must be produced at a lower threshold than physical damage. At one time, pain appeared quite promising as a desirable effect; however, recent arguments support the notion that pain is not valid when subjects are emotionally tense, or when certain personalities are involved. (It still appears that threat of pain or discomfort has value in certain scenarios, such as the legal crowd.) A quantifiable relationship between the stimulus and the response has not been established; however, some nonphysiologically desirable effects data based on level of force were generated by the Methods Group (Tables VI and VII)*.

With regard to the specific data bank of nonphysiological undesirable effects, it was judged that this effect would be either 0 or not applicable for all levels of force and for all civil scenarios examined. The minutes of the Methods Group meeting at which the above determinations were made are included as Appendix G. The reader may refer to that appendix for assumptions, relevant discussion, and rationale for the percentage estimates which were rendered.

E. Exercise of the Mathematical Model

The final level of sophistication of the overall mathematical model for evaluating the effectiveness of the less lethal weapons has not as yet been established. Various submodels for determining hit probability (Figure 2)

and dosage are available. There is, however, no program of a complete set of calculations for a computer, because the final forms of the intermediate data have not been determined; moreover, general models are usually modified to provide a sensitivity to the particular item under consideration. Exercise of the model, Table VIII, is thus based upon present forms of the data and, as such, must be considered only a provisional indication of the manner in which the .38 caliber weapon system effectiveness as a less lethal weapon might be obtained. Complete exercise of the model will entail quantifying the contribution of the effect of display of the weapon, the effect of threat to use the weapon, and the effect of use of actual weapon--among other factors. If these effects are independent, a summation of effects yields a measure of weapon effectiveness in terms of a response.

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*All entries in Tables VI, VII and VIII are averages of the individual estimates by the Methods Group voting members and have been rounded to the nearest five percent.

TABLE VI

PROBABILITY ESTIMATES OF NONPHYSIOLOGICALLY DESIRABLE EFFECTS - SUSPECT FLEEING ON FOOT, CIVIL SCENARIO III

Level of Force	P_{DE}
Physical presence of officer	NA
Threat of weapon use	0.25
Weapon use*	
Not hit	0.35**
Hit (nonincapacitating wound)	0.50**

*Might not be a warning shot.
**Includes those subjected to threat.

TABLE VII

PROBABILITY ESTIMATES OF NONPHYSIOLOGICALLY DESIRABLE EFFECTS - CROWD DISPERSAL, CIVIL SCENARIO IV

Level of Force	P_{DE}
Physical presence of officer	0.10
Threat of weapon use	0.25
Weapon use	
Fire over crowd	0.90
Fire into crowd	1.00

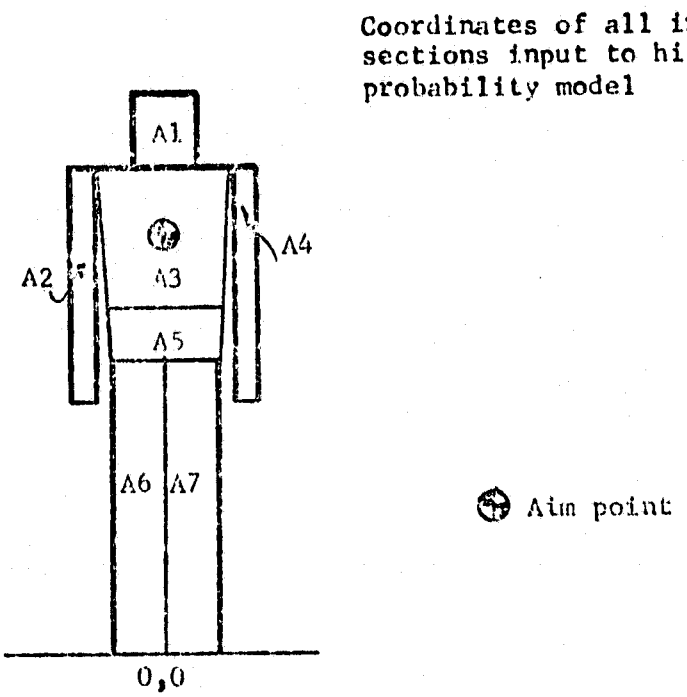

FIGURE 2. Target Description for Hit Probability Model

TABLE VIII

EXAMPLE COLLATION OF INPUT DATA FOR MODEL EXERCISE

Target Area	Damage Level	P_{H}*	$P_{DE/H}$
A_1	Grade 1	.000	1.00 (Table IV)
A_2	Grade 1	.005	0.25 (Table V)
A_3	Grade 5	.336	1.00 (Table IV)
A_4	Grade 2	.006	1.00 (Table V)
A_5	Noncritical	.000	0.30 (Table VI)
A_6	Grade 3	.000	0.50 (Table V)
A_7	Grade 4	.000	1.00 (Table V)

*Exercise of hit probability model is from Appendix G of Volume I.

III. OBSERVATIONS

In the course of the analysis of the .38 caliber weapon system as a baseline for evaluating less lethal weapons, the following observations have been made:

A. The more frequently encountered situations in which the police revolver might be used require that incapacitation of the target be complete and occur within a few seconds, particularly at short ranges.

B. A brief summary of data on hospitalized persons who have been wounded by bullets fired from a .38 caliber revolver reveals that quite a few of these persons had been shot several times during the incident. This could indicate that the shooter did not believe the target to be incapacitated to the proper degree in the required time period. On the other hand, this may be an invalid conclusion drawn from the small sample investigated. Additional investigation of this question could produce a more quantitative answer.

C. At least three major police departments which were contacted have on their own initiative reviewed the effectiveness of their police weapon system (.38 caliber) and judged it to be adequate. Of significance, however, is the fact that these departments have had pressure from individual police members to "increase the effectiveness" of their weapons by going to a more powerful weapon system, such as the .357 magnum, the 9mm, or the .45 caliber. In some instances individual police members have attempted to increase their revolver effectiveness by utilizing unauthorized ammunition.

D. As part of the work on Task I under LEAA/LWL Interagency Agreement No. LEAA-J-IAA-014-2, some experiments have been run using the standard 158-grain, round-nose, .38 caliber bullet against laboratory animals. These tests, although very limited, show that the bullet (at 750 fps) generally gives complete penetration with little or no tumbling. In fact, exit wounds were so small that some went undiscovered until necropsies were performed. According to the scenarios and other statistics, the ranges of interest are short;

therefore, complete penetration of a target has no value and may in fact increase the hazard to other nearby persons. Although penetration of a vital organ, such as the liver or kidney, is indeed damaging (or fatal), hits on these organs and/or less critical areas may not produce the desired incapacitation in sufficient time to avoid lethal return-fire on the officer; and although it would appear that a quick incapacitation might be achieved by increasing the force or decreasing the time of action (increased bullet velocity), it may actually be more beneficial to decrease velocity and stability of the bullet which may, in turn, shorten the onset time of incapacitation. Based on some analysis of hand-gun firing, one might also conclude that the probability of hitting the target could be increased by lowering the recoil shock. Although all of this is somewhat speculative, a limited number of tests could certainly help to clarify many of these questions.

The above observations are based on limited data analysis. A more comprehensive program for determining the physiological effects of the .38 caliber bullet is recommended since very little specific investigation has been done along these lines. The basic questions of effectiveness could also be investigated in the field.

IV. APPENDICES

APPENDIX A

.38 CALIBER WEAPON HISTORY AND AMMUNITION CHARACTERISTICS

The caliber .38 cartridge was first introduced in 1876 in caliber .38 Short Colt and in caliber .38 Long Colt using lead bullets of 130 grains and 150 grains, respectively, and loaded with black powder. The caliber .38 Long Colt was adopted by the US Army in the 1880's. Little, if any, change was made in this cartridge until after the Phillippine Campaign of 1899 against Moro Tribesmen, when the cartridge failed to provide sufficient stopping power to "put down" the enemy. The outcome of this problem was that Daniel B. Wesson began work on improving the cartridge. His aim was to induce the Army to make a change, preferably to a Smith & Wesson product. Although the Army had been using Smith & Wesson revolvers since 1899, they had all been chambered for the caliber .38 Long Colt. Wesson's efforts resulted in the design of the caliber .38 Smith & Wesson Special Cartridge.

At first, this round still utilized black powder loads but the amount was increased by three grains to give a slightly higher velocity. The weight of the bullet was increased by eight grains to what is now the standard 158-grain bullet. The shape of the bullet also underwent a change, that change being a flattening of the base of the bullet. This in turn enabled the relationship between the bullet diameter and groove diameter of the revolver barrel to be held to much closer tolerance limits, eliminating the necessity for expansion by the bullet skirt upon firing, and thus allowing for greater accuracy. However, despite the vast superiority of this round over the Long Colt, the Army declined to consider it, since they had already reached the decision that any future change in handguns would be to a caliber .45 firearm.

