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LEGISLATIVE ISSUES RELATED TO DRINKING AND DRIVING

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LEGISLATIVE ISSUES

RELATED TO DRINKING AND DRIVING

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LEGISLATIVE ISSUES RELATED TO DRINKING AND DRIVING

EXECUTIVE SUMMARY

Introduction

This report, prepared by the Traffic Injury Research Foundation of Canada (TIRF), concerns possible revisions of Section 236(1) of the Criminal Code of Canada. The text of that section is as follows:

> 236. (1) Every one who drives a motor vehicle or has the care or control of a motor vehicle, whether it is in motion or not, having consumed alcohol in such a quantity that the proportion thereof in his blood exceeds 80 milligrams of alcohol in 100 millilitres of blood, is guilty of an indictable offence or an offence punishable on summary conviction and is liable
>
> (a) for a first offence, to a fine of not more than two thousand dollars and not less than fifty dollars or to imprisonment for six months or to both; (b) for a second offence, to imprisonment for not more than one year and not less than fourteen days; and
>
> (c) for each subsequent offence, to imprisonment for not more than two years and not less than three months.

Section 236(1) of the Criminal Code is a so-called "per se" statute. This means that valid chemical test results of BAC constitute irrefutable evidence that an offence has been committed. It differs from, and complements, Section 234(1) of the Criminal Code, reproduced below.

> 234. (1) Every one who, while his ability to drive a motor vehicle is impaired by alcohol or a drug, drives a motor vehicle or has the care or control of a motor vehicle, whether it is in motion or not, is guilty of an indictable offence or an offence punishable on summary conviction and is liable
>
> (a) for a first offence, to a fine of not more than two thousand dollars and not less than fifty dollars or to imprisonment for six months or to both;
>
> (b) for a second offence, to imprisonment for not more than one year and not less than fourteen days; and
>
> (c) for each subsequent offence, to imprisonment for not more than two years and not less than three months.

Section 234 is a "behaviour-based" statute. In principle, conviction under Section 234 would require evidence of driving impairment due to alcohol, including (if available) admissable chemical test results.

The study by TIRF, sponsored by the Department of Justice, addressed two issues:

1) lowering the current statutory limit in Section 236(1) from 80 milligrams to 50 milligrams of alcohol per 100 millitres of blood (that is, from 80 mg% to 50 mg% w/v); and

2) defining two or more offences under Section 236, the seriousness of the charge and the severity of the penalty based on blood alcohol concentration (BAC).

The purpose of the study was to summarize relevant information for use by those responsible for resolving these issues; to recommend courses of action related to revising Section 236(1); and to inform interested parties of scientific data pertinent to these issues.

The issues translate into the following specific questions:

- Issue One: Lowering the Statutory BAC Limit

  -- Do BACs between 50 and 80 mg% so adversely affect driving-related skills as to constitute "impairment" of the "ability to drive"?

  -- Are BACs between 50 and 80 mg% strongly associated with an increased risk of accident-involvement?

- Issue Two: Tiered Statutes Based on BAC

  -- What empirical basis--in terms of driving impairment and accident risk--exists to support differential charging (or sanctioning) of persons based solely on BAC?

To answer these questions, TIRF reviewed and summarized findings from scientific studies reported in the literature. Pragmatic, political, and social considerations also play a role in legislative decision-

making. Therefore, although this report concentrates on scientific research, the authors also identify other considerations and (to the extent possible) review the experience in other countries related to the issues under study.

Research on Drinking and Driving

Experimentation and epidemiology are distinct but complementary approaches used to define drinking-driving problems. Experimental studies relate BAC to the effects of alcohol on driving-related skills. Epidemiologic studies relate BAC to the likelihood (or risk) of accident-involvement. Neither body of knowledge can fully answer questions about BAC limits in Law. Taken together, however, experimental and epidemiologic evidence offers the best available guidance for resolving these legislative issues.

The relevance of research on drinking and drinking to the issues stems from the rationale for per se laws. Section 236(1) of the Criminal Code makes valid chemical test results for BAC irrefutable evidence of an offence. Per se laws, however, have as their justification the implicit links (1) between BAC and alcohol's effects on the ability to drive and (2) between BAC and alcohol's influence on the risk of accident-involvement.

Thus, the current statutory BAC limit of 80 mg% assumes that all persons with a BAC exceeding that limit will have had their ability to drive impaired by alcohol and will have had an increased risk of accident-involvement. Findings from scientific studies allow us to examine that assumption for lower BAC limits (e.g., 50 mg%). Similar information permits us to assess the validity of higher BAC limits--those that implicitly distinguish "impaired driving" and "moderate accident risk" from "very impaired driving" and "high accident risk" based solely on chemical test results.

Lowering the Statutory BAC Limit

Experimental and epidemiologic evidence indicates that:

1) BACs between 50 and 80 mg% do not so adversely affect driving-related skills as to constitute "impairment" of the "ability to drive" in many groups of drivers; and

2) BACs between 50 and 80 mg% are not strongly associated with increased risk of accident-involvement except for some groups of drivers.

Experimental studies show that BACs less than the present statutory limit can decrease performance of driving-related skills. The magnitude of these effects is not great. The variability of people's responses to low and moderate amounts of alcohol preclude judgment that all persons have their ability to drive impaired at BACs between 50 and 80 mg%. Therefore, BACs less than 80 mg% should not be considered irrefutable evidence of an offence implicitly that of alcohol-impaired driving.

Epidemiologic studies generally indicate that drivers with BACs between 50 and 80 mg% have an increased risk of accident-involvement compared to the average nondrinking driver. The increased risk is not great, nor is it substantially different from that of the sober driver. The weakness of the association between accident risk and BACs in this range is explained by the fact that many drinking drivers--for example, those that consume alcohol frequently or have high annual mileage--have no increased risk of accident involvement compared to the average nondrinking driver when their BACs are between 50 and 80 mg%. We cannot conclude, therefore, given other factors and circumstances, that all drivers in this range of BAC have a substantially increased risk.

Taken together, experimental and epidemiologic evidence suggests that some drivers with BACs between 50 and 80 mg% have their ability to drive impaired by alcohol and thereby face an increased risk of accident-involvement. These findings also indicate that other drivers with BACs in the same range do not differ for all intents and purposes from the

average nondrinking driver. Note that the present array of alcohol-impaired driving statutes in the Criminal Code adequately addresses this issue. Persons judged to have their ability impaired by alcohol at concentrations less than 80 mg% can be arrested and convicted under Section 234(1). Alcohol-impaired drivers with BACs between 50 and 80 mg% thus find no loophole in the law. At the same time, those not judged impaired with BACs in the same range need not be prosecuted and sanctioned for the criminal offence of driving with a BAC exceeding the legal limit.

Considerations other than scientific data can, and should be, taken into account in deciding whether or not to lower the statutory BAC limit.

It seems clear that the great majority of drinking drivers have little understanding of how alcohol consumption relates to BAC. Furthermore, there is no evidence that simply lowering the legal BAC limit has any intrinsic value in altering drinking-driving behaviour. Providing objective tests of BAC for use by individuals may increase the likelihood of informed decision-making about driving after drinking too much. Further study is needed, however, before any conclusions can be reached about how this approach itself might reduce the frequency of alcohol-impaired driving.

Lowering the legal BAC limit, given the stability of drinking-driving behaviour in Canada, may <u>double</u> the number of drivers who drive with illegal BACs. The frequency of alcohol-impaired driving under the present law, combined with limited resources to enforce it, suggests a pragmatic option: Concentrate efforts to deter or prevent driving with BACs exceeding the present legal limit rather than extending them to deal with marginally impaired drivers at relatively low risk of accident-involvement. As other experts have observed, in terms of cost-effectiveness, society may have more to gain (in terms of overall reduction in human and economic losses due to alcohol-related road accidents) by targeting the high-BAC, high-risk driver for action.

We recommend, based on our findings, that the current statutory limit of 80 mg% not be lowered to 50 mg%.

Tiered Statutes Based on BAC

This issue concerns defining alcohol-impaired driving offences in terms of two or more BAC ranges. The purpose of such tiered statutes is to distinguish the seriousness of the offence or to guide the severity or type of penalty using BAC as the primary or sole criterion. The review of scientific studies dealt with a two-tiered statute that specifies BAC ranges of 81-149 mg% (the lesser offence and 150+ mg% (the more serious offence). This approach simplified assessing the empirical basis of other tiered statutes that are per se laws.

Experimental studies show that some individuals with BACs over 150 mg% do not evidence intoxication or gross impairment while others below 150 mg% do. The higher limit of 150 mg% would not, therefore, reliably discriminate between "impaired" and "very impaired" driving in a certain percentage of cases. Given the variability of individual responses to higher BACs, both chemical test results and behavioural evidence would offer a more reliable and realistic basis for judging the degree of driving impairment in any one case.

Epidemiologic evidence tends to support experimental findings. Although the relative risk of accident involvement generally increases with increasing BAC, estimates of relative risk overlap discrete BAC values. As a consequence, some percentage of persons with BACs in the higher range will have a relative risk equal to or less than those with BACs in the lower range. Conversely, many persons in the lower range will have a relative risk of accident involvement similar to that associated with higher BACs. Factors and characteristics other than BAC influence the relationship between BAC and relative risk, contributing to uncertainty in individual cases. In sum, many drivers with higher BACs do not automatically fall into higher risk categories compared to others with lower BACs.

Despite the weak empirical basis for tiered statutes based on BAC, many other jurisdictions have adopted them. No studies could be identified that assessed the effectiveness of tiered statutes compared to those that simply proscribe driving over a single statutory limit, such as Section 236(1) of the Criminal Code. Given general public ignorance of BAC and its relation to the subjective experience of alcohol's effects, tiered statutes may not have any intrinsic value in deterring people from driving after drinking varying amounts of alcoholic beverages. As a means to facilitate differential charging or sanctioning, of course, their utility cannot be questioned. The fairness in using them for these purposes can be questioned in light of the public's current inability to measure BAC objectively prior to driving.

Another consideration is the prevalence of problem drinkers and alcoholics among those convicted for alcohol-impaired driving offences. These groups of drivers will likely have BACs corresponding to the higher BAC range and thus be subject to stiffer penalties. Harsher treatment under the law for these offenders, however, may not serve society's interest in rehabilitating problem drinkers and reducing recidivism in this group.

We conclude that a two-tiered, per se statute with lower and upper limits of 80 and 150% does not find strong support from scientific fact. Other alternatives, each aimed at creating a more serious offence of "grossly impaired driving", have been suggested. For example:

- define an offence equivalent to driving while "very impaired" by specifying a higher upper limit, for example, 200 mg%;
- designate BACs exceeding 150 mg% as presumptive evidence of a more serious offence;
- retain the present, single limit of 80 mg% and implement a sentencing policy that calls for increased penalties for higher BACs associated the overt and serious behavioural impairment; and
- create a two-tiered, per se statute with lower and upper limits of 80 and 150 mg%, but establish an overlapping penalty structure corresponding to greater and lesser impairment found in each of the tiers.

These alternatives engender many of the same problems and issues discussed above. For example, even an upper limit of 200 mg% is still subject to attack on scientific grounds. A two-tiered per se statute with overlapping penalty structures does not avoid the fundamental unsoundness of relying solely on BAC as a measure of the seriousness of the offence. Requiring other, behaviour-based evidence to establish a more serious offence (or to increase penalties upon conviction) leads back to reliance on subjective judgments of behavioural impairment--an approach found difficult (to say the least) in the past.

Moreover, the suggested alternatives listed above also have implications for criminal justice. For example, presumptive limits have led to widespread "plea bargaining" in other jurisdictions, a tactic often resulting in less serious charges and reduced penalties. Therefore, these and related alternatives require careful review for such implications, a task beyond the scope of this report.

Another alternative is simply to let Section 236(1) stand as written. This last alternative seems attractive. Experts in the field have argued that increasing penalties for alcohol-impaired driving offences. in and of itself, has little deterrent value. Greater gains are possible through increasing enforcement of existing laws and thereby increasing the perceived risk of arrests among drinking drivers. Moreover, existing laws appear to have adequate ranges of penalties to accommodate variations in the seriousness of offences under Section 236(1). Restructuring Section 236(1) to create a more serious alcohol-impaired driving offence based on a higher BAC limit seems less needed than other possible revisions of the Criminal Code. These might include: (1) mandatory screening of offenders for problem drinking; (2) creating more serious alcohol-impaired driving offences based on the consequences of that behaviour (for example, causing accidents resulting in death or injury to others); and (3) providing for a range of sentencing options, so that characteristics of offenders and circumstances leading to their arrest and conviction can be used to identify the nature of additional sanctions most appropriate in each case.

LEGISLATIVE ISSUES RELATED TO DRINKING AND DRIVING

FINAL REPORT

OUTLINE

OUTLINE (continued)

LIST OF FIGURES AND TABLES

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1.0 INTRODUCTION

This report deals with two legislative issues that relate to possible changes in present Criminal Code statutes concerning alcohol-impaired driving:

- lowering the current statutory limit of blood alcohol concentration (BAC) from 80 milligrams to 50 milligrams of alcohol per 100 millilitres of blood (i.e., 80 mg% to 50 mg% w/v); and
- replacing the existing one-tiered Criminal Code statute (236) with a two-tiered structure based on BAC (e.g., 80 - 149 mg%; 150 mg% and greater).

The aim of the study is to summarize relevant information for use by those responsible for decisions on these matters; to recommend courses of action related to revising Section 236(1); and to inform interested parties of scientific data pertinent to these issues.

1.1 Background

In this project, one of several related efforts undertaken by TIRF and sponsored by the Department of Justice, TIRF reviewed the available literature and compiled data pertaining to the legislative issues identified above. This effort addressed the following specific questions:

- Do BACs between 50 and 80 mg% so adversely affect driving-related skills as to constitute "impairment" of the "ability to drive"?
- Are BACs between 50 and 80 mg% strongly associated with an increased risk of accident-involvement?
- What empirical basis exists to support differential charging (or sanctioning) of persons based on concentration ranges of blood (or breath) alcohol?

These questions have been raised periodically over several decades in many countries. Usually the context is either (1) defining presumptive

limits for behaviour-based statutes or (2) setting (or re-setting) BAC limits for per se laws, those based solely on chemical tests. For the purpose of drafting or revising this kind of legislation, scientific studies and empirical data may be important but rarely suffice alone. Pragmatic concerns have had, and no doubt will continue to have, a place in these policy decisions. These include social, political, practical, and economic considerations. With this in mind, we focus here primarily on the scientific aspects of the legislative issues.

We have summarized results of empirical studies drawn from two separate, but complementary, areas of research. Experimental studies relate BAC to the effects of alcohol on human performance. These employ laboratory tests of skills related to driving, driving simulators, and vehicle-based methods on closed driving courses. Epidemiologic studies relate BAC to the likelihood (or risk) of accident-involvement. Given their inherent limitations, neither approach alone can fully answer questions concerning the appropriateness of BAC limits. Taken together, however, findings from experimental and epidemiologic research offer a more complete and integrated picture of BAC in relation to alcohol-impaired driving laws.

Scientific data provide only one of several bases for decisions about BAC limits. In fact, in our review of the literature, we found, with very few exceptions, hardly any careful assessments of relevant data in discussions of legislative changes of statutory BAC limits! Pragmatic, political, and social considerations have played a dominant role in decision-making. Therefore, although the focus of this report is on empirical research, we also identify these other considerations and review (to the extent possible) experience in other jurisdictions related to the legislative issues.

1.2 Scope of Report

This report has five sections. Those that follow are briefly described below.

Section 2.0, Research on Drinking and Driving: Its Relevance to Legislative Issues, provides background information on studies relevant to questions addressed in this report. The limitations of such studies--both experimental and epidemiologic--and their use in resolving the legislative issues are discussed.

Section 3.0, Lowering the Statutory BAC Limit, reviews present knowledge relating to the decision to lower the current limit of 80 mg% to 50 mg%. Implications of what is known, along with other considerations, are outlined.

Section 4.0, Tiered Statutes Based on BAC, examines the factual basis of laws that use BAC ranges to dictate (1) the seriousness of a charge of alcohol-impaired driving or (2) the severity of punishment for the offence. In particularly, two-tiered per se statutes are considered.

Section 5.0, References, lists reports and articles cited.

2.0 RESEARCH ON DRINKING AND DRIVING: ITS RELEVANCE TO LEGISLATIVE ISSUES

This section presents background information on research relevant to resolving the legislative issues. Experimentation and epidemiology are two basic approaches used to define the problem of alcohol-impaired driving and alcohol-related road accidents. In this section, we describe each approach and discuss how, taken together, they offer an adequate, not perfect, basis for informed decisions about the legislative issues.

2.1 Experimentation Related to Drinking and Driving

Experimental research includes studies carried out under controlled conditions to measure the effects of alcohol. It provides an extensive body of knowledge (e.g., Wallgren and Barry 1970). Experimentation spans many disciplines, for example, biochemistry, pharmacology, toxicology, psychology, pathology, ergonomics, and other behavioural sciences. Areas of study are also diverse:

- the absorption, distribution, metabolism, and excretion of alcohol;
- the short- and long-term effects of alcohol on the body, its organs, and functions;
- the effects of alcohol on measures of human performance, including social interactions; and
- the relation of dose to response (or concentration to effect) over time.

Of interest here, of course, is the ability to drive a motor vehicle. This ability includes many skills: sensory, psychomotor, and cognitive. In addition, the ability to drive depends on the condition, or state, of the person driving. "Car handling and control skills, however, comprise only one aspect of driving. Alcohol also affects attitudes, the ability to perceive hazards, and the willingness to take risks" (Donelson 1983a, p. 14). Not only alcohol but also other drugs, fatigue, medical conditions, and physical disability can affect the ability to drive. Only

for alcohol, however, have objective standards been established in Law to define limits beyond which the ability to drive is presumed impaired. Per se laws, such as Section 236(1) of the Criminal Code, make valid chemical test results for alcohol irrefutable evidence of the offence. Per se laws have as their rational justification the implicit link between BAC and alcohol's potential to impair the ability to drive.

2.1.1 The state of knowledge: Overview. Reflecting the importance of experimental research to the area of drinking and driving, many reviews of the literature have appeared (e.g., Jones and Joscelyn 1979a,b; Organisation for Economic Co-operation and Development 1978; Perrine 1974). Most experts have criticized the state of knowledge in this area (for example, see Carpenter [1963] and Levine, Greenbaum, and Notkin [1973]). Reported studies taken as a whole simply lack depth, as Perrine (1973) commented on the alcohol-driving literature:

> Perhaps more so than with any other specialty in behavioral science, the alcohol literature seems to be cluttered with the bones of isolated, poorly controlled, one-shot studies by investigators who were probably just curious about what happened when alcohol was simply added as a treatment condition in an area of research which they had already been pursuing. Thus, the greatest single need appears to be a willingness on the part of investigators to pursue a line of research in sufficient depth to permit definitive statements to be made about the particular topic or subtopic which they are examining. (pp. 165-166)

Warren and Donelson (1982, pp. 54-62) discussed BAC in relation to the ability to drive safely. They pointed out issues that complicate the use of experimental findings in setting, or re-setting, BAC limits:

- Past research studies are not comparable and fragmented results do not offer a complete picture of alcohol's effects on driving ability.
- Methods used to test performance lack critical elements of the real-world driving task.

- Research findings of "skill impairment" are not necessarily important for actual driving ability.
- The aim of experimental research appears more that of demonstrating that alcohol can impair driving skills than determining whether moderate BACs do impair the ability to drive.
- The well-known variability of alcohol's effects on different groups of people is not so fully explored as to establish who is impaired (or not impaired) at lower BACs.

The last-listed item refers to a fundamental question: If, for many people, the ability to drive is not impaired at BACs below the present legal limit (80 mg%), then is it fair and just to make it a criminal offence for everyone who drives with BACs in a lower range (e.g., 50 mg% to 80 mg%)? This question is addressed in Section 3.0. Other questions relate to BAC as a general measure of alcohol's effects: Are all people with the same BAC affected to the same extent? If not, how reliable is BAC as a measure to establish "impairment"--especially in the driving context? This question pertains to both legislative issues. In the context of criminal law, is BAC as a measure of the degree of alcohol's effects really "irrefutable" evidence of impairment of the ability to drive? Per se laws, of course, treat valid BAC test results as such. How sound, however, is the factual basis for per se laws?

Reviewers of experimental research have concluded that past studies do not provide definitive answers about BAC limits. Below, we discuss in more detail why definitive answers are not forthcoming. Then we describe how the present state of knowledge can be used to form judgments about the legislative issues under study.

2.1.2 Methodological and other limitations of experimental research. The primary drawback of experimental research is the lack of methods that reproduce the real-world driving task. Present technology accomplishes this for the piloting of aircraft and the operation of military hardware (computerized simulators). In fact, the magnitude of alcohol's effects on the ability to fly certain aircraft (in normal and emergency situations) can be reliably and validly tested using these

simulators. Combined with standards for performance (also well defined), BAC limits (or limits on other drugs, including medication) prove less of a problem. The central point here is that governments and industry concerned with the prevention of road accidents have yet to commit funds to develop similar tools for the study of road safety problems. Thus, in criticizing methods used to study the effects of alcohol on driving, we certainly do not accuse the many intrepid experimentalists who have sought to approach real-world driving as closely as possible within funding limits. Nonetheless, to date, no one has succeeded in bridging the gap from the laboratory (simulator or closed driving course) to the real world (cf. Perrine [1976]). In the absence of techniques and methods that reproduce actual driving demands, including simulated risk, the meaning of experimental findings for real-world applications remains in doubt.

Performing the driving task (also, "operating a motor vehicle") combines and integrates many different skills. Experiments that measure the effects of alcohol on one or more separate skills do not measure the effects of alcohol on driving. The results of such experiments do not directly indicate the degree to which alcohol can impair the ability to drive. This limitation of experimentation stems from the following:

1. Alcohol affects different driving skills at different BACs. Moderate amounts of alcohol affect some but not all driving skills.

2. At moderate BACs, many people can compensate for the effects of alcohol and still perform well (e.g., paying more attention, being more careful, trying harder).

3. Some sensitive laboratory methods can measure effects of alcohol at very low BACs--for example, after the equivalent of one or two drinks. These effects, however significant statistically, may have little import for actual driving ability or real-world driving performance.

That alcohol affects separate skills at different BACs is documented in the next section. The ability of people to compensate for the effects of moderate amounts of alcohol may seem controversial. For instance,

some agencies have published statements that "one or two drinks" impair driving. This may be true for some people, but not necessarily for most drinking drivers. This issue is also discussed in the next section. Chapanis (1967), perhaps, best addressed the third point made above:

> In focusing on statistical significance a laboratory experiment completely ignores the problem of practical significance. It is a curious paradox: the more successfully a laboratory scientist increases the precision of his experiment, the more likely it is that he will prove statistical significance for effects that are practically trivial. That is, nonetheless, one of the major difficulties we face when we try to generalize from laboratory experiments to the solution of practical problems. The results of a laboratory experiment may tell us that we are dealing with a statistically significant effect, but they never tell us whether the effect is practically important or unimportant. (pp. 571-572)

Warren and Donelson (1982) discussed this "paradox" in relation to experimental research that links alcohol "impairment" with BAC:

> Undoubtedly, the effects of moderate amounts of alcohol result in statistically significant decreases in precise measures of human performance. But experimental studies of alcohol's effects have evidenced a certain value-loading, or bias, in their design and conduct. Often, demonstration of impairment or skills reduction appears the purpose of experimentation. With increasingly refined techniques, decreases in performance measures can be found at even lower BACs. The practical meaning of such findings appear to decrease as well. "Impairment" here may not equate with "unsafe" in the larger context. (p. 58)

External validity--the extent to which experimental findings truly reflect actual situations--is but one of numerous methodological problems that limit generalizations from the laboratory to the real world. Other important methodological issues are outlined in Table 1 along with examples and consequences. Very few studies avoid all methodological problems. Hence, it is imperative that the results of any study be interpreted in light of its inherent limitations.

TABLE 1

SUMMARY OF METHODOLOGICAL ISSUES IN EXPERIMENTAL RESEARCH ON ALCOHOL AND DRIVING

Issue	Example	Consequence
A: Beverage		
(1) Dose	- only small doses employed	- effects of higher doses not known
	- different studies use different doses	- lack of comparability among studies
	- not standardized by body weight	- lack of control over concentration of alcohol
(2) Number of different doses	- only one or two doses studied	- dose-response relationship not fully characterized
(3) Frequency of drug administrations	- usually only one administration	- difference between acute and chronic effects unknown
(4) Placebo	- placebo group not used	- inappropriate comparisons - no control for expectations
(5) Beverage type	- beverage unfamiliar to subjects	- overestimation of drug effects
	- only one type used	- different beverages have different effects on performance
B: Subjects		
(1) Screening	- little or no assessment of alcohol use or other drug use	- may underestimate drug effects due to acquired tolerance
	- volunteers used	- use of those most eager to participate may introduce bias
(2) Selection	- ethical standards prevent use of drug-naive subjects	- does not allow for accurate estimate of true drug effect on initial exposures
	- prevention of use of underage subjects	- young drivers remain unstudied in terms of effects of alcohol on this high risk group
	- use of college students	
	- experimental subjects not generally representative of population of driving drivers	
(3) Number	- very small groups of subjects used	- high probability of introducing sampling error: unusual sensitivity or tolerance likely to influence results

TABLE 1 (continued)

Issue	Example	Consequence
(4) Sex	- males generally used	- there is little evidence concerning the effect of alcohol on females
C: Technique for measuring drug response		
(1) Selection	- research employs methods selected not for relevance to driving but because they are available	- results are indicative of alcohol effects on performance but not necessarily related to driving
	- complex tasks involve many skills	- uncertainty about which skills are affected
	- skills or behaviours measured not critical to driving	- results are largely irrelevant in relation to traffic safety
	- methods used by different researchers have different performance requirements	- conflicting results fill the literature, creating confusion
(2) Number of tests	- number of tests performed not adequate to assess drug effect	- over- or underestimation of drug's true effect on performance
	- tested at peak BAC or on falling limb of BAC curve	- results are fragmented and comparisons of different phases of absorption cannot be made - measures at peak BAC give maximum effect, measures during elimination underestimate maximum effect
(3) Validity	- artifical laboratory tests have limitations as valid predictors of drug effects on actual driving	- leads to reliance on such tasks as definitive proof of impairment of ability to drive
		- external validity never established
D: Experimental Design		
(1) Time of testing	- testing at times not coincident with usual drug administration (e.g. morning)	- leads to exaggerated drug effects
	- lack of testing over full range of drug effects, including residual effects	- introduces bias in size of estimated drug effect - effect may change over course of metabolism

TABLE 1 (continued)

Issue	Example	Consequence
(2) Repeated tests	- failure to establish stable baseline performance	- measured effects may include substantial learning - increased intersubject variability - lack of realism in study: driving is a highly overlearned task
(3) Sources of Variability	- lack of attention to intervening variables that may influence drug effects	- increased variability in results may produce findings that are statistically insignificant
(4) Variables Measured	- failure to measure potentially important variables such as (a) concentration of alcohol at time of testing (b) subjective estimates of performance	- valuable data lost - theoretical BAC may not match actual BAC, leads to inappropriate conclusions - relationship of performance changes to BAC not established - comparison between perceived and actual performance changes might be important in developing countermeasures
E: Reporting of Research	- incomplete reporting of methods, subjects, etc. - stating conclusions not warranted by results	- evaluation of studies difficult - misleading statements about alcohol effects and their relation to traffic safety - difficult to compare studies directly

Scientifically, the study of alcohol's effects on the ability to drive is far from complete. In addition to methodological problems, the limits of experimental research also stem from the following:

- o the lack of funding to develop methods and techniques that replicate the driving task as experienced in the real world environment;
- o the preoccupation with "proving" alcohol impairs driving, rather than exploring how, under what circumstances, in whom, etc.;
- o the low priority of research as an area of activity relevant to efforts to deal with the alcohol-crash problem; and
- o the lack of a cadre of researchers to study--in a systematic, more continuous fashion--questions related to drinking-driving issues.

