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Calculating BACs For Dummies: The Real-World Significance of Canada's 0.08% Criminal BAC Limit for Driving

Robert Solomon & Erika Chamberlain[*]

Although calculating blood-alcohol concentrations (BACs) may be straightforward for toxicologists, it remains a mystery to many government policy makers, legal professionals and the general public. Most people can understand the concept of a legal BAC limit, but few realize what this means in terms of their own and others' alcohol consumption. This article demystifies BAC calculations, illustrates the patterns of alcohol consumption associated with various BAC levels, and discusses the traffic safety implications of the current Criminal Code 0.08% BAC limit. The authors provide a step-by-step explanation of BAC calculations using the example of a typical 200-pound male. The results indicate that he could drink over six beers in two hours and drive with little fear of being charged if stopped and tested by the police. Not surprisingly, most Canadians would view this level of consumption as wholly irresponsible for those intending to drive. Nevertheless, as long as discussions about BAC limits are framed in scientific terms, few Canadians will appreciate the high degree of impairment currently tolerated under the Criminal Code. The authors conclude that BAC limits need to be expressed in terms that the general public can understand and to which they can relate. Only then will there be a meaningful discussion of the issue and a broad call for lower BAC limits.

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Le calcul du taux d'alcoolémie dans le sang demeure un mystère pour plusieurs décideurs gouvernementaux, professionnels du domaine juridique et pour le public, même s'il s'agit d'une opération toute simple pour les toxicologues. La plupart des gens sont capables de comprendre ce que signifie la notion de limite légale du taux d'alcool dans le sang, mais peu d'entre eux comprennent vraiment ce que cela veut dire sur le plan de leur consommation d'alcool ou de celle des autres. Cet article démythifie le calcul du taux d'alcoolémie, donne des exemples d'habitudes de consommation d'alcool qui sont associées aux différents taux d'alcoolémie et discute des incidences sur la sécurité routière qu'a la limite du taux dans le sang de 0,08% prévue par le Code criminel actuel. À l'aide de l'exemple d'un homme moyen de 200 livres, les auteurs expliquent, étape par étape, comment on calcule le taux d'alcoolémie dans le sang. Les résultats démontrent que cet homme moyen pourrait boire plus de six bières sur une période de deux heures, puis conduire sans avoir peur de se faire accuser advenant que la police l'arrête et lui fasse passer un test. Comme on peut s'y attendre, la plupart des Canadiens verraient comme irresponsables les personnes ayant l'intention de conduire après avoir consommé autant d'alcool. Cependant, peu de Canadiens seront conscients du niveau élevé de capacités affaiblies actuellement toléré par le Code criminel tant et aussi longtemps que la question de la limite du taux d'alcool dans le sang sera débattue en termes scientifiques. Selon les auteurs, la limite du taux d'alcool dans le sang doit donc être expliquée avec des termes que le public peut comprendre et auxquels il s'associe. Ce n'est qu'à ce moment-là qu'une réelle discussion sur le sujet pourra avoir lieu et que la diminution la limite légale du taux d'alcool dans le sang sera demandé.

A. Introduction

The relationship between science, law and injury prevention policy is often tangled. This has clearly been the case in the ongoing debate about whether to introduce a new *Criminal Code* summary conviction offence for driving with a blood-alcohol concentration (BAC) in excess of 0.05%.[1] The debate will likely intensify when the House of Commons Standing Committee on Justice and Human Rights holds public meetings on the issue in the near future. The alcohol industry and others who oppose introducing a 0.05% BAC offence argue that it would interfere with normal "social drinking," and would prevent many women from drinking any alcohol before driving.[2] It is contended that, by needlessly punishing responsible drinkers, a

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1 More specifically, the proposed offence would include streamlined procedures for processing cases, carry lower penalties than the current 0.08% BAC offence, and protect first-time 0.05% BAC offenders who do not re-offend from having a permanent criminal record. The new offence would complement the existing *Criminal Code* impaired driving offences, which would remain unchanged. Moreover, the proposed offence would be compatible with current provincial and territorial short-term licence suspension legislation. R. Solomon and G. Dingle, *The Section 253(c) Proposal* (Mississauga, Ontario: MADD Canada, 2002).

2 See, for example, E. Therien, President of the Canada Safety Council, "One for the Road" *Globe and Mail* (18 January 2001), online: Globe and Mail home page <www.globeandmail.com> (date accessed: 14 September 2001); and D.J. Beirness, "Lowering the BAC Limit: A Canadian Perspective" (paper presented to *International Conference on Alcohol, Drugs and Traffic Safety — T'2000*, Stockholm, 22-26 May 2000), online: ICADTS 2000 home page <www.vv.se/traf_sak/t2000/index2.htm> (date accessed: 14 September 2001).

0.05% BAC law would undermine public support for the federal driving legislation.[3] Unfortunately, in making these and many other unsubstantiated assertions,[4] the critics rarely explain what a BAC is, the drinking patterns necessary to produce a 0.05% or 0.08% BAC, the BAC level at which police lay criminal charges, or the risks associated with driving at those levels of impairment.

The purpose of this article is to demystify the science behind BAC calculations, illustrate the patterns of alcohol consumption associated with various BAC levels, and discuss the traffic safety implications of the current 0.08% BAC *Criminal Code* offence. Readers hoping for a riveting and exhaustive discussion of the toxicology of alcohol will be sadly disappointed. Our intended audience are the scientifically challenged, among whom we count ourselves. We are not attempting to prove that any one method of calculating BACs is more accurate than another. Nor can we take any credit for the toxicological research, theories or assumptions that underlie the formula that we adopted. As we will explain, our calculations generally adopted the approach of the American National Highway Traffic Safety Administration (NHTSA), one of the world's leading traffic safety research organizations. We have simply provided a step-by-step application of this and other leading theories to a specific fact scenario, in an attempt to explain the science behind BAC calculations.