In 1902 the Smith & Wesson Military and Police Revolver, Model 1902, was introduced to the general public, and at the same time the caliber .38 Smith & Wesson Special was made available to them. Through the intervening years this cartridge has become the standard round for nearly every civilian law enforcement agency in the country. In very recent years, a slight change in name took place in the form of shortening it from caliber .38 Smith & Wesson

Special to just caliber .38 Special. The ammunition is produced by the vast majority of the world's manufacturing companies.

During the last few decades a number of changes to this cartridge have been introduced. These changes have been in such areas as bullet styles and weights, some examples of the various styles being jacketed hollow point, jacketed soft point, blunt nose, metal piercing, etc. and the weights ranging from 95 grains to 200 grains. There have also been changes in muzzle velocity and muzzle energy thereby causing changes in range, accuracy, penetration, wound-producing capabilities, flatness of trajectory, muzzle blast, recoil, etc. Muzzle velocities now range from approximately 730 feet per second to approximately 1,542 feet per second, depending on the weight and configuration of the bullet, as well as the weight of the powder charge. Muzzle energies range from approximately 195 foot pounds to 580 foot pounds.

Table A lists various commercial manufacturers of this cartridge and available information concerning it.

TABLE A

CALIBER .38 SPECIAL

Manufacturer	Bullet Weight (grains)	Bullet Style	Velocity - Feet Per Second Muzzle	Velocity - Feet Per Second 50 Yards	Velocity - Feet Per Second 100 Yards	Energy - Foot Pounds Muzzle	Energy - Foot Pounds 50 Yards	Energy - Foot Pounds 100 Yards
Remington-Peters	95*	Semi-Jacketed, Hollow Point	985	920	865	205	189	160
	158	Targetmaster, Lead	855	820	790	255	235	220
	200	Targetmaster, Lead/Metal Point**	730	695	665	235	215	195
	148	Targetmaster, Lead Wadcutter	770	655	560	195	140	105
	158	Lead (Hi-Speed)	1090	1030	980	415	370	335
	158	Semi-Jacketed, Hollow Point	960	920	880	325	295	270
	125	Semi-Jacketed, Hollow Point	1160	1055	985	375	310	270
	158	Semi-Wadcutter	855	810	765	255	230	205

*Only for use in revolvers with 2"-3" barrels
**Different bullet types, same ballistics

TABLE A (CONT)

Manufacturer	Bullet Weight (grains)	Bullet Style	Velocity - Feet Per Second Muzzle	Velocity - Feet Per Second 50 Yards	Velocity - Feet Per Second 100 Yards	Energy - Foot Pounds Muzzle	Energy - Foot Pounds 50 Yards	Energy - Foot Pounds 100 Yards
Smith & Wesson	110	Jacketed, Hollow Point	1390	1192	1055	472	347	272
	125	Jacketed, Hollow Point	1380	1200	1071	528	400	318
	148	Lead, Wadcutter	800	726	662	210	173	144
	158	Lead, Round Nose	910	865	825	289	262	239
	158	Jacketed, Hollow Point	1145	1053	986	460	389	341
	158	Jacketed, Soft Point	1145	1053	986	460	389	341
Super Vel	110	Jacketed, Hollow Point	1370	1240		458	375	
	110	Jacketed, Soft Point	1370	1245		458	380	
	158	Semi-Wadcutter, Lead	855	755		256	199	
	158	Semi-Wadcutter, KOP-PERKOTE	1100	995		423	346	
	148	Hollow Base Wadcutter	775	680		196	149	

TABLE A (CONT)

Manufacturer	Bullet Weight (grains)	Bullet Style	Velocity - Feet Per Second Muzzle	50 Yards	100 Yards	Energy - Foot Pounds Muzzle	50 Yards	100 Yards
Winchester-Western	158	Lubaloy*, Lead	855			255		
	158	Metal Point	855			255		
	158	Lead, Hollow Point (Police)	1060			395		
	200	Lubaloy, Lead (Super Police)	730			235		
	158	Semi-Wadcutter (Super Speed)	1060			395		
	150	Lubaloy	1060			375		
	150	Metal Piercing	1060			375		
	148	Lead, Super Match Wadcutter	770			195		
	158	Lead, Super Match	855			255		
Federal	148	Lead, Wadcutter	770			195		
	158	Lead (Service)	855			256		
	158	Lead (High Velocity)	1080			415		

*Lubaloy is a copper-like coating

TABLE A (CONT)

Manufacturer	Bullet Weight (grains)	Bullet Style	Velocity - Feet Per Second Muzzle	50 Yards	100 Yards	Energy - Foot Pounds Muzzle	50 Yards	100 Yards
Amron	148	Match	770			195		
	158	Lead, Round Nose	855			255		
	125	Semi-Jacketed, Soft Point	1150			366		
	158	Semi-Jacketed, Soft Point	1150			465		
	200	Lead, Round Nose	730			235		
Norma	110	Jacketed, Hollow Point	1542			580		
	148	Lead, Wadcutter	800			210		
	158	Jacketed, Hollow Point	900			285		
	158	Fully Jacketed, Semi-Wadcutter	900			285		
	158	Lead, Round Nose	870			266		

APPENDIX B

SAMPLE SURVEY* OF REVOLVERS AND AMMUNITION USED BY LAW ENFORCEMENT AGENCIES

Police Department	On-Duty Handgun (Cal & Make)	On-Duty Ammunition (Cal & Desc)	Remarks on Training
Atlanta	.38 Special Colt or Smith & Wesson, 4" barrel	.38 Special	Practical pistol course
Baltimore City	.38 Special Smith & Wesson, 4" barrel	.38 Special, 158-gr lead, round nose	
Chicago	.38 Special	.38 Special, 158-gr lead, round nose	Part bull's-eye type target, part combat silhouette
Cleveland	.38 Special	.38 Special	Practical pistol course (combat silhouette)
Dallas	.38 Special Colt or Smith & Wesson, 4" barrel	.38 Special	Part bull's-eye type target, part combat silhouette
Miami	.38 Special Smith & Wesson M&P, Model 10, 4"-5" barrel	.38 Special, 110-gr jacketed soft point (Super Vel)	Combat silhouette only
New Orleans	.38 Special	.38 Special, 125-gr semi-jacketed soft point	
New York City	.38 Special	.38 Special, 158-gr lead, semi-wadcutter (Remington)	

*1972-1973

APPENDIX B (CONT)

Police Department	On-Duty Handgun (Cal & Make)	On-Duty Ammunition (Cal & Desc)	Remarks on Training
Philadelphia	.38 Special	.38 Special, 158-gr lead, semi-wadcutter (Remington)	
Phoenix	.38 Special Colt or Smith & Wesson, 4" barrel	.38 Special, 110-gr jacketed hollow point	Part bull's-eye type target, part combat silhouette
Salt Lake City	.38 Special Colt or Smith & Wesson, 4" barrel	.38 Special	NRA police combat course
St. Louis	.38 Special Colt or Smith & Wesson, 4" barrel (minimum length)	.38 Special, 158-gr lead, hollow point (Winchester-Western)	Combat silhouette
San Antonio	.38 Special Smith & Wesson M&P, Model 10, 4" barrel	.38 Special, 200-gr lead, round nose	Part bull's-eye type target, part combat silhouette
Seattle	.38 Special	.38 Special, 158-gr lead, round nose	
Wichita	.38 Special Smith & Wesson, Model 10, 4" heavy barrel	.38 Special, 158-gr semi-jacketed hollow point	Combat silhouette
Washington, DC	.38 Special Colt, 4" barrel	.38 Special, 158-gr lead, round nose	

APPENDIX B (CONT)

Police Department	On-Duty Handgun (Cal & Make)	On-Duty Ammunition (Cal & Desc)	Remarks on Training
Illinois State Police	9mm Smith & Wesson, Model 39	9mm Luger, 100-gr, soft point (Winchester-Western)	
Maryland State Police	.38 Special Colt or Smith & Wesson, 6" barrel	.38 Special, 158-gr, lead, round nose	Part bull's-eye type target, part combat silhouette
Texas Rangers	.357 Magnum and .45 Gov't model Colt, .38 Special	.357 Magnum, .45 ACP, and .38 Special	
FBI	.38 Special Smith & Wesson, 4" barrel	.38 Special, 158-gr lead, roundnose	Practical pistol course (combat silhouette)
US Secret Service	.38/.357 bore Smith & Wesson, Models 19 & 66, 2-1/2" barrel	.38 Special, 110-gr, hollow point (Super Vel)	Practical pistol course

APPENDIX C

STATISTICAL ANALYSIS OF MAN-WEAPON TEST DATA RELATING TO BASIC AND TIME-STRESS TESTS OF THE .38 CALIBER SPECIAL

Tests were conducted by the US Army Land Warfare Laboratory (LWL) to establish an accuracy and effectiveness data base for: (1) .38 caliber ammunition, (2) .38 caliber weapon systems, and (3) .38 caliber weapon system/user combinations. Shooters from the Harford County (Maryland) Sheriff's Department and the Baltimore (City) Police Department participated in these test firings. The "raw data" for these tests are presented in LWL Technical Note No. 73-01.