These constraints apply to many areas of scientific research, not only to experimentation as it relates to alcohol and road accidents. That now, after half a century of study, such constraints still limit the state of knowledge in this area seems surprising, if not disappointing.

In discussing experimental research findings we identify and acknowledge these methodological and other constraints. We do, however, accept the evidence as the best available. Replication is one of the building blocks of science; therefore, until such time as the results are extended (or refuted) by more definitive studies, the available evidence simply represents the present state of knowledge. At the same time, as discussed above, we have to recognize that experimental research on BAC and the effects of alcohol remains inherently indicative, not definitive.

2.1.3 Value and use of experimental findings. After reading the foregoing, the reader unfamiliar with scientific research on drinking and driving might conclude that results of experimental studies have little value and hardly any use in resolving legislative issues related to statutory BAC limits. On the surface, this conclusion has some validity. Few investigators have explored in a thorough way the spe-

cific issues under consideration. Our task in this report involved sifting through the hundreds of experimental studies that correlated BAC and the effects of alcohol on "driving-related" measures of human performance. Few if any studies can escape criticism on methodological grounds. Few addressed the legislative issues themselves directly and explicitly. How, then, are experimental findings to date of value and use in deciding the legislative issues?

We offer below a two-part answer to this important question. First, we briefly describe the nature of scientific research as a process of discovery. Second, we discuss criteria by which legislative issues related to statutory BAC limits can be resolved--in part--using present knowledge from experimental studies.

As a process of discovery, scientific research is, by design, careful (even painstaking), systematic, seemingly slow-moving, and, as viewed by nonscientists, never conclusive. For example, more often than not, research papers end with the sometimes aggravating plea for "more research", not with hard answers to pressing questions. Even more frustrating, perhaps, is that good research generates more new questions than definitive findings for the ones inspiring the original studies! This, then, reflects the nature of science itself. But, whereas scientists tend to be critical, they are not nihilistic. Scientific research, building on what is known as fact and advancing knowledge, is constructive, not destructive. Scientific research is a process of discovery, and it continually moves into previously unexplored or ill-defined areas as its raison d'etre. In doing so, scientists may appear to have little regard for, or to pay little attention to, practical questions that arise outside their "ivory towers". For example, the term basic research has negative connotations for policymakers, practitioners, and the public concerned about action, not "more research". Nonetheless, experts within the scientific community do appreciate the need to distill what is known for those required to develop and implement policy, plans, and programs. Thus, whereas ultimately science proves nothing, scientific research can and does provide reasonable certainty about problems and ways to resolve them

(Donelson 1983b). "Reasonable certainty" does not mean "conclusive proof". Practical problems and other real-world issues rarely demand such anyway. Scientific experts have the task, therefore, of weighing available evidence relevant to issues; determining whether or not that evidence does provide a sound basis for decisions (using the criterion of reasonable certainty); and offering their informed judgment concerning alternative ways to resolve the issues.

This report represents just such an exercise. We have emphasized what is known (and what is not known); discussed the limitations of present knowledge; and, based on our judgement, reached conclusions that we believe meet the criterion of reasonable certainty. We have not engaged in what some call a "wrecking exercise", in which past studies are meticulously dissected, roundly criticized for methodological weaknesses, and dismissed as worthless. This approach, though clearly feasible, serves no purpose for anyone interested in resolving the issues at hand.

We return to the question raised above--concerning the value and use of experimental data on alcohol's effects and BAC--by discussing the legislative issues in terms of the criterion "reasonable certainty".

The issue of lowering the statutory BAC limit to 50 mg% from 80 mg% itself raises a question: Do all (or even most) persons with BACs between 50 and 80 mg% have their ability to drive impaired by alcohol? By reviewing past studies, we can assess (1) the degree of alcohol's effects on relevant skills and behaviours in this BAC range and (2) the extent to which experimental subjects always (or just sometimes) respond adversely to alcohol in this concentration range. In light of cumulated facts, we can judge whether or not there exists reasonable certainty that BACs between 50 and 80 mg% do impair the ability to drive, and that all (or the great majority of) persons with such BACs should be covered by alcohol-impaired driving statutes (i.e., Section 236(1) of the Criminal Code).

The issue of multiple tiers in per se statutes (corresponding, for example, to "impairment" and "gross impairment" [or intoxication]) involves far more basic questions concerning BAC. For example, is BAC a true and reliable measure of alcohol's effects, that is, the degree to which the ability to drive is impaired by alcohol? Are all (or most) persons with higher BACs "more impaired" than those with lower BACs? Again, within limitations of present knowledge, we examine the reliability and validity of BAC as a quantitative measure of alcohol's influence on behaviour. We determine how confidently we can state that higher BAC ranges indicate greater impairment and, by implication, how just and fair more serious charges or more severe penalties would be for those with higher BACs. Experimental data on inter-subject variability related to alcohol effects and tolerance to alcohol play an important role in this analysis.

For both legislative issues, therefore, experimental research on alcohol and its effects on behaviour offers relevant and useful information. Despite their limitations, experimental findings provide valuable in-put to policy decisions regarding statutory BAC limits. They complement epidemiologic studies (discussed below) and represent one of two convergent lines of evidence for resolving these issues (see Section 2.3).

2.2 Epidemiology Related to Drinking and Driving

Epidemiology, traditionally speaking, is the scientific study of the distribution and determinants of disease in populations. The science of epidemiology evolved in response to epidemics of unknown origin and cause, which swept through and devastated whole communities. Thus, the discipline finds its roots in problems related to acute, infectious conditions like cholera. Its application today, however, extends to investigations of chronic, noninfectious disorders such as cancer and heart disease--and to the study of accidental trauma. "The methods of epidemiology are primarily observational. Unlike experimentation, which is characterized by intervention and in which efforts are made to control all but the one or two variables of interest, epidemiologic research attempts to observe as many factors as feasible in order to

develop hypotheses about their relationship to the event and about their interaction with each other" (Joscelyn and Donelson 1980a, p. 9). Epidemiologic research is a process that begins by describing the phenomenon in question, leads to forming hypotheses based in theory, and (if feasible) tests those hypotheses by means of "quasi-experimental" studies in the real world.

The general aim of epidemiologic research is to define how certain phenomena--for example, alcohol and road accidents--are related. "...The investigation of a relationship can be seen to progress from demonstration of statistical association to demonstration that the association is causal, and ultimately to ascertainment of its directness" (MacMahon, Pugh, and Ipsen 1960, p. 12). Road accidents, like some diseases, have many and multiple causes, including human, vehicular, and environmental factors. In studying the relationship between any one factor (e.g., alcohol) and road accidents, one has to take into account the contribution of other factors as well, which may in some cases relegate alcohol to a minor or negligible role in the causal sequence.

The researcher (and those who use the results of research) face the common pitfall of misleading conclusions based on "single-factor analyses" (Zylman 1968). As Wigle (1975) noted, the traditional notion of causality in disease ("one disease, one cause") has been an hindrance to the study of nonacute disease and noninfectious conditions in general. Haddon, Suchman, and Klein (1964) observed the same in the field of accident research:

> Ideally, the approach must be intentionally multifactorial and must avoid unsupported presuppositions as to the primary causes either of accidents in general or of those in the specific group under study. Unsupported presuppositions....have proved a stumbling block to many who, in discerning the unique contributions of their own disciplines, have attempted to explain essentially all accident phenomena in terms of the concepts and groups of variables with which they are customarily concerned. (p. 15)

MacMahon, Pugh, and Ipsen (1960) refer to the involvement of multiple factors in the etiology of events as "the web of causation", preferring this description over the common phrase "chains of causation", which tends to oversimplify. "In fact, the classical notion of cause, which was deterministic, has been replaced by the theory of probability. Probability statements indicate the likelihood or degree of certainty about events, and do not assume absolute certainty about their occurrence. Epidemiologic research findings are inherently probabilistic, measuring the degree and directness of association among various factors and the phenomenon under investigation" (Joscelyn and Donelson 1980a, p. 11).

In the context of highway (or traffic) safety, risk has been defined as the probability of a road accident and attendant losses. Beyond describing the prevalence of alcohol use and other factors in road accidents, epidemiologic research seeks to measure the relative risk of road accidents given the presence of a certain factor (e.g., alcohol) compared to the risk in its absence. To accomplish this, researchers have conducted studies comparing the frequency of alcohol use among persons involved in road accidents with those not involved (i.e., surveyed at roadside checkpoints). The degree to which alcohol in various concentration ranges is overrepresented in the accident population indicates the extent to which alcohol may increase risk of accident involvement, compared to, for example, the average nondrinking driver.

Although a relatively high prevalence of a factor among accident-involved drivers indicates a strong association, further in-depth study is needed to determine (1) how many of the crashes involving that factor were actually caused by it, and (2) whether other factors contribute to, or give rise to, the apparent association. One of the most common misunderstandings in the area of alcohol and road accidents is the reading of "alcohol-involved road accidents" to mean "alcohol-caused road accidents". Moreover, single-factor analyses focused on alcohol often convey the impression that but for the involvement of alcohol, none of the drinking-driving accidents would have occurred. Multi-disciplinary accident investigations (the so-called "clinical ap-

proach") show, however, that accidents due solely to the influence of alcohol appear rare; most often, a cluster of risk factors combine to precipitate the causal sequence, but for any one, the accident would not have happened (Terhune 1982; Treat et al. 1979; Perchonok 1977; Baker 1963,1960). Some percentage of road accidents involving alcohol would occur even in its absence. At present, estimates of that percentage are not precise (see Reed [1981]).

2.2.1 The state of knowledge: Overview. The epidemiology of alcohol and road accidents has ranged from anecdotal, descriptive accounts to well-designed, large-scale surveys to measure the increased risk of accident-involvement associated with alcohol. (See Jones and Joscelyn [1979a,b] for comprehensive reviews of the state of knowledge in this area.) Since 1938, when Holcomb reported the first "controlled" study of alcohol as a risk factor in automobile accidents, less than ten such surveys have been conducted. The small number of studies, along with a relative lack of depth in these investigations, has served only to demonstrate a "strong association" between BAC and the relative risk of accident-involvement. In other words, the more alcohol consumed, the greater the likelihood of having a road accident. For many, this utterly predictable finding satisfies. Nonetheless, data from these and other surveys indicate a much more complex picture than this simple result might suggest.

For example, Zylman (1968) discussed eight other factors (time of day, age, occupation, race, driving experience, drinking experience, marital status, and sex) associated with accident risk. As he noted, "that all uses of alcohol by all categories of persons in all highway situations are productive of very serious damage is questionable. There is a clear need to establish the nature of the particular uses, users and situations which are highly related to that damage, and to develop and verify means for adjustment" (p. 232). Ten years later, Jones and Joscelyn (1979a, pp. 99-103) reached similar conclusions, reflecting the pronounced lack of progress in this area. As summarized in another report prepared under this contract, "Characteristics of Drinking Drivers", information on personal and social characteristics of people who drive

after drinking and have road accidents--which may represent "root causes" of this persistent, widespread problem--is still fragmentary, unreliable, and inconclusive. The present state of knowledge does not adequately define "the nature of the association between alcohol and road accidents, for example, whether alcohol played a predominantly causal role in the occurrence of accidents or whether the presence and amount of alcohol simply indicated the type of people who engage in behaviour more likely to involve them in accidents" (Donelson 1983a, p. 16).

2.2.2 Methodological and other limitations of epidemiologic research. Perhaps the greatest limitation of epidemiologic research relates not to the quality of past studies but to the type and depth of surveys not done to date. As exploratory, descriptive research, early studies provided valuable data on alcohol (i.e., BAC) and other factors linked to increased accident risk. This kind of research, repeated in several countries, only goes so far in defining the alcohol-crash problem. For example, after decades of study, we have but rough estimates of the magnitude of the problem itself (Warren and Donelson 1982, pp. 76-79; Reed 1981; Zylman 1974). Similar to the literature on experimental research, epidemiologic research cannot give satisfactory answers to such basic questions as the following:

- What characteristics distinguish accident-involved drinking drivers from other drinking drivers who do not have accidents? Similarly, what characteristics do accident-involved nondrinking drivers have in common with corresponding groups of drinking drivers?
- At what BAC does the risk of accident involvement become significant independent of other factors, such as other drug use, alcohol tolerance, age, sex, driving experience, attitudes, risk-taking behaviour, etc.?
- What percentage of people with given BACs have an increased risk of accident involvement?
- What percentage of accidents of different severity (fatal, injury, property damage only) can be attributed directly to alcohol-impaired driving?

- How many people are killed, injured, and disabled due to drunk drivers each year?

These and other questions represent the "frontiers" of epidemiologic research in this area. Unfortunately, survey designs and methods required to advance the state of knowledge--beyond that achieved in the landmark study by Borkenstein et al. in Grand Rapids, Michigan, in the 1960's--have yet to be applied. Of interest, these same designs and methods are well established in other areas of research, especially for heart disease, cancer, tobacco smoking, and genetic disorders (e.g., prospective, longitudinal surveys; community-based cohort studies).

As with experimental research, epidemiologic studies providing the best available data do have methodological shortcomings. Many of these stem from practical constraints common to other social sciences, especially the difficulty of conducting surveys in the field:

- lack of cooperation by persons surveyed;
- number of cases sampled too small for detailed statistical analyses;
- surveys of limited geographical scope, compromising generalization of findings to other locales;
- few variables beyond age, sex, and BAC measured; and
- accidents other than those involving one or more fatalities rarely studied.

Other limitations concern the failure of investigators to perform "in-depth analyses of the conditions surrounding the crashes...to support stronger statements about causation. While such analyses have been made of the roles of many other factors, the role of alcohol has not been subject to the same close scrutiny in the studies" (Jones and Joscelyn 1979a, pp. 33-34). That reviews of the state of knowledge depend greatly on four or five studies, whose results have been analyzed and re-analyzed over the past decade, points to the continued need for more definitive surveys that capture more in-depth, comprehensive data than those now available.

2.2.3 Value and use of epidemiologic findings. Although past epidemiologic research has not adequately defined the nature and magnitude of the alcohol-crash problem, the findings of past surveys have great value in examining the legislative issues considered in this report. First, the traditional emphasis on BAC and accident risk has generated data that specifically address key questions (Are BACs between 50 and 80 mg% strongly associated with an increased risk of accident involvement? Do persons with BACs greater than 150 mg% have a greater risk of accident involvement than persons with lower BACs?). Second, detailed reporting of findings has made available raw data for analyses specific to the purposes of the present study. By applying statistical methods to these data, we can calculate confidence limits for BAC ranges in question (in other words, the precision of risk estimates for BAC ranges). Third, data on variables other than BAC permit our defining the relationship of BAC and accident risk for sub-groups of drinking-drivers. These analyses allow preliminary judgements about the applicability of BAC-risk estimates for different groups of drinking-drivers.

2.3 Experimentation and Epidemiology: Complementary Approaches and Converging Lines of Evidence

Experimental research on the effects of alcohol, despite its limitations, has clearly shown that this drug can impair the ability to drive. Experimental research has also served to describe how alcohol can affect driving, for example, by identifying specific mechanisms through which alcohol influences behaviour. Precise laboratory tests have detected statistically significant decreases in the performance of driving-related skills by persons with relatively low BACs. These studies indicate that even small amounts of alcohol have the potential to impair driving. Nevertheless, although findings of strong effects demonstrate potential risk to traffic safety, findings of "statistically significant" effects may not indicate a substantial risk potential, especially if the magnitude of measured effects is not great (Donelson et al. 1980; Simpson and Warren 1981). To determine whether amounts of alcohol that produce lesser but significant effects actually impair the ability to drive, surveys of people who drive after drinking are required.

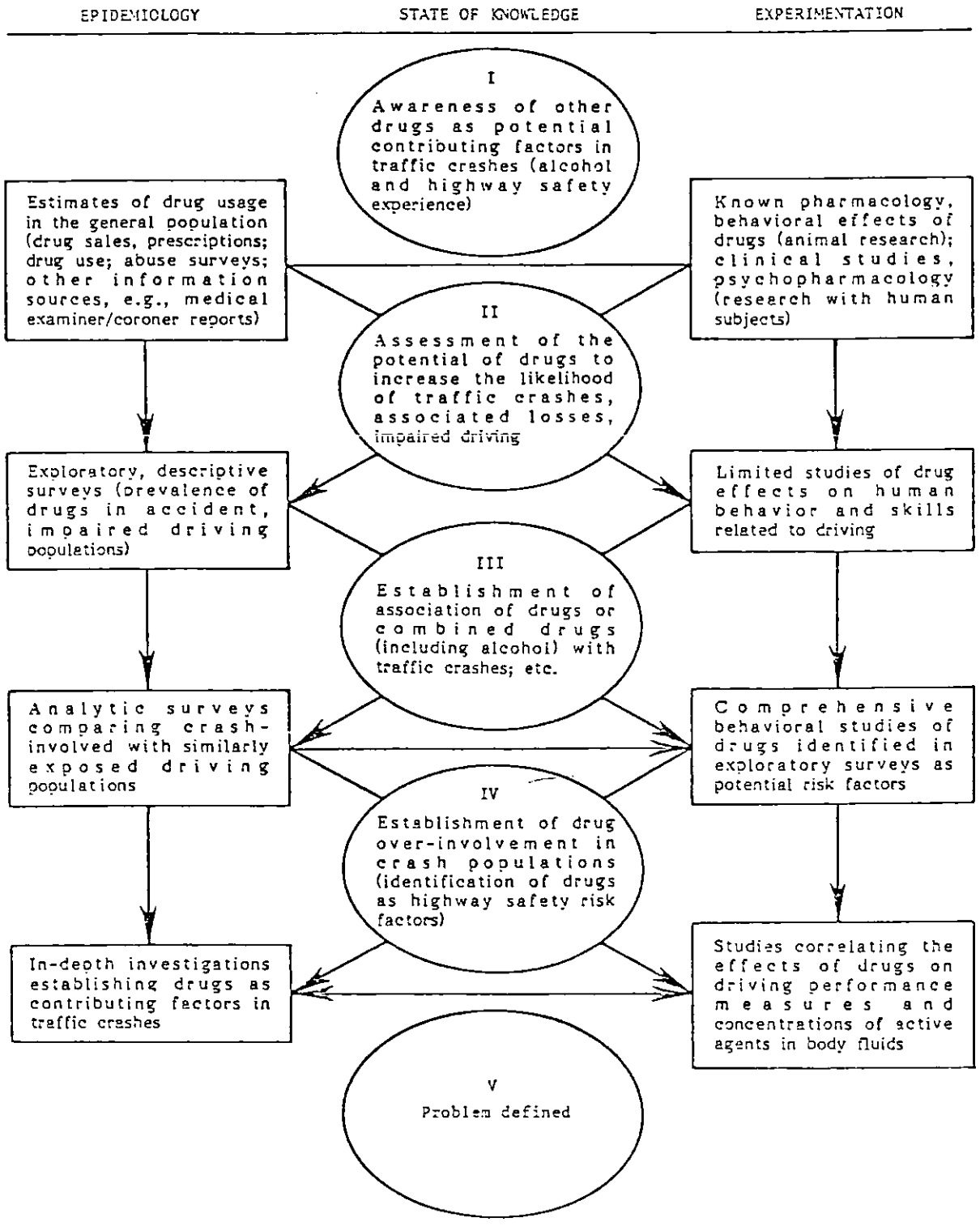
Epidemiologic research, or "field studies", have in turn demonstrated a strong association between the consumption of alcoholic beverages by drivers and road accidents. Limited in-depth studies have shown that various proportions of road accidents, depending on severity, can be attributed (at least in part) to alcohol impairment. Some case-control surveys--ones that compare groups of accident-involved drivers with similar groups using the roads at the same time of day and place--have indicated increased accident risk associated with moderate BACs (e.g., 50 mg% to 80 mg%). These studies, however, did not provide evidence ruling out the possibility that, at low BACs, "it was not the alcohol per se, but rather, other characteristics of the individuals who drove after drinking, (i.e., their irresponsibility or reckless attitude) that involved them in collisions--in other words that the alcohol itself was purely coincidental" (Simpson and Warren 1981, p. 195). To resolve this issue, experimental studies that examine these "other characteristics", and their possible contribution to risk of collision are needed. As MacMahon, Pugh and Ipsen (1960) pointed out:

> The fact that the contributions of other disciplines are required in addition to those of epidemiology is implicit in the statement that the methods of epidemiology are predominantly observational. Since the most convincing test for causal relationship is usually through experiment, the methods of other disciplines are needed for more critical examination of suspected causal relationships and for the investigation of their mechanisms. (p. 10)

The paragraphs above describe the complementarity of experimental and epidemiologic research on drinking and driving. Figure 1 graphically portrays the inter-relationship of these basic approaches for the overall process of defining the problem of drugs (including, of course, alcohol) and highway safety. The results of experimentation and epidemiology in the area of drinking and driving form two lines of converging evidence. Experimental and epidemiologic findings taken together, have established that alcohol in concentrations above 80 mg% impairs the ability to drive in most persons and also that alcohol is the single most common risk factor in road accident causation.

FIGURE 1

PROBLEM DEFINITION IN DRUGS AND HIGHWAY SAFETY AS A PROCESS: COMPLEMENTARITY OF EPIDEMIOLOGIC AND EXPERIMENTAL RESEARCH



(From Joscelyn, Donelson, et al., p.17)

In the following sections (3.0 and 4.0), we assess the extent to which these same lines of converging evidence assist in resolving the legislative issues defined above: in other words, whether present knowledge provides answers to the questions with reasonable certainty.

3.0 LOWERING THE STATUTORY BAC LIMIT

This section summarizes information from scientific studies that pertain to the issue of statutory BAC limits in so-called "per se" laws. These laws proscribe operating (or having care and control) of a motor vehicle with a BAC exceeding a certain limit as measured by a chemical test. Specifically, this section addresses the questions of whether the BAC limit now specified in Section 236 of the Canadian Criminal Code should be lowered from 80 milligrams of alcohol per 100 millilitres of blood (80 mg%) to 50 mg%, based on empirical data. Such data include (1) the degree to which alcohol adversely affects (or "impairs") the ability to drive and related skills (experimental research); and (2) the extent to which BACs between 50 and 80 mg% increase risk of road accidents (epidemiologic research). In addition, we identify other considerations that may influence the resolution of this issue.

3.1 Experimental Evidence

Prior to the advent of methods to measure the amount of alcohol in body fluids, police officers had to depend solely on their own judgment in assessing a driver's sobriety or lack thereof. Legislation authorizing blood and breath tests provided the means for obtaining objective evidence on blood and breath alcohol concentrations in drivers suspected of driving while impaired. Breath tests are advantageous because they are easily administered, relatively noninvasive, painless, and generally reliable. Such tests also reduce reliance on subjective judgments of behavioural impairment. In fact, per se statutes based on blood or breath tests effectively eliminate any behavioural criterion of impairment due to alcohol. Having an alcohol concentration (BAC) in excess of the statutory limit while driving has been defined as an offence in and of itself, even if a driver does not appear overly affected by the alcohol consumed. The assumption (and presumption) behind such a law is that a BAC exceeding the specified value constitutes impairment of the ability to drive. When we consider lowering the statutory BAC limit, we have to concern ourselves not only with the simple numerical value of that limit, but also how much that BAC impairs the ability to drive in how many (and which kinds of) people.

The following sub-sections address this issue by discussing the driving task and experimental findings on how and to what degree alcohol can affect this task and related skills.

3.1.1 The driving task. As with other routine activities that occupy less than our full attention, so driving seems to involve little effort on our part. Behavioural psychologists describe such tasks as "overlearned". Nevertheless, when we drive, we integrate and coordinate many skills and actions. Thus, driving, although familiar and usually straightforward, is a complex task. Perhaps newly licenced, novice drivers appreciate this most. At any rate, as an introduction to how alcohol influences the ability to drive, we describe a model of the driving task itself and some of the processes involved in performing it.

Driving involves dynamic and continuous interactions among the driver, the vehicle, and the environment. The task requires the swift and accurate transfer of information from the environment to the driver. The driver processes the information; decides if, how, and when to respond; and translates decisions into motor actions, which guide the vehicle. Figure 2 illustrates an "information-processing model" of driving. Information from the external environment must initially be sensed and perceived by the driver. Once organized into meaningful and relevant components, this information is then transferred to the decision mechanism which, depending on the immediate goals and present state of the individual, leads to selection of a course of action in response to the information. This decision is then fed to the effector mechanism that selects and executes a corresponding motor response. This information processing system includes both internal and external feedback loops to assist in the execution and correction of responses. Each information processing stage is constrained by both time and quantity of information, i.e., it takes time to process each bit of information and only so much can be handled at one time.

Two types of human factors operate in this model. Enduring traits, such as attitudes, personality, and motor capability are assumed to be relatively stable factors within an individual. Each time the indi-

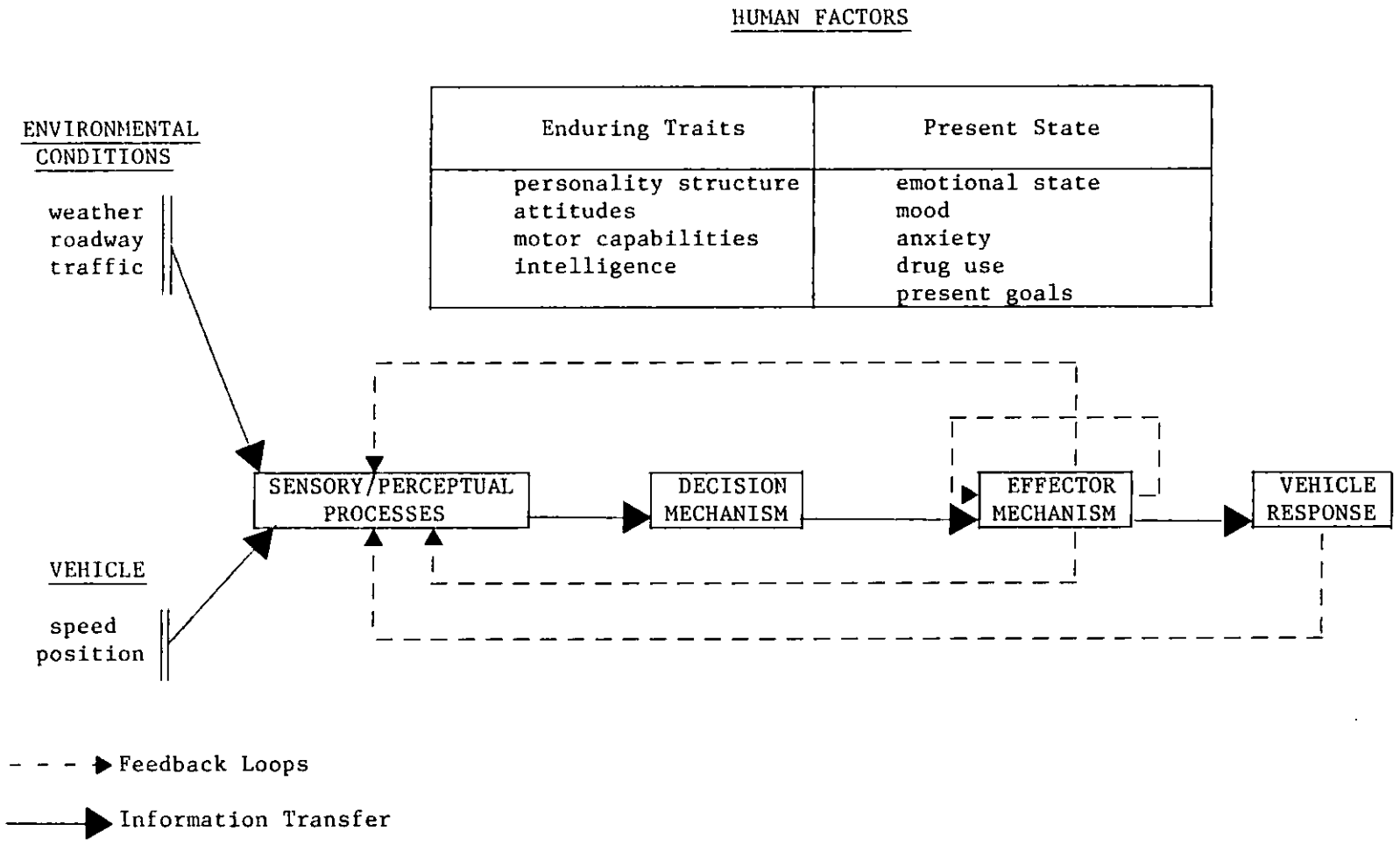


Figure 2

An Information-processing Model of Driving

vidual drives, these same factors apply. The present state of the individual, influenced for example by emotions, mood, and drug use, exerts transient effects on driving performance, which may vary in intensity both within and between driving episodes. The interaction of the present state and enduring traits of the individual also affect the efficiency of information processing in driving.