Although we will briefly refer to some of the research, this article does not review the substantial bodies of evidence on the merits of lowering BAC limits.[5] Rather, this article focuses on the real-world significance of the current *Criminal Code* 0.08% BAC offence,[6] the patterns of consumption associated with various BACs, and how BACs are calculated.

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3 *Ibid.* See also House of Commons Standing Committee on Justice and Human Rights (Chair: J. Maloney, M.P.), *Toward Eliminating Impaired Driving* (Ottawa: Publications Service, 1999) at 11-12.

4 For a detailed response to the arguments against establishing a 0.05% BAC offence, see E. Chamberlain and R. Solomon, "The Case for a 0.05% Criminal Law Blood Alcohol Concentration Limit for Driving" (2002) 8 (Supp. III) Injury Prevention iii1 at 10-14.

5 See generally, *ibid.*, for a full discussion on the need to introduce a criminal 0.05% BAC offence in Canada.

6 Section 253 of the *Criminal Code*, R.S.C. 1985, c. C-46, contains two impaired driving offences. While our focus is on the 0.08% BAC offence in section 253(b), it should be noted that section 253(a) prohibits driving while one's ability to do so is impaired by alcohol or a drug. The key issue in this latter offence is the impairment of one's driving ability, not whether the vehicle is being driven in a careless or dangerous manner. *R. v. Polturak* (1988), 1988 CarswellAlta 145, 9 M.V.R. (2d) 89 (Alta C.A.). Similarly, the amount of alcohol or drugs consumed is irrelevant. *R. v. Winlow* (1988), 1988 CarswellOnt 8, 13 M.V.R. (2d) 112 (Ont. Dist. Ct.). Although drivers can be convicted under s. 253(a) even if their BACs are below 0.08%, this is uncommon.

As we will briefly discuss, impairment of key driving-related skills begins at levels well below 0.08%. Nevertheless, many judges refuse to convict an accused unless he or she was actually driving in an impaired manner. See, for example, *R. v. Jones* (1996), 1996 CarswellOnt 782, [1996] O.J. No. 687 (Ont. Gen. Div.). In addition, a number of lower courts require the police to prove that the driver exhibited multiple, visible signs of severe intoxication. See, for example, *R. v. Zubrecki* (1999), 1999 CarswellBC 2063, 46 M.V.R.

B. The 0.08% BAC Limit and Alcohol Consumption Patterns

Our interest in BAC calculations was first sparked by the comments of veteran traffic officers. They repeatedly expressed frustration with judges, who readily accept an accused's testimony that he or she had consumed only a "couple of drinks," and then reject both the officer's testimony and the breath-test results establishing the accused's high BAC.[7] More importantly, we were surprised when the officers explained how much alcohol a person has to consume before he or she is charged with the 0.08% BAC offence. Presumably like most Canadians, we thought that the current *Criminal Code* BAC limit would prohibit even large men from driving after consuming four or five drinks over the course of an evening. As the following charts and calculations will illustrate, this assumption was very wrong.

While we knew that the criminal BAC limit was 0.08%, we did not appreciate what that meant in terms of an individual's actual drinking pattern. The more we learned about the consumption patterns necessary to trigger a 0.08% BAC charge, the more obvious it was to us that a lower BAC limit is required. Canada's 0.08% law allows individuals to drink very large quantities of alcohol in a relatively short period of time, and then drive without fear of criminal sanction.

Before turning to the BAC charts, it is necessary to briefly discuss police charging practices and the term "standard drink." Although it is an of-

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(3d) 153 (B.C. S.C.). In contrast, the appeal courts have ruled that slight impairment of driving ability is all that is required for conviction. *R. v. Stellato* (1993), 1993 CarswellOnt 74, 18 C.R. (4th) 127, 78 C.C.C. (3d) 380 (Ont. C.A.), affirmed 1994 CarswellOnt 1159, 1994 CarswellOnt 84, 31 C.R. (4th) 60, 90 C.C.C. (3d) 160, [1994] 2 S.C.R. 478 (S.C.C.); and *R. v. Andrews* (1996), 1996 CarswellAlta 7, 46 C.R. (4th) 74, 104 C.C.C. (3d) 392 (Alta. C.A.), leave to appeal refused [1996] S.C.C.A. No. 115, 106 C.C.C. (3d) vi, [1996] 2 S.C.R. ix (S.C.C.). In our view, the lower courts' approach reflects an outdated attitude that ignores the empirical research and equates impairment of driving ability with being in an alcohol-induced stupor. Given these problems with enforcing and prosecuting charges under section 253(a), the 0.08% BAC offence in s. 253(b) has taken on greater importance.

7 This is the pattern generally followed with the "*Carter* defence," so named for the 1985 Ontario Court of Appeal decision that affirmed its validity: *R. v. Carter* (1985), 1985 CarswellOnt 2, 19 C.C.C. (3d) 174 (Ont. C.A.). At the risk of over-simplification, the defence basically proceeds as follows. The accused, sometimes corroborated by his or her drinking companions, testifies to drinking only a small amount of alcohol on the date of the alleged offence. The defence then calls a toxicologist who testifies that, based on the accused's consumption testimony, his or her BAC should have been below 0.08%. According to the defence, if the accused's consumption evidence is believed, it follows that the results from the evidentiary breath test, which indicate a higher BAC, must be wrong. This is seen as sufficient "evidence to the contrary" to rebut the presumptions of accuracy and identity in s. 258(1) of the *Criminal Code*, and the accused is inevitably acquitted. See recently, *R. v. Jedig* (2000), 2000 CarswellOnt 1092, [2000] O.J. No. 1120; *R. v. Patel* (1999), 1999 CarswellOnt 3420, 47 M.V.R. (3d) 59 (Ont. C.J.); and *R. v. Crayne* (1999), 1999 CarswellSask 107, [1999] S.J. No. 136, 40 M.V.R. (3d) 185 (Sask. Q.B.).