This analysis of the man-weapon test data was made by personnel of the Research Analysis Office, LWL. The results of this analysis are condensed into Tables C-I through C-V. Tables C-I through C-IV list the individual performances with regard to time spent firing and accuracy achieved, while Table C-V summarizes the same information to obtain each team's performance and their combined performance. The labels used to identify the participants are the same as those used in LWL Technical Note No. 73-01, i.e., Shooter A in the tables here is the same individual as the one labeled Shooter A in LWL Technical Note No. 73-01. Shooters A-E were from county police, and Shooters F-J from the city police. It is assumed that the shooters are above-average marksmen, and a greatly expanded test program would be required to determine accuracy data for the "average" law enforcement officer.

From an examination of the results presented in the five tables, the following observations are noted:

1. The dominant source of error differences within police groups is the variability between different individual firers.

2. In general, mil error decreases as range increases.

3. Within range groups, there is some indication that mil error decreases with increasing time-of-fire. This is somewhat noticeable at the 1, 7 and 25-

yard ranges for the city police and at the 1 and 25-yard ranges for the county police. However, it is not apparent at the 50-yard range for either team, nor is it readily apparent at the 7-yard range for the county police.

4. The large time variations and the large inaccuracies at the shorter ranges may well be attributed to the lack of a challenge presented by the short ranges.

5. First-round accuracy appears to be about the same as that of subsequent rounds.

6. The rate-of-fire of the county police was generally slower than that of the city police.

TABLE C-I

INDIVIDUAL PERFORMANCES

Range = 1 Yard

Shooter	Rounds	Average Time Per Round, sec	Error, mils
A	All	1.223	27.039
B	All	1.430	14.287
C	All	0.820	15.494
D	All	0.743	17.786
E	All	0.847	14.780
A	First	1.567	10.102
B	First	1.967	18.742
C	First	1.417	12.362
D	First	1.042	21.848
E	First	1.083	16.558
F	All	0.803	25.323
G	All	0.700	21.377
H	All	0.550	29.545
I	All	0.397	46.664
J	All	0.320	48.707
F	First	1.200	26.753
G	First	1.050	16.677
H	First	0.700	40.408
I	First	0.550	42.541
J	First	0.500	62.529

TABLE C-II

INDIVIDUAL PERFORMANCES

Range = 7 Yards

Shooter	Rounds	Average Time Per Round, sec	Error, mils
A	All	1.560	11.999
B	All	1.503	10.337
C	All	0.833	9.797
D	All	0.793	16.854
E	All	1.127	9.709
A	First	1.833	11.742
B	First	2.250	6.454
C	First	1.667	10.298
D	First	1.083	15.718
E	First	1.375	13.428
F	All	1.457	4.997
G	All	0.807	7.509
H	All	1.517	4.166
I	All	0.453	12.266
J	All	0.417	24.023
F	First	1.933	5.806
G	First	0.717	4.236
H	First	2.383	5.863
I	First	0.450	13.108
J	First	0.733	33.839

TABLE C-III

INDIVIDUAL PERFORMANCES

Range = 25 Yards

Shooter	Rounds	Average Time Per Round, sec	Error, mils
A	All	1.750	10.067
B	All	2.550	6.417
C	All	2.253	5.573
D	All	2.127	6.703
E	All	2.330	4.395
A	First	2.208	13.304
B	First	2.958	7.841
C	First	3.708	2.427
D	First	2.333	10.325
E	First	2.000	4.220
F	All	1.440	4.777
G	All	1.183	2.905
H	All	2.133	2.349
I	All	1.213	4.871
J	All	1.463	2.812
F	First	2.283	6.171
G	First	0.567	3.289
H	First	4.017	2.432
I	First	1.017	5.018
J	First	1.517	2.321

35,6

TABLE C-IV

INDIVIDUAL PERFORMANCES

Range = 50 Yards

Shooter	Rounds	Average Time Per Round, sec	Error, mils
A	All	2.580	5.839
B	All	2.483	4.046
C	All	3.837	3.020
D	All	2.243	3.580
E	All	2.720	3.430
A	First	3.333	2.312
B	First	3.417	6.943
C	First	5.708	2.810
D	First	2.583	3.522
E	First	2.417	3.493
F	All	2.947	3.726
G	All	2.557	5.884
H	All	3.033	1.763
I	All	1.830	3.662
J	All	2.377	1.906
F	First	2.650	4.369
G	First	1.750	3.095
H	First	3.233	1.219
I	First	0.775	2.768
J	First	0.750	2.609

TABLE C-V

SUMMARY OF TEAM AND OVERALL PERFORMANCES

Shooters	Range, Yds	Rounds	Average Time Per Round, sec	Error, mils
A-E	1	All	1.013	19.023
A-E	1	First	1.415	16.847
F-J	1	All	0.553	41.618
F-J	1	First	0.800	49.275
A-J	1	All	0.804	33.573
A-J	1	First	1.108	43.730
A-E	7	All	1.163	13.593
A-E	7	First	1.642	9.767
F-J	7	All	0.930	20.073
F-J	7	First	1.243	17.642
A-J	7	All	1.047	20.470
A-J	7	First	1.443	21.723
A-E	25	All	2.203	7.143
A-E	25	First	2.642	9.133
F-J	25	All	1.487	4.572
F-J	25	First	1.880	5.092
A-J	25	All	1.845	6.252
A-J	25	First	2.261	10.351
A-E	50	All	2.773	4.385
A-E	50	First	3.492	4.394
F-J	50	All	2.550	4.272
F-J	50	First	1.907	3.743
A-J	50	All	2.661	4.401
A-J	50	First	2.727	4.743

7. The county police were more accurate at the 1 and 7-yard ranges, but the city police were more accurate at the 25 and 50-yard ranges.

APPENDIX D

ACCURACY DATA FOR THE .22, .38 AND .45 CALIBER WEAPONS

Tests Conducted By	Rate of Fire	Firers	Range (Yds)	Cal	Average Aiming Error (mils) σ_x	Average Aiming Error (mils) σ_y	Overall Aiming Error (mils) σ_t
Human Engineering Lab (HEL), APG, MD	Slow	Average (Military)	25	.45	8.7	8.0	8.4
			25	.38	5.7	5.0	5.4
			25	.22	4.6	4.3	4.5
	Slow	Proficient (Civilian)	25	.45	3.5	3.7	3.6
			25	.22	2.5	2.2	2.4
Land Warfare Lab (LWL), APG, MD	Time Stress	Small County Sheriff's Office	7	.38	10.9	12.3	11.6
			25	.38	7.6	7.1	7.3
			50	.38	3.7	3.3	3.5
	Time Stress	Metropolitan Police Dept	7	.38	22.9	16.1	19.8
			25	.38	4.8	4.3	4.6
			50	.38	3.7	3.3	3.5
	Slow	State Police*	7**	.38	1.4	1.4	1.4
			25**	.38	2.7	2.9	2.8
			50**	.38	2.7	1.6	2.2
			7***	.38	1.7	1.3	1.5
			25***	.38	3.4	3.9	3.7
			50***	.38	1.0	2.4	1.9
	Time Stress	Government Agency****	7	.38	9.0	23.0	17.5
			25	.38	4.7	7.8	6.4
			50	.38	2.9	3.6	3.3

*Sample size of 1
**Single action
***Double action
****Practical pistol course

APPENDIX D (CONT)

Tests Conducted By	Rate of Fire	Firers	Range (Yds)	Cal	Average Aiming Error (mils) σ_x	Average Aiming Error (mils) σ_y	Overall Aiming Error (mils) σ_t
Rock Island Arsenal (RIA), Rock Island, IL	Slow	Machine Rest	50	.38	1.3	1.0	1.2
			50	.38	1.1	1.4	1.3
			50	.38	1.1	1.7	1.5
			50	.38	1.0	1.0	1.0

APPENDIX E

STATISTICAL ANALYSIS AND SUMMARY OF .38 CALIBER SHOOTING INCIDENTS IN THE BALTIMORE AREA

In an effort to obtain a gross estimate of the effectiveness of the caliber .38 weapon system in relation to human beings, the Research Analysis Office (RAO) reviewed current (1971-1972) records from certain hospitals in Baltimore City and from the Office of the Chief Medical Examiner of the State of Maryland. These records (the reduced raw data is presented in Tables E-I and E-II) represent a total of 56 cases of reported caliber .38 shootings which occurred within the city limits of Baltimore*. Each group of records that were reviewed, i.e., the hospital records and the Medical Examiner's records, covered a time-interval of nine months.