As an everyday, simple example, imagine a driver approaching a stop sign. The driver must first of all see the stop sign and recognize it as such. This information is then used to help decide the course of action to be taken. Assuming the driver chooses to stop, the decision is then transferred to the effector mechanism for action. The appropriate action pattern is selected (i.e., applying pressure to the brake pedal with the foot) and the motor units (muscles) are instructed to respond. Both the act of braking as well as the slowing of the vehicle provide feedback that help guide and correct the movement.

The information-processing model of driving behaviour assists in defining the nature of the task and in identifying how alcohol may interfere with driver performance. Lacking methods to replicate real-world driving and to measure effects on the ability to drive, researchers have to disassemble the driving task into hypothetical parts for examination and study.

The following sub-sections review the experimental evidence concerning the effects of alcohol in relation to this model.

3.1.2 General effects of alcohol. Beverage alcohol is rapidly and completely absorbed in the upper gastrointestinal tract. Once absorbed, alcohol is uniformly distributed throughout all body fluids, crossing both the blood-brain and placental barriers. The elimination of alcohol is accomplished primarily through metabolism in the liver; only about 5% of alcohol is excreted unchanged through the breath and urine. The metabolism of alcohol proceeds at a relatively constant rate (approximately 15 mg% per hour) which is, for the most part, independent of the concentration of alcohol in the blood. Although substantial

individual differences in this rate have been observed (Kalant 1970), it should be noted that even after prolonged heavy alcohol consumption, this rate of elimination is still extremely slow. The absorption of alcohol is not constrained by such restrictions. Therefore, it is possible to achieve a blood alcohol concentration (BAC) of 80 mg% in less than an hour; the elimination of this concentration of alcohol would usually require more than 5 hours. The point here is that BAC can rise more quickly than it falls.

Little is known of the exact nature by which alcohol produces its primary pharmacological effects. The sedative, or depressant, effect of alcohol is generally thought to result from the drug's inhibiting or slowing of brain functions, particularly those dealing with alertness and wakefulness (i.e., the brain stem reticular formation). Thus, for many people, alcohol relieves tension or anxiety, and facilitates social interactions (e.g., Wallgren and Barry 1970). The euphoric effects often associated with alcohol consumption appear to depend upon the expectations and psychological state of the individual.

In general, the pharmacologic effects of alcohol are proportional to the concentration of the drug in the body. This relationship is, however, neither exact nor undirectional, for it has been repeatedly shown that small amounts of alcohol can produce a paradoxical improvement in performance (e.g., Perrine 1973). This is not to say that "two drinks make better drivers". Nonetheless, some people in some circumstances do perform certain tasks more proficiently after consuming small amounts of alcohol. This biphasic action of alcohol--improved performance at low BACs, decreased performance at higher BACs--complicates the relationship between BAC and performance changes.

3.1.3 Sensory/perceptual processes. Of all the sensory modalities, vision is clearly the most important for driving. Hence, any disturbance of the visual system could be critical for the safe operation of a motor vehicle. Contrary to popular wisdom, the alcohol literature is in general agreement that simple visual functions are relatively insensitive to the influence of low to moderate BACs. Static

visual acuity, binocular coordination, depth perception, and peripheral vision are not significantly affected until BACs in excess of 100 mg% (Perrine 1973; Wallgren and Barry 1970). Alcohol rarely produces blurred and/or double vision at BACs below 100 mg%.

Dynamic visual acuity (the ability to recognize and follow moving objects) is a perceptual skill correlated with accident involvement (Burg 1970). Concentrations of alcohol as low as 20 mg% have been shown to produce statistically significant decrements in this ability (Honneger et al. 1970). The relationship between dynamic visual acuity and BAC is complex, however, improving at moderate alcohol concentrations (80 mg%) before it deteriorates again.

Several studies indicate modest reductions in the ability to detect visual signals at BACs around 80 mg% (Brukhuisen and Jongman 1972). An important aspect of visual sensitivity is the location of the signal. It was previously stated that peripheral vision was relatively unaffected by moderate doses of alcohol. However, when a person occupies the central visual field with another task, alcohol produces a progressive decline in the ability to detect signals from the periphery (Hamilton and Copeman 1970). The magnitude of this effect increases from a 6% deficit at very low BACs (20 mg%) to 20% at moderate concentrations (50-80 mg%) and a 36% reduction at a BAC of 100 mg%. The evidence indicates that when an individual under the influence of alcohol is focussing on a central task, fixation on this task may occur. Eye movements to the periphery become less frequent, less accurate, and less expansive. This sometimes results in a failure to perceive or recognize objects and signals outside the central visual field. The reduction in functional visual field, or tunnelling, resembles the inability of novice drivers to use peripheral vision in performing the driving task.

Other visual functions affected by alcohol include adaptation to darkness and glare recovery (Mortimer 1963). Deficits in these abilities only become noticeable at BACs in excess of 80 mg% and are more pronounced in older individuals.

3.1.4 Motor skills. Experimental measures of ataxia or body sway are sensitive to the effects of alcohol over a wide range of BACs (Franks et al. 1976; Fregley et al. 1967). Alcohol's effects begin to appear in the range of 40-60 mg%. The reliability of these effects has led to the adoption of this measure as a rough indicator of BAC level by law enforcement agencies. Ataxia per se, though, has little demonstrable relevance to driving ability.

A multitude of studies have demonstrated that even low doses of alcohol can significantly increase reaction time to both visual and auditory stimuli (e.g., Carpenter 1959; Huntley 1972). The magnitude of decrements depend on the type of task and the number of response alternatives. In general, when the task involves a decision as well as a motor response, the effects of alcohol become noticeable at BACs of 50-70 mg%.

Visual-motor coordination has often been assessed by means of some form of tracking task. Several studies have reliably demonstrated that BACs as low as 50 mg% produce significant performance decrements. As BAC increases, performance deteriorates progressively, resulting in 20-30% slower performance at 80 mg% (Beirness and Vogel-Sprott 1982; Chiles and Jennings 1970). Both speed and accuracy are important components and often one can be maintained at the expense of the other. As task demands become increasingly complex, alcohol effects on performance become even more pronounced (Moskowitz 1973). For example, when a signal detection task is simultaneously performed with a tracking task, the efficiency of tracking decreases and fewer signals are detected (Moskowitz and De Pry 1968). It appears that the time-sharing capability is decreased by BACs as low as 50 mg%. This may occur either because alcohol imposes limitations on the already fixed capacity of the brain to process information or because the rate of information transmission is slowed by alcohol, or both. This implies that simple tasks involving little demand for information processing should be relatively unaffected by moderate doses of alcohol. As task demands become increasingly complex and greater amounts of information must be processed, the capacity of the information processing system can become overloaded,

ultimately resulting in the loss of some information due to processing failure.

This model of alcohol effects has direct applicability to driving. The ordinary information processing demands of driving seem quite minimal for the experienced driver. After consuming a moderate dose of alcohol, the individual will probably remain capable of performing the task with the same degree of efficiency. However, if demands on information processing abruptly increase, such as in heavy traffic, adverse conditions, unfamiliar surroundings, or unexpected situations, then the influence of alcohol may result in some potentially important information being lost. Performance in these kinds of circumstances may reflect this effect of alcohol. The same is true, of course, for nondrinking-drivers who panic and for novice drivers. For example, inexperience requires more attention devoted to the mechanics of the driving task. Hence, most of the information processing capacity is consumed with performing the task. Even minor increases in processing demands can overload the system. This is an argument is favour of a "tiered statute" that would set a lower BAC limit for novice drivers.

Closed-course driving studies may have greater validity as a method of determining the extent of alcohol effects on driving performance. In general, such studies (Bjerver and Goldberg 1950; Huntley 1973; Attwood et al. 1980) indicate some performance deficits at BACs as low as 50 mg%, with some reporting effects at 30 mg% for some individuals. Alcohol-induced deficits include abilities such as cornering, stopping efficiency and smoothness, time to respond to relevant cues, more numerous and extensive variations in steering and velocity as well as an increase in the number of procedural errors.

Analyzing the effects of alcohol on various independent tasks offers information on the types of skills and behaviours affected by alcohol. This approach tells us little about driving performance as an integrated task. Attwood et al. (1981) made this point in describing the computer-monitored driving performance of volunteers at BACs between 50 and 90 mg%.

> The differences in behaviour between the drug and placebo conditions that we were able to isolate were so subtle that they would hardly be noticed by observation. Only when the outputs from a number of sensitive transducers are combined and analyzed with the aid of multivariate techniques do the differences between drug conditions become evident. (p. 23)

Attwood et al. thus confirm what law enforcement officers observe daily: that most persons with moderate BACs can (if they choose) drive in a manner not indicative of behavioural "impairment" by alcohol. Obvious effects on behaviour that call attention to alcohol-impaired driving (e.g., weaving, frequent and uncalled-for speed changes, driving very slow or "too carefully") are not necessarily present. Therefore, most drivers with moderate BACs would be unlikely suspects for routine enforcement of alcohol-impaired driving laws. This is reflected in impaired-driver statistics, which show average BACs upon arrest exceeding twice the legal limit--or more!

One intuitively appealing hypothesis is that even though it is difficult to distinguish the performance of sober and mildly intoxicated drivers in everyday situations, under emergency conditions the effects of alcohol will probably be more pronounced. However, Laurell (1977) examined the response to an unexpected driving situation and found no significant differences between the performance of drinking subjects (BAC = 50 mg%) and those in the control group. Similar findings were reported by Taylor and Stevens (1965) using BACs of about 65 mg%.

3.1.5 Cognitive functions. Experimentally confirming common experience, at relatively low BACs (i.e., 30-50 mg%) individuals report feelings of pleasure and euphoria. These feelings give way to lack of concentration, increased fatigue, and depression beginning at BACs around 80 mg% (Wallgren and Barry 1970). These effects have been reported for social drinkers, subject to individual differences, expectations, and the extent of prior drinking (Mello 1972).

Violent and aggressive behaviours may occur following alcohol consumption (Sobell and Sobell 1975). The extent and reliability of this

effect are still under investigation. Present knowledge indicates that there is a tendency, after drinking, towards aggressive behaviour in some individuals (usually those with a history or predisposition for violent behaviour) in some situations. Alcohol seems to have a causal (if only partial) role in this regard (Zeichner and Pihl 1979).

Self-evaluated performance becomes unreliable under the influence of alcohol. Experimental subjects recognize that they have consumed alcohol, but they consistently err in judging the effects of the drug on their performance. Some over-estimate, some under-estimate how well they perform (Vogel-Sprott 1975).

Many believe that alcohol produces an increased willingness to accept risky alternatives even when the objective probabilities associated with each action are made explicit. Some researchers have reported that BACs of 40-100 mg% produced increased risk-taking (Goodwin, Powell and Stern 1971) whereas others have found no such effects (Browning and Wilde 1979). In a lengthy discussion of the issue, Allen et al. (1978) concluded that risk-taking increases with BAC and that the higher incidence of risk-taking results from deficits in perceptual and motor capabilities, not increased acceptance of risk. This issue remains unresolved as it relates to alcohol-impaired driving.

Of the few studies available, all have concluded that the decision-making, or the "response-selection process", is vulnerable to the influence of alcohol (Moskowitz and Burns 1973; Tharp et al. 1974). The effects appear more pronounced when the number of response options is large and the alternatives are novel (Huntley 1974). This evidence suggests that alcohol reduces the efficiency of information processing (i.e., decision-making) and that situations involving uncertainty with many response alternatives will exacerbate these effects.

3.1.6 Factors that influence the effects of alcohol. An impression gained from experimental research is that alcohol produces performance deficits proportional to the amount of alcohol consumed. Individual and situational differences, however, contribute greatly to

the variability of responses. This variability renders it virtually impossible to predict the extent of alcohol's effects on any particular individual. This section briefly outlines some factors known to alter the influence of alcohol.

One factor contributing to variability of performance is the ability to compensate for the detrimental effects, which reduces the extent to which alcohol affects behaviour. The specific nature of this compensatory response is not completely understood. Some regard it as a form of homeostatic mechanism that counteracts disturbances produced by drugs (Siegel 1982; Solomon 1980). Some individuals can also invoke this compensatory response in certain critical situations (Carpenter 1962; Jellinek and McFarland 1940; Perrine 1973; Wallgren and Barry 1970). In fact, in studies that involved incentives to perform well, it has been clearly demonstrated that individuals offered incentives can compensate for and reduce the impairing effects of alcohol on performance (Beirness and Vogel-Sprott 1984; Damkot et al. 1983; Myrsten et al. 1979).

The compensatory response has also been proposed as the primary mechanism responsible for tolerance (Beirness and Vogel-Sprott 1984). In the short term (i.e., for most social drinkers), this compensatory response produces a form of "behavioural tolerance" to some of the more common disruptions in performance resulting from the ingestion of moderate amounts of alcohol. This phenomenon appears specific and selective for certain tasks or behaviours as well as situations. Hence, an individual who shows no behavioural disturbances after consuming a given amount of alcohol in one situation, may not be able to "hold his liquor" quite so well in another. Further research is required to investigate the magnitude and duration of this compensatory response and determine how behavioural tolerance is acquired in social situations.

Another type of tolerance can be demonstrated after a single dose of alcohol. Acute tolerance is observed as a smaller drug effect when BAC is falling compared to the effect observed at the same BAC when the concentration is rising (Hurst and Bagley 1972; Vogel-Sprott 1976).

This indicates that alcohol-induced changes in performance will be greater during the absorption phase, when BAC is rising. Acute tolerance may also be the result of individuals compensating for the effects of alcohol after peak BAC has been attained.

More studied and better defined is that tolerance associated with drug dependence and acquired through chronic consumption of large volumes of alcohol (Jellinek 1960). Tolerance of this type has been repeatedly demonstrated in studies that show heavy drinkers (e.g., alcoholics) display less impairment following a given dose of alcohol than moderate drinkers or abstainers (e.g., Goldberg 1943; Moskowitz et al. 1974). People who consume large amounts of alcohol regularly and frequently will have higher BACs before substantial effects of alcohol appear.

Women, as a group, drink less than men (Cahalan, Cisin, and Crossley 1969; Vogel-Sprott 1983). Anecdotal evidence suggests that they do so because they are more affected by alcohol than men. In fact, after one considers the lower proportion of body fluids in women, the reason for this observation is that they reach a higher BAC than a male of the same body weight after consuming the same amount of alcohol. There is little evidence to suggest that females are more adversely affected than males at equivalent BACs when drinking habits and other variables are controlled.

Interactions between age and alcohol appear complex. Some researchers have demonstrated improvements in performance following alcohol consumption in older individuals and deficits in younger subjects (Wilson, Barboriak, and Kass 1970). Others indicate that older individuals experience more impairment on some tasks than younger subjects (Barrett and Vogel-Sprott 1984). Not known is to what extent these effects can be attributed to higher BACs attained by older subjects or to the influence of "acquired" tolerance.

Different levels of skill brought to a task have often been suggested as a source of variability in alcohol effects. Highly skilled or experienced individuals were thought less susceptible to disruption by

alcohol than those less experienced or skilled (Jellinek and McFarland 1940; Jones 1972; Tarter et al. 1971). This hypothesis, for example, is frequently invoked as an explanation of the "young driver problem". But the situation is not as simple as once believed, due to such confounding factors as age and drinking experience, which complicate the issue. In a recent study that controlled for these factors, skill levels did not affect the degree of performance decrements produced by alcohol consumption (Beirness and Vogel-Sprott 1982).

3.1.7 Summary and discussion. At present, Sections 234(1) and 236(1) of the Criminal Code read in part as follows:

> 234. (1) Every one who, while his ability to drive a motor vehicle is impaired by alcohol or a drug, drives a motor vehicle or has the care or control of a motor vehicle, whether it is in motion or not, is guilty of an indictable offence or an offence punishable on summary conviction...
> (emphasis added)
>
> 236. (1) Every one who drives a motor vehicle or has the care of control of a motor vehicle, whether it is in motion or not, having consumed alcohol in such a quantity that the proportion thereof in his blood exceeds 80 milligrams of alcohol in 100 millilitres of blood [80 mg%], is guilty of an indictable offence or an offence punishable on summary conviction... (emphasis added)

Section 234(1) is an example of a "behaviour-based" alcohol-impaired driving statute as the phrases "ability to drive a motor vehicle" and "impaired by alcohol" suggest. To obtain a conviction under this statute requires evidence not only of the consumption of alcohol by the accused but also of behaviour or actions indicative of alcohol impairment. Partly because the terms ability to drive and impaired are vague and have no operational definition, courts have encountered difficulties. Even evidence that defendants had BACs in ranges normally presumed to impair the ability to drive (for example, BACs exceeding 150 mg%) has often proved insufficient to secure convictions.

These and other difficulties led to the enacting of per se statutes to complement existing behaviour-based ones, such as Section 236(1). These statutes do not refer at all to behaviour related to driving. Per se

statutes make it an offence simply to have, under the circumstance described, a BAC exceeding the specified limit (i.e., 80 mg%). Implici in per se statutes, however, is the intrinsic link between the specifie limit and alcohol impairment of the ability to drive. Without thi link, per se statutes would have little meaning and no inherer justification. If we consider changing the statutory BAC limit (in thi case, lowering it), we then also have to re-examine the strength c association between any proposed new limit and behaviour-based criteria This we have done above in terms of experimental evidence, which relate most directly to alcohol's effects on behaviour.

The word "impair" means to make worse or reduce. This implies a chang from some criterion in a negative direction or in a detrimental fashior Experimental researchers "operationalize" their definition of impairmer by establishing a base-line measure of performance for the "drug-free or "sober" condition. They compare performance of tasks under th influence of, for example, alcohol, with base-line performance. In thi way, impairment of performance due to alcohol can then be evaluated c an individual or group basis. Impairment is not an absolute; it i relative to some criterion.

This approach to studying the effects of alcohol--measuring changes i performance due to alcohol relative to standards or norms of performanc for identical, but alcohol-free, conditions--works well with discrete well-defined skills. Laboratory tests are readily available for suc skills as reaction time, sensory-perceptual functions, and the like. A discussed at length in Section 2.1.2, however, the ability to drive i not discrete or well-defined. Nor do present laboratory or othe techniques reproduce the driving task adequately for studying th effects of alcohol on the ability to drive. Existing technology coul be, and has been, applied to developing tools for such studies c real-world tasks and the effects of alcohol. To date, this is not th case for the driving task.

Researchers have circumvented the issue of reproducing the driving tas by developing models of real-world driving and by identifying skills an

abilities important to competent, safe performance. They have disassembled the driving task into component parts; studied each "part" under alcohol and nonalcohol conditions; and "reassembled" the results to describe the possible effects of alcohol on real-world driving. The difficulties (and dangers) inherent in this approach have been well documented (Huntley 1973; Moskowitz 1973; Perrine 1973) and were summarized in Section 2.1.2. The question that often remains unanswered is whether or not the effects of alcohol on skills and abilities isolated for study are definitive of alcohol's influence on actual driving.

The ability of the researcher to manipulate or control the conditions of an experiment often compounds the artificiality of the methods employed. For example, eliminating, or controlling for, other factors that influence the ability to perform tasks helps to increase the precision of measuring alcohol's effects. At the same time, such experimental control widens the gap between the laboratory and the real world. Thus, many of the strengths of experimental research become its weaknesses when we wish to generalize or to apply research findings to actual driving.

We re-emphasize these considerations because uncritical reading of experimental findings can lead directly to simplistic and erroneous conclusions. In this context, we note another potential pitfall in assessing the import of experimental research. Even in carefully controlled laboratory studies, subjects differ in their responses to alcohol, not only among others in a common group, but also compared to themselves at different times. The degree of inter-subject and intra-subject variability tends to increase with the effects of alcohol. Perhaps the most common effect of moderate amounts of alcohol is the resultant increase in performance variability (e.g., Perrine 1973). Moreover, this observed variability appears to increase with rising BAC (Levine, Kramer, and Levine 1975). In summarizing the findings of experimental studies, it is common practice to report the average decrease (or increase) of performance at an average BAC. This practice, however, conceals the variability of the effects of alcohol in groups of subjects. At low to moderate BACs, some individuals may show little or

no change in performance skills whereas others will appear much more affected. Nonetheless, some might interpret the finding that alcohol decreases the performance of a certain skill 20% to mean that alcohol impairs the ability to drive of all persons with that BAC by 20%. We have to avoid such interpretations here, given the sensitivity of the issue and the serious consequences of conviction under Section 236(1).

With these cautionary notes in mind, we can summarize the foregoing discussion of the effects of alcohol on sensory, motor, and other functions related to driving and offer some conclusions based on experimental evidence.

Many of the different effects of alcohol begin to appear in the range of BACs between 30 and 80 mg%. The magnitude of alcohol effects in this range is generally small. Although many individuals do not perform certain tasks as well as when alcohol-free, many others do not show any decrements in performance. Moreover, many functions, such as perceptual skills, are not substantially altered until higher concentrations of alcohol are reached.

We can conclude, therefore, that present experimental evidence clearly shows that BACs between 50 and 80 mg% can affect performance of certain skills and behaviours related to driving. Most measured effects, given the design and methods used, are adverse. The lack of valid methods to assess alcohol's effects on the ability to drive--which involves many different functions and skills--precludes definitive judgments on whether BACs in this range so influence the ability to drive as to constitute "impairment". For example, some vehicle-based studies indicate that people with moderate BACs can drive in a normal, safe, and prudent manner. The variability of responses to alcohol, however, makes it just as wrong to state that no one is impaired between 50 and 80 mg% as it is to state that everyone is impaired. Perhaps the central question is the following:

- What percentage of people with BACs between 50 and 80 mg% have their ability to drive impaired by alcohol?

Although this question also has no definitive answer (even to estimate ranges of percentages would appear highly speculative), the best available evidence indicates that many persons do not have their ability to drive impaired at BACs between 50 and 80 mg%. The question above can be rephrased for policymaking and legislative purposes:

- Is it acceptable (i.e., fair and just) to make it a criminal offence for everyone to drive with a BAC between 50 and 80 mg% when many (and possibly most) people may not have their ability to drive impaired by alcohol in this range of concentration?

Some might argue that any effect of alcohol is, by definition, impairing, and (by extrapolation) that any positive BAC (i.e., greater than zero) would impair a person's ability to drive. Such arguments if used to support legislation setting the statutory limit to zero BAC, would probably receive little or no consideration. This line of reasoning, however, differs only in degree when BAC limits lower than 80 mg% are proposed. We can assume that a higher percentage of people have their ability to drive impaired at BACs between 50 and 80 mg% than between 0 and 49 mg%. Nevertheless, given the consequences of conviction under Section 236 of the Criminal Code--a criminal record, temporary loss of driving privilege, fine, increased insurance rates, and less tangible social and personal losses--we question whether experimental findings give us sufficient confidence that such punishment fits the "crime", especially if many persons so penalized were not actually impaired at the time of arrest. We conclude that such evidence as produced to date do not support the lowering of the BAC limit from 80 to 50 mg%. It is not reasonably certain that all, or even most persons with BACs in that range have their ability to drive impaired by alcohol under the present meaning or intent of the law.

We note here that persons judged to have their ability to drive impaired by alcohol at concentrations less than 80 mg% can be arrested and convicted for that offence under Section 234 of the Criminal Code. We find it appropriate that this section be employed in such cases, since the weight of experimental evidence, at least, calls into question the

validity of any per se statute with a BAC limit less than 80 mg%. To consider chemical test results showing a BAC up to 80 mg% as irrefutable evidence of an offence implicitly that of alcohol-impaired driving is, in our opinion, arbitrary and capricious.

As we discussed in Section 2.0, experimental studies on the effects of alcohol provide one of two bodies of knowledge relevant to this legislative issue. Although experimental evidence does not adequately support the case for lowering the BAC limit from 80 to 50 mg%, epidemiologic studies may indicate that BACs in this range are strongly associated with increased risk of accident involvement. Findings of this kind would complement and extend experimental data showing that moderate concentrations of alcohol do have at least some effect on driving-related skills. In the following section we examine the extent to which epidemiologic evidence supports the case for lowering the statutory BAC limit.

3.2 Epidemiologic Evidence

The findings of epidemiologic research discussed below relate to whether or not BACs between 50 and 80 mg% increase the risk of accident involvement compared to that of the average nondrinking driver. Epidemiologic studies that address this issue compare accident-involved drivers with a "control" group, for example, drivers sampled in roadside surveys at the same time and place of prior accidents. The number of studies done to date using this method is small. They differ in geographic location, year completed (1938 to 1979!) and severity of accident investigated. Nonetheless, the results of these surveys, taken together, provide the best available data for analysis.

We approach this discussion by first defining relative risk of accident involvement. Next, we consider the precision of estimates of relative risk as a function of BAC. We follow these introductory topics with a review of findings that relate relative risk to BACs between 50 and 80 mg%. We then examine other factors that also influence relative risk of accident involvement as a function of BAC. In this way we assess the

reliability and validity of BAC as a measure of relative risk. Finally, we discuss the implications of epidemiologic evidence for resolving the issue of lowering the statutory BAC limit.

3.2.1 Relative risk of accident involvement. The term risk, in the parlance of science, means the likelihood, or probability, of an event or condition. The risk of road accidents can be estimated, but only very indirectly. A common estimate is the frequency of fatal road accidents per "vehicle-kilometer-travelled". The number of fatal road accidents is reliably recorded. The number of kilometers travelled by vehicles, however, is calculated based on fuel-sales data and estimates of the average number of kilometers travelled per litre of fuel used by Canadian motor vehicles. This gross estimate of "accident risk" serves as an indicator of overall road safety, but does little to define the risk of accident involvement due to specific factors, such as alcohol-impaired driving. In fact, given real-world constraints on the collection of needed data, directly measuring the risk of road accidents --much less the risk associated with alcohol-impaired driving--seems remote indeed.