In a recent survey of Canadian police officers, 29% felt that judges give greater credibility to defence witnesses than to the police in impaired driving trials. B. Jonah *et al.*, "Front-line Police Officers' Practices, Perceptions and Attitudes About the Enforcement of Impaired Driving Laws in Canada" (1999) 31 Accid. Anal. and Prev. 421 at 432 [hereinafter Police Perceptions].

fence to drive with a BAC above 0.08%, most police will not even charge a suspect unless both of his or her evidentiary breath-test readings are 0.10% or higher.[8] This is not due to any lack of concern on the part of the police. Rather, given certain recognized defences[9] and the margin of error accepted by the courts,[10] the police realize that most judges will not convict an accused with BAC readings below 0.10%. Thus, the current *de facto* criminal BAC limit in Canada is 0.10%. Due to these same factors, a 0.05% BAC law would likely create a *de facto* 0.07% limit.[11]

In most jurisdictions, researchers adopt a common measure — the standard drink — to facilitate analysis of the various types of alcoholic beverages, which vary greatly in volume and alcohol content. The standard drink in a jurisdiction typically reflects the alcohol content and serving sizes most commonly used by the alcohol and hospitality industries. In Canada, a standard drink is generally accepted to contain 0.60 Imperial fluid ounces of pure alcohol.[12] Thus, a 12-ounce beer containing 5% alcohol by volume, a 5-ounce glass of wine containing 12% alcohol by volume, and a 1½-ounce serving of liquor containing 40% alcohol by volume all constitute a standard drink in Canada.[13]

In contrast, a standard drink in the United States is generally accepted to contain 0.54 fluid ounces of pure alcohol (for example, a 12-ounce beer containing 4.5% alcohol by volume). To complicate matters further, the American standard drink is measured in American fluid ounces, which have a slightly greater volume than the Imperial fluid ounces used in Canada.[14] It is

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8 In the above-mentioned survey, three-quarters of Canadian police indicated that they only charge suspects with impaired driving if their BACs are 0.10% or higher. The authors suggested that this likely reflects a desire to ensure that the BAC reading will not be challenged in court, due to the margin of error that the courts attribute to current breath-testing instruments. Police Perceptions, *ibid.* at 429.

9 See, *supra*, notes 6 and 7.

10 See *R. v. Phillips* (1988), 1988 CarswellOnt 65, [1988] O.J. No. 415, 64 C.R. (3d) 154, 42 C.C.C. (3d) 150 (Ont. C.A.) at 163. See also *R. v. Gibson* (1992), 1992 CarswellSask 16, 72 C.C.C. (3d) 28, 13 C.R. (4th) 165 (Sask. C.A.); and *R. v. Jaenen* (1984), 1984 CarswellSask 365, 34 Sask. R. 132 (Sask. Q.B.).

11 Thus, contrary to what its critics suggest, a 0.05% law would not trigger a flood of criminal charges against people who drove after having two drinks with lunch. For example, even a 130-pound woman who consumed two standard drinks in 1 hour would have a BAC of only 0.060%, assuming that all the alcohol was instantaneously absorbed and she was subject to evidentiary breath testing immediately thereafter. Even in this implausible scenario, her BAC would still be below the likely threshold for being charged.

12 See, for example, "The Standard Drink," online: Liquor Control Board of Ontario home page <http://www. lcbo.com/programs_services/party_planner/content_standard.shtml> (date accessed: 10 February 2002).

13 *Ibid.*

14 *Computing a BAC Estimate* (Washington: National Highway Traffic Safety Administration, 1994), online: National Highway Traffic Safety Administration home page <www.nhtsa.dot.gov/people/injury/alcohol/bacreport.html> (date accessed: 9 February 2002) [hereinafter Computing BAC]. An American fluid ounce has a slightly greater volume (29.573 cm^3) than the Imperial fluid ounce (28.413 cm^3), which is used to measure the volume of liquids in Canada. See Ann Marie Aldighieri, ed., *Canadian Almanac & Directory* (Toronto: Micromedia, 2002).

for these reasons that a BAC chart based on American standard drinks will differ signficantly from a chart based on Canadian standard drinks.[15] In the remainder of this article, we refer to an Imperial fluid ounce as simply a fluid ounce.

The BACs of Males in Relation to Time,Weight and Standard Canadian Drinks*

	2 hours			3 hours			4 hours		
	170 lbs	185 lbs	200 lbs	170 lbs	185 lbs	200 lbs	170 lbs	185 lbs	200 lbs
2 standard drinks	0.0185%	0.0146%	0.0112%	0.0035%	0.000%	0.000%	0.000%	0.000%	0.000%
3 standard drinks	0.0428%	0.0369%	0.319%	0.0278%	0.0219%	0.0169%	0.0128%	0.0069%	0.0019%
4 standard drinks	0.0671%	0.0592%	0.525%	0.0521%	0.0442%	0.0375%	0.0371%	0.0292%	0.0225%
5 standard drinks	0.0913%	0.0815%	0.0731%	0.0763%	0.0665%	0.0581%	0.0613%	0.0515%	0.0431%
6 standard drinks	0.1156%	0.1038%	0.0937%	0.1006%	0.0888%	0.0787%	0.0856%	0.0738%	0.0637%
7 standard drinks	0.1398%	0.1261%	0.1144%	0.1248%	0.1111%	0.0994%	0.1098%	0.0961%	0.0844%
8 standard drinks	0.1641%	0.1484%	0.1350%	0.1491%	0.1334%	0.1200%	0.1341%	0.1184%	0.1050%