Before beginning any analysis of the data, however, it is desirable to state briefly the rationale used in limiting the number of cases utilized in the study to 56, as noted above. Since this was an initial effort and was intended mainly to serve as groundwork for a more comprehensive effort in the future, the amount of time expended to obtain the present information was of particular importance. While the information on fatalities could be obtained from one location, viz., the Medical Examiner's Office, this was not the situation for the nonfatalities or hospital cases. The information for these latter cases had to be obtained in a "roundabout" fashion, i.e., first the police records were reviewed to obtain a listing of the caliber .38 shootings, then the hospitals were contacted to elicit their cooperation in extracting the records of interest from the respective files, and finally it was necessary to visit each hospital to review the records. (It should be mentioned here that extensive notes were taken for the various cases reviewed; however, mechanical reproduction of the records was not permitted by any of the hospitals.) Since each phase of the data collection required a considerable amount of time, it was necessary at the outset (after reviewing the police records) to assign arbitrary criteria, such as the time interval (nine months) during which the shootings took place and the geographic boundaries of the shootings (the city limits of Baltimore). The 56 cases

used in this study were the only ones that met the established criteria. Because of the limited sample size any statistics presented in this analysis should be viewed in their proper perspective, as representing possible trends rather than "hard numbers."

An initial point of interest in analyzing the data is the fact that of the 56 reported caliber .38 shootings, 57% of the victims survived. This appears to indicate a lack of lethality on the part of the caliber .38 weapon system.

Several factors, however, should be investigated before making a final judgment on the caliber .38's effectiveness. One point that should be considered is the body area/organ receiving the wound. In the case of head-

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*It should be noted that since only those cases in which one individual shot another were of interest, all cases involving suicide were excluded.

TABLE E-I

CALIBER .38 WOUND DATA (BASED ON MEDICAL EXAMINER RECORDS)

Age Groups			Sex		Race		"T"*		Wound Locations															No. of Times Shot	
0-30	31-60	61-90	M	F	C	N	Hr	Min	HEAD	Neck	Mouth	Eyes	Skull	TRUNK	Abdomen	Lungs	Heart	Liver	Kidney	Spleen	Intestines	Stomach	EXTREMITIES	Legs	Arms	1	>1
X			X			X	1	00	X[1]	X	X															X	
	X		X			X		15						X		X										X	
X			X			X		13	X[2]	X				X		X	X										X
X				X		X		45	X[3]				X													X	
	X		X			X	1	22	X[4]	X																X	
	X		X			X		21						X		X	X									X	
	X		X			X	--	---	X[3]				X													X	
	X			X		X		08	X[3]		X		X													X	
X			X			X		15						X		X	X	X									X
	X		X			X		20	X[3]				X													X	
X			X			X		50	X[3]				X	X[5]									X		X		X
	X		X			X	1	00						X	X				X				X	X			X
X			X			X	--	---						X	X			X	X							X	
	X		X			X		20						X		X	X									X	
X			X			X		05	X[3,6]			X	X													X	
X				X		X		30	X[3]				X										X	X			X
	X		X			X		16						X			X	X				X				X	
	X		X			X		15	X[7]	X																X	
X			X			X		40						X	X	X										X	
X			X		X		--	---	X[3]				X	X		X	X										X
X			X		X		10	43						X		X	X									X	
	X		X			X		22						X[8]		X											X
X			X			X		10	X[7]	X													X	X			X
	X		X			X		15	X[7]					X		X	X						X	X	X		X
12	12	0	21	3	2	22	←TOTALS→		14	5	2	1	8	14	3	10	8	3	2	0	0	1	5	4	2	15	9

*time interval from when shooting occurred until victim was pronounced dead

[1]bullet lacerated hypopharnyx
[2]bullet lacerated esophagus
[3]bullet penetrated brain
[4]bullet lacerated jugular vein
[5]grazed right upper part of back
[6]perforated right orbital plate of skull - eyeball not perforated
[7]superficial scalp wound
[8]bullet wound in right shoulder

TABLE E-II

CALIBER .38 WOUND DATA (BASED ON HOSPITAL RECORDS)

Age Groups (yrs)			Sex		Race		Δt*		"H"**	Wound Locations																			
0-30	31-60	61-90	M	F	C	N	Hr	Min	Days	HEAD	Neck	Mouth	Eyes	Skull	TRUNK	Abdomen	Lungs	Heart	Liver	Kidney	Spleen	Intestines	Stomach	EXTREMITIES	Legs	Arms	No. of Times Shot	
																											1	>1
X			X			X	--	---	--															X		X	X	
X			X			X	1	30	3															X		X		X
X			X			X	1	05	2	X		X															X	
X			X			X	--	---	7						X	X						X		X	X	X		X
X			X			X	--	---	25	X[1]		X			X	X			X					X	X			X
X			X			X		15	9						X[2]												X	
		X	X			X	1	40	10	X	X				X[3]									X		X		X
X			X			X	2	50	7															X	X		X	
X			X			X		10	<1															X	X		X	
X				X		X		25	12						X	X							X	X		X	X	
X			X		X		1	12	3						X[4]													X
X			X			X	--	---	--															X	X		X	
X				X		X	--	---	--						X[5]	X			X	X								X
X			X			X		29	<1						X[6]												X	
X			X			X		03	14						X[7]	X				X							X	
		X	X			X		35	8	X[8]				X										X		X		X
X			X			X	2	04	6															X	X		X	
X			X			X	1	30	12						X[9]	X			X		X		X				X	
X				X		X	2	55	24															X	X		X	
X			X			X	2	18	9						X[10]												X	
	X		X			X		09	16															X		X	X	
	X		X			X		21	26						X[11]	X			X									X
X			X		X			25	9						X[12]	X											X	
X			X		X			45	14	X	X				X[13]					X				X	X			X
		X	X		X		3	07	<1															X	X		X	
	X		X			X		20	10						X[14]												X	
	X		X			X		15	<1															X	X	X		X
X			X			X	1	40	<1															X	X	X		X
X			X			X	1	00	<1															X		X	X	
X				X		X		35	8						X[15]	X								X	X			X
X				X		X		33	12	X[16]	X	X		X	X[17]					X				X		X		X
	X		X			X	--	---	7						X					X							X	
24	5	3	27	5	4	28	←TOTALS→			6	3	3	0	2	18	9	0	0	4	5	1	2	1	20	12	11	19	13

*time interval from when shooting occurred until victim received treatment
**length of time shooting victim was hospitalized

[1]wound located at mid-forehead at hairline (a grazing-type wound)
[2]two ribs fractured
[3]wound located in soft tissue of left shoulder
[4]chest area wound - bullets did not enter chest cavity (soft tissue trauma)
[5]two ribs fractured; also, large contusion on lung
[6]wound located in left axilla area - no bone damage
[7]bullet transected left gastric artery, lacerated splenic vein and injured adrenal gland - large amount of bleeding
[8]bullet passed from left to right occipital area (lodged extracranially) - no evidence of neurological complications
[9]diaphragm lacerated
[10]wound located in chest area - some accumulation of blood and air in the pleural cavity
[11]wound located in diaphragm; also large amount of bleeding from gastrohepatic omentum and retroperitoneal areas
[12]no penetration of peritoneal cavity; however, a large hematoma in right retroperitoneal area
[13]perforation of splenic flexure of colon, fracture of a portion of the right clavicle, lacerations of right innominate artery, subclavian vein and right subclavian artery
[14]chest wound - pulmonary hematoma; no evidence of pneumothorax
[15]wound in left shoulder and perforation of proximal jejunum
[16]skull area - bullet located extracranially
[17]trunk wounds - hole in left hemidiaphragm, perforation of colon, and wound in left shoulder

woundings, for example, 30% of the victims survived, but in none of the survival cases were any critical veins (such as the jugular vein) lacerated nor was the skull/brain penetrated. On the other hand, in those cases where people died from head wounds, damage to the aforementioned areas appears to have played a prominent part in the cause of death. Other examples of the importance of considering the body area/organs wounded can be shown by the fact that in all those cases reviewed where the individual was shot in the heart, death occurred, while in none of the cases where the person was shot in the extremities only, did death occur.

Another factor that should be considered when examining the data is the influence (or lack of it) of multiple woundings on whether the individual survives. Upon reviewing the data, however, there appears to be no simple correlation between the number of times the individual was shot in the various body areas/organ combinations and whether he lived or died.

A third factor for consideration is the time interval from when the shooting occurred until the individual was given medical treatment or was pronounced dead. While there appears on the surface to be no direct correlation between this time interval and the ultimate well-being of the individual, this may be due in part to an absence of information concerning any medical treatment that might have been given to the nonsurvivors.