Nevertheless, the methods of epidemiology offer a way to estimate the extent to which drinking drivers have an increased risk of accident involvement compared to that of nondrinking drivers. Table 2 summarizes how different groups of drivers are compared to estimate relative risk (also termed relative probability or relative hazard). (See Donelson et al. [1980] for a formal discussion of this approach.) The reasoning behind this approach is as follows. If a factor neither increases nor decreases the likelihood of accidents, then we would expect the frequency of this factor to be the same in both accident and nonaccident groups. The colour of drivers' eyes might be such as factor. We would expect that the percentage of brown-eyed persons in accident and control groups to be the same. If, on the other hand, a factor increased the likelihood of an accident, then we would expect that the factor would appear more often in accident than nonaccident groups. Alcohol, of course, is one such factor. We would expect, and do find, that the frequency of alcohol use among accident-involved drivers is greater than

TABLE 2

COMPARING DRIVING POPULATIONS TO INDICATE
THE SIGNIFICANCE OF BAC RANGES
AS RISK FACTORS IN TRAFFIC SAFETY

A. Four Groups of Drivers Distinguished

Independent Variable: BAC = 50 to 80 mg%	Dependent Variable(s) Accident-involvement: +	Dependent Variable(s) Accident-involvement: -
+	Accident BAC (50-80mg%) (group a)	No Accident BAC (50-80mg%) (group c)
-	Accident ZERO BAC (group b)	No Accident ZERO BAC (group d)

B. Over-involvement (or Overrepresentation) of BACs Between 50 and 80 mg% in Road Accidents: An Indication of Relative Risk

- Approach 1: The Case-Control Study

$$\frac{\text{percentage of accident-involved drivers with BACs Between 50 and 80 mg\%}}{\text{percentage of nonaccident-involved drivers with BACs Between 50 and 80 mg}}$$

$$\frac{\frac{a}{a+b} \times 100}{\frac{c}{c+d} \times 100}$$

- Approach 2: The Cohort Study

$$\frac{\text{percentage of drivers with BACs between 50 and 80 mg\% involved in accidents}}{\text{percentage of drivers with zero BAC involved in accidents}}$$

$$\frac{\frac{a}{a+c} \times 100}{\frac{b}{b+d} \times 100}$$

that among control groups. Alcohol, as a risk factor, is thus "overrepresented" in the accident group. The same approach has been used to estimate how much alcohol (measured as BAC) increases the relative risk of accident involvement.

In Table 2, with the case-control study as an example, the percentage of drivers with a certain BAC in the accident group is divided by the percentage of drivers with the same BAC in the "at risk", or control group. The resulting value is then related to a reference (or baseline) value for BACs equalling zero (or, sometimes, very low BACs, e.g., less than 20 mg%). This latter calculation is necessary because even drivers with a zero BAC have a finite risk of accident involvement.

> For example, suppose that 100 of 1000 accident-involved drivers have BACs of 150 mg% and that 10 of 1000 drivers surveyed at roadside have the same BAC. This indicates that persons with BACs of 150 mg% are overrepresented in the accident group by a factor of 10 (100 divided by 10). The reference value is calculated by dividing the percentage of accident-involved drivers with a zero BAC by the percentage of drivers with a zero BAC in the control group. If 50% of the accident-involved drivers and 75% of the control group had BACs equal to zero, the reference value would be 0.67 (50 divided by 75). This factor is divided into the ratio above (10) to obtain the relative risk ratio (about 15). Thus, in this example, drivers with a BAC of 150 mg% appear about 15 times more likely to become accident-involved than drivers who had not been drinking.

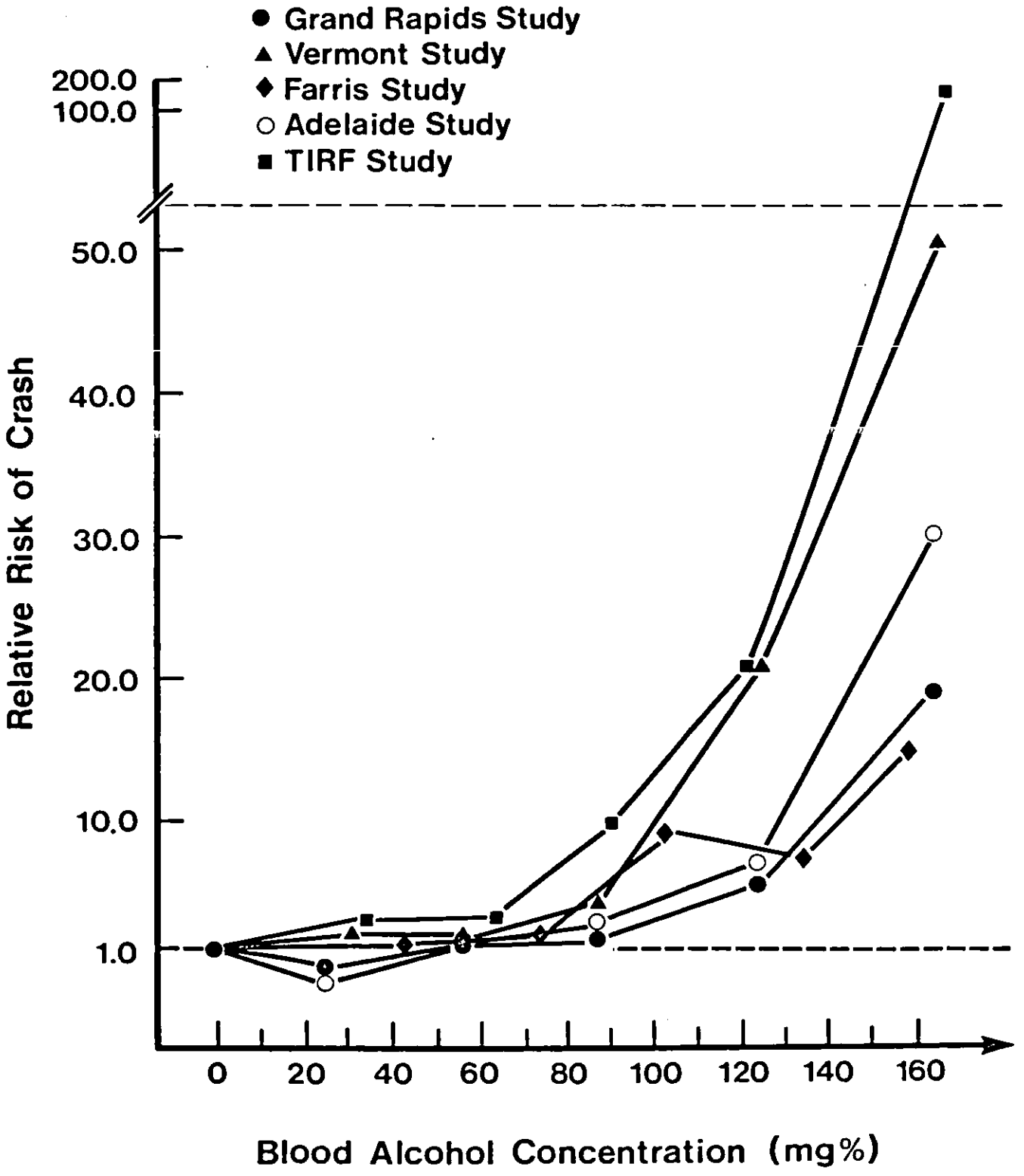
In the same way, across a range of BACs, a relative risk "curve" can be constructed. Figure 3, from Mayhew (1983), presents a set of "BAC-risk" curves from five studies (Mayhew 1982 [TIRF Study]; McLean et al. 1980 [Adelaide Study]; Farris et al. 1977 [Farris Study]; Perrine et al. 1971 [Vermont Study]; Borkenstein et al. 1964 [Grand Rapids Study]). The most striking feature of these curves is the increase in relative risk in the 80 to 100 mg% range. This finding has often been cited to support setting BAC limits at 80 and 100 mg% in alcohol-impaired driving statutes.

The curves in Figure 3, however, do not include any indication of the precision of relative risk estimates for the BAC ranges. Because all

Figure 3

RELATIVE RISK OF CRASH AS A FUNCTION OF BAC

Source: Mayhew 1983



measurements are subject to error, statistical methods are used to estimate the exactness of measured values. This is important because the findings of scientific studies, which may seem significant, may actually result from random (or chance) variations in observed phenomena. The following sub-section deals with this issue.

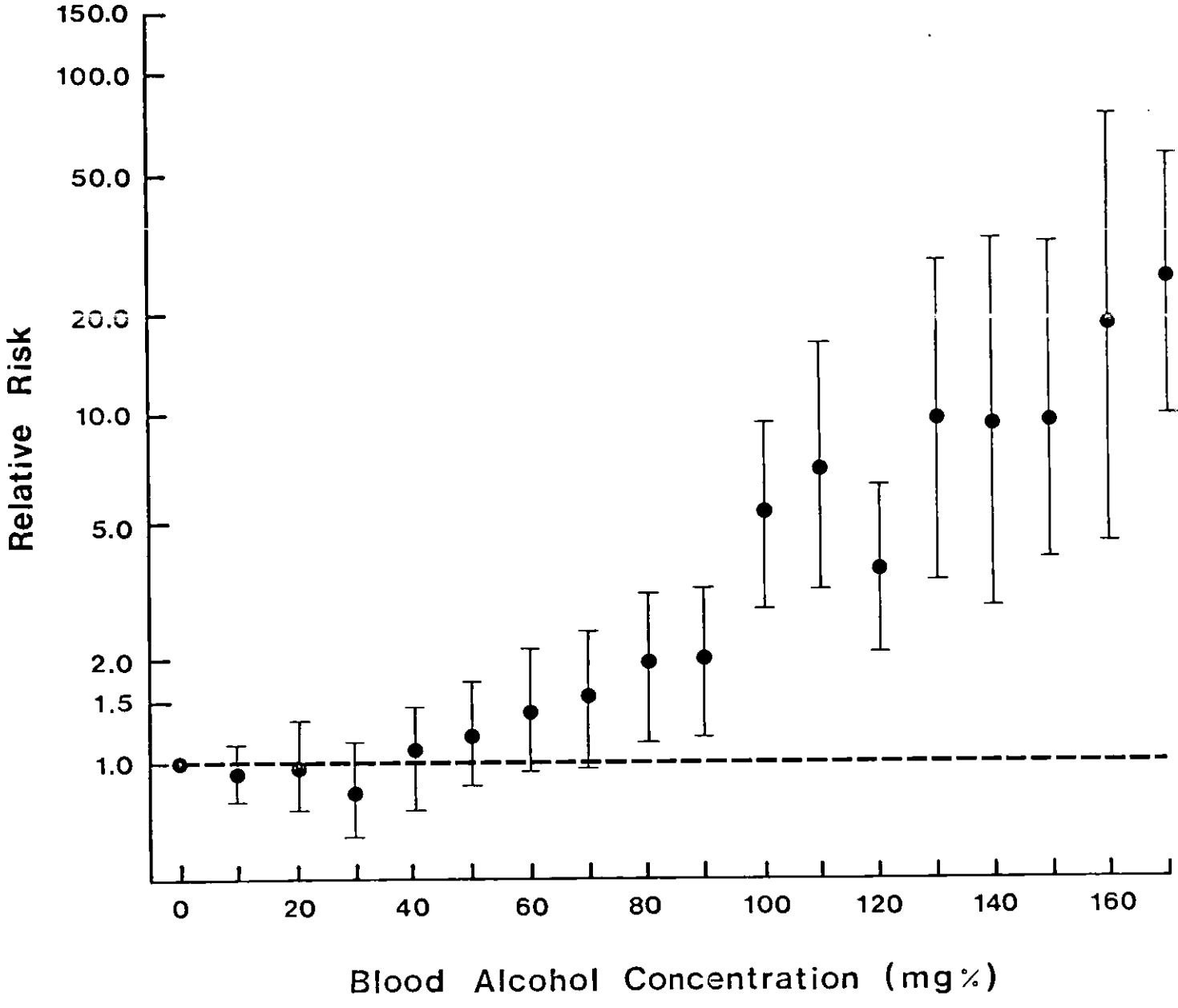
3.2.2 The precision of relative risk estimates. We have to interpret values of relative risk associated with BAC with caution. For example, a statement to the effect that "a BAC of 80 mg% doubles or quadruples the risk of an accident" is not only simplistic but also misleading. Relative risk estimates are simply that: estimates, subject to some degree of uncertainty. This uncertainty may have much more to do with the variability of the phenomenon we wish to measure than mistakes or errors made when actually measuring.

In epidemiologic research, the calculation of confidence intervals indicates the precision of relative risk estimates (Armitage 1971; Gart 1962). The 95% confidence interval--a common standard in scientific studies--predicts that, in repeated surveys of the same sample size, the value of the relative risk estimate would fall within the specified range 95 out of 100 times. This confidence interval is, essentially, a "test of significance" of the relative risk estimate. Values outside the confidence interval would be considered highly unlikely, given the results of the scientific study.

Figure 4 provides a case in point. Here we have taken data from the landmark Grand Rapids study (Borkenstein et al. 1964) and calculated 95% confidence intervals for relative risk associated with BAC ranges between 10 and 170+ mg%. The value of 1.0 for relative risk represents the (uncalculated) risk of accident involvement for the average non-drinking driver. For ease of comparison, a dashed line has been drawn horizontal to the line for BAC. Without confidence limits (shown by vertical lines through each point on the graph), we might conclude that drivers with BACs 30 mg% or lower BAC have a lower risk of accident relative to the nondrinking driver. Similarly we might decide that drivers with BACs greater than 40 mg% have a higher risk of accident

Figure 4

BAC and Relative Risk of Accident Involvement: The Grand Rapids Study



Source: Borkenstein et al – 1964

involvement. The confidence limits for all points up to 80 mg%, however, indicated that no estimate differs significantly from the risk of accident involvement associated with the average nondrinking driver. Based on these data we could not conclude with confidence that drivers with BACs between 50 and 80 mg% have a significantly higher risk of accident involvement than the average nondrinking driver (cf. Borkenstein et al. 1964, p.p. 117-124).

The Grand Rapids study, however, is cnly one of a number of surveys. Moreover, data from the study by Borkenstein et al. can be combined differently. The sub-section below presents other analyses of the Grand Rapids study and also examines the results of other surveys.

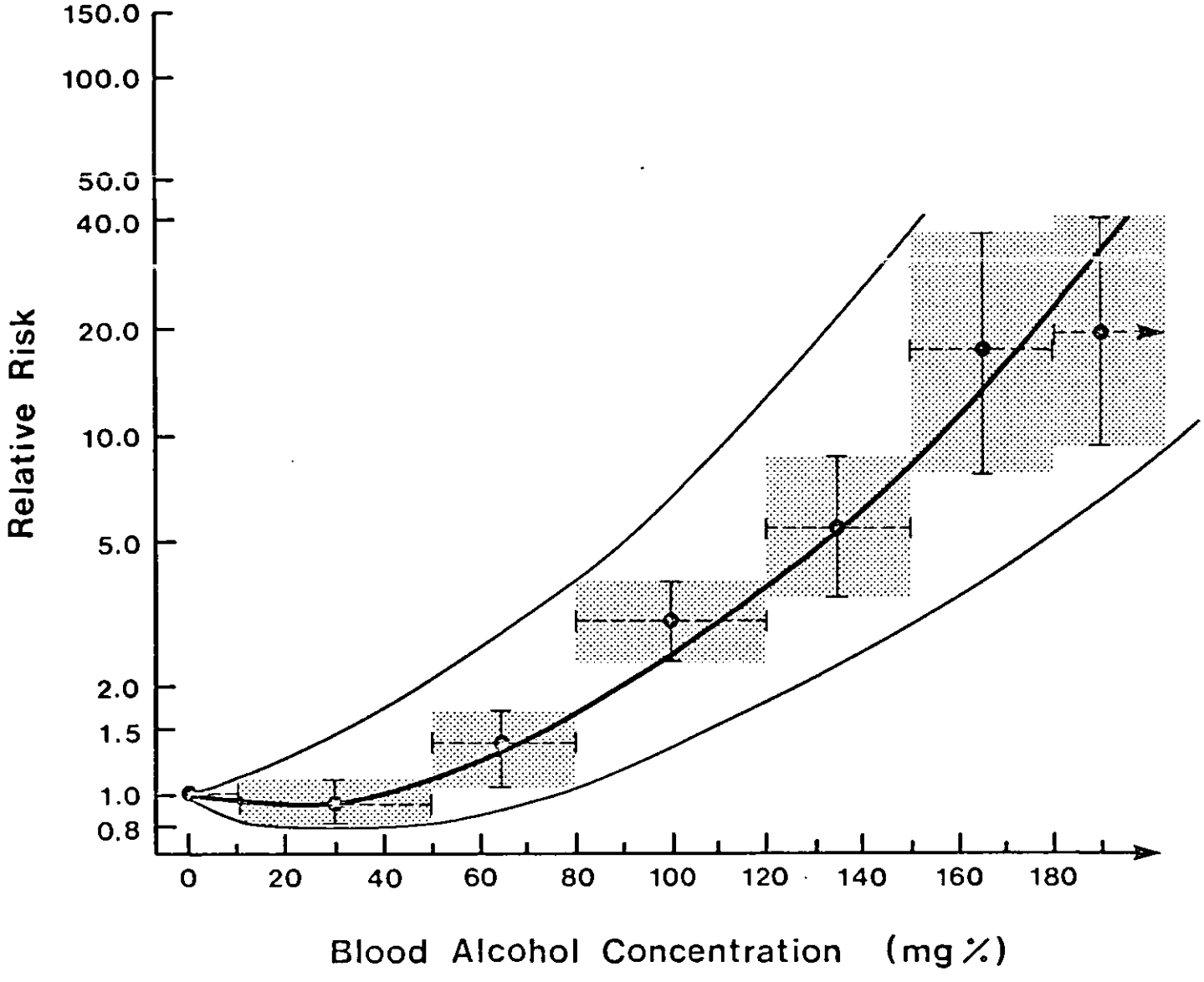
3.2.3 BACs between 50 and 80 mg% and the relative risk of accident involvement. Figure 4 indicates that BACs less than 80 mg% (in intervals of 10 mg%) are not associated with a relative risk of accident involvement significantly different from that of the average nondrinking driver. This data, however, when combined in larger or different intervals, can yield different results.

(This is a common procedure employed when the number of cases for smaller BAC intervals is inadequate for more detailed analyses, or when data are analysed for different purposes. In Figure 5, and in others that follow, we not only place a confidence interval about the relative risk estimate but also indicate the range of BACs included in the estimate. In doing this we establish an area on the graph in which the most likely estimate of relative risk falls. The shaded portions represent these areas. Using these areas of estimation we can approximate maximum and minimum risk curves.)

Figure 5 presents the same data graphed in Figure 4, only grouped to form larger BAC ranges: 10-49 mg%; 50-79 mg%; 80-119 mg%; 120-149 mg%; 150-179 mg%; and 180+ mg%. By comparing confidence intervals for the relative risk estimates for 50 through 70 mg% in Figure 4 with that for the BAC range 50-79 mg% in Figure 5, we find an apparent contradiction. Whereas the three data points in Figure 4 are not statistically

Figure 5

Relative Risk of Crash Involvement by BAC



Source: Borkenstein et al (1964)

significant, the relative risk of accident involvement associated with the BAC range of 50-79 mg% in Figure 5 is significantly different from that of the average nondrinking driver! How can smaller intervals of BAC, each of which does not differ significantly from 1.0, when combined, now produce a statistically significant value? The answer lies in the mathematical method of calculating confidence intervals for relative risk estimates. Basically, increasing the group size (i.e., the number of individual cases included in a BAC range) tends to shrink the confidence interval. In addition, all values in the intervals combined were closely related and greater than 1.0. As a result, the average value for the larger BAC range is also greater than 1.0 and becomes "statistically significant".

This mathematical "explanation" for the apparent contradiction described above does little to resolve the legislative issue of whether or not BACs between 50 and 80 mg% increase the risk of accident involvement compared to the average nondrinking driver. Here we encounter--in a single study--a fundamental problem: how to apply findings for groups of persons to individuals, based on a single characteristic like BAC. For example, if an individual has a BAC of 60 mg%, then do we consider that person a member of the smaller 60 mg% group or a member of the larger 50-80 mg% group? The former group does not have a relative risk that differs significantly from the average nondrinking driver while the latter group does.

This problem is one of a cluster of problems that stems from basic differences in the disciplines of Science and Law. These differences warrant separate study for their general policy implications concerning the role of Science in Law. For present, more restricted purposes, a brief discussion may prove useful in defining the issue.

Scientific research uses groups of "cases" to discover general principles or rules of behaviour--which may or may not apply to some individuals, even those in the groups studied. Research findings are probablistic, indicating the likelihood of their being correct. Thus, there always exists the possibility of exceptions to the rule. The

rules of Law, especially as applied to adjudicating the guilt or innocence of individuals charged with committing an offence, operate on an individual, or case-specific basis. Judges, for example, do not review a set of similar cases as a sole basis for deciding the outcome of a proceeding. They weigh the evidence presented for that case and decide on that basis. This difference can be summarized briefly as follows: A scientific expert might indicate, based on relevant studies, the likelihood that an individual belonging to a group with a certain BAC had an increased risk of accident involvement. A judge has to decide whether that individual, given actual facts in evidence, had an increased risk of accident involvement.

Unfortunately, this basic difference between Science and Law is blurred by such statutes as Section 236 of the Criminal Code of Canada. This section makes it a criminal offence to drive or have care and control of a motor vehicle with a BAC exceeding a certain value. Although implicitly based on scientific research showing likely impairment and probably increased accident risk, this statute requires only evidence from chemical tests showing that the accused had a BAC over the legal limit--whether or not that individual was actually impaired or had a demonstrably increased risk of an accident. In other words, even if that individual were an exception to the rule that most persons above the legal BAC limit are impaired, nonetheless, that person could (and would) be convicted under Section 236.

The present statutory limit of 80 mg% (.08) has received general (but not complete) acceptance as one that fairly defines the criminal offence of alcohol-impaired driving. That is, a large majority of drivers who have BACs exceeding 80 mg% have their ability to drive impaired to some unacceptable degree--and thereby have an unacceptably increased risk of accident involvement. The central question we have to address now is whether or not we can make this same statement about a statutory limit set at 50 mg%. As we have seen thus far, the Grand Rapids study, the largest and most comprehensive of its kind conducted to date, yields equivocal answers, depending on how we analyze the statistical evidence.

Before we take up this issue of applying group results to individual cases again in Section 3.2.4, we review other epidemiologic studies and their findings.

Figures 6-8 present relative risk curves and approximate maximum and minimum curves for three other case-control studies:

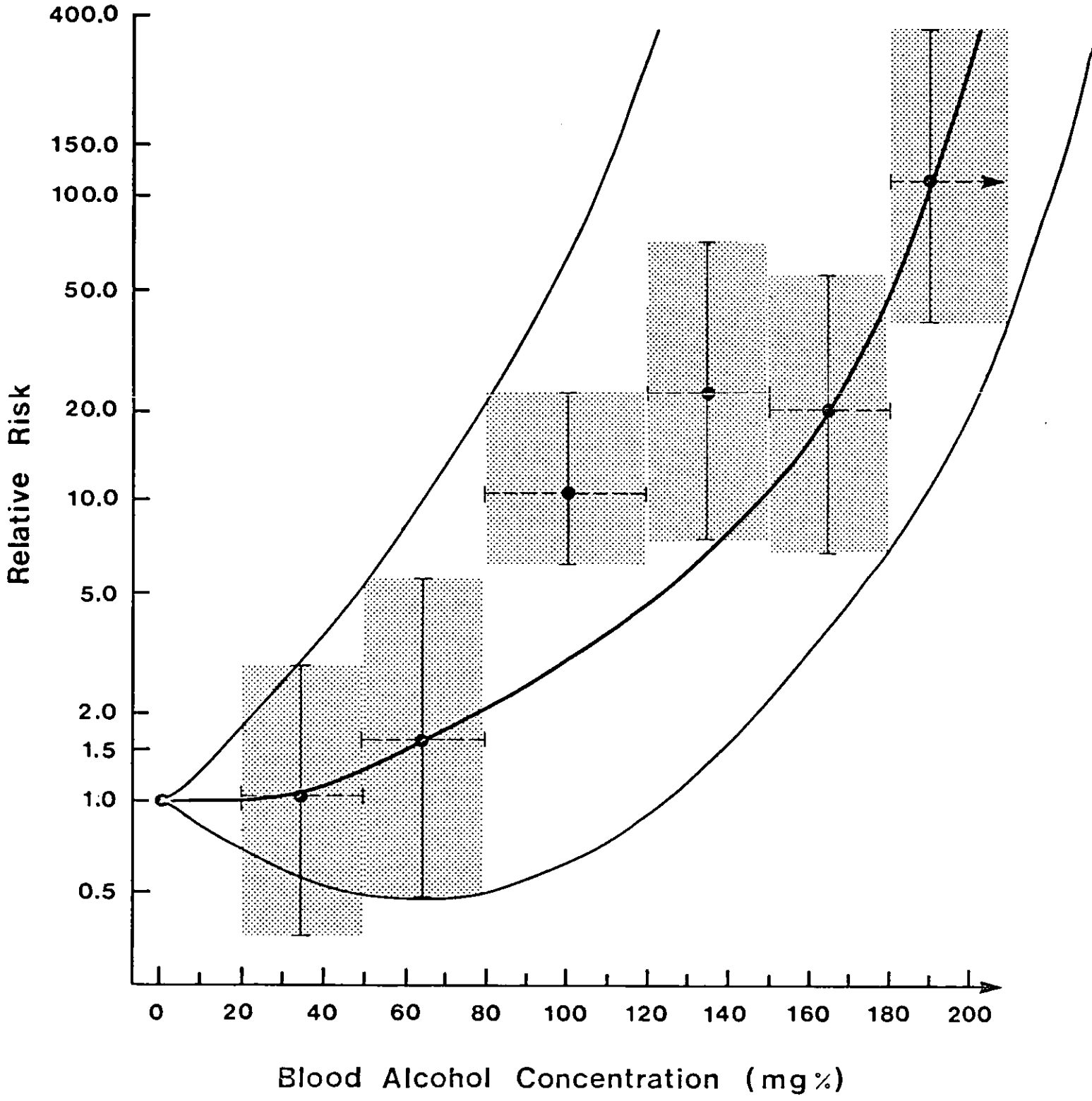
- Figure 6: Perrine et al. (1971), 106 fatally injured drivers, 1341 drivers in control group.
- Figure 7: Farris et al. (1977), 2415 injured drivers, 4637 drivers in control groups.
- Figure 8: McLean et al. (1980), 298 injured drivers, 1196 drivers in control group.

In Figure 6, our calculations of confidence intervals for the study by Perrine et al. (1971) indicate that BAC ranges below 80 mg% do not differ significantly from 1.0, the baseline value for the average nondrinking driver. Note, however, how relative risk estimates for higher BAC ranges do differ significantly from 1.0. The wide confidence intervals about all BAC ranges reflect the very low number of cases included in the survey.