15 As a matter of interest, a "standard drink" in Australia contains 10 grams (0.4456 fluid ounces) of pure alcohol, and a standard drink in the United Kingdom contains only 8 grams (0.3565 fluid ounces) of pure alcohol. This is considerably less alcohol than both the American (12.60 grams) and Canadian (13.46 grams) standard drinks. The differences are due to the smaller serving sizes used in Australia and the United Kingdom. See International Center for Alcohol Policies, "What is a 'Standard Drink'?" (September 1998) 5 ICAP Reports, online: ICAP home page <http://www.icap.org/pdf/report5.pdf> (date accessed: 9 February 2002).

The BACs of Females in Relation to Time, Weight and Standard Canadian Drinks*

	2 hours			3 hours			4 hours		
	120 lbs	130 lbs	140 lbs	120 lbs	130 lbs	140 lbs	120 lbs	130 lbs	140 lbs
2 standard drinks	0.0514%	0.0451%	0.0398%	0.0364%	0.0301%	0.0248%	0.0214%	0.0151%	0.0098%
3 standard drinks	0.0921%	0.0827%	0.0746%	0.0771%	0.0677%	0.0596%	0.0621%	0.0527%	0.0446%
4 standard drinks	0.1328%	0.1202%	0.1095%	0.1178%	0.1052%	0.0945%	0.1028%	0.0902%	0.0795%
5 standard drinks	0.1734%	0.1578%	0.1444%	0.1584%	0.1428%	0.1294%	0.1434%	0.1278%	0.1144%
6 standard drinks	0.2141%	0.1953%	0.1793%	0.1991%	0.1803%	0.1643%	0.1841%	0.1653%	0.1493%
7 standard drinks	0.2548%	0.2329%	0.2141%	0.2398%	0.2179%	0.1991%	0.2248%	0.2029%	0.1841%

* These charts adopt, with one exception, certain assumptions about human physiology that NHTSA uses in calculating BACs. Rather than using NHTSA's average metabolism rate for a moderate drinker (0.017%), we use a lower or more conservative metabolism rate (0.015%), which appears to be widely accepted in Canada. See *Computing a BAC Estimate* (Washington: National Highway Traffic Safety Administration, 1994); H.R. Fisher, R.I. Simpson and B.M. Kapur, "Calculation of Blood Alcohol Concentration (BAC) by Sex, Weight, Number of Drinks and Time" (1987) 78 Can. J. Public Health 300 at 301; and correspondence with W. Jeffery, Head, Toxicology, RCMP Vancouver (26 January 2002).

C. The Policy Implications of the Current 0.08% BAC Offence

The purpose of the above charts is to provide a general reference on the approximate BACs of average individuals who consume particular quantities of alcohol over a given period of time. They are also intended to give legal professionals, politicians and the public some critical perspective on the current *Criminal Code* limit. Rather than having abstract discussions about BAC limits, the facts need to be conveyed in terms that non-toxicologists can understand and to which they can relate. At some point in their lives, most Canadians have probably had three, four or more drinks in a sitting,[16] and they

16 A Canadian study reported that 52% of males and 35% of females aged 15-19 reported binge drinking (five or more drinks in a sitting) at least once in the year prior to the survey. In comparison, 73% of males and 51% of females aged 20-24 reported binge drinking during the same period. N.L. Galambos and L.C. Tilton-Weaver, "Multi-risk behavior in adolescents and young adults" (1998) Autumn Health Reports (Statistics Canada) at 10. See online: <www.statcan.ca/english/ads/82-003-XPB/10-98.htm> (date accessed: 2 November 2002).

Similarly, two-thirds of the undergraduate students who participated in the 1998 *Canadian Campus Survey* admitted to having five or more drinks in a sitting in the two or

likely realize just how impaired they would have been had they attempted to drive in that condition. The charts allow policy makers and the public to relate their own personal drinking experiences to the significant level of impairment currently tolerated under the *Criminal Code*.

Studies of public opinion show that individuals are more likely to support lower legal BAC limits when they understand the consumption patterns associated with various BAC levels. For example, a recent poll indicated that 59% of Canadians support or strongly support lowering the *Criminal Code* limit.[17] However, this figure jumped to 69% when participants were informed that an average 200-pound man could drink six beers in 2 hours without exceeding a 0.10% BAC and thus, would not likely be charged if he were caught driving. The number who strongly supported lowering the BAC limit jumped from 29% to 44%.[18]

Comparable results were observed in an earlier American study when BAC limits were expressed to respondents in terms of consumption patterns.[19] When asked how many beers a person should be allowed to drink within 2 hours before driving, approximately 70% of respondents gave an answer equivalent to a BAC of 0.05% or lower. Further, when asked to state the number of beers that they would personally be able to drink and still drive safely, only one-third of respondents gave an estimate that exceeded a 0.04% BAC. Thus, both Canadian and American research indicates that, when BAC limits are presented in terms of actual consumption, rather than more abstract BAC levels, public opinion clearly supports a lower limit. It is, therefore, understandable why the opponents of lower BAC limits do not want to publicize the very significant consumption levels permitted under our current law.

In addition to the consumption patterns associated with the current 0.08% BAC offence, the Canadian public needs to understand the risks of driving at this BAC level. We have briefly outlined below the experimental research on the adverse impact that even low doses of alcohol have on key driving skills, and the statistical studies on the elevated relative risks of crash death at moderate BAC levels.