A final factor for consideration in evaluating the effectiveness of the caliber .38 weapon system is the scenario-type situations under which the aforementioned shootings occurred. The influence of these situations can be viewed from two aspects: first, the overall relationship between the scenario-type situations and the well-being of the individual(s) involved; secondly, the ability to predict the chance of a fatality by knowing the frequency with which a given scenario-type situation occurs. In regard to the first aspect, Figure E-1 depicts the well-being of the individual as a function of the scenario-type situation, while Figure E-2 shows the frequency with which the various scenario-type situations occurred*. Additionally, using the data illustrated in Figure E-1, it is possible to predict the probability of a

fatality as a function of the scenario-type situation, as is presented in Table E-III. When attempting to consider the second aspect, however, i.e., the ability to predict the chance of a fatality (shown in Table E-III) as a function of the frequency with which a given scenario-type situation occurs (as in Figure E-2), it becomes apparent that the small number of cases used in this study precludes establishing whether any correlation exists between the two variables--probability of fatality and frequency of scenario occurrence.

An important conclusion drawn from this initial investigation of the effectiveness of the caliber .38 weapon system in relation to human beings is that a great deal more work needs to be done in this area in order to obtain a large statistical base. A major effort will be required to review hospital and medical examiner records for several other large cities and analyze the

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*The scenario statistics represent 50 of the 56 cases reviewed--scenario data was not available for the remaining six cases.

TABLE E-III

PROBABILITY OF FATALITY AS A FUNCTION OF SCENARIO TYPE

Scenario Type	Probability of A Fatality	Ratio of Fatalities to Nonfatalities
Participation in robbery	.78	3.5:1
Shot by unknown assailant	.69	2.2:1
Altercation	.40	0.7:1
Victim of robbery	0	-
Accidental shooting	0	-

FIGURE E-1

FATALITIES VS NONFATALITIES AS A FUNCTION OF SCENARIO

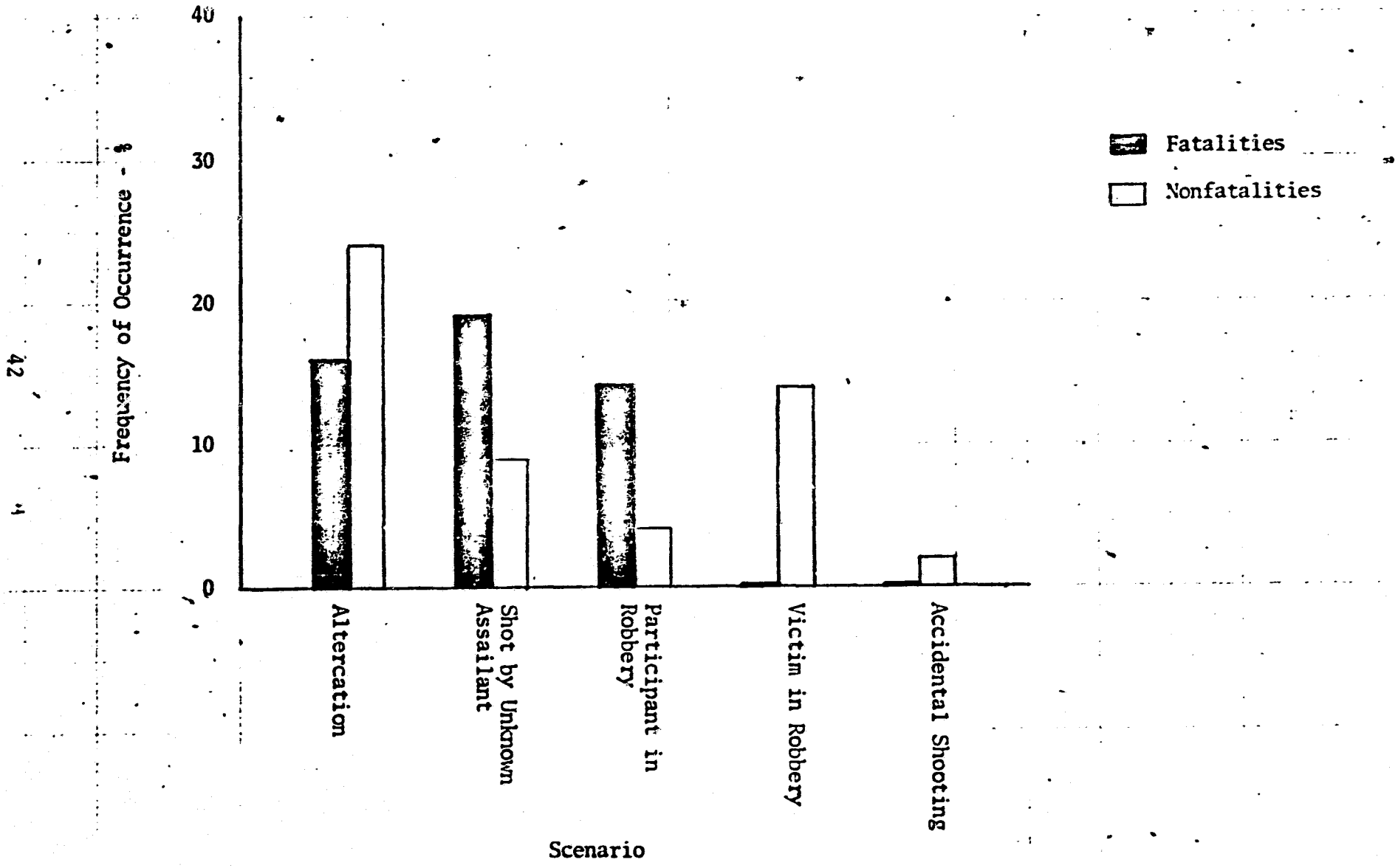
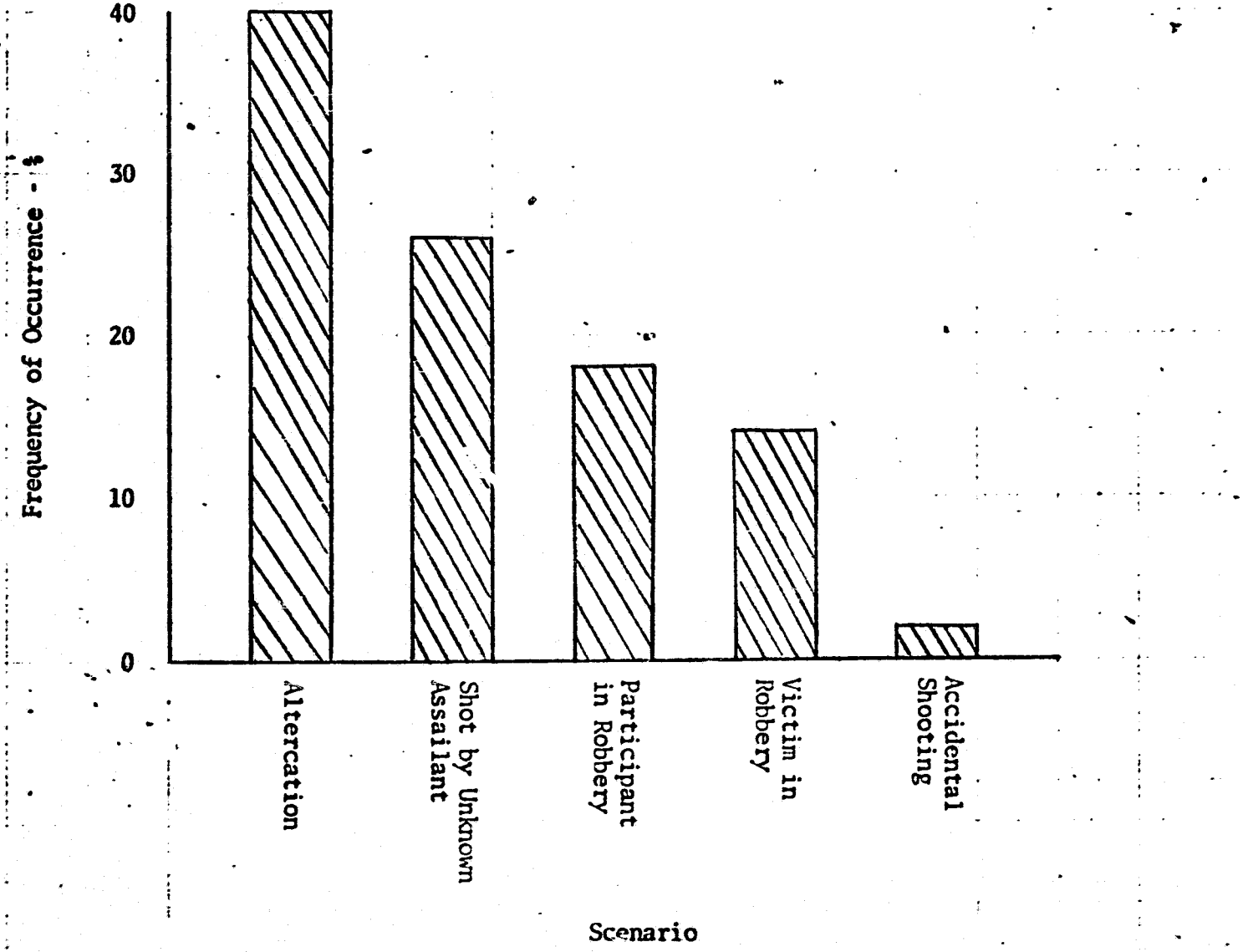


FIGURE E-2

DISTRIBUTION OF CALIBER .38 SHOOTINGS AS A FUNCTION OF SCENARIO



data using procedures similar to those used in this study. This larger statistical base is necessary before final judgment can be exercised on the effectiveness of the caliber .38 weapon system.