In a much larger study conducted in two U.S. cities, Farris et al. (1977) produced data showing a much more regular increase in relative risk with increasing BAC ranges. Unfortunately, the authors did not present finer breakdowns of their findings. As a result, the BAC-risk curve reconstructed from their report in Figure 7 is not strictly comparable to the others due to differing BAC ranges. In addition, the authors grouped persons with low BACs (less than 30 mg%) with nondrinking drivers. Other studies, particularly those of Borkenstein et al. and McLean et al., have found that the relative risk of drivers with low BACs tends to be lower (though not necessarily significantly lower) than that of nondrinking drivers. Combining both groups of these drivers, however, may have the effect of increasing the relative risk ratio for the specified BAC ranges. Along with large numbers of cases in both accident- and nonaccident-involved groups, the overall finding is that groups of drivers with BACs greater than 30 mg% have an increased

Figure 6

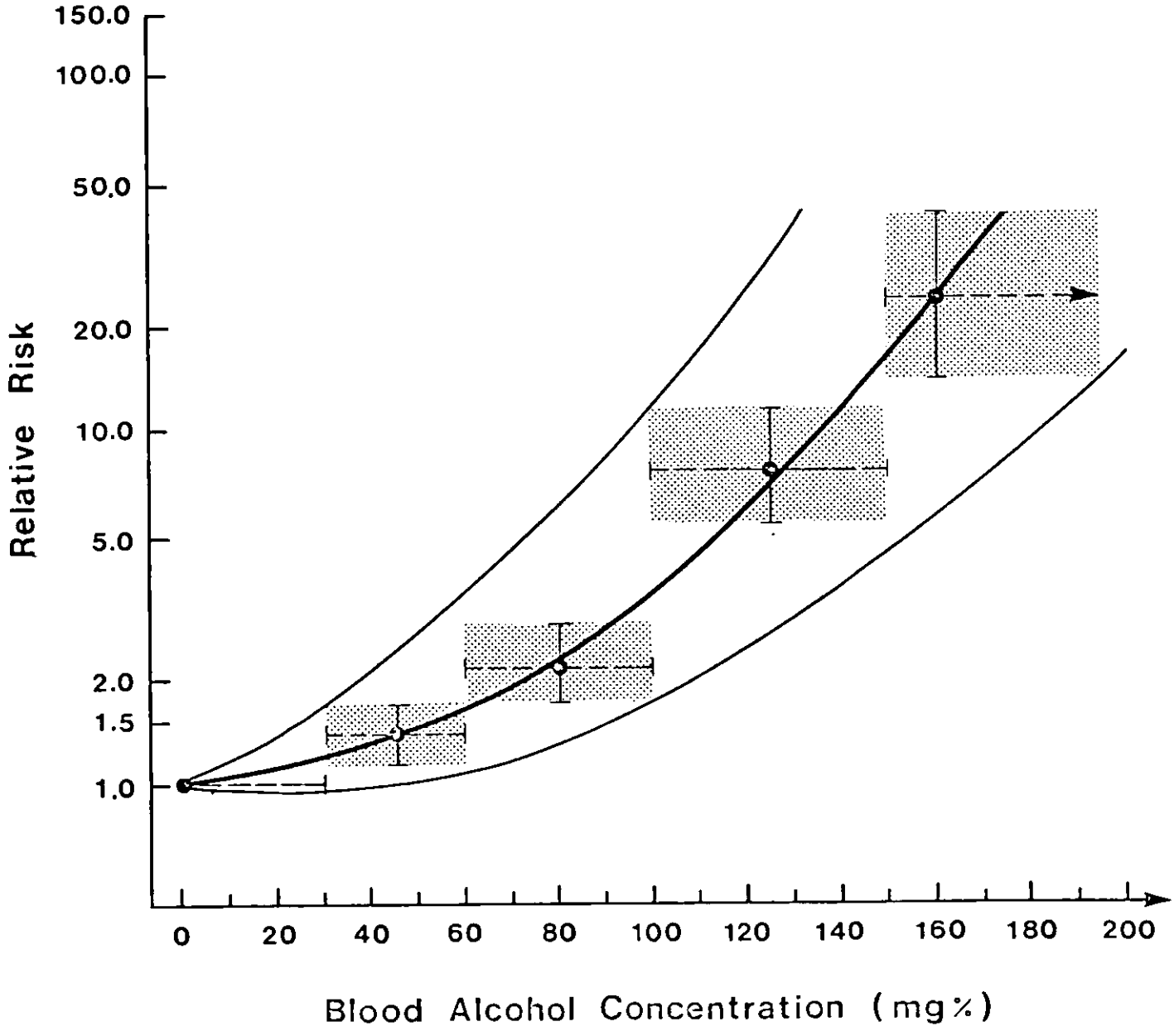
BAC and Relative Risk of Accident Involvement: The Vermont Study



Source: Perrine et al – 1971

Figure 7

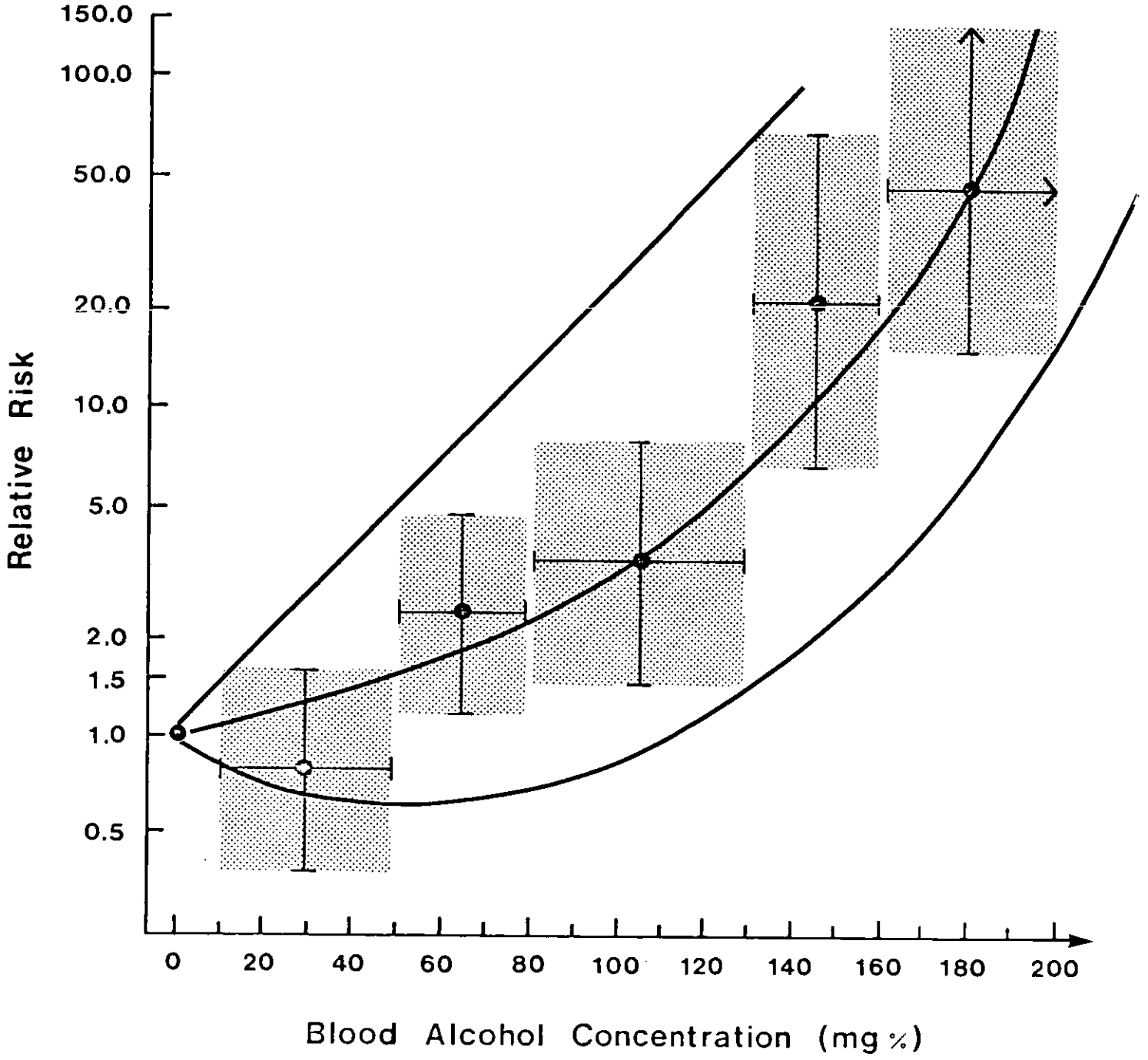
BAC and Relative Risk of Accident Involvement: The Farris Study



Source: Farris et al – 1977

Figure 8

BAC and Relative Risk of Accident Involvement: The Adelaide Study



Source: McLean et al – 1980

relative risk that differs significantly (albeit slightly) from drivers with low or zero BACs. If the data were combined in a way more applicable to the aims of this study, it is quite possible a different finding would emerge. Nonetheless, the study by Farris et al. indicates that BACs between 50 and 80 mg% are associated with an increased relative risk of accident involvement. Whether or not this increase differs significantly from that of the average nondrinking driver is a question that cannot be answered with available data.

Our re-analysis of data reported by McLean et al. (1980) produced the BAC-risk curve shown in Figure 8. The lower relative risk associated with BACs between 10 and 49 mg% is not statistically significant. (This finding is similar to that found in the Grand Rapids study [Borkenstein et al. 1964]. As discussed by Allsop [1966], this apparent reduction had more to do with different proportions of drivers with characteristics other than BAC in accident and control groups. Allsop's discussion "explaining away" the so-called "Borkenstein dip" in that BAC-risk curve is similar to Section 3.2.4, which qualifies the general finding that BACs between 50 and 80 mg% increase the relative risk of accident involvement. Both discussions point to BAC, in and of itself, as an unreliable measure of relative risk.) In Figure 8 we see that the relative risk estimate for BACs between 50 and 80 mg% differ significantly, though very slightly, from the baseline value of 1.0. The large confidence intervals for higher BAC ranges reflect the small number of cases in this study.

The finding of McLean et al. that the relative risk associated with BACs between 50 and 80 mg% differ significantly from that of the average nondrinking driver needs qualification. First, the lower confidence limit of the estimate (1.09) differs hardly at all from baseline (1.00). Second, the small number of cases included in the survey decreases confidence in the result. For example, in a similar survey, should only two additional control drivers be found with BACs between 50 and 80 mg%, compared to the same number of accident-involved drivers in that BAC range, the estimate would not reach statistical significance. Finally, even McLean et al. (1980), in discussing the results of their study, concluded the following:

> The legal limit for a driver's blood alcohol concentration in South Australia is 0.08. The determination of the legal limit is, properly, a political decision but it can be noted that no evidence has been produced by this project that would provide strong support for a change in the 0.08 limit. (p. 36)

In summary, epidemiologic studies that relate BAC to relative risk of accident involvement have generally found that groups of drivers with BACs between 50 and 80 mg% have an increased risk of accident involvement compared to nondrinking drivers. This increase in relative risk is not great, barely reaching statistical significance. This finding is consistent with the results of many experimental studies, which demonstrated measurable but small effects on skills related to driving by BACs in similar ranges. The question remains:

- Do all drivers with BACs between 50 and 80 mg% have a significantly increased risk of accident involvement compared to the average nondrinking driver?

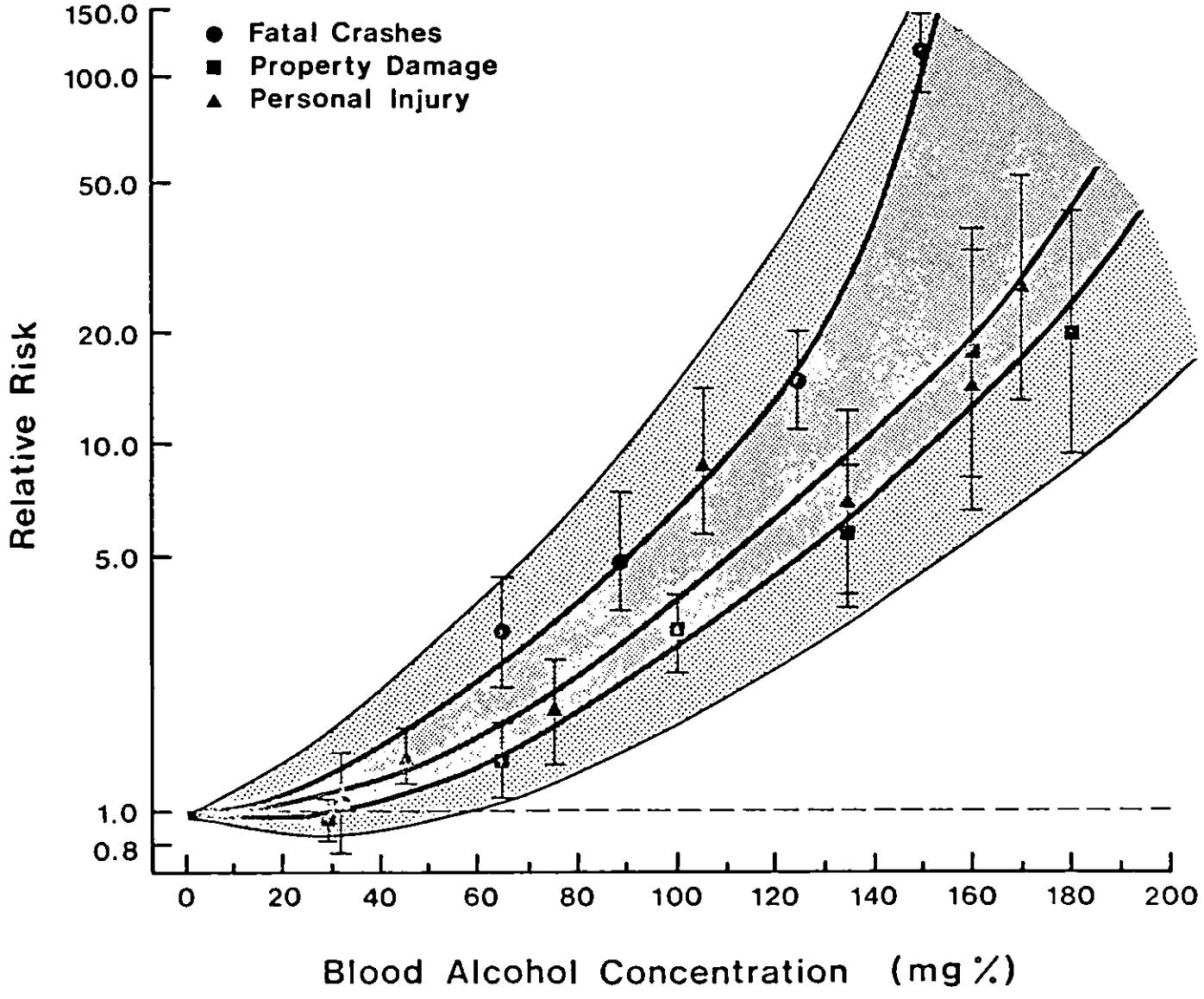
To address this question we examine other characteristics of drivers in relation to BAC.

3.2.4 Factors that influence relative risk estimates. In addition to BAC, many other factors can affect the relative risk of accident involvement, for example, driving experience, time of day, age, and drinking practices. Moreover, these same factors can influence the relationship between relative risk and BAC. Borkenstein et al. (1964) identified a total of eight such factors (see Zylman 1968). Below, we present data on two types of factors: accident-related factors and personal variables. As well be seen, BAC-risk curves can be altered, sometimes dramatically, when these other factors are taken into account.

Figure 9 displays the relative risk by severity of crash at various BACs. Approximate maximum and minimum risk curves are also shown. This figure shows that the relative risk of crash involvement is highest for the most serious type of crash (i.e., fatal) at all BAC levels. The

Figure 9

BAC and Relative Risk of Accident Involvement: Severity of Accident



relative risk associated with different types of accidents descends according to crash severity: fatal, personal injury and property damage only. (Note that the absolute frequency of the different types of accidents follows the reverse order. Thus, given any BAC and accident-involvement, the most likely outcome is property damage only.)

When driver culpability (or responsibility) is examined by BAC (Figure 10), one finds that the relative risk of accident involvement is greater for drivers judged responsible for crashes than for drivers deemed not at fault. Interestingly, drivers with high BACs (100 mg%) and considered not at fault have a greater risk of accident involvement than the average sober driver! This may indicate a higher likelihood of failing to avoid accident-involvement even though technically not at fault.

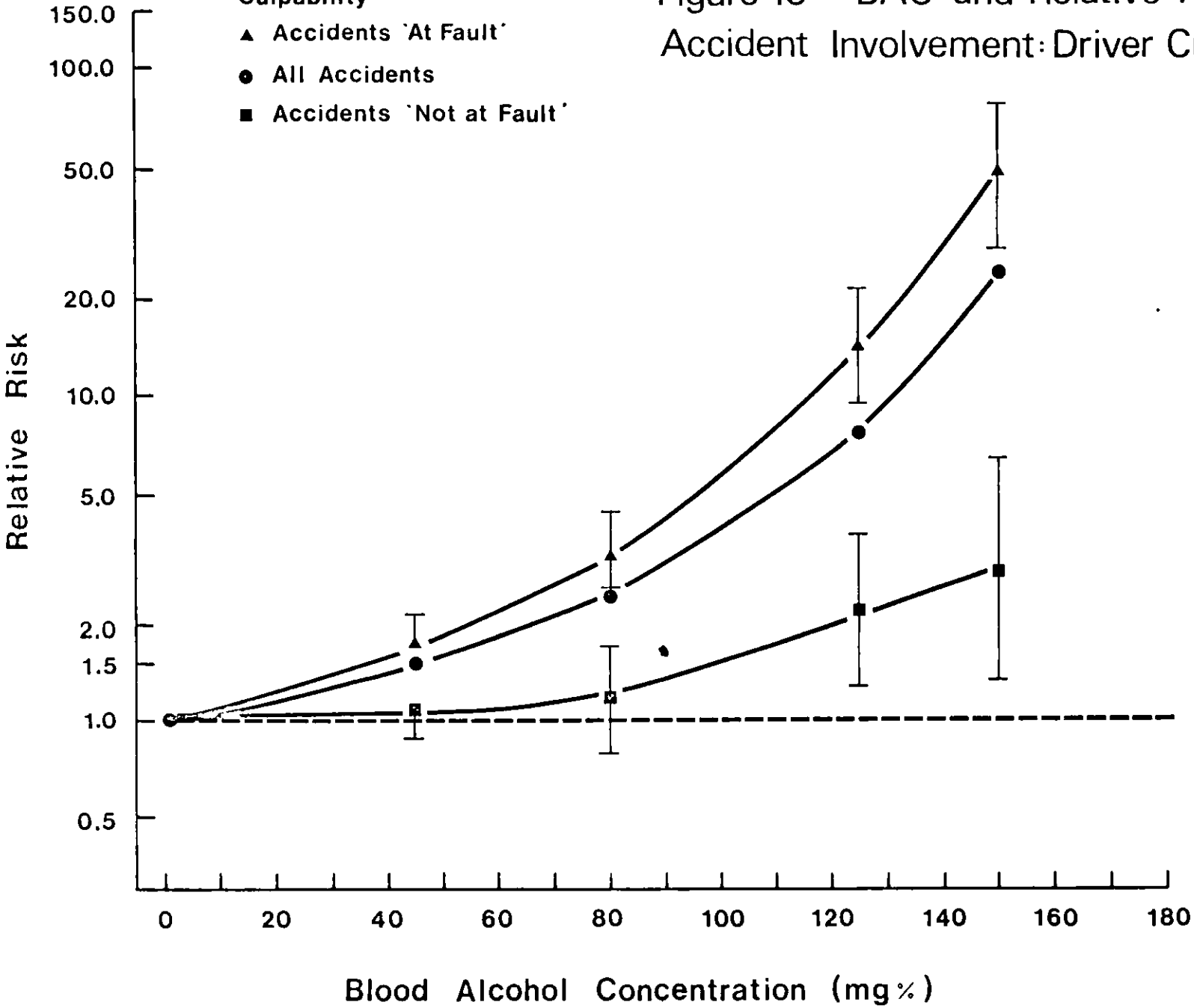
Three personal factors for which data are available will be examined in relation to relative risk: age, drinking frequency, and annual mileage.

Age as an independent variable may reflect driving experience, drinking experience and other, less measurable factors such as maturity and attitudes towards risk-taking. Thus, although age as a "risk factor" is easily related to BAC and relative risk, explanation of any relationship may not be straightforward. With this in mind, we examine BAC-risk curves for different age groups.

People in different age groups have quantitatively different relative risk curves (Figures 11 and 12). Young drivers have a markedly increased relative risk at moderate BACs (e.g., 80 mg%) compared to other drivers. Statistically significant increases are evident at BACs between 50 and 79 mg%. For older drivers, this increase occurs at higher BACs, typically between 80 and 100 mg%.

Drinking frequency is a variable that strongly influences estimates of relative risk. Hurst (1973) examined data from the Grand Rapids (Borkenstein et al. 1964) and Vermont (Perrine, Waller, and Harris 1971) studies and discussed BAC-risk curves as a function of self-reported

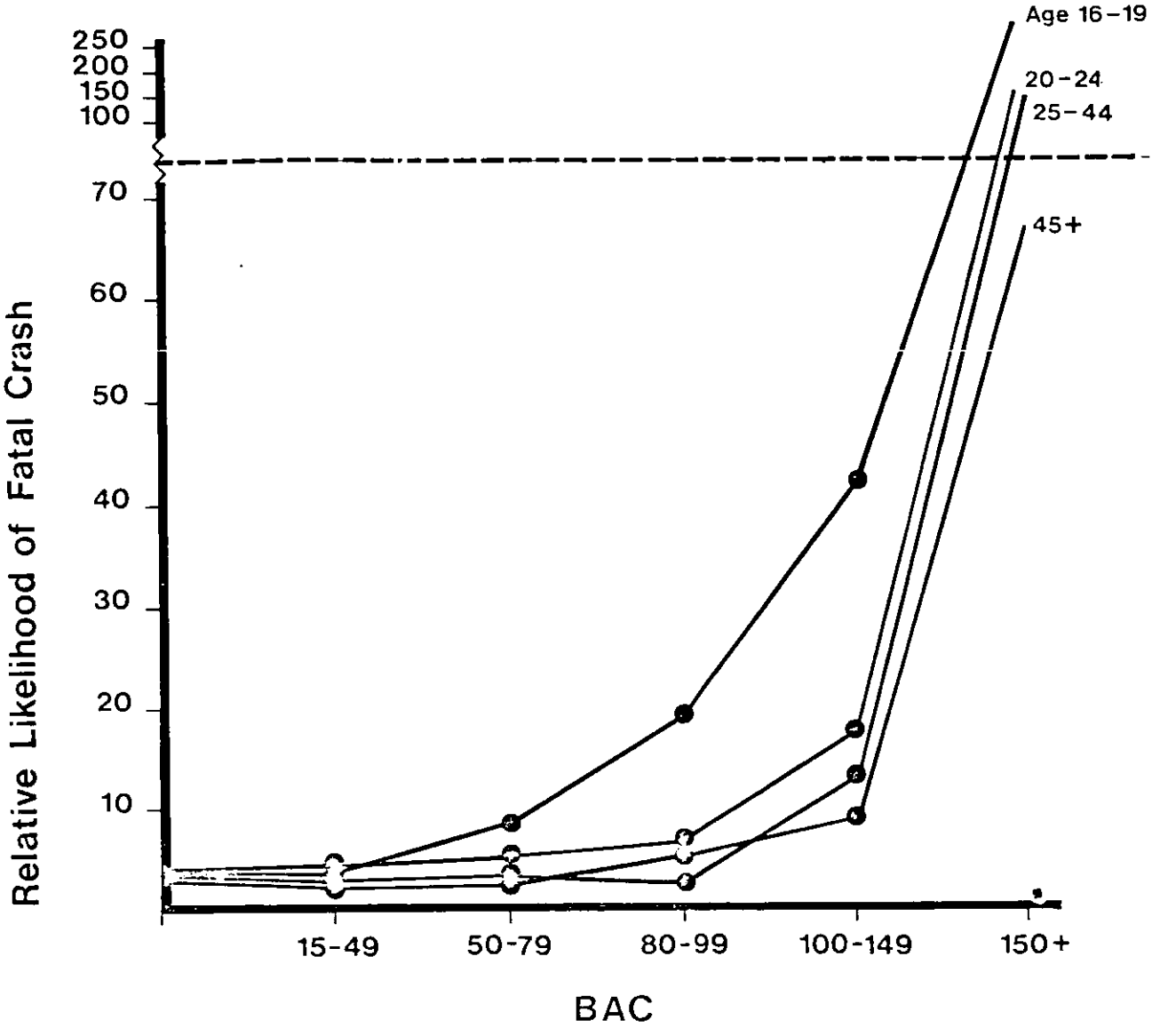
Figure 10 BAC and Relative Risk of Accident Involvement: Driver Culpability



Source: Farris et al – 1977

Figure 11

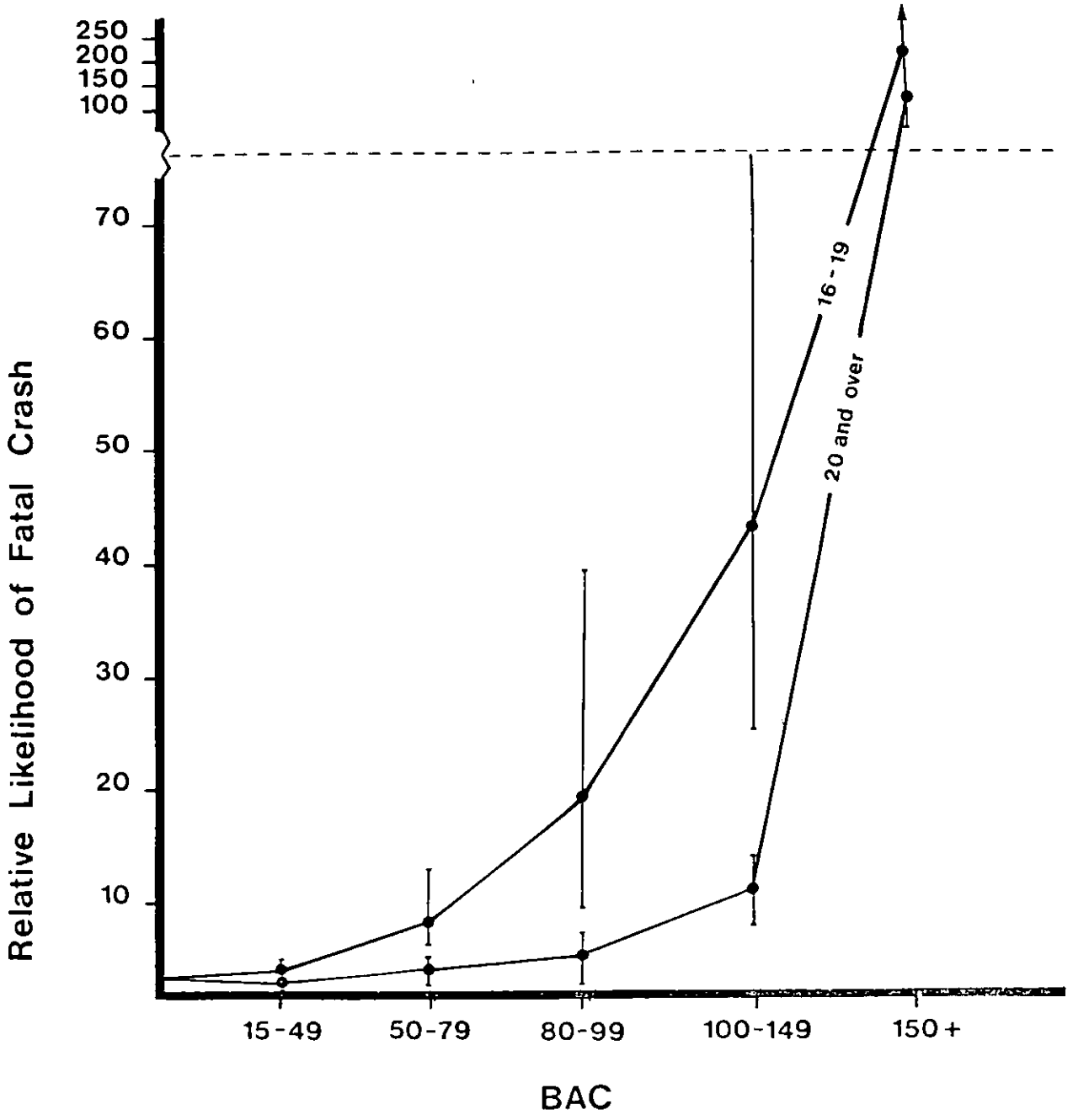
Relative Likelihood of Fatal Crash as a Function of BAC and Age



Source: Mayhew-1982

Figure 12

Relative Likelihood of Fatal Crash for Drivers Age 16–19 and for Drivers Age 20 and Over as a Function of BAC



Source: Mayhew–1982

drinking frequency. Figure 13 presents our re-analysis of the Grand Rapids data, performed in order to calculate confidence limits. As Hurst and others have observed, drinking frequency has a strong inverse relationship to relative risk in each BAC intervals. That is, the more frequently one consumes alcohol, the lower one's relative risk of accident involvement at given BACs.