International medical and traffic safety studies spanning several decades have established that driving-related skills and driving performance are adversely affected by relatively small and moderate amounts of alcohol. As early as 1960, a British Medical Association report stated that "a concentration of 50 mg% of alcohol in 100 ml of blood [0.05% BAC] while driving a motor vehicle is the highest that can be accepted as entirely consistent with

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three months prior to the survey, and one-third reported having eight or more drinks in a sitting during that period. Moreover, the undergraduate students admitted to consuming five or more drinks in a sitting an average of 13.4 times during the past year. L. Gliksman *et al.*, *Canadian Campus Survey 1998* (Toronto: Centre for Addiction and Mental Health, 2000) at 25-26.

17 Goldfarb Consultants, *Getting to a 0.05% BAC Limit: Public Opinion, Knowledge and Support* (Toronto: MADD Canada, 2002) at 26-29.

18 *Ibid.*

19 M.B. Snyder, *Driving Under the Influence: A Report to Congress on Alcohol Limits* (Washington: National Highway Traffic Safety Administration, 1992) at 15-17 and G-10.

the safety of other road users."[20] More recently, the authors of a review of 109 studies on the effects of low doses of alcohol concluded that there is "strong evidence that impairment of some driving-related skills begins with any departure from a zero BAC."[21] Moreover, they found that those skills and abilities considered to be most important for driving were among the most sensitive to alcohol.

Similar results were obtained in a 2000 NHTSA study involving 168 subjects of various ages and drinking patterns.[22] The subjects' performance was assessed in terms of both divided attention tasks and driving simulation tests.[23] Based on various response measures, 82% of the subjects' overall performance in the divided attention tasks was impaired at a BAC of 0.06%.[24] In addition, 84% of the subjects exhibited overall impaired performance on the driving simulation tests at this BAC level. The authors stated that the "major conclusion of this study is that a majority of the driving population is impaired in some important measures at BACs as low as 0.02%."[25]

Given the adverse effects of moderate amounts of alcohol on critical driving skills, it is not surprising that the relative risk of a fatal crash rises sharply at BAC levels well below 0.10%. As the following chart based on American data illustrates, drivers with BACs above 0.049%, particularly those in the 0.080% to 0.099% range, are at dramatically increased risks of death relative to their counterparts with 0.00% BACs.

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20 Quoted in: *Combating Drink Driving: Next Steps. A Consultation Paper Response by the Institute of Alcohol Studies* (St. Ives: Institute of Alcohol Studies, 1998).

21 H. Moskowitz and D. Fiorentino, *A Review of the Literature on the Effects of Low Doses of Alcohol on Driving-Related Skills* (Washington: National Highway Traffic Safety Administration, 2000). Online: <www.nhtsa.dot.gov/people/injury/research/pub/Hs809028.htm> (date accessed: 2 November 2002).

22 H. Moskowitz *et al.*, *Driver Characteristics and Impairment at Various BACs* (Washington: National Highway Traffic Safety Administration, 2000).

23 The divided attention tasks measured reaction time, tracking error, and incorrect responses on a peripheral search and recognition task. On the driving simulator, researchers examined, *inter alia*, speed deviation, lane deviation, reaction time, and number of collisions. *Ibid.*, Table 2.

24 *Ibid.*

25 *Ibid.*

The Relative Risk of a Fatal Single-Vehicle Crash for Males at Various BACs

	.020% - .049%	.050% - .079%	.080% - .099%	.100% - .149%
Age 16-20	4.64	17.32	51.87	240.89
Age 21-34	2.75	6.53	13.43	36.89
Age 35+	2.57	5.79	11.38	29.30

Source: P.L. Zador, S.A. Krawchuk and R.B. Voas, "Alcohol-Related Relative Risk of Driver Fatalities and Driver Involvement in Fatal Crashes in Relation to Driver Age and Gender: An Update Using 1996 Data" (2000) 61 J. Stud. Alcohol 387 at 392.

Canadian research has also documented the increased risks associated with BACs below 0.10%.[26] A Traffic Injury Research Foundation (TIRF) study indicated that drivers with BACs of 0.051% to 0.080% are 7.2 times more likely to be involved in a fatal crash than drivers with 0.00% BACs.[27] In addition, TIRF has consistently documented the extremely high relative risks among young drinking drivers.[28] One of their earlier youth studies reported that 16-19 year-old drivers with BACs of 0.080% to 0.099% have 40 times the risk of a fatal crash relative to youth who have not consumed alcohol.[29]

Perhaps our greatest concern is that, despite their dramatically elevated relative risks of fatal crash, drivers with BACs in the 0.080% to 0.099% range are largely immune from criminal sanction in Canada. Legal policy makers should consider whether the current law, and the *de facto* 0.10% BAC threshold it has created, sends drivers an appropriate message. In our view, the law does not admonish drivers to refrain from drinking and driving. Rather, the message in Canada appears to be "Don't drive when you're very drunk, but any lesser level of impairment is fine." As long as this attitude prevails, impaired driving will remain, by far, the leading criminal cause of death in Canada,[30] and one of the country's leading criminal causes of injury.

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26 See, for example, H.M. Simpson, *The Repeat Offender: Future Directions for Impaired Driving Programs and Policies* (Ottawa: Traffic Injury Research Foundation, 1993); and D.J. Beirness and H.M. Simpson, *Study of the Profile of High-Risk Drivers* (Ottawa: Transport Canada, 1997).

27 *The Hard Core Drinking Driver* (Ottawa: Traffic Injury Research Foundation, 1996).