APPENDIX F

MINUTES OF MEDICAL GROUP MEETING, 15 DECEMBER 1972

The purpose of this meeting was to generate desirable and undesirable effects percentage estimates for one or more of the civil scenarios....based on physiological effects from .38 caliber bullet impacts.

In order to establish sufficient background for these estimates an agenda as below was followed:

1. Reviewed results of .38 caliber revolver laboratory tests.

2. Discussed applicability of existing blunt-trauma damage criteria and grades to .38 caliber bullet impacts and merits on modified, extended or entirely new damage standards. The present Grade 5 is applicable only to massive destruction of a critical organ, bone fragmentation and skin lacerations.

3. Assigned damage levels for the 18 test shots using the previously established grade levels.

4. Discussed police and hospital records pertaining to .38 caliber wounds.

5. Reviewed civil scenarios.

6. Rendered desirable and undesirable effects estimates for one or more civil scenarios....based on physiological damage effects.

7. Briefly discussed possibility of nonphysiological effects.

High-speed, edited, negative film of the .38 caliber laboratory animal test series conducted at the Hazelton Laboratories was viewed. Several of the prominent comments noted during the showing, aside from those pertaining to plate identification errors, were:

- o Film speed should be noted on film.
- o Too much repetition.
- o Micronex movie would show organ displacement.

With regard to the first comment above, it was pointed out that the energy absorbed could be determined from differences detected on single-frame viewing the entrance and exit velocities. The second comment stands as stated. The movies required by the third comment, although expensive, would also quantify the temporary cavity formed by the impacts. (Probably better applied to the blunt, nonpenetrating impact mechanism).

A damage level of 5 was assigned to all of the 18 test shots. Under the existing damage criteria a perforation of the skin is an automatic 5, while

the 5 category for other vital organs and body areas results from massive destruction of the organ or bone fragmentation. The initial damage levels were established with blunt, nonpenetrating damage mechanisms in mind. It was noted that damage level 5 can be used to define penetrating wounds, such as those inflicted by the .38 caliber bullet, if we define the resulting damage as $\geq$ to the originally established definition. In each of 17 tests with the .38 caliber bullet the animal died either immediately, or within 10 minutes. The only survivor was the domestic swine which was impacted in the thigh.

In conjunction with these damage levels the applicability of the current blunt-trauma damage criteria to the .38 caliber was discussed. Discussion centered around modified and extended damage standards. The formulation of new standards was, for this meeting, de-emphasized. It was pointed out that the only apparent equivalency between the penetrating and nonpenetrating weapons was death. Death has been observed in one hundred percent of the .38 caliber critical organ tests (damage level 5), while on the average death resulted in about 75% of the superball tests against organs in which the damage level assessment was in the 4 and 5 categories.

At this juncture in the discussion the question of applicability of the .38 caliber revolver to the civil scenarios was pursued. It was pointed out quickly that this was the weapon most prevalent among personnel engaged in law enforcement activities, and that both police and hospital records verify that not all .38 caliber gunshot wounds are fatal. (For the latter, an insufficient number of hospital cases have been reviewed to establish meaningful percentages.)

An attempt was made to establish the applicability of the .38 caliber revolver to each of the civil scenarios. Each of the scenarios was reviewed by the panel members. Written descriptions and a simple sketch of each scenario were provided in reference format to focus the effort. The consensus of panel comments for each of the scenarios reviewed is given in Table F-I.

The Fleeing Suspect scenario was thought to be the most applicable, therefore, the necropsy slides were viewed and commented upon principally with this scenario in mind. Physiologically-based undesirable and desirable effects estimates rendered with supporting rationale for this scenario can be found in Table F-II. Recall that an undesirable effect is defined as that effect which persists longer than 24 hours and prevents an individual from performing routine daily tasks and/or produces permanent disability as defined by the American Medical Association (AMA) ratings. The desirable effect varies with the scenario. In the case of the fleeing suspect, the desirable effect is that physiological effect (for this meeting estimate) which will reduce the suspect's flight speed to a value which would permit a law enforcement officer to pursue, overtake and apprehend within a reasonable distance or time*. All damage levels associated with test results (critical organ and body areas) were graded 5.

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*Reasonable distance would be 20 to 100 meters; reasonable time would be 20 to 30 seconds.

TABLE F-I

COMMENTS ON APPLICABILITY OF THE .38 CALIBER WEAPON SYSTEM TO THE CIVIL SCENARIOS

Scenario	Description	Comment
I	One-on-One	This scenario was generally thought to be applicable. Scenario Variations A, B, and C each offer possibilities, but effects would depend strongly on the area impacted.
II	Barricade and Hostage	Not applicable because no line-of-sight exists to offender. The possibility of inadvertent injury to hostage from ricochet of ballistic missile exists.
III	Suspect Fleeing on Foot	All agree that this scenario is very applicable. The key, however, is that the suspect is fleeing on foot. Suspect fleeing in car is entirely different situation.
IV	Crowd Dispersal	Pertinent with reservations. Undesirable effect was thought to far overshadow any desirable effect which could be achieved. Medical Group would evaluate undesirable effect; Methods Group would evaluate desirable effect.
I, II, III, IV		Undesirable effects would be essentially the same for all scenarios.

TABLE F-II

PROBABILITY ESTIMATES FOR PHYSIOLOGICAL EFFECTS - SUSPECT FLEEING ON FOOT, CIVIL SCENARIO III

Organ or Body Area	Damage Level D_L	P_{DE}*	P_{UE}**	Remarks
Heart	5	1.00	1.00	Internal bleeding is so great that it is impractical to render surgical aid***. Also, it is immaterial as to where heart is hit or how big the wound is; a direct hit to the middle is not needed. A graze could be lethal too.
Kidney	5	1.00	1.00	Pain, blood loss, and/or shock would produce the desirable effect.
Lung	5	1.00	1.00	200cc blood loss--One animal fatal <10 min. (Some people with perforated lung have walked into hospital.)
Liver	5	1.00****	1.00	There would be pain, blood loss (≈1000cc in human would be typical) and shock. Estimate incapacitation within 20-30 seconds.
Thigh	5	1.00	1.00	Bone broken in test animal. Probably would get more damage in adult human. Young pig and young human bones tend not to fracture so much. Mechanical failure would cause suspect to run slower, or crawl.

*Probability of Desirable Effect
**Probability of Undesirable Effect
***Very few reported instances of repairable cases.
****Some reservation noted here....could be <1.00....more data needed.

It was generally agreed that for the critical organs and body areas a 100% desirable effect would be achieved. Unfortunately, this was accompanied with a 100% undesirable effect.

It was pointed out that animal organs (such as the pigs', used in our experiments) are much smaller than human organs. Consequently, human effects estimates made on the basis of damage to animal organs tend to be conservative. A direct hit on a 40-gram animal liver would have more of an effect than a comparable hit on a 100-gram human liver.

Regarding the extremities, and utilizing a classification of incapacitation according to a functional disability grouping, the panel members rendered estimates for the Fleeing Suspect scenario based on their medical expertise and experiences (Table F-III).

It was noted that nerves are located very close to arteries in many cases. Discussion continued for noncritical wounds to the chest and adbominal cavities (Table F-IV).

It was noted that approximately 80-90% of the neck area is critical and that there is about an 80% chance of a severe wound to the larnyx given a hit. Caliber .38 impacts to the trachea, esophagus and spine as well as the carotid arteries would produce both 100% desirable and 100% undesirable effects.