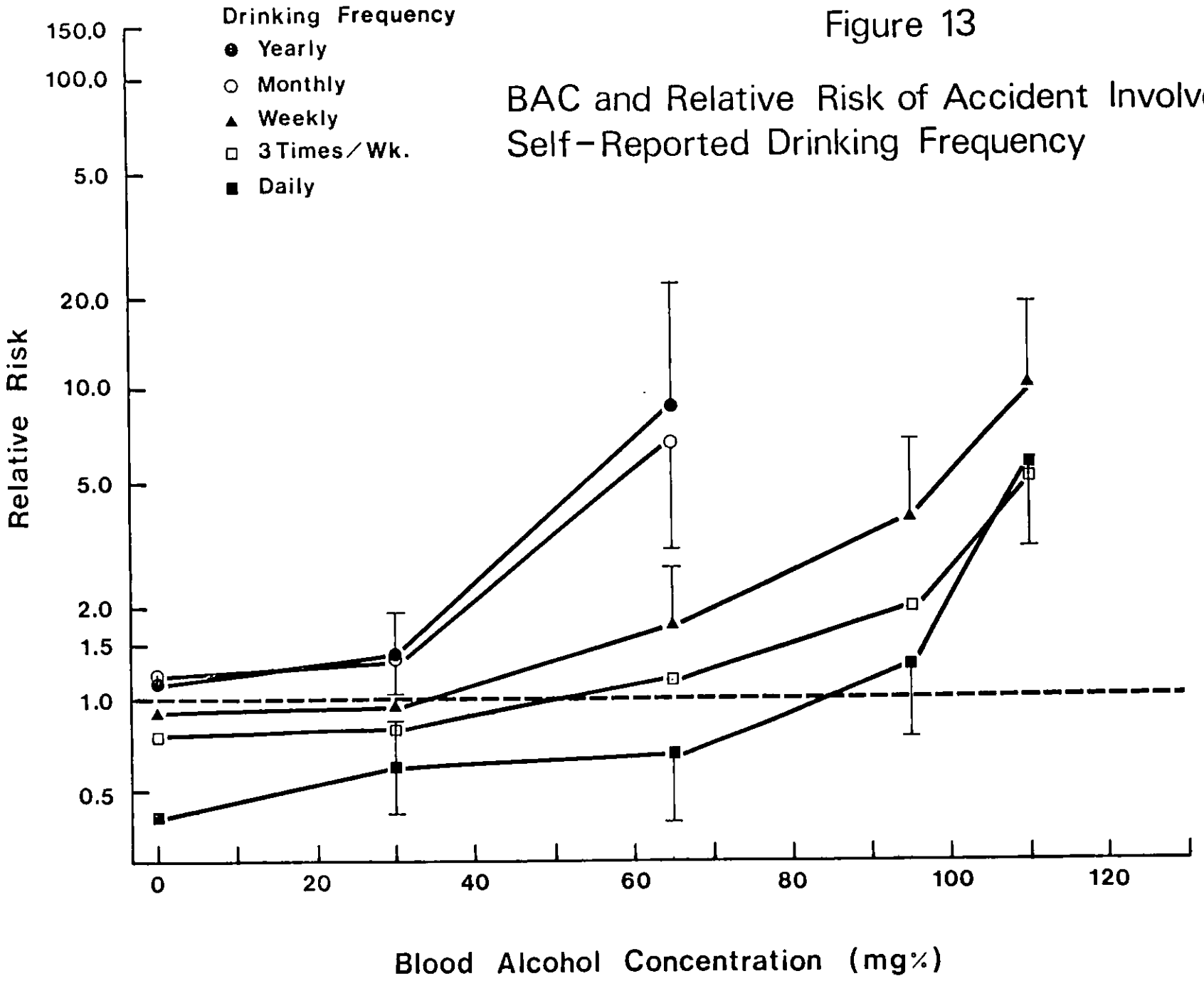
> Although such self-reports can never be accepted at face value, the orderliness of the data is compelling. There are three major lessons implied. The first is that the average self-reported daily drinker is, for whatever reason, almost as safe a driver at a BAC of 0.09% as the average abstainer or near-abstainer is when he is cold sober. The second is that the daily drinker is not, at any positive BAC, as safe a driver as he is when he has not been drinking. Third, the infrequent drinker is very seriously impaired at a level (0.06%) quite close to that at which many state laws presume that nobody is impaired. (Hurst 1973, p. 136)

The Grand Rapids study also provided data on self-reported annual mileage driven. This variable relates both to driving experience and exposure to risk. Figure 14 presents relative risk curves for four groups of drivers who report different annual mileages. Less annual mileage is associated with higher risk of accident involvement at lower BACs; for those in the highest mileage category the risk of accident does not differ from the average nondrinking driver until BACs exceed 100 mg%.

BAC-risk curves plotted as a function of age, drinking frequency, and annual mileage show the influence of these variables on the relationship between BAC and the likelihood of accident involvement. Similar curves could be presented for other such variables (Borkenstein et al. 1964; Zylman 1968). From this review of epidemiologic evidence, we can appreciate that BAC, although highly correlated with relative risk, does not--in and of itself--reliably measure increased relative risk. The precision of relative risk estimates is low, due partly to sampling error and partly to the influence of many other factors. These factors not only increase (or decrease) relative risk in the absence of alcohol, but may also interact with the effects of alcohol to enhance or mitigate

Figure 13

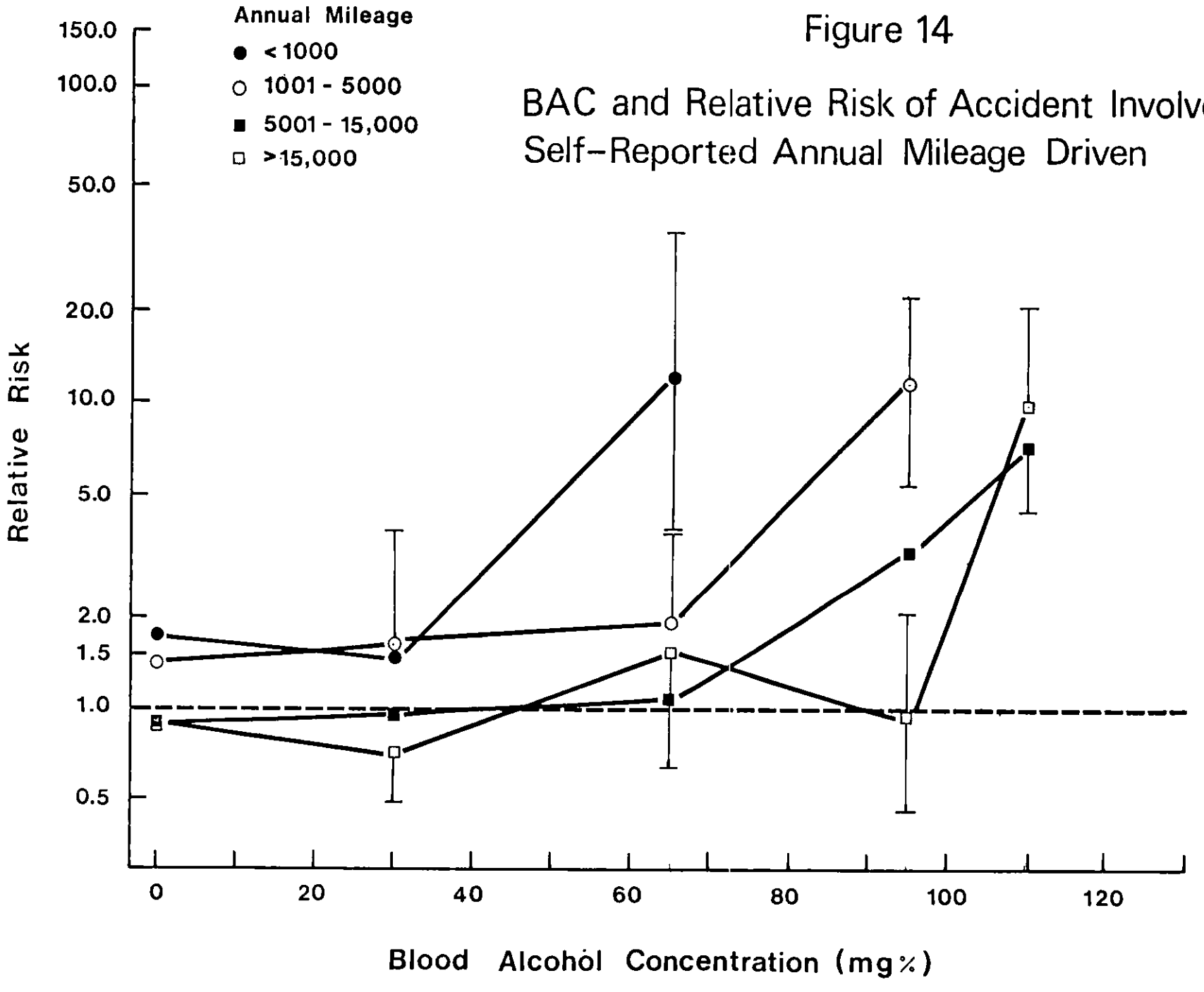
BAC and Relative Risk of Accident Involvement: Self-Reported Drinking Frequency



Source: Borkenstein et al – 1964

Figure 14

BAC and Relative Risk of Accident Involvement: Self-Reported Annual Mileage Driven



Source: Borkenstein et al - 1964

relative risk associated with BAC. As we begin to look at other factors that characterize sub-groups of drivers at risk we discover that some groups of people appear to have a significantly increased relative risk of BACs between 50 and 80 mg%. These groups include 16-19 year olds; infrequent drinkers; and low-mileage drivers who have BACs in this range. These groups, of course, are not mutually exclusive, nor do they constitute a majority of all drivers. Moreover, as Jones and Joscelyn (1979a) cautioned:

> Considerable care in interpreting the findings of studies of the characteristics of individuals who drink and drive. The reader is alerted to two pitfalls that are common in such interpretations. First, it is sometimes assumed that the finding that a given characteristic is associated with a higher than average alcohol-crash risk means that all individuals possessing that characteristic are high-risk drivers. A second pitfall is the assumption that different characteristics that have been found to be associated with increase alcohol-crash risk can be combined to form a composite picture of a high-risk driver and that all individuals matching that profile are high-risk drivers.
>
> Both pitfalls are to be avoided since they will lead to erroneous conclusions. No characteristic or combination of characteristics can safely be used to identify a given individual as a certain alcohol-crash threat, but can only be used for identifying the alcohol-crash risk of entire groups of drivers. Moreover, the usefulness of simplistic "profiles" for underscoring common characteristics of high-risk drivers can be out-weighed by the danger that such a profile may erroneously be assumed to describe the highest risk group of drivers as priority targets for counter-measures. (p. 57, emphasis added)

Based on the evidence to date from epidemiologic studies, we conclude that BACs between 50 and 80 mg% do not produce an increased risk of accident involvement relative to the nondrinking driver for all drinking drivers in that group. The statistical findings do indicate that certain sub-groups of drivers with BACs in that range may have a significantly increased relative risk. Nonetheless, given the comparatively small increases, many individuals in those groups may not have a demonstrably increased risk of accident involvement. The epidemiologic evidence is clear on one point: Only at higher BAC values --those exceeding the present legal limit--are relative risk estimates

significantly different from that of the average nondrinking driver, independent of other factors. Thus, epidemiologic evidence to date does not provide a strong case for lowering the present statutory limit of 80 mg% to 50 mg%.

3.2.5 Summary. To date, a small number of epidemiologic studies have examined the relationship between BAC and the relative risk of accident involvement. These studies have compared accident-involved drivers with nonaccident-involved, or "at risk" drivers. Relative risk estimates for different BACs are based on the frequency of BACs in the comparison groups. Across the range of possible BACs, relative risk curves are constructed. The precision of these estimates can be determined by calculating confidence intevals using standard statistical methods.

In addressing the issue of statutory BAC limits, we examined whether or not BACs between 50 and 80 mg% increase the risk of accident involvement relative to that of the average nondrinking driver. Available epidemiologic evidence does not provide a clear answer. In fact, data from the studies reviewed could be used to support both lowering the legal limit and retaining the present limit of 80 mg%, depending on how the data were combined--and interpreted.

This area of scientific research raises a basic issue: how to apply findings for groups of persons with a given characteristic to individuals possessing that characteristic. This is critically important because it relates to charging individuals with a criminal offence based on scientific evidence that may or may not apply to them.

Epidemiologic studies have generally found that groups of drivers with BACs between 50 and 80 mg% do have an increased risk of accident compared to nondrinking drivers. This finding, in some studies, was statistically significant. Nevertheless, when other factors are considered, we cannot state with any certainty that all drivers with BACs between 50 and 80 mg% have a significantly increased risk of accident-involvement. Factors other than BAC also influence relative risk.

When these factors are taken into account, we find that certain groups of drivers with BACs between 50 and 80 mg% do not have an increased risk of accident-involvement relative to nondrinking drivers. Based on our review of the epidemiologic evidence, we do not find a strong case for lowering the present statutory limit of 80 mg% to 50 mg%.

3.3 Other Considerations.

Taken together, experimental and epidemiologic evidence do not offer a sound justification for lowering the present statutory limit from 80 to 50 mg%. To supplement the discussion above, we find it useful to review decisions made in other jurisdictions concerning this issue. We also discuss another issue--the ability of drinking drivers to comply with per se laws.

3.3.1 BAC limits in other countries. In 1976, in the United Kingdom, a committee on drinking and driving re-examined many issues, including the initial impact of the Road Safety Act in 1967 and the rapid waning of that effect (Blennerhassett 1976). They considered, among other topics, whether or not to recommend lowering the statutory limit from 80 to 50 mg%. They concluded as follows:

> 5.1 We have considered whether the present prescribed maximum blood alcohol concentration of 80 mg/100 ml should be changed. The only alteration which could be contemplated would be in the downward direction, and we do not think that change would be justified.
>
> 5.2 The present limit was set in 1967 on the advice of the Medical Research Council and the British Medical Association. It is a level above which the curve of accident risk rises steeply. It is one which, we believe, commands general public assent. To reduce it to 50 mg/100 ml - which is the level in some countries - would be of doubtful benefit while police resources remain severely limited; there are real disadvantages in enlarging the category of potential offenders when it is certain that many over the present limit avoid detection. The existing power to vary the limit by regulations approved by both Houses of Parliament is however one which it might be appropriate to use at some future time, and we recommend that it should be retained. (p.20)

More recently, in 1980, the British Academy of Forensic Sciences re-considered this question because the process of legislative change

was (once again) engaged. Without explicitly stating why, a panel of scientists, lawyers, and doctors agreed with the government's recommendation that the statutory limit be retained at a level of 80 mg%. Note that, in both deliberations, empirical data were not cited as a basis for the recommendations. Rather, practical concerns predominated.

In Australia as of 1972, all States except Victoria had statutory limits of 80 mg%. Victoria had a limit of 50 mg%. Robertson (1972) briefly discussed the issue in comparing the BACs of persons arrested for alcohol-impaired driving in the various states. He found, for example, that alcohol distributions for Queensland and Victoria were not significantly different despite different statutory limits. In fact, alcohol distributions in this population of drivers seemed independent of the statutory limits:

> It is sometimes argued that the legally permissible limit should be varied; either that the 80 mg% limit operating in all States except Victoria should be lowered to the Victorian 50 mg% level, or conversely. The present data give some information on this point. The proportion of cases falling between 50 mg% and 79 mg% are as follows:
>
> | | | |
> |---|---|---|
> | Queensland | | 3.0% |
> | New South Wales | | 11.8% |
> | Victoria | | 3.8% |
> | Tasmania | | 13.4%* |
> | S. Australia | | 3.7% |
> | W. Australia | | 5.0% |
> | | TOTAL | 6.8% |
>
> (*later figures, supplied by S.A. Police, October 1971).
>
> The question may therefore not be one of very great importance, for less than 10 per cent of cases on average fall into this debated interval. It seems likely that drivers usually either drink nothing or very little, or else they drink a great deal. However, it is important to remember that these are not random samples of the driving populations and a good estimate of the proportions in each category on the low side of the curve will only be possible when permission is given for such a sample to be obtained.

Robertson's discussion does not address the issue of statutory BAC limits in a rigorous manner. No epidemiologic data are provided, only data from persons arrested for impaired driving--information greatly dependent on enforcement practices. Thus his conclusion--that the

question of BAC limits may not be of great importance--has more to do with the possible percentage of drivers with BACs between 50 and 80 mg% than their actual risk of accident involvement.

Ward (1972) also discussed this issue and concluded that the critical level (meaning the statutory BAC limit) "will be fixed more by what is politically feasible than by what is desirable". He cautioned against "demanding too high a standard of sobriety of a driver" on practical and sociological grounds without specifying "the correct limit" and without giving an empirical basis for his argument. His greatest concern was over drivers who, having exceeded a low BAC limit, would "feel no restraint and drink more than [they] would if a more tolerant level of alcohol, somewhat nearer [their] normal consumption, were made the permissable level" (p. 494). Ward offered no evidence either supporting his concern or indicating that "more tolerant" BAC limits have any effect on drinking practices. Nor did he address the issue of drivers' ability to estimate BAC based on alcoholic beverage consumption.

Since then, with the exception of South Australia, all states in Australia have lowered their statutory BAC limit to 50 mg%. South Australia retains a limit of 80 mg%. In a personal communication to TIRF staff, Dr. Jack McLean of the Road Accident Research Unit in Adelaide indicated that the rationale for lowering the legal limit seemed to be "if 80 is good, 50 must be better". Not only is this logic simplistic, but even the effectiveness of a limit of 80 mg% has not been convincingly demonstrated in any country. Moreover, Dr. McLean stated that a limit of 50 mg% cannot be adequately enforced because for the most part, most drivers with BACs between 50 and 80 mg% cannot be detected except by random roadside checks. This requires a large investment of time, effort, and money to apprehend and prosecute a relatively small number of violators who may not otherwise encounter any problems.

Thus, based on available, published reports, neither the U.K. nor most Australian states have examined the issue of BAC limits in terms of detailed scientific evidence. Rather, when expert groups have recom-

mended changing or retaining existing limits, they have done so based on practical considerations or on subjective (and largely unsupported) judgements.

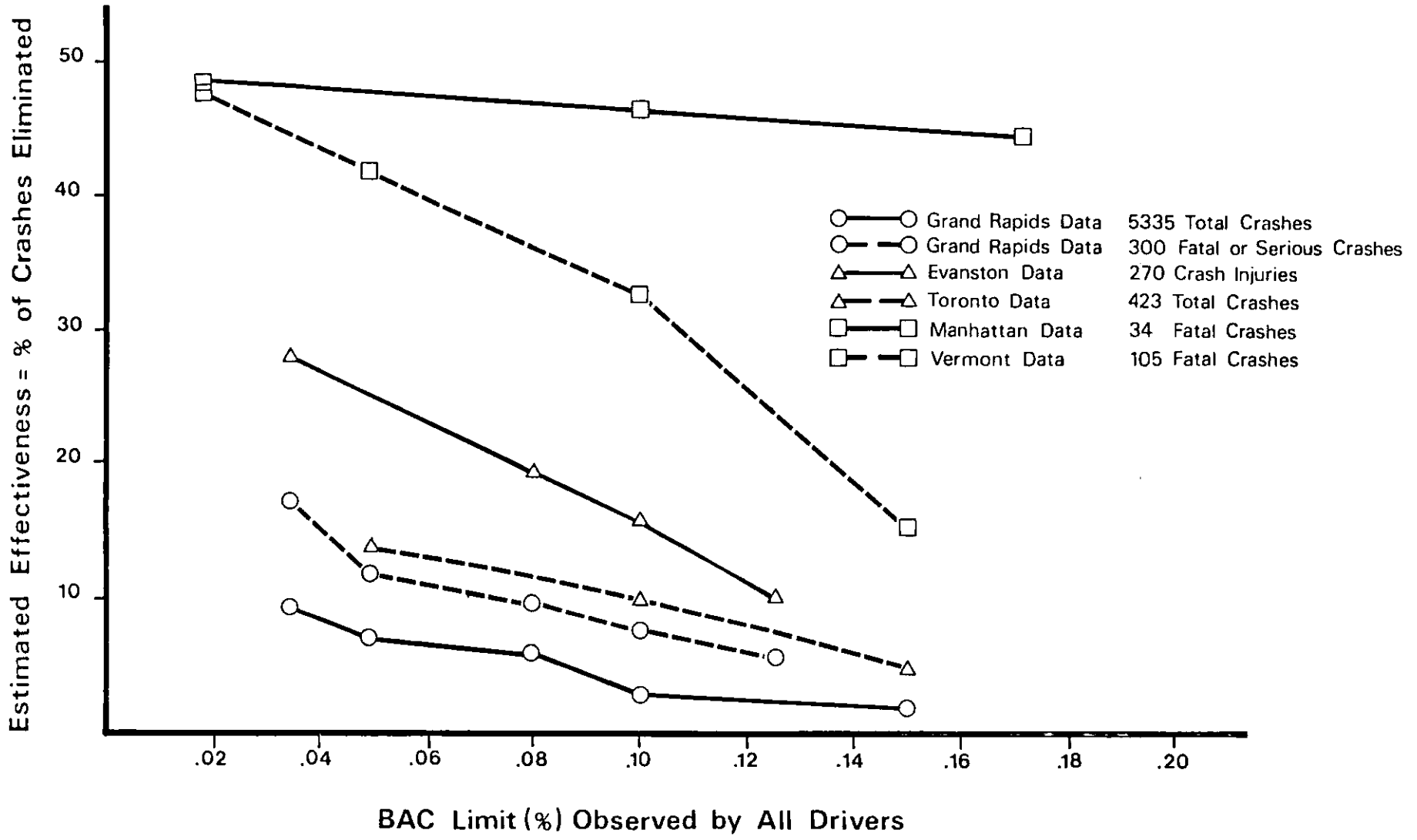
In the United States of America, per se laws have only recently received general acceptance. The reluctance to pass such legislation may have stemmed partly from the belief than not all persons above an arbitrarily set BAC limit are necessarily impaired. It may also reflect a greater concern for individual rights and the presumption of innocence than evident in other jurisdictions. Nevertheless, in 1983, the Presidential Commission on Drunk Driving recommended that all states pass legislation that makes driving with a BAC exceeding 100 mg% an offence per se.

Earlier, Hurst (1973) discussed why BAC limits lower than 100 mg% should not be legislated. His analysis deserves careful review and study. He examined the "effectiveness" of different BAC limits that no driver would exceed them (that is, assuming a perfect countermeasure or complete compliance with the law). As in this report, he used epidemiologic data from controlled studies. Each study gave different answers in terms of effectiveness (see Figure 15).

> From the "estimated effectiveness" functions, one can draw some tentative conclusions. If one wishes to reduce total crash incidence to an important degree, one must evidently choose a rather stringent BAC limit. Although the estimates are probably conservative, as explained above, there seems little to be gained by enforcing a liberal limit. An enforced (complied with) limit of 0.15% would be only one fifth to one third as effective as a 0.05% limit in reducing total crashes (Grand Rapids and Toronto data); a 0.10% limit would be about one half to two thirds as effective as a 0.05% limit. A limit of 0.08% would be nearly twice as effective as a 0.10% limit in reducing total alcohol-involved crashes, according to the Grand Rapids data, amounting to a total crash reduction (from all causes) of 6% as opposed to slightly over 3%. The Toronto data suggest much less relative difference in alcohol-involved crashes, but a similar total crash reduction: 12% for the 0.08% limit as opposed to 10% for the 0.10% limit.
>
> Turning to the "fatalities" data, one estimates much greater effectiveness from BAC limit compliance, as was to be expected. In Manhattan, it would appear that reducing the very high BAC's even to the relative sobriety of 0.15%(!) would be very nearly as effective as the most stringent limit conceivable. Vermont's effectiveness function shows considerably greater sensitivity.

Figure 15

Effectiveness of BAC Limits



Source: Hurst – 1973 ; pg. 147

> Here, the estimated potential savings in total fatal crashes from BAC limit compliance are 42% for a 0.05% limit, 36% for a 0.08% limit, and 33% for a 0.10% limit. The savings in total fatalities from a 0.15% limit would be only 15%.
>
> Thus, it appears that the effectiveness of a BAC limit is strongly dependent on how you assess it: Total crashes, fatal crashes, or some intermediate criterion. There are two reasons why an alcohol-safety program might well focus on the fatalities criterion: First, because of their much higher social cost; and second, because alcohol seems to play a much greater role in them. Alcohol countermeasures can do a lot more about total highway fatalities than they can about total highway crashes. According to this premise, we may approach the cost/effectiveness determination in terms of fatality reduction.
>
> As would be expected, the effectiveness data generally imply that the lower the limit, the greater effectiveness. Yet one must bear in mind the potential impact on public acceptance of too severe a limit: As Borkenstein et al. (1963) have warned, we must get the normal nonpathological drinker on our side. This brings us to the nebulous "cost" side of our cost/effectiveness determination, e.g., is the increased savings from a 0.08% limit, as opposed to a 0.10% limit, worth the problems it might create? In terms of perfect compliance, the difference in Vermont would represent a 36% reduction in total highway driver fatalities as opposed to a 33% reduction. The Manhattan data, though based on a smaller sample, suggest an even smaller difference. So do the French data. What we must consider is that these calculations are based on perfect compliance and the extent to which this ideal is approached might be strongly contingent on public acceptance. Most current enforcement practices are surely falling far short of this ideal and the foregoing data indicate that improved compliance is likely to pay off far more than more stringent limits....
>
> As to the level at which the absolute limit should be set, I think the evidence suggests we could accomplish a great deal of our goal (at least in the U.S.A.) by adequate enforcement of the presently recommended DOT maximum of a 0.10% limit [100 mg%]. There may well be a warrant for reducing this limit in certain jurisdictions for younger drivers. (pp. 141, 142, emphasis added).

Hurst's discussion seems as timely today as when he published his analysis in 1973. He raises a critical issue: To what extent do we in Canada now have perfect compliance (an "enforced" limit) with our current statutory limit of 80 mg%? The answer, clearly, is that we do not have an enforced limit of 80 mg% (e.g., Warren and Donelson 1982). The need to emphasize enforcement of existing BAC limits, rather than to lower statutory limits, is evident. Lower BAC limits do not appear to have any intrinsic value independent of adequate enforcement. No

jurisdiction, to our knowledge, has accomplished the aim of an "enforced limit", whether it be zero, 50 mg%, 80 mg%, or 100 mg%. To advocate lowering the current statutory limit does not address the main problem, namely, how to deter (or prevent) persons with BACs over twice the legal limit from driving. High-BAC, high-risk groups of drivers represent primary targets for action programs, not those marginally impaired with only a slightly increased relative risk of accident involvement.

In summary, consideration other than scientific evidence from experimental and epidemiologic studies seem to have played the greater role in decisions about lowering BAC limits in some other jurisdictions. These include the following:

- the limitations in police enforcement capability;
- the substantial increase in the number of potential offenders;
- the relatively low number of people evidencing impaired driving in lower BAC ranges;
- the possible resistance among the public to lower BAC limits;
- the large cost of enforcing lower BAC limits; and
- the low cost-effectiveness of enforcing lower BAC limits when enforcement of existing limits remains marginal at best.

Jurisdictions that have enacted statutory limits of 50 mg% have not done so based on scientific evidence nor have they based their decisions on practical grounds. Their success to date enforcing such limits remains questionable at best (see Ross 1982).

3.3.2 Compliance--the public's dilemma. Another consideration in the decision to lower the statutory BAC limit from 80 to 50 mg% has to do with people's ability to comply with the law. Section 236 makes it a criminal offense to drive or to have care or control of a motor vehicle with a BAC exceeding 80 mg%. This law may have greatly simplified enforcement and adjudication of alcohol-impaired driving offences but

it has done little to assist the public in complying with the law. Most people may know (by rote) the legal limit; few seem to understand what it means in terms of personally experienced effects of alcohol. Moreover, the units of measurement, which are metric (80 milligrams of alcohol in 100 millilitres of blood), are incomprehensible to all but those familiar with chemistry and related disciplines.