28 See, for example, D.R. Mayhew and H.M. Simpson, *Youth and Road Crashes: Reducing the Risks from Inexperience, Immaturity and Alcohol* (Ottawa: Traffic Injury Research Foundation, 1999); and H.M. Simpson and D.R. Mayhew, *Reducing the Risks for New Drivers: A Graduated Licensing System for British Columbia* (Victoria: Ministry of the Attorney General, Motor Vehicle Branch, 1992).

29 D.R. Mayhew *et al.*, "Youth, Alcohol and Relative Risk of Crash Involvement" (1986) 18 Accid. Anal. and Prev. 273 at 282.

30 Figures indicate that 1,245 Canadians were killed in alcohol-related crashes in 1999. Traffic Injury Research Foundation, *STRID 2001 Monitoring Report: Progress in 1998 and 1999* (Ottawa: Canadian Council of Motor Transport Administrators and Transport Canada,

Not surprisingly, millions of Canadians continue to drink and drive.[31] Canada remains far behind many comparable democratic countries in reducing alcohol-related traffic deaths and injuries,[32] even though most of these countries have far higher per capita rates of alcohol consumption.[33] For example, while Germans consume 70% more alcohol than Canadians, Transport Canada has reported that only 11% of Germany's fatally injured drivers were impaired (as defined as having a BAC of 0.05% or higher).[34] In contrast, 32% of Canada's fatally injured drivers were reported to be impaired (as defined as having a BAC of 0.08% or higher). These other countries have succeeded to a far greater extent in inducing their populations to separate drinking from driving. Their laws are deterring impaired driving and protecting the public, whereas ours are deterring police and protecting drinking drivers from criminal sanction.

D. The Bases of Our Calculations

We did not attempt to develop a unique approach to calculating BACs. Nor did we review the scientific literature that NHTSA relied upon in formulating its assumptions about human physiology and alcohol metabolism. Rather, we accepted at face value these assumptions and applied the appropriate numbers. We had hoped to find a recent Canadian analysis of BAC calculations that was widely adopted by the Canadian and international research communities. While several Canadian organizations have published BAC charts, the ones we found were either dated[35] or did not provide a clear explanation of the bases for their calculations. It is for these reasons that we decided to adopt the assumptions that NHTSA uses in calculating BACs. In addition to being current, widely accepted and readily understandable,

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2000) at 26. In contrast, Statistics Canada reported that there were 536 homicides in 1999, including all murder, manslaughter and infanticide cases. Homicide Offences, Number and Rate, online: Statistics Canada home page, <www.statcan.ca/english/Pdgb/State/Justice/legal12a.htm> (last accessed: 14 September 2001).

31 See H.M. Simpson, D.J. Beirness and D.R. Mayhew, *National Opinion Poll on Drinking and Driving* (Ottawa: Traffic Injury Research Foundation, 1999); and D.J. Beirness *et al.*, *The Road Safety Monitor. Drinking and Driving* (Ottawa: Traffic Injury Research Foundation, 2001). Both studies reported that approximately one in five licensed drivers admitted to driving after drinking in the year prior to the survey.

32 A 2001 Transport Canada report indicated that, in terms of the percentage of fatally injured drivers who were legally impaired, Canada ranked last of eight OECD countries — Japan, the Netherlands, Germany, Sweden, Great Britain, Finland, and the United States. This is especially noteworthy because five of these seven countries have BAC limits that are lower than Canada's, and thereby define "legal impairment" at levels below 0.08%. Transport Canada, *Road Safety Vision 2001* (Ottawa: Minister of Public Works and Government Services, 2001) at 16.

33 See *World Drink Trends, 1999 Edition*. Online: ALCOWEB home page, <http://www.alcoweb.com/english/gen_Info/alcohol_health_society/eco_aspects/consumption/world/world.html> (date accessed: 20 April 2001).

34 See, *supra*, note 32.

35 See, for example, H.R. Fisher, R.I. Simpson and B.M. Kapur, "Calculation of Blood Alcohol Concentration (BAC) by Sex, Weight, Number of Drinks and Time" (1987) 78 Can. J. Pub. Health 300 [hereinafter Fisher].

NHTSA's step-by-step explanation is accessible on its website.[36] Obviously, since an American standard drink contains less alcohol (0.54 American fluid ounces, or 12.60 grams) than a Canadian standard drink (0.60 Imperial fluid ounces, or 13.46 grams), appropriate adjustments were made.

A BAC is simply the ratio of the *weight* of pure alcohol in a given *volume* of blood. Although commonly referred to as a 0.08% limit, the *Criminal Code* specifically prohibits driving with more than 80 milligrams (80/1000ths of a gram) of alcohol in 100 millilitres (100/1000ths of a litre) of blood.[37] As NHTSA and others have noted, the calculation of BACs is based on certain underlying physiological facts. For example, alcohol, which is water-soluble and fat-insoluble, distributes itself evenly in the total volume of water in the human body.[38] Furthermore, alcohol is metabolized by the liver at a rate that may vary considerably from one individual to another.[39]

NHTSA and other researchers also make certain simplifying assumptions based on physiological research. First, NHTSA assumes that 58% of an average male's body weight is water and that 49% of an average female's body weight is water.[40] Second, it assumes that, on average, blood contains 80.6% water.[41] Third, NHTSA identifies a range of metabolism rates. The average metabolism rate for moderate drinkers produces a 0.017% per hour decline in BAC, whereas the average metabolism rate for heavy drinkers (60 or more American standard drinks a month) results in a 0.020% per hour decline.[42] NHTSA indicated that "if one wished to use a very conservative figure," which less than 20% of the population would exhibit, one could use a metabolism rate that results in a 0.012% per hour decline in BAC.[43] These metabolism rates appear to be based on the assumption that the individual is drinking on an empty stomach. If an individual eats before or while drinking, this would slow down the rate at which the alcohol is absorbed into the blood and, thus, lower the individual's peak BAC.[44]

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36 Computing BAC, *supra*, note 14.