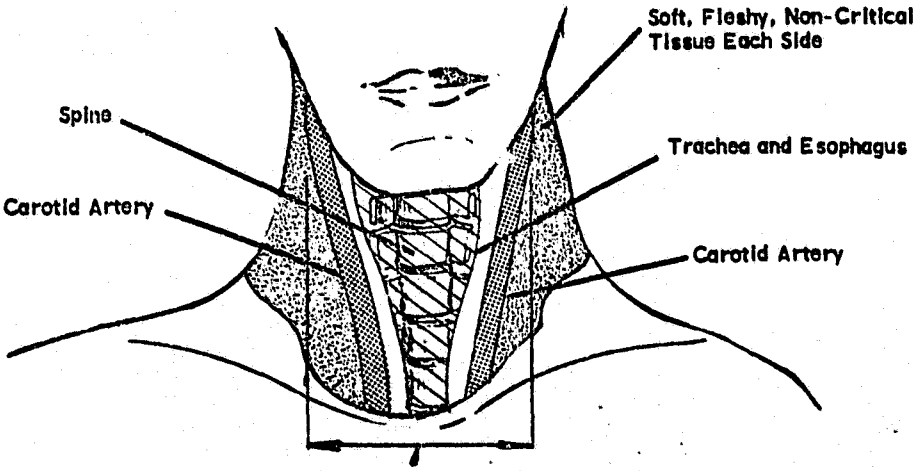


TABLE F-III

PROBABILITY ESTIMATES FOR PHYSIOLOGICAL EFFECTS FOR VARIOUS IMPACTS TO THE EXTREMITIES - SUSPECT FLEEING ON FOOT, CIVIL SCENARIO III

Description	P_{DE}*	P_{UE}**
One arm hit, no bone or nerve hit, but Grade 5 damage to the skin and/or muscle with no major nerve or blood vessel severed.	0.25	1.00
As above, except major nerve hit	1.00	1.00
As above, except major blood vessel hit	0.50	1.00
As above, except bone hit	1.00	1.00

*Probability of Desirable Effect
**Probability of Undesirable Effect

TABLE F-IV

PROBABILITY ESTIMATES FOR PHYSIOLOGICAL EFFECTS FOR NONCRITICAL WOUNDS TO THE CHEST AND ABDOMINAL CAVITIES - SUSPECT FLEEING ON FOOT, CIVIL SCENARIO III

Impact Zone	P_{DE}	P_{UE}	Remarks
Chest	0.30	1.00	Suspect would probably keep running.
Abdomen	0.30	1.00	Suspect would probably stop soon after "escape."

One-on-One Scenario, Variation C, Suspect Has Knife

Considerable discussion--mostly qualitative--evolved when an attempt was made to estimate desirable and undesirable effects for the One-on-One Scenario.

There are four variations of the One-on-One Scenario, as follows:

- o Variation A - Unarmed offender pushes, shoves, etc.
- o Variation B - Offender used blunt, nonpenetrating object to strike officer.
- o Variation C - Offender uses sharp, penetrating object, such as knife, to attack officer.
- o Variation D - Suspect uses gun to attack officer.

It was attendee consensus that the police would not normally utilize the .38 caliber on Variation A or B. In Variation C it was assumed that the offender had a knife. In this situation it was agreed that the officer might have to use deadly force. In Variation D we have a lethal rather than non-lethal engagement which it was felt was not within the purview of this investigation.

The undesirable effects for this scenario were thought to be the same as for the Suspect Fleeing on Foot.

The panel members agreed that onset time was a crucial parameter. This is because the first priority in this scenario is to protect the officer from threat. The desirable effect must then be measured by the ability of the mechanism to produce rapid incapacitation onset times. Due to the proximity of the offender, one-second onset times or less are highly desirable.

The panel members did not give probability estimates, but instead related impact areas to onset times. Their discussion is summarized in Table F-V.

Scenario IV - Crowd Dispersal

Desirable effects for Scenario IV--Crowd Dispersal--were briefly addressed. From examination of data published by the Miami Police Department, we know that approximately 28% of fleeing suspects stopped on a warning shot. It seemed logical that approximately 28% of the crowd would probably disperse with a warning shot. This area should be addressed further by the Methods Group.

The medical panel consensus was that the desirable effect of a hit on a crowd member was probably zero or a very low value. The panel agreed that a person hit in the crowd would produce an undesirable effect, i.e., people might cluster around the wounded man. Here again, this area should be addressed by the Methods Group.

TABLE F-V

ONSET TIMES FOR ONE-ON-ONE SITUATION, VARIATION C(I), CIVIL SCENARIO I

Impacted Area	Onset Time (sec)	Remarks
Head or Cervical Reticular Cord	<1	Stop suspect essentially immediately
Heart, Lung, Kidney, etc.	>5	Would not stop suspect from using knife on police within one second and probably not within five seconds.
Thigh (Femur)	--	Breaking the bone in the thigh would cause mechanical collapse of the suspect; depending upon orientation of fall, suspect could still use knife on police officer.
Extremity Handling Weapon (up to shoulder)	<1	Must hit bone or major nerve. Same effect as head shot.
Solar Plexus	--	A possibility--Similar to head shot. The onset time would depend on how much energy is transferred to suspect. More data is needed here as it is inferred from the swine shots that this might not be true for the .38 caliber in that they did not displace very much on bullet impact.

Recommendations for Future Test Proceedings

1. Microscopic necropsies on organs, especially for low-energy superball shots.

2. Complete microscopic necropsies on 90 ft-lb energy levels.

APPENDIX G

MINUTES OF METHODS GROUP MEETING, 29 DECEMBER 1972

The primary purpose of this meeting was to generate desirable effects probability estimates for two or more of the civil scenarios....based on psychological effects of the .38 caliber revolver and ammunition.

In order to establish sufficient background for these estimates, meeting attendees keyed on an agenda as below:

1. Estimation of Psychological Effects

   a. Define undesirable psychological effect.

   b. Examine possibility of undesirable effects associated with civil scenarios.

   c. Review civil scenarios - Discuss most probable emotional level for each scenario, crowd hostility, and crowd breakup and promotion of same.

   d. Generate provisional probability estimates of desirable effects of the .38 caliber revolver. Effects examined are to include:

      (1) Physical presence of armed law enforcement officer

      (2) Threat of weapon use (verbal order of warning shot)

      (3) Weapon Use: Observers (target personnel who do not get hit but see others hit); Hit on target (noncritical flesh wound).

2. Discussion of Other Mechanisms of Effect, Excluding Pain

3. Discussion of Individual vs Group Desirable Effects.

A brief review of the overall program regarding objectives, present status, future funding and the like was given by the Chairman, Mr. Shank. Particular emphasis was placed on the applicability of the provisional estimates to be rendered to the general evaluation methodology which had been formulated previously. Physiologically-based probability estimates of desirable and undesirable effects as generated by the Medical Group were discussed, as well as the method employed (slides, animal tests, etc.) and the rationale used. It was noted that the Methods Group should keep in mind when rendering the estimates that desirable effects are characterized by relatively short onset times and lasting effects of less than 24 hours; whereas, undesirable effects are generally thought of as latent (excluding immediate death) and persisting for more than 24 hours. At this juncture, the need for a definition of the psychological effects (similar to Medical Group definition) was stated.

There was agreement among the attendees that a psychologically-undesirable effect could be defined as "an effect which persists longer than 24 hours and

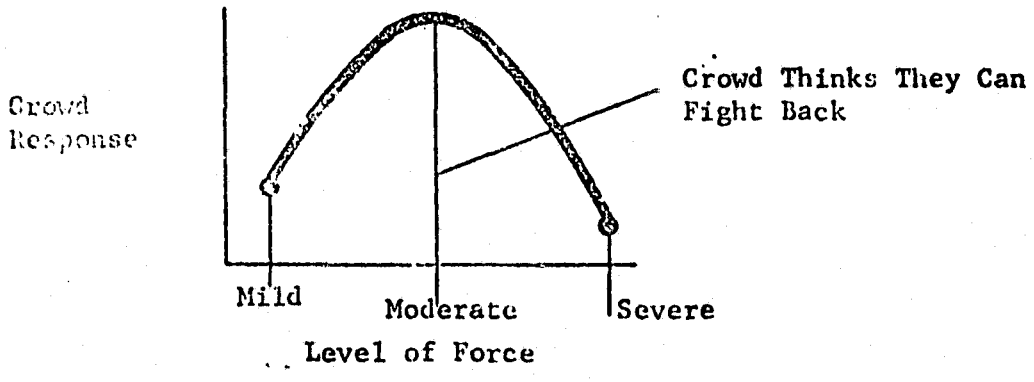
prevents an individual from performing routine daily tasks."* The desirable effects are defined by the scenarios.

The use of the word "psychological" was discussed regarding its salability. This discussion prompted comments, such as: "Just to find a new word, especially an esoteric term, is pointless"...."Why not let 'psychological' stand?" ...."As everyone knows, it has something to do with the mind which is not fully understood...." These responses were so basic and pure as to illicit no rebuttal from meeting attendees and thus the doctrine of "silence is consent" governed and the term "psychological" stood.

At this juncture, a review of the civil scenarios was initiated. Written descriptions and a simple sketch of each scenario were provided. Most of the discussion dealt with the Suspect Fleeing on Foot and Crowd Dispersal scenarios. The Barricade and Hostage and the One-on-One scenarios were only briefly addressed.

At the request of the other members of the Methods Group, Dr. Greenspan had conducted some research on crowd behavior prior to this session. Interest in crowd breakup and what promotes it, as well as the emotional state or level of the crowd as it would relate to applicable scenarios, prompted this effort. Dr. Greenspan summarized briefly the results of his investigation.

Unfavorable crowd response is maximum when the control forces exert only moderate force on the crowd. When the level of force is mild or severe, the crowd is more easily handled. This is illustrated in the sketch below.