In setting a statutory limit, we tend to forget that driving after drinking is legal within that limit. We also fail to appreciate the public's dilemma in "obeying" the BAC limit. Without objective tests of BAC, most people have no way of knowing if or when they have a BAC exceeding 80 mg%, the present limit. In the absence of such tests, drinking drivers have to rely on their own judgements of "impairment" and "increased risk". Of course, even moderate amounts of alcohol can contribute to the difficulty of "knowing one's limit". These and other issues related to noncompliance with per se laws have been discussed elsewhere (Beirness and Donelson 1983).

Lowering the statutory BAC limit from 80 mg% to 50 mg% may exacerbate an already problematic situation. As many people drive with BACs between 50 and 80 mg% as with BACs exceeding the legal limit (Smith et al. 1975; Interministerial Committee on Drinking-driving 1980; Lawson et al. 1982). Those with BACs in the lower range probably represent, for the most part, moderate drinkers and responsible drinking-drivers. As mentioned earlier in Section 3.1.4, many people with moderate BACs can perform driving-related tasks within normal bounds of care and safety. It is likely that these same people, who may not reliably estimate their BAC, feel "okay" to drive after drinking moderately. We can only wonder about this group's reaction if the legal limit were lowered, enforcement increased through random police checkstops, and many of them charged with the criminal offence of driving with a BAC exceeding the legal limit. As one consequence, general public support for such countermeasures might erode substantially.

There is also a consideration of fairness. Most people do not know, nor can many appreciate, what the present BAC limit means in terms of

practical, everyday behaviour. Simply lowering this limit to 50 mg% would probably do little to alter the public's understanding and, by default, actually increase noncompliance by doubling the number of drivers over the legal limit! Furthermore, if such a change were accompanied by admonitions to have one drink per hour or less to stay within the new lower limit, then conflicts with normative drinking patterns may be resolved by many ignoring what they might then perceive as an unrealistic limit.

An analogy to the public's dilemma over BAC limits involves another, more familiar safety measure: speed limits. We may take for granted that motor vehicles are equipped with speedometers, without which we would find it difficult to comply with posted limits. Imagine, however, a society that built motor vehicles without speedometers, posted speed limits on all roads and highways, and then "cracked down" on speeders as a means to end the daily carnage of road accidents. We can suppose that some speeders, especially those going twice the legal limit, should have known better and deserved a speeding ticket. However, we might sympathize with those others who, though in some excess of the posted limit, drove in a manner consistent with normal care and safety. In fact, we might question the validity of the posted limit even if we did not think up an "obvious" solution: the speedometer.

The technology for testing breath to estimate BAC has advanced greatly since the first equipment became available for purposes of law enforcement. In fact, breathtesting equipment for public and private use--large, coin-operated machines to personal, portable devices--is widely marketed. An obvious measure that would address some of the considerations raised in this sub-section suggests itself: increased availability and more widespread distribution of "BAC-meters", to assist otherwise responsible drivers to obey the legal limit, whether set at 80 mg% or 50 mg%.

3.4 Summary and Conclusion

This section dealt with the legislative issue concerning whether or not the current BAC limit specified in Section 236 of the Criminal Code

should be lowered from 80 milligrams of alcohol per 100 millilitres of blood (80 mg%) to 50 mg%, based on empirical data. We summarized findings from scientific studies that addressed two specific questions:

- Do BACs between 50 and 80 mg% so adversely affect driving-related skills as to constitute "impairment" of the "ability to drive"?
- Are BACs between 50 and 80 mg% strongly associated with an increased risk of accident-involvement?

The experimental and epidemiologic evidence discussed above provides equivocal answers to these questions.

Our review of experimental studies indicates that BACs between 50 and 80 mg% can adversely affect performance of driving-related skills. The magnitude of these effects is not great for many, if not most, people. In fact, many responses are "altered in such small amounts under moderate doses of alcohol that the changes need not be an important factor of the behaviour" (Carpenter 1959, p. 495).

Experimental research has not definitely identified sub-groups within the population most vulnerable to the influence of small amounts of alcohol. It has been hypothesized that such sub-groups may include the young, the elderly, those inexperienced in performing the driving task, infrequent low-volume drinkers, and females. Only infrequent or low-volume drinkers have consistently shown greater performance deficits under alcohol than comparison groups of heavy drinkers. The variability of people's responses to these moderate concentrations of alcohol, however, certainly preclude judgment that all persons with BACs between 50 and 80 mg% have their ability to drive impaired by alcohol. In fact, there is evidence that people with BACs in this range can operate motor vehicles in a safe and careful manner. This is not to say that many people with BACs between 50 and 80 mg% do not have their ability to drive impaired by alcohol. Undoubtedly, some people will show substantially impaired behaviour at moderate BACS. Given marked differences among people, though, we do not believe that chemical test results showing a BAC up to 80 mg% should be considered irrebutable evidence of

an offence implicitly that of alcohol-impaired driving. We conclude that experimental data do not support the lowering of the current per se limit of 80 mg% to 50 mg%.

Epidemiologic studies have generally shown that drivers with BACs between 50 and 80 mg% have an increased risk of accident-involvement compared to the average drinking driver. The increase in relative risk associated with this BAC range is not great, nor in the words of McLean et al. (1980, p. 34) "meaningfully different from that of a sober driver..." Thus, BACs between 50 and 80 mg% are not strongly associated with an increased risk of accident involvement. When we examine groups of drivers with characteristics other than BAC, we discover why. Some groups of drinking drivers--for example, those that drink frequently, or who have high annual mileage--have no increased risk of accident involvement compared to the average nondrinking driver when their BACs are between 50 and 80 mg%. These groups of drinking drivers may have a higher (though not necessarily a statistically significant) risk compared to themselves at lower BACs. Nonetheless, the overrepresentation of these groups of drivers in the population "at risk" weakens the overall association between moderate BACs and relative risk. We cannot conclude, therefore, that, given other factors and circumstances, all drivers with BACs between 50 and 80 mg% have a substantially increased risk of accident-involvement. We do not believe, therefore, that present data support lowering the statutory BAC limit to 50 mg%.

Thus, both experimental and epidemiologic evidence appear consistent. Each body of knowledge suggests that some drivers with BACs between 50 and 80 mg% have their ability to drive impaired by alcohol and thereby face an increased risk of accident-involvement. Findings from similar (and, in some instances, the same) studies indicate that other drivers with BACs in the same range do not differ from the average nondrinking driver.

We again point out that the present array of alcohol-impaired driving statutes in the Criminal Code adequately addresses this issue. Persons

judged to have their ability impaired by alcohol at concentrations less than 80 mg% can be arrested and convicted under Section 234. Alcohol-impaired drivers with BACs between 50 and 80 mg% find no loophole in the law. At the same time, then, those not judged impaired with BACs in the same range need not be prosecuted and sanctioned for the criminal offence of driving with a BAC exceeding the legal limit.

Considerations other than scientific data can, and should be, taken into account in deciding whether or not to lower the statutory BAC limit.

It seems clear that the great majority of drinking drivers have little understanding of how alcohol consumption relates to BAC. We think it unlikely that simply lowering the legal BAC limit will have any intrinsic value in altering drinking-driving behaviour. Providing objective tests of BAC for use by individuals would, in our opinion, increase the likelihood of informed decision-making about driving after drinking too much. Further study seems required, however, before any conclusions can be reached about how this approach itself might reduce the frequency of alcohol-impaired driving.

Lowering the legal BAC limit, given the stability of drinking-driving behaviour in Canada, may double the number of drivers who drive with illegal BACs. The frequency of alcohol-impaired driving under the present law, combined with limited resources to enforce it, suggests a pragmatic option: Concentrate efforts to deter or prevent driving with BACs exceeding the present legal limit rather than extending them to deal with marginally impaired drivers at relatively low risk of accident-involvement. As Hurst and others have pointed out, in terms of cost-effectiveness, we have more to gain by focusing on the high-BAC, high-risk driver in terms of overall reduction in human and economic losses due to alcohol-related road accidents.

We do not recommend, based on our findings, lowering the current statutory limit of 80 mg% to 50 mg%.

4.0 TIERED STATUTES BASED ON BAC

This section deals with the legislative issue of tiered statutes, those that specify two or more BAC ranges defining alcohol-impaired driving offences. In principle, the purpose of such statutes is to distinguish the seriousness of the offence or to guide the severity (or type) of punishment. At present, Section 236(1) of the Criminal Code (the per se statute) simply defines driving with a BAC exceeding 80 mg% as an offence. It does not mandate greater penalties for higher as opposed to lower BACs, although in practice judges may base the severity of sentence (e.g., the amount of fine) on evidence of a person's BAC. It does, however, specify greater minimum penalties for those convicted of two, three, or more offences, which is, in fact, a tiered system of sanctioning in and of itself.

Some provinces have enacted legislation that, along with Criminal Code statutes, in effect establishes a two-tiered approach based on BAC. The laws differ somewhat from province to province, but generally they permit police officers to remove drinking drivers from the road for periods ranging from 6 to 24 hours without requiring formal legal proceedings. For example, in Manitoba, Section 238.1(6) of the Highway Traffic Act provides for a six-hour licence suspension where a roadside breath test for alcohol indicates a driver has a BAC between 50 and 100 mg%. Ontario's law (Chapter 198, Section 30a(5) of the Highway Traffic Act) specifies a 12-hour suspension where the roadside breath test indicates a BAC of 50 mg% or greater. In British Columbia and Alberta, similar laws allow roadside suspension of licences but require drivers to show their BACs do not exceed a certain value.

The legislative issue we consider in this section, however, concerns replacing the present one-tiered statute in the Criminal Code (Section 236(1)) with a two-tiered statute based on BAC. For the sake of discussion, we have defined the two tiers as follows: greater than 80 mg% and less than 150 mg% (81-149 mg%); and 150 mg% or greater (150+ mg%). We have chosen 150 mg% as the threshold limit of a second tier because this value has traditionally served to demarcate lower and higher BAC

ranges. For example, early in the alcohol/traffic safety experience, experts judged BACs of 150 mg% or more as presumptive evidence of a driver's being "under the influence of intoxicating liquor" (National Safety Council 1978, p.13). BACs less than 150 mg% were not so regarded at that time, although BACs between 50 and 150 mg% might be used along with other evidence to determine whether the person charged was "under the influence" or not. Even today, a BAC of 150 mg% defines the threshold of more serious alcohol-impaired driving offenses in some of the United States, some European countries including Sweden, and in some Australian states.

BAC limits other than 150 mg%, of course, might be considered for defining the offence of driving while "very impaired" or "intoxicated" by alcohol. Moreover, more than two tiers could be specified. For example, Denmark presently has the distinction of legislating the most complex per se statute in the world: five tiers ranging from 80 mg% to 250+ mg% (Ross 1983). Our examining a two-tiered statute with the higher limit of 150 mg% has the primary advantage of simplifying review and discussion of the more general issue:

- What empirical basis exists to support differential charging (or sanctioning) of persons based on concentration ranges of blood (or breath) alcohol?

Three sub-sections below summarize relevant findings from experimental and epidemiologic studies and other information from the United States and abroad. In addition, other considerations related to this issue are discussed.

4.1 Experimental Evidence

We discussed in Section 3.1.7 the rationale implicit in statutory BAC limits, namely, that BACs exceeding legal limits, given valid test results, constitute irrebutable evidence of an offence. Tiered statutes based on BAC have a similar rationale: that there exists discrete BAC ranges corresponding to gradations, or degrees, of alcohol-impaired driving in individuals. This approach in Law can conflict with basic

principles and knowledge in scientific disciplines concerned with the effects of drugs (including alcohol) on human behaviour.

In general, the higher the concentration of a drug, the greater its effects on measures of performance. For example, the effects of alcohol on driving-related tasks are, on average, greater with increasing BAC. The relationship between measures of performance and BAC is continuous, with no dividing lines at any given point to determine "impaired" as opposed to "very impaired" conditions. The difference in effect between close BAC values--for example, 140 mg% and 160 mg%--may be negligible. Comparing measures of performance of subjects at 100 mg% and 160 mg%, we may well find substantial differences. These generalizations, of course, apply to groups of people, not necessarily to individuals. The variance of response of people to the same BAC complicates defining BAC ranges corresponding to degrees of driving impairment. In principle, then, we would not expect to find a single BAC limit that discriminates reliably between "impaired" and "grossly impaired" ability to drive.

Beyond theory to practice, the experimental literature tends to confirm this expectation. Unfortunately, past experimental studies have not systematically examined the effects of alcohol at higher concentrations on human behaviour. Most research to date has concerned the effects of moderate BACs. Other studies, using specific tests of performance, have estimated BACs at which measurable effects of alcohol on behaviour appear. For ethical and pragmatic reasons, studies that have examined the effects of BACs greater than 100 mg% generally employed "heavy drinkers" or "alcoholics" as experimental subjects (e.g., Mello and Mendelson 1970; Talland and Kasschau 1965). Given the degree of tolerance to alcohol and the manifest dependency on alcohol associated with these groups of subjects (Jellinek 1960), results of such studies do not apply to the "average" drinking driver. The magnitude of changes in performance among these subjects at high BACs would probably be greater in people described as "social drinkers". This has relevance, however, for our consideration of tiered BAC statutes.

In a recent review of the literature, Vingilis (1983) estimated that between 30 and 50% of those convicted of alcohol-impaired driving could be considered alcoholics. Leaving aside the semantic problem engendered by the term "alcoholic", the prevalence of high BACs among persons arrested for alcohol-impaired driving indicates a very large percentage of "heavy drinkers". We cited in Section 3.1.6 evidence that people who consume large amounts of alcohol frequently show lesser effects from a given dose of alcohol than to moderate drinkers or abstainers. These findings and inferences, drawn from epidemiologic and experimental research, suggest that many persons arrested for alcohol-impaired driving may belong to the group of individuals less affected by high BACs than the average drinking driver.

In the preceding section, which deals with minimum statutory BAC limits, we concluded that many drivers who had BACs above a lower limit of 50 mg% would not have their ability to drive impaired by alcohol. In considering the issue of tiered statutes based on BAC, we have to ask whether or not many drivers above a higher BAC limit would be impaired to the same (or even to a lesser) degree compared to other drivers with BACs in the lower range.

Two reports in the literature offer some insight into this matter.

Harger and Hulpieu (1956) reviewed seven studies that examined the frequency with which subjects were judged to display the common signs of drunkenness (i.e., slurred speech, difficulty of locomotion) at different BACs. Of 5850 subjects, 34% were judged intoxicated at BACs between 51 and 100 mg%, 64% between 101 to 150 mg%, and 86% between 151 to 200 mg%. Forney and Harger (1971) reviewed studies of alcohol effects published prior to 1963. They found that the BAC at which most subjects displayed measurable deficits in performance varied from a low of 25 mg% to a high of 150 mg%.

These reports document the wide range of BACs over which both subtle and overt effects of alcohol appear. The experimental and clinical studies reviewed indicate that (1) some individuals with BACs less than 150 mg%

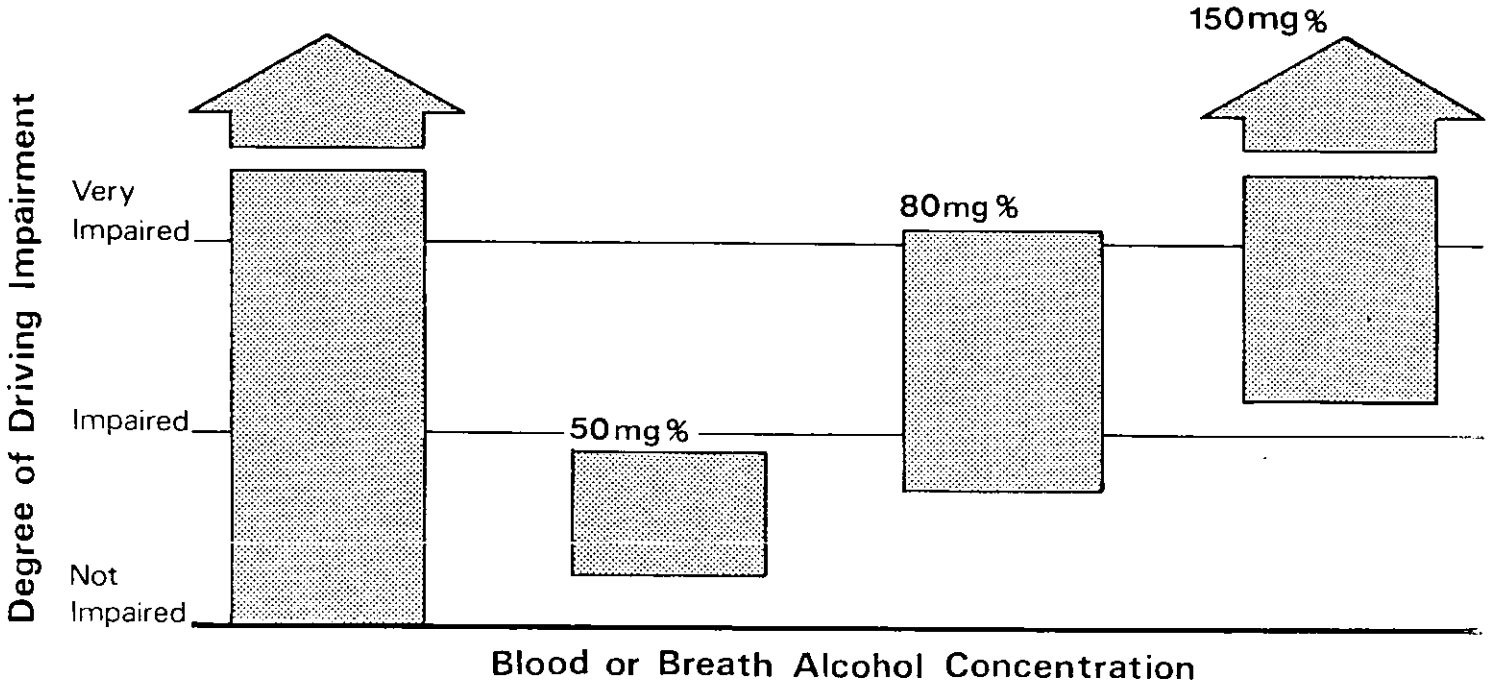
behave in an intoxicated or "grossly impaired" manner, and (2) some individuals with BACs above 150 mg% do not. Figure 16 summarizes--in an hypothetical way--the general relationship between BAC and driving impairment. People with a certain BAC evidence different degrees of driving impairment. Conversely, a given degree of driving impairment may be found across a range of BACs. The ranges of driving impairment associated with BAC cross the vaguely defined categories of "impaired" and "very impaired". While not based on data from an experimental study, in all probability the relationships reflect the actual situation.

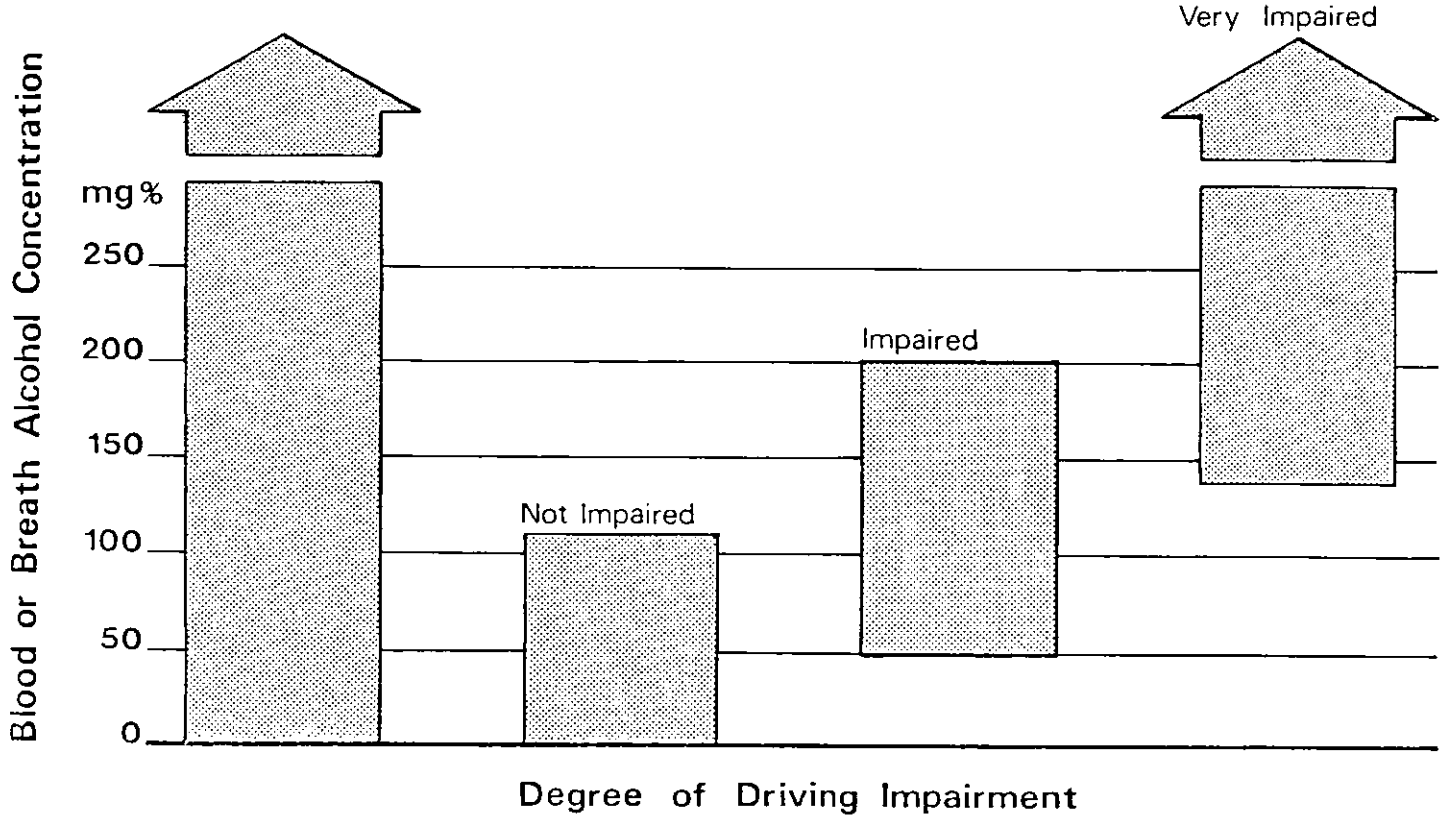
The implications of the foregoing are clear. A tiered statute with higher limit of 150 mg% certainly simplifies the legal definition of "very impaired" as opposed to "impaired" driving. It does not correspond exactly to the known relationship between BAC and driving impairment. Not only will some persons with BACs in the higher range be "only" impaired, but also some below the higher limit will be "very impaired". The lack of experimental research in this area, however, precludes estimating the percentage of alcohol-impaired drivers who might belong to either category. Present knowledge does indicate that some percentage of drivers would be categorized inappropriately on the basis of BAC only.

In summary, attempting to define a "second tier" of alcohol effects solely on the basis of experimental research is difficult. Few studies have employed BACs in excess of 100 mg%. Reported research has generally used alcoholic subjects. Nevertheless, available data indicates that alcohol effects begin to appear in some individuals at BACs between 50-80 mg%; in more individuals between 80-100 mg%; and, by the time 150 mg% is reached, almost all subjects display observable behavioural signs of impairment. These ranges are estimates based on average values from a number of separate studies. The actual magnitude of effects due to alcohol varies from individual to individual. The extent of individual differences suggest that for the purpose of charges or penalties for various degrees of alcohol-impaired driving, both chemical test results and assessments of behaviour would offer a far more reliable and

Figure 16

The General Relationship Between BAC and Driving Impairment





realistic basis for judgement. This and other alternatives to a two-tiered statute are discussed in Section 4.4.

4.2 Epidemiologic Evidence

Section 3.2 described epidemiologic research that estimates the relative risk of accident involvement associated with BAC. The studies reviewed in that section also provide data relevant to the issue of tiered statutes based on BAC.

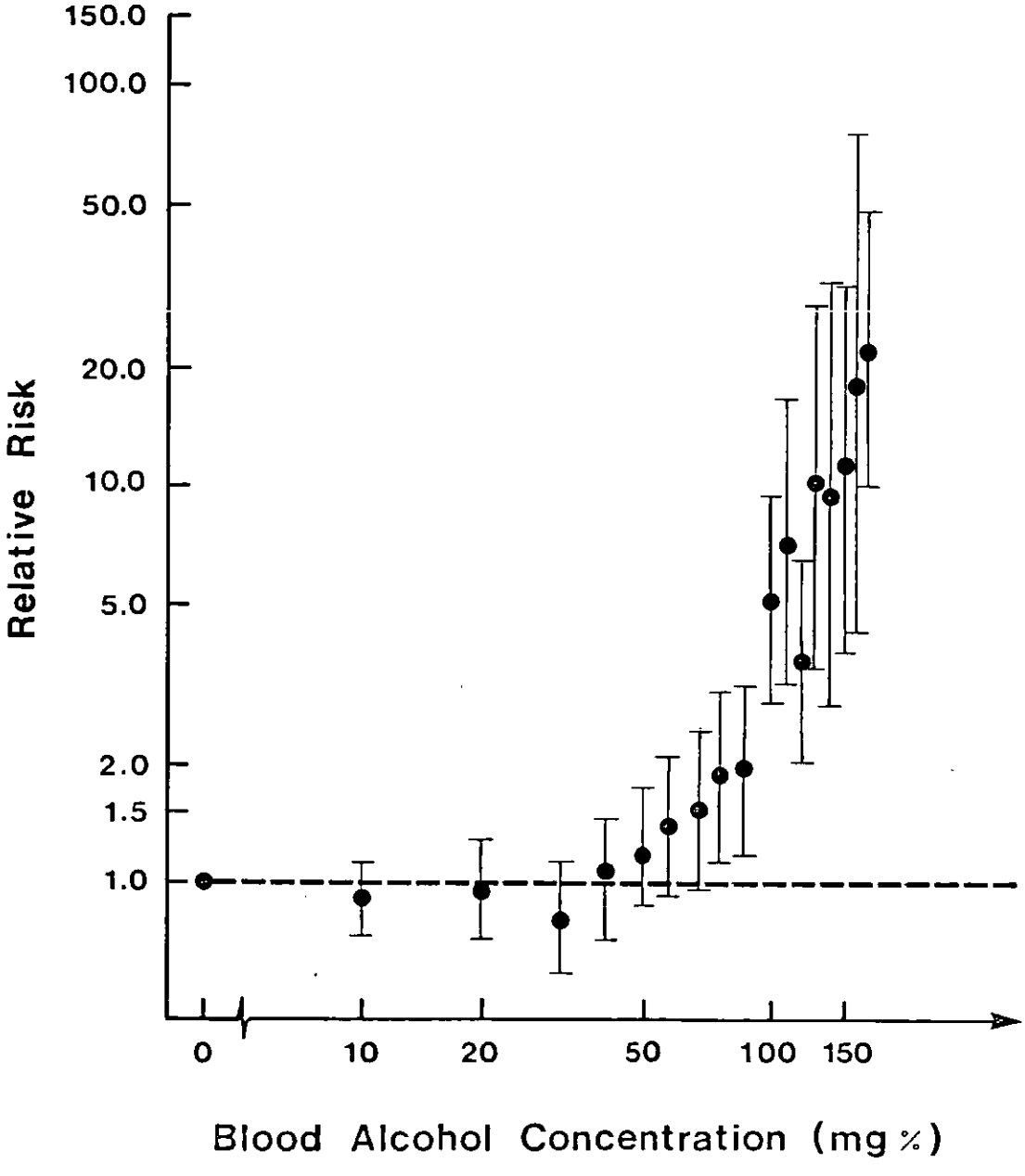
Figure 17 presents data from the Grand Rapids study (Borkenstein et al. 1964). The relative risk of accident involvement, along with calculated confidence intervals, is plotted by BAC in 10 mg% ranges. The last point represents BACs 170 mg% and over. This figure shows that relative risk estimates for BACs greater than 150 mg% do not differ significantly from most in the range between 110 and 140 mg%. This finding is similar --to a greater or lesser degree--in other studies (see Figures 6-8).