37 *Supra*, note 6, s. 253(b).

38 Computing BAC, *supra*, note 14; and Fisher, *supra*, note 35 at 301.

39 *Ibid.*

40 Computing BAC, *supra*, note 14. In comparison, Fisher, *supra*, note 35 at 301, indicates that an average male's body weight is 58.3% water, while an average female's body weight is 48.5% water.

41 Computing BAC, *supra*, note 14. Fisher, *supra*, note 35 at 301, indicated that blood is comprised of 80% water.

42 *Ibid.*

43 *Ibid.*

44 Fisher, *supra*, note 35 at 302. Since food in the stomach slows down the alcohol absorption rate, the alcohol stays in the body for a longer period of time, and therefore, results in significantly lower peak BAC.

E. Applying the Physiological Facts and Simplifying Assumptions

In order to demonstrate how our calculations were applied, we have set out below the step-by-step analysis we followed in calculating the BAC of an average 200-pound man who consumes six beers in 2 hours. The calculation of an individual's BAC involves five general steps. First, we must determine the volume of water in the individual's body, measured in litres. Second, the total weight of pure alcohol consumed by the individual must be calculated in grams. Third, we calculate the individual's water-alcohol concentration. Fourth, we convert the water-alcohol concentration into the blood-alcohol concentration. Fifth, we take into account the decrease in the individual's BAC due to the metabolism of alcohol over time.

1. Determining the volume of water (measured in litres) in the man's body

- A 200-pound man weighs 90.7194 kilograms (200 lb. ÷ 2.2046 lb. per kilogram).
- On average, a male is 58% water by weight. Therefore, the body of an average 90.7194-kilogram man contains 52.6173 kilograms of water.
- A kilogram of water has a volume of 1 litre of water. Therefore, the body of an average 90.7194-kilogram man contains 52.6173 litres of water (90.7194 kilograms x 58% water).

2. Determining the weight of alcohol (measured in grams) in the man's body

- A bottle of beer in Canada typically contains 12 fluid ounces, or 0.60 fluid ounces of pure alcohol (12 fluid ounces x 5% alcohol by volume). This is a standard Canadian drink.[45]
- Since alcohol has a specific gravity of 0.79, a fluid ounce of alcohol weighs 22.44 grams (28.41 grams x 0.79). Therefore, 0.6 of a fluid ounce of alcohol weighs 13.46 grams (22.44 grams x 0.6 of a fluid ounce).
- Next, we assume that the man consumed six bottles of Canadian beer. This means that he would have consumed a total of 80.76 grams of alcohol (6 beers x 13.46 grams of alcohol).

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[45] While a *bottle* of beer contains 12 fluid ounces (341 millilitres), a *can* of Canadian beer contains 12.49 fluid ounces (355 millilitres) of beer. Thus, a can of Canadian beer contains 0.6245 ounces of pure alcohol, which is slightly more than a standard Canadian drink.

3. Determining the man's water-alcohol concentration

- Having calculated the volume of water and the weight of alcohol in the man's body, we can now calculate his water-alcohol concentration.
- Assuming for the moment that the man consumed and absorbed all the alcohol at once, the alcohol concentration in the water in his body would be 80.76 grams (80,760 milligrams) of alcohol in 52.6173 litres (52,617.3 millilitres) of water.
- This would produce a concentration of 1.535 milligrams of alcohol in each millilitre of water (80,760 milligrams of alcohol ÷ 52,617.3 millilitres of water). This is the equivalent of 153.5 milligrams of alcohol in each 100 millilitres of water, which may also be expressed as a water-alcohol concentration of 0.1535%.

4. Determining the man's blood-alcohol concentration

- In Canada, as in most other countries, the criminal limit is defined in terms of an individual's blood-alcohol concentration. Therefore, it is necessary to convert the man's water-alcohol concentration into his blood-alcohol concentration.
- According to NHTSA, on average, blood is composed of 80.6% water. Thus, leaving aside the issue of metabolism for the moment, the man's blood-alcohol concentration would be 123.72 milligrams of alcohol per 100 millilitres of blood (153.5 milligrams of alcohol x 80.60%). This may also be expressed as a blood-alcohol concentration of 0.1237%.

5. Allowing for metabolism of alcohol

- To this point, we have assumed that the man consumed all the alcohol at once, that it was all instantaneously absorbed into his bloodstream and that he was tested immediately. NHTSA describes the product of these assumptions as a "theoretical instantaneous BAC."[46] The 200-pound man's theoretical instantaneous BAC is, therefore, 0.1237%. We must now factor in alcohol metabolism during the two-hour period.
- NHTSA states that the "average" metabolism rate for a moderate drinker is a 0.017% decline in BAC per hour. However, we have adopted the more conservative metabolism rate of 0.015%, which seems to be widely accepted as "average" in Canada.[47]
- To factor in metabolism during the two-hour drinking period, we must decrease the man's BAC by 0.030%. Therefore, our 200-pound man's blood-alcohol concentration would be 93.72 milligrams of alcohol per

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46 Computing BAC, *supra*, note 14.
47 See Fisher, *supra*, note 35 at 301.

100 millilitres of blood. (123.72 milligrams of alcohol - 30 milligrams of alcohol) This may also be expressed as a blood-alcohol concentration of 0.0937% (0.1237% - 0.030%).