The use of mild force by police is advocated and is evident from police training procedures. It is better to have a few policemen to "talk the crowd down" while the garrisoned troops remain off to the side or around the corner

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*This is similar to the definition agreed upon by the Medical Group. It seems unlikely that any appreciable number of psychologically-undesirable effects will result in a psychotic episode. It was stated and there was agreement between the psychologist and the psychiatrist that a psychotic episode usually lasts several months and is hardly ever caused by a single event. (This infers that the probability of a psychotic episode for the scenarios of interest would be nil.)

or otherwise out of the view of the crowd; the garrisoned troops can be immediately summoned if the few policemen are not adequate.

Another important consideration relating to crowd response is the indecisiveness of control forces. If the police hesitate, hedge, etc, the crowd will be aggressive. If the police exhibit a strong decisive force, the crowd will be passive*. Coupled with the credibility of this threat is the physical appearance which the policeman presents to the crowd (A big, burly officer is impressive.). The holstered pistol is also a good back-up. Once the crowd has the impression that the police mean business, they will be more docile. It is clear that the nonlethal weapon should be used in a "no-nonsense" way or its use may have a negative effect. For example, if the risk to the individual was small, say one or two high-energy Q-spheres (a proposed less lethal munition), then the crowd would not disperse. It would be better to shower the crowd with the high-energy Q-spheres. The analogy was drawn that one bee would not disperse the crowd, but a whole swarm of bees would. Further discussion of crowds was deferred by the moderator until the Crowd Dispersal Scenario was discussed.

With the foregoing as background, attendees settled down to the business at hand of rendering the psychological effects estimates.

The first scenario considered was the Suspect Fleeing on Foot. Assumptions for the estimates included:

1. The threat is real (the policeman "means business").

2. Fleeing suspect is "average" adult offender.

3. Suspect is unarmed (scenario is written this way).

The desirable effect is to slow down or stop the offender so that he may be apprehended. It was noted that the .38 caliber revolver did not fit the scenario too well, but also that we did not want to rewrite the scenario.

Table G-I summarizes the probability estimates for the psychologically-based desirable effects (P_{DE}).

It is interesting to note that the probability estimates in Table G-I agree closely with some police data. Specifically, Dade County, FL, police records show that 28% of offenders stop when the police fire a warning shot. In those cases where suspects are hit but do not stop, 28% are apprehended later. According to our panel estimates, these numbers would be 25% and 25%, respectively. (Some of the panel members rendering the estimates had access to this information; therefore, some unquantifiable amount of bias might be expected.)

For those suspects in this scenario who escape, the undesirable effects are not applicable. Attendees agreed that the suspects would probably be scared for a few hours.

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*Not violent or physical

TABLE G-I

SUMMARY OF PROBABILITY ESTIMATES OF PSYCHOLOGICALLY-BASED DESIRABLE EFFECTS - SUSPECT FLEEING ON FOOT SCENARIO

Level of Force	P_{DE}*	Remarks
Physical presence of officer	NA	Suspect is running away--Probably does not see officer.
Threat of weapon use	0.25	Motivation is key; most will keep running.
Weapon Use**		
Not hit	0.35***	Small percentage might think officer "means business."****
Hit (nonincapacitating wound)	0.50***	A guess at best

*Probability of Desirable Effect
**Might not be a warning shot.
***Includes those subjected to threat.
****For our assumptions, panel consensus was that of the 75 out of 100 persons who would keep running after the threat, only 10 would stop on weapon use without a hit. This again depends on local police doctrine and suspect's knowledge thereof.

The attendees agreed that it seemed remote that the single event of capture would cause a psychotic episode. A psychotic episode would, of course, last several months but is a built-up thing which has been compounded on many other things. About the only thing that shooting at these people does..... from the psychological view, is to confirm their view (distorted as it may be) of the world as a mean place that wants to kill them. People will get mad at the police for shooting at them; and, in particular, the fleeing suspect has a greater anger toward the police if shot at. Moreover, the suspect's desire for retribution may be increased if he is shot at.

Summarizing, then, for all levels of force, the psychological undesirable effect is either not applicable or zero.

The next scenario that was addressed was the Crowd Dispersal Scenario. At this juncture, it seemed appropriate that Dr. Greenspan continue his discussion of crowd behavior. Dr. Greenspan related that crowds are an effective way for grieved individuals to "blow-off-steam." A crowd is a homogenous group containing individuals with average or better intelligence. The emotional intensity (EI) of the crowd may lie somewhere between peaceful and hostile. Ordinarily, the crowd will be passive* and illegally gathered; however, the crowd has stages. In the beginning, there is purpose. Depending on the display of force, weak members of the crowd may leave and then wander back in. In the early stages, the police are better off not "reading the riot act"; for when they do, the threat credibility is challenged as individuals within the crowd are unable to perceive a personal threat. In later stages, the emotional intensity of the crowd tends toward hostility as their purpose is reinforced as they prepare for arrest, jail and bail. It was also noted that clever demonstrators start peaceful demonstrations and that these demonstrations are often well-organized and logistically supported; however, this is not always recognized by law enforcement agencies.

With these additional comments taken under advisement, meeting attendees rendered desirable effects probability estimates for the Crowd Dispersal Scenario. Assumptions for the estimates included:

- o Crowd is gathered illegally with purpose.
- o Crowd is passive.

The desirable effect is to cause the crowd to leave the area.

Table G-II summarizes the probability estimates for the psychologically-based desirable effect (P_{DE}).

At this point, it was noted by Dr. Greenspan "....we are so eager to get quantitative answers that we risk distorting our scenarios to do so."

The Barricade and Hostage Scenario received the least treatment. The .38 caliber weapon is inappropriate for this scenario. "Talk" would probably be

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*Not violent or physical

TABLE G-II

SUMMARY OF PROBABILITY ESTIMATES OF PSYCHOLOGICALLY-BASED DESIRABLE EFFECTS - CROWD DISPERSAL SCENARIO

Level of Force	P_{DE}*	Remarks
Physical presence of officer**	0.10***	Authoritativeness of his movements, physical size, etc. "Riot Act" has been read.
Threat of weapon use	0.25	Most do not believe policeman will shoot. Threat credibility is challenged when individuals are unable to perceive threat as a personal threat.
Weapon use		
Fire over crowd	0.90	If police fire over the crowd, the crowd reacts.
Fire into crowd	1.00	Crowd would be surprised because most riot policemen are armed only with nightstick and possibly tear gas.

*Probability of Undesirable Effect
**No obvious weapon, other than nightstick (If there are a small number of police, the crowd probably would disperse and risk a reassembly.)
***0.10 means 10 out of 100 people are expected to leave.

as effective as any weapon and would represent the least risk to the well-being of the hostage. Many references consulted by Dr. Greenspan in preparing for the meeting advocate that tear gas be employed under similar conditions. Panel members tended to agree; therefore, the discussion of this scenario was terminated.

The One-on-One Scenario was examined next. The panel members agreed that Variation A of this scenario was appropriate to consider regarding the psychological effects. In Variation A the unarmed offender pushes, shoves, jerks away, swings, kicks, bites, etc. The offender indulges in this sort of activity to counteract the action of the police. The scenario is one of physical interaction between the police and the offender. (The conditions of Variation A do not normally require the use of a weapon as lethal as the .38 caliber!) Assumptions for the estimates included:

o This is the "average" adult offender.

o The desirable effect is to apprehend (handcuff) the offender within 30 seconds.

Table G-III summarizes the probability estimates for the psychologically-based desirable effects (P_{DE}).

It should be noted that independent estimates were initially made by each of the voting members of the group in the presence of the other voting members and not by secret ballot as had been their intention. Group members preferred this method. After all estimates had been made, they were discussed by the entire group. Although modifications to the estimates were permitted, none were actually made. A consensus estimate was determined by averaging the individual estimates and rounding to the closest 5%. Thus .282 became .30; .273 became .25, etc.

A few comments were made regarding other psychological effects, exclusive of pain. Two terms which were mentioned but not discussed in depth were "autonomic response" and "endocrine effect."

CONTINUED

1 OF 2

Individual versus group behavior was discussed only briefly. It was concluded that individually most persons will do what benefits them most; however, in a crowd, they will do what is best for the crowd.

One item not covered was how each voting member assessed the emotional state of the crowd when they rendered individual estimates at the Methods Group meeting of 17 August 1972.

TABLE G-III

SUMMARY OF PROBABILITY ESTIMATES OF PSYCHOLOGICALLY-BASED DESIRABLE EFFECTS - ONE-ON-ONE SCENARIO, VARIATION A

Level of Force	P_{DE}	Remarks
Physical presence of officer	NA	Physical interaction. Presence of officer dictates scenario.
Threat of weapon use	0.70	Policeman is the aggressor.
Weapon use		
No hit	0.80	
Hit	--	

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END

7 attachments