Figure 18 illustrates the general relationship between BAC and relative risk of accident involvement. As with the degree of driving impairment, so various BACs can produce among drivers of different characteristics a range of risks. To a greater or lesser extent these ranges of risk will overlap, depending on how close the values are. As shown in Figure 18, the range of risks for 50 and 80 mg%, and for 80 and 150 mg% probably overlap, but those for 50 and 150 mg% probably do not. Conversely, the conditions of risk--low (or normal), moderate, and high--will correspond to ranges of BAC, which can also overlap.

Tiered statutes based on BAC present an unavoidable dilemma. An arbitrary limit defining higher tiers must be chosen. Adjacent BAC ranges are thus produced. As discussed above in terms of driving impairment, some percentage of persons in the lower range will have a relative risk of accident involvement associated with higher BAC values. Others in the higher range will have a lower risk of accident involvement.

Figure 17

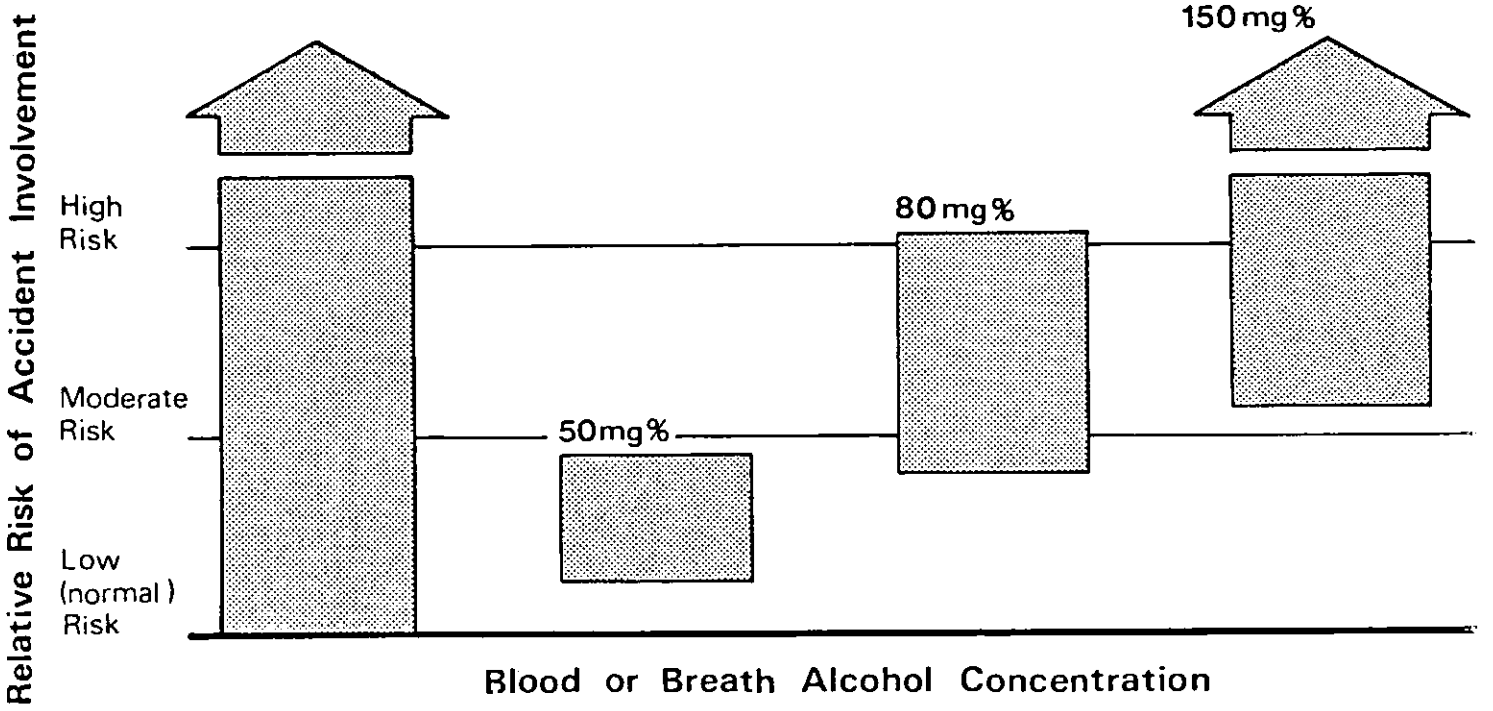
BAC and Relative Risk of Accident Involvement: The Grand Rapids Study

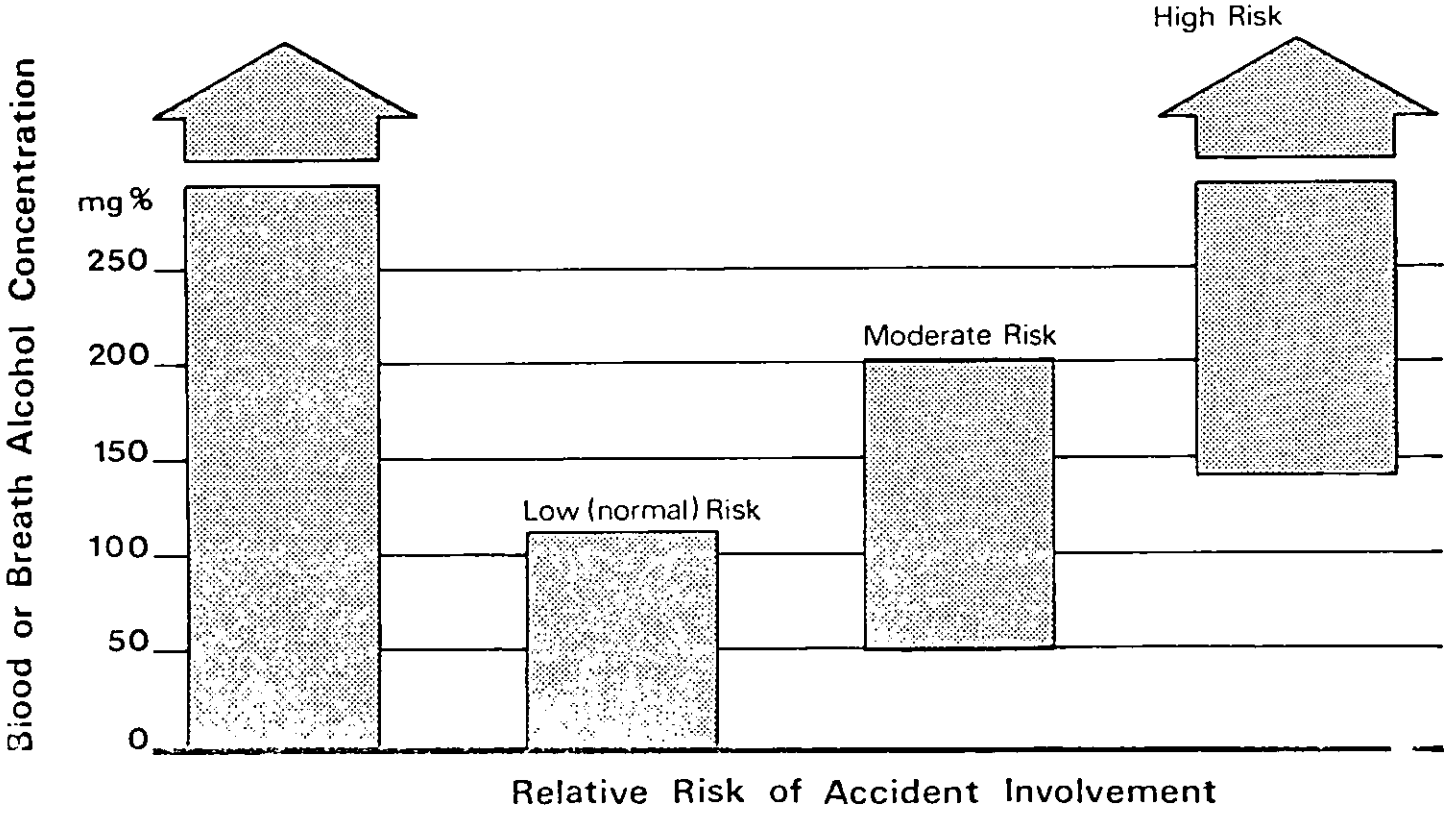


Source: Borkenstein et al – 1964

Figure 18

The General Relationship Between BAC and Relative Risk of Accident Involvement





Epidemiologic studies demonstrate that BAC as an objective measure of relative risk is not as reliable as many may believe. Too many factors other than alcohol also contribute to, or reduce, the risk of accident involvement. Some factors interact with influence of alcohol to increase, or to decrease, the relative risk of accident involvement associated with BAC. This considerable variability renders difficult the choice of a BAC to define higher tiers and additional or more severe penalties.

One factor that confuses this issue is the broad spectrum of driving behaviour associated with high BACs.

Contrast, for example, the behaviour of two different drivers, each with a BAC of 180 mg%. Driver A races at high speed down an unlit, rural road in a late model, sporty vehicle. He fails to negotiate a poorly marked curve and slams into an embankment, dying instantly. Driver A is 24 years old, single, and unemployed. Driver B--37 years old, married, white collar worker--pokes along a suburban lane, slightly weaving, managing to avoid roadside hazards, like parked cars and utility poles. His behaviour--ultracautious compared to a sober driver in a neighbourhood with almost no other traffic--goes unnoticed, and he (once again) returns home safely. This example, deliberately extreme, is not unrealistic. High BACs do not, in and of themselves, produce a higher relative risk of serious crash involvement. In fact, the motivation to compensate for alcohol impairment at high BACs may be more typical than near suicidal behaviour characteristic of some people involved in serious automobile accidents.

We know from epidemiologic studies that alcohol use among drivers is strongly associated with serious traffic crashes. Drivers fatally injured in, and responsible for, these accidents often have very high BACs. These disturbingly consistent findings lead us to overlook other evidence. Alcohol use (even in great amounts) is neither a necessary nor a sufficient condition for the occurrence of road accidents. In fact, the vast majority of "drunk-driving" trips are completed successfully and do not result in arrest or accident. The absolute risk of

accident involvement when a person drives with a BAC of 150 mg% is very low. If, as has been crudely estimated elsewhere (Warren and Donelson, 1983), the average risk of a fatal accident is 1 in two million driving trips, even a risk of 100 times greater than average results in a probability of 1 in 20,000 drunk-driving trips. BACs in the range of 200 mg% may increase relative risk anywhere from 10 to 30 times the average, based on large-scale surveys. We can illustrate this finding by stating that, statistically, a person could drive drunk around the world without expecting to be involved in a serious road accident.

The point of this discussion is not to argue that higher BACs among drivers represent an acceptable risk and, therefore, should not be punished more severely. Rather, we wish to underscore the fact that many drivers with higher BACs do not automatically fall into high-risk categories compared to others with lower BACs. Again, other factors and characteristics of the drivers themselves become deciding variables. Even this statement has a caveat, however. As BAC increases into very high ranges, for example, 250+ mg%, the percentage of drivers with a relative risk of accident involvement comparable to lower BAC ranges becomes extremely low. Thus, one alternative to an higher limit of 150 mg% is one even higher. We believe that a BAC of 200 mg% represents a fair choice much as 80 mg% seems a fair limit defining the offense of alcohol-impaired driving now. At the same time we realize that many drivers below 200 mg% will have a "very high" risk of accident involvement. Unfortunately, BAC alone does not offer a reliable means to discriminate between higher and moderate risk states.

4.3 Other Jurisdictions

During the course of our investigation we contacted experts in other countries to gather information about tiered statutes, their use in practice, and any considerations that may apply to Canada. We found it very difficult, given available time and resources, to obtain documentation, either copies of different statutes or reports concerning enforcement and adjudication. To our knowledge, no studies have yet assessed the impact or effectiveness of tiered statutes. Very few, if any,

reports even summarize basic statistics on the number and type of charges and penalties given to those convicted in jurisdictions with tiered statutes (see, however, the work of Homel [1982] in Australia). This is a problem also found in Canada, where reliable national and provincial statistics related to alcohol-impaired driving charges, sanctions, and recidivism are almost nonexistent. What follows, therefore, is a summary of the fragmentary information we obtained through telephone conversations and letter exchanges. What is greatly needed, therefore, is a detailed examination of laws and practices in other countries, should such information be deemed useful in further revisions of Criminal Code statutes related to alcohol-impaired driving.

Many of the United States have moved to adopt per se statutes like Section 236(1) of the Criminal Code, with a BAC limit of 100 mg%. Some of the United States, though, still have legislation that provides for different charges based on "presumptive" BAC limits. For example, in some U.S. jurisdictions, driving while intoxicated (DWI) (150 mg% or higher) is more serious than driving under the influence of liquor (DUIL) (100 mg% or higher). These statutes, however, are not per se laws. That is, chemical test results showing that a person's BAC exceeded those limits do not constitute irrefutable evidence that the person committed either offense. Evidence of driving impairment must also be introduced to secure a conviction. In practice, plea bargaining to lesser charges (even nonalcohol-related charges such as careless driving) can and does occur.

Dr. A.J. McLean of the Road Accident Research Unit at the University of Adelaide was contacted to provide information on the Australian laws concerning drinking and driving. Each of the seven Australian states has the responsibility of setting its own BAC limit, which is incorporated into the state's Road Traffic Act. In the last two to three years every state except one has moved to a per se limit of 50 mg%. South Australia retains the 80 mg% limit. Many states also have a two-tiered statute based on BAC. In South Australia, for example, upon conviction of driving with a BAC between 80 to 149 mg%, an individual is subject to a fine of between $300 to $600 and a three month licence suspension.

There is a separate offence of driving with a BAC over 150 mg%; upon conviction, the individual is liable to a $400 - $700 fine and a six-month suspension of the driver's licence. Subsequent convictions carry licence suspensions of two and three years. Imprisonment is not viewed as a viable sentencing alternative. South Australia's two-tiered system has a "penalty structure" for fines that overlaps higher and lower BAC ranges. This suggests a possible resolution of the problem described above: an overlapping penalty structure would accommodate the overlapping seriousness of impaired-driving offences associated with different BACs.

Other, less relevant information obtained may also be of interest. Some Australian states also differentiate (for purposes of sanctioning) between those apprehended in random checks and those who bring themselves to the attention of the police, either through an accident, violation, or erratic driving. All individuals who require emergency treatment in hospital following a traffic accident (drivers and passengers!) are required to provide a blood sample for analysis. The hospital staff is immune to civil action but can be charged with an offence if they refuse to take the sample. All accident victims are included in blood test legislation to spare hospital staff from the task of identifying drivers of vehicles.

Homel (1982) has reported most extensively on sentencing practices in New South Wales (NSW). He analysed data obtained from court records of 14311 offenders convicted in NSW in 1976. His studies, which contain valuable insights into processes involved in sentencing convicted impaired drivers, may not reflect any recent changes in NSW statutes related to BAC. Pertinent to this report, Homel found that:

> higher BAC scores were associated with tougher penalties, although the correlations were not as marked as we might expect. The probability of imprisonment and a bond climbed steadily with BAC (1.5% were imprisoned at BAC levels below 130, 4.8% at levels above 200) but the chances of a bond or a restricted licence were unrelated to BAC. Mean fines increased from $150 to levels below 130 to $205 at levels above 200, and disqualification periods increased from 7 months to 14 months over the same range. (p.43)

Homel also found, using one analytical model, that BAC ranked last and next to last among factors predicting 556A--offender found guilty but having regard to his "character, antecedents, age, health, or mental condition" no conviction is recorded--and imprisonment, respectively. "Surprisingly, BAC exerted a relatively minor influence on the penalty despite the fact that it is widely regarded as an objective indicator of offence seriousness" (p.85). To decrease sentencing disparities, Homel recommended that guidelines be defined based on two dimensions: "seriousness of the offence as measured by BAC together with the perceived "danger of harm to the community" and the blameworthiness of the offender as measured by previous drink/drive and motoring convictions" (p.98).

Dr. Roger Bonnichsen of the National Police Board in Stockholm provided some current information on the Swedish situation. Sweden has a per se limit of 50 mg% and essentially three tiers with associated penalties. Between 50 and 80 mg% the driver is liable to a "heavy" fine but in most cases little if any penalty is imposed. Between 80 and 149 mg% the driver's licence is suspended and the heavy fine is mandatory. Only if one is found driving with a BAC over 150 mg% is a jail sentence imposed. The term of incarceration can vary from a minimum of 30 days to about 60 days depending on the circumstances. Those with exceptionally high BACs and those involved in accidents generally receive longer jail terms. This sentence is served in an "open" jail, a type of facility used almost exclusively by impaired drivers. The Swedish government has a policy of not exposing drinking drivers to "hardened" criminals occupying regular jails. Hence their introduction of the "open" jail concept, made practicable by the large numbers of convicted impaired drivers with BACs exceeding 150 mg%. Even so, as Ross (1983) reports, "exceptions to the prison requirement has always been allowed... and the number of categories in which exceptions are permitted has increased [to seven] over time... even though evidence is presented that [the offender] drove with a BAC over .15 percent [150 mg%]".

Ross (1983) provided an update on recent trends in Scandinavia in a paper entitled "Liberalization and Rationalization of Drunk-driving Laws

in Scandinavia". The trend towards liberalization manifested as lesser reliance on imprisonment as a standard penalty. Ross defines the trend toward "rationalization" as the "replacement of clinical evidence of impairment by blood alcohol concentration (BAC) evidence, in "random" testing and similar procedures which simplify the apprehension of suspects, and efforts to establish proportionality between the severity of punishment and the degree of driving impairment as measured by BAC". As documented by Ross, the rationalization process involved greater reliance on BAC test results to gauge the severity of offence. In both Sweden and Denmark, however, two-tiered per se laws defining less and more serious offences did not necessarily translate into sentence severity accordingly. In practice, as reported by Ross, upper and lower BAC limits seem to function more as guidelines than as strict prescriptions for sentencing.

4.4 Other Considerations

The experience of jurisdictions outside Canada offer some guidance for resolving the issue of tiered BAC statutes. The guidance, however, has more to do with considerations other than their value as a tool to deter alcohol-impaired driving. As reviewed by Ross (1982), the international experience with general deterrence indicates that laws proscribing alcohol-impaired driving and their enforcement have not produced results of the intended (and expected) magnitude. Moreover, we know of no data that permit an assessment of tiered statutes compared to "single-limit" laws as found in the Criminal Code.

One consideration relates to the percentages of persons arrested for alcohol-impaired driving who would be charged with offences based on various BAC ranges. In Canada the great majority of those charged have BACs over 150 mg%. Depending on the penalties imposed for a more serious charge of driving with a BAC exceeding 150 mg%, this may or may not pose practical problems for the criminal justice system. For example, Sweden's statute mandates a minimum 30 days in jail for a first offence for persons convicted for driving with BACs over 150 mg%. Because a great percentage of those arrested in Sweden have BACs over

that limit, the cost and logistics of jailing those convicted has become burdensome. Depending on the penalty structure of offences defined by higher BAC ranges, similar problems could well arise in Canada after adopting a tiered statute based solely on BAC.

Another consideration in defining more serious offences in terms of higher BAC ranges is the personal attributes and problems of people so charged and convicted. A high percentage of people with BACs over 150 mg% evidence symptoms of problem drinking and alcoholism. Harsher penalties and more severe punishment for this group of offenders, some would argue, are just as appropriate as for others who simply had a "few too many". We question that position. It seems neither humane nor--given the intent of the law, namely to reduce recidivism--in the best interests of society. Harsh treatment under the law of persons with drinking problems may exacerbate those problems and, in the long run, contribute to an higher rate of recidivism. This area requires careful study, which to date it has not received. Homel (1982) has found that more severe punishment was associated with higher rates of recidivism. We can only speculate as to the factors explaining this association. It may be that stiffer penalties given to people with drinking problems increase their other problems--economic, family relations, etc.--and further decrease their "social connectedness", thus increasing their reliance on alcohol. Given the need for private transportation and the frequency with which people convicted of impaired driving operate motor vehicles even with suspended licences, an increased redivism rate becomes understandable, if intolerable. In this regard, however, the possibility that certain alcohol-impaired driving laws are counterproductive might well be considered.

This "speculation" finds some support from the Swedish experience. Klette (1977, cited in Ross [1983]), found that 67% of persons convicted of the more serious alcohol-impaired driving offence (150+ mg%) and 50% of those convicted of the lesser offence (less than 150 mg%) had previously received treatment for alcohol-related problems. As Ross (1983) commented:

> The very high BACs of those drivers who are apprehended for violating the drunk-driving laws in all these [Scandinavian] countries in itself attests to the strong probability of alcohol pathology among the bulk of them. It is paradoxical to reserve the most stringent criminal penalties for a group consisting largely of those whose culpability may well be mitigated on the grounds of illness and whose condition is acknowledged as indicating the need for medical help.

A third consideration, not dealt with by Ross, Homel, and others, concerns a fundamental problem inherent in so-called per se laws. People simply do not know, nor do they have access to means for knowing, their BAC. To argue (as some have) that people who, having consumed alcoholic beverages, "ought to have known better" than to drive afterwards, not only begs the question but also fails to take into account the social context, which contributes greatly to drinking-driving behaviour. This consideration, of course, applies also to the present law prohibiting driving with a BAC exceeding 80 mg%. If the present trend toward increased enforcement of alcohol-impaired driving laws and toward increased penalties upon conviction of these offences continues, then we recommend strongly that regulations requiring breath-testing devices in all commercial establishments serving alcoholic beverages also be considered. Encouraging the development and marketing of personal breath-testing devices should also have a place in the overall societal response to the drinking-driving problem. Given widespread availability and use of these devices, per se laws--with one, two, or more tiers based on BAC--would appear much more rational and amenable to compliance among the drinking-driving public.

4.5 Summary and Conclusion

In this section we have considered the issue of tiered statutes based on BAC. Existing legislation even now adopts a "tiered" approach. For example, an increased penalty is specified by Section 236(1) of the Criminal Code for second and subsequent convictions. Provincial laws allow roadside licence suspensions for persons with BACs under 80 mg%. Moreover, in practice, many judges may base decisions concerning the severity of sentence on evidence of a person's BAC.

We restricted our analysis to a two-tiered statute that specifies BAC ranges of 81-149 mg% and 150+ mg%. This simplified examining the more general issue of assessing the empirical basis of similarly tiered statutes, their sole criterion being BAC.

Experimental evidence confirms the prediction of theory. Studies show that some individuals with BACs over 150 mg% do not evidence intoxication or gross impairment while others below 150 mg% do. The higher limit of 150 mg% would not, therefore, reliably discriminate between "impaired" and "very impaired" driving in a certain percentage of cases. Given the variability of individual responses to higher BACs, both chemical test results and behavioural evidence would offer a more reliable and realistic basis for (1) judging the degree of driving impairment in any one case and (2) for determining the severity and type of sentence.

Epidemiologic evidence tends to support experimental findings. Although the relative risk of accident involvement generally increases with increasing BAC, estimates of relative risk overlap discrete BAC values. As a consequence, some percentage of persons with BACs in the higher range will have a relative risk equal to or less than those with BACs in the lower range. Conversely, many persons in the lower range will have a relative risk of accident involvement similar to that associated with higher BACs. Basically, many drivers with higher BACs do not automatically fall into higher risk categories compared to others with lower BACs. Factors and characteristics other than BAC can enhance, or reduce, relative risk.

Despite the weak empirical basis for tiered statutes based on BAC, many other jurisdictions have adopted them. We found few studies that assessed the effectiveness of tiered statutes compared to those that simply proscribe driving over a single statutory limit, such as Section 236(1) of the Criminal Code (see, however, Ross [1983]). Given general public ignorance of BAC and its relation to the subjective experience of alcohol's effects, we question whether tiered statutes have any intrinsic value in deterring people from driving after drinking varying

amounts of alcoholic beverages. As a means to facilitate differential charging or sanctioning, of course, their utility cannot be questioned. The fairness in using them for these purposes can be questioned in light of the public's current inability to measure BAC objectively prior to driving.

We have also to consider whether tiered statutes based on BAC comply with established principles of Justice. Assuming, based on available scientific data, that some percentage of persons with higher BACs will not have committed a more serious offence in terms of driving impairment or increased accident risk, would Justice be served by charging everyone with higher BACs with a more serious offence, and, upon conviction, punishing all more severely based on an arbitrary and demonstrably unreliable standard? We think not.

Another consideration concerns the prevalence of problem drinkers or alcoholics among those convicted of alcohol-impaired driving offences. Here there exists a basic division of opinion, reflecting the interface between Medicine and Law. The conceptualization of alcohol dependence and addiction as disease underlies the position of those who believe that alcoholics should be treated, not punished for alcohol-related offences. These offences are therefore viewed as symptoms and outcomes of a disease process for which affected persons should not be held criminally responsible. Others would divorce medical from legal issues. They advocate punishing anyone convicted of alcohol-impaired driving offences irrespective of problem drinking or alcoholism. Beyond this debate, which lies beyond the scope of this report, we can question the effectiveness of laws that prescribe more severe penalties for a group of offenders that contains many for whom harsher treatment under law may increase the likelihood of recidivism. This possibility remains speculative. Nonetheless, given the persistence of problem drinking in the absence of treatment and the likelihood that many problem-drinking offenders will continue driving, this possibility deserves careful consideration and warrants further inquiry.

We conclude that a two-tiered per se statute with lower and upper limits of 80 and 150% does not have a strong basis in scientific fact. Other alternatives, each aimed at creating a more serious offence of "grossly impaired driving", have been suggested. For example:

- o define an offence equivalent to driving while "very impaired" by specifying a higher upper limit, for example, 200 mg%;
- o designate BACs exceeding 150 mg% as presumptive evidence of a more serious offence requiring other, behaviour-based evidence to establish "gross impairment";
- o retain the present, single limit of 80 mg% and implement a sentencing policy that calls for increased penalties for higher BACs if supported by evidence of overt and serious behavioural impairment; and
- o create a two-tiered per se statute with lower and upper limits of 80 and 150 mg%, but establish an overlapping penalty structure corresponding to greater and lesser impairment found in each of the tiers.

These alternatives engender many of the same problems and issues discussed above. For example, even an upper limit of 200 mg% is still subject to attack on scientific grounds. A two-tiered per se statute with overlapping penalty structures does not avoid the fundamental unsoundness of relying solely on BAC as a measure of the seriousness of the offence. Requiring other, behaviour-based evidence to establish a more serious offence (or to increase penalties upon conviction) leads back to reliance on subjective judgments of behavioural impairment--an approach found difficult (to say the least) in the past.

Moreover, the suggested alternatives listed above also have implications for criminal justice. For example, presumptive limits have led to widespread "plea bargaining" in other jurisdictions, a tactic often resulting in less serious charges and reduced penalties. Therefore, these and related alternatives require careful review for such implications, a task beyond the scope of this report.

Another alternative is simply to let Section 236(1) stand as written. This last alternative seems attractive. Experts in the field have argued that increasing penalties for alcohol-impaired driving offences. in and of itself, has little deterrent value (Homel 1982; Ross 1982). Greater gains are possible through increasing enforcement of existing laws and thereby increasing the perceived risk of arrests among drinking drivers. Moreover, existing laws appear to have adequate ranges of penalties to accommodate variations in the seriousness of offences under Section 236(1). Restructuring Section 236(1) to create a more serious alcohol-impaired driving offence based on a higher BAC limit seems less needed than other possible revisions. These might include (1) mandatory screening of offenders for problem drinking; (2) creating more serious alcohol-impaired driving offences based on the consequences of that behaviour (for example, causing accidents resulting in death or injury to others); and (3) providing for a range of sentencing options, so that characteristics of offenders and circumstances leading to their arrest and conviction can be used to identify the nature of additional sanctions most appropriate in each case.

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