- Since the police practice is to round down the BAC, the man's BAC would likely be reported as 0.093% or 0.09%.
- Thus, our 200-pound man who consumed six bottles of beer in 2 hours would have a BAC well below the 0.10% threshold that is used by most police for the purpose of laying charges under section 253(b) of the *Criminal Code*.

F. Our Calculations in Perspective

We consciously adopted a very conservative approach in the preceding step-by-step analysis, which would significantly overestimate the evidentiary BAC of an "average" 200-pound man. We have outlined below some of the major factors that illustrate this approach. First, we assumed that the man was drinking on an empty stomach. If he had eaten prior to or while drinking, his BAC would have been lower.[48] Second, we adopted the relatively conservative metabolism rate of 0.015% decline in BAC per hour from Fisher, Simpson and Kapur's 1987 article in the *Canadian Journal of Public Health*. Had we adopted NHTSA's average metabolism rate for a moderate drinker, which produces a 0.017% decline in BAC per hour, the man's BAC would have been 89.7 milligrams of alcohol per 100 millilitres of blood or 0.0897% (0.1237% – 0.034%).

Third, our calculations were based on the assumptions that the man was subject to evidentiary breath testing almost immediately after he finished drinking and started driving, yet at a time when all the alcohol in his gastrointestinal system had been absorbed. These are not realistic assumptions. A person's BAC will generally not peak until 30 minutes or more after his or her last drink.[49] Thus, if the 200-pound man were tested almost immediately after finishing his last drink, the alcohol in that last drink and, perhaps, some of the alcohol in his second-last drink, would not yet have been absorbed and his BAC would be lower than we have indicated.

Fourth, our example ignores the possibility that the man may not have been stopped by the police until, for example, 30 minutes or more after he had stopped drinking. More importantly, our assumptions ignore the fact that it takes considerable time to process an impaired driving suspect.[50] It would have been more realistic to assume that it took the police a minimum of an hour to: question the man after stopping his vehicle; subject him to a roadside

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48 See, *supra*, note 44.

49 Fisher, *supra*, note 35 at 301.

50 A recent police survey reported that it takes an average of 2.6 hours to process a single impaired driving charge under the *Criminal Code*. Police Perceptions, *supra*, note 7 at 426.

test on an approved screening device (ASD);[51] transport him to the police station; inform him of his right to counsel, and give him a reasonable opportunity to contact and consult with counsel; conduct the first evidentiary breath test; wait the 15 minutes required by the *Criminal Code*;[52] and conduct the second evidentiary breath test. Obviously, if the man had not been tested for an hour or an hour and a half after he stopped drinking, he would have metabolized more alcohol and his evidentiary BAC would have been considerably lower than in our example.[53]

Is it possible that a 200-pound man could consume six bottles of beer over a two-hour period, register a BAC of 0.10% or higher, and be convicted under the *Criminal Code*? Yes it is. There are significant individual variations in several of the factors involved in calculating BACs. For example, if the man had a very high percentage of body fat, he would have considerably less than the average of 58% water by body weight.[54] As a result, the concentration of alcohol in the water of his body and in his blood would be significantly higher than that of an average 200-pound man. Similarly, a man with an extremely low metabolism rate for alcohol would not break down the alcohol as quickly as other people, even in the lowest 20% of the population. Finally, if the man consumed all six bottles of beer in the last 30 minutes of the two-hour period, and it was all absorbed into his blood stream, relatively little of the alcohol would have been metabolized and his BAC could have exceeded 0.10%.[55] Nevertheless, given our very conservative approach, our calculations and conclusions would be accurate for all but extremely exceptional individuals or extremely unusual situations.

G. Conclusion

As disconcerting as it may be, we want Canadians to think about our example of the 200-pound man the next time they or their family members have to drive late Thursday, Friday or Saturday night. It is important for Canadians to understand the high levels of impairment that are currently tolerated under the *Criminal Code*. They will not understand this issue if we limit ourselves to abstract discussions of 0.05% and 0.08% BAC limits. The public, policy makers and politicians need to know what these limits mean in

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51 Since ASDs are typically set to register a fail at a BAC of 0.10% or higher, the police might well have ended their criminal investigation at this point, and never taken the driver to the police station for evidentiary breath testing.

52 *Criminal Code*, *supra*, note 6, s. 258(1)(c)(ii).

53 For example, if the man had an instantaneous BAC of 0.1237%, as in our example, and we allowed for 3 hours of metabolism at the rate of 0.015% decline per hour, his BAC would be 0.0787% after 3 hours and 0.0712% after 3½ hours.

54 As indicated, alcohol is water-soluble and fat-insoluble. Therefore, an individual with a higher percentage of body fat has a higher-than-average fat-to-water ratio, and will have a higher BAC after consuming the same amount of alcohol as a lean person of the same weight. See Fisher, *supra*, note 35 at 302.

55 Under these implausible assumptions, the man's BAC would be closer to the theoretical instantaneous BAC of 0.1237%.

terms of drinking patterns, impairment of driving skills and the relative risk of fatal crash. These are issues that they can readily understand and to which they can relate.

The preceding charts and analysis have demonstrated that introducing a 0.05% *Criminal Code* BAC offence would not prevent Canadians from engaging in responsible social drinking. As our charts indicate, it takes much more than a drink or two for the average male to reach the current legal limit of 0.08%, let alone the *de facto* legal limit of 0.10%. Few Canadians would consider such high levels of consumption to be tolerable, let alone responsible, for an individual who is intending to drive. By putting the current and proposed legal limits in perspective, we hope to have exposed the significant risks posed by our current legal limit, and explained the need to introduce a 0.05% *Criminal Code* BAC offence in Canada.