Letters to the Editor

Culpability analysis is still a valuable technique
From JEFF BRUBACHER,1* HERBERT CHAN1 and MARK ASBRIDGE2

1Department of Emergency Medicine, University of British Columbia, Vancouver, Canada and 2Department of Community Health and Epidemiology, Dalhousie University, Halifax, Canada

*Corresponding author. Department of Emergency Medicine, University of British Columbia, Vancouver General Hospital, 855 West 12th Avenue, Vancouver, BC, V5Z 1M9, Canada. E-mail: jbrubacher@shaw.ca

The February 2013 issue of the IJE included our study which used culpability analysis to examine the association of cellphone use with motor vehicle crashes.1 In a commentary in the same issue, Sanghavi stated that ‘culpability analysis won’t help us understand crash risk due to cellphones’.2 Sanghavi’s categorical rejection of culpability analysis is unfortunate and seems based on a misunderstanding of the method and perhaps aversion to the term ‘culpability’.

Culpability analysis, also referred to as responsibility analysis, is a powerful technique with a long history in road safety research. The method was first used in 1951 by Smith and Popham to study the association of alcohol with crashes3 and has since been applied numerous times to the study of crash risk.4–13 A standard feature of the culpability design is that all drivers have been involved in a crash and are therefore subject to standard legal or medical investigations which may reveal the presence of potential risk factors for crashing. As such, culpability analysis is well suited to the study of transient exposures, as related to crash risk, that are typically difficult to determine in a valid control population of non-crash involved drivers. For example, when studying drug use in relation to driving, it is a challenge to measure the actual rate of drug use in non-crash involved drivers because the refusal rate for drug testing in roadside controls typically exceeds the proportion of drivers who test positive for drugs, severely limiting data interpretation.14–17 Culpability analysis can overcome this problem when there are legal or medical protocols in place to determine drug use of crash involved drivers.9–11 The study of cellphone use while driving is another situation where obtaining good data in comparable non-crash involved drivers (or during a comparable ‘control driving period’ if using the case-crossover methodology) is a particular challenge. Our study employed culpability analysis to study the risk of crashes associated with cellphones for this very reason.1 Our findings were consistent with those derived using alternative study designs and support the growing understanding of the risks of driving while using cellphones.

The term ‘culpability’ when used in the assessment of crashes is drawn from its historical application as a means for determining legal fault; however, modern applications of culpability analysis have moved beyond this perspective to assess responsibility based upon a comprehensive set of indicators observed from the crash. Modern culpability studies, as well as considering whether actions of the index driver contributed to the crash, also look for other contributory factors such as road type, driving conditions, vehicle condition, contribution from other parties, crash type and difficulty of the task being performed. When actions of the index driver did not contribute to the crash and other factors did contribute, then the index driver is deemed ‘non-culpable’. It is the non-culpable drivers that are of greatest interest in a culpability analysis. As summarized by Wahlberg, culpability analysis is based on the assumption that drivers found non-culpable after a car crash represent a random sample of the general driving population that was ‘selected’ to crash by circumstances beyond their control and therefore have the same risk factor profile of other drivers on the road at the same time (odds ratio (OR) = 1.00). If this ‘randomness assumption’ is met, then the risk estimate derived from a culpability analysis would be expected to be similar to that from a standard case-control study.18,19

To explain the assertion that culpability studies cannot help us understand crash risk due to cellphone use, Sanghavi presents a hypothetical scenario whereby cellphones prevent crashes and have a stronger protective effect during bad driving conditions. The author claims that this scenario could account for our findings and explains this by speaking of ‘culpable conditions’. We would first like to point out that Sanghavi’s hypothetical scenario where cellphones prevent crashes is inconsistent with extensive experimental research that demonstrates that cellphones impair concentration, reaction time and other skills required for safe driving.20

Leaving this
issue aside, Sanghavi's discussion of 'culpable conditions', and the implicit assumptions that crashes are somehow random events and that drivers who crash in good driving conditions will be deemed culpable, demonstrate an overly simplistic understanding of culpability analysis. As explained above, modern culpability tools attempt to capture the complexity of the crash event and are based on the assumption that crashes occur for a reason and not at random. All else being equal, crashes that occur in good driving conditions are more likely to be due to driver factors than those that occur in bad conditions, and this reality is reflected in the culpability assessment tool. However, even under good conditions, if the driver did not contribute to the crash and other factors did, then the driver will be deemed non-culpable.

For the sake of argument, let's accept that a culpability analysis of cellphone use may be biased because of associations between driving conditions, cellphone use and probability of being deemed culpable. This hypothetical bias would be easy to test and control for in the analysis and should not result in categorical rejection of a useful research tool such as culpability analysis. A review of our data finds that 78% of cellphone users and 84% of non-users crashed in good driving conditions. At first glance, this might suggest that cellphone use protected against crashing in good driving conditions. However, in good driving conditions, 80% of cellphone users were found culpable whereas 70% of non-users were culpable (crude OR = 1.7). That is, a higher proportion of cellphone users crashed in good driving conditions for no apparent reason other than driver action. Similar results were noted for crashes in bad driving conditions: 57% of cellphone users vs 50% of non-users were culpable (crude OR = 1.3). These observations suggest that cellphone use increases the risk of crashing under both good and bad driving conditions and are inconsistent with the hypothesis that our findings can be explained by an association between cellphone use and driving conditions.

The culpability analysis method is conceptually more difficult than the standard case-control technique and it requires a rigorous method of assigning culpability, that is blinded to exposure status. When properly done, the risk estimates obtained from culpability analysis approximate those derived from a standard case-control study while allowing researchers to answer important questions about crash risk without being limited by a lack of adequate exposure data from representative samples of crash-free drivers. Despite Sanghavi's misunderstanding, this valuable technique, which can be adapted to study any driver-based risk factor or transient exposure, should continue to be employed in traffic medicine research and epidemiological studies of crash risk.

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References
In a commentary in the February 2013 issue of IJE, I noted serious concerns about inferring the relationship between cellphone use and crash risk from the association between cellphone use and culpability. I also noted a range of possible biases and measurement errors that challenge the internal validity of the study by Asbridge et al. Despite the technical nature of these arguments, the authors have responded by appealing to tradition and noting the consistency of their findings with other studies on cell phone use. Since the fundamental inference issues remain unaddressed, I highlight the central arguments from my original commentary here. As before, my interest is limited to causal inference methodology.

In their response, Brubacher et al. do not address the potential sources of bias and measurement error in their analysis. For example, it is possible that police reporting of cellphone use was nonrandom and correlated with the culpability assessment, especially given the small proportion of identified cellphone users, relative to what might be expected. In particular, unsafe driving actions, which come with heavy penalties on the culpability tool, may be more likely to be reported when cellphone use is reported. Also, cellphone use may be more likely to be reported when other explanations are not identified. In fact, the differences in the culpability assignments between cellphone users and non-users that are provided by Brubacher et al. in their response could easily be overwhelmed by these considerations.

Furthermore, the inference by Asbridge et al. that cellphone use increases crash risk, based on a positive association between cellphone use and culpability, in part assumes its conclusion. Culpable and non-culpable conditions are a set of parameters, ranging from the weather to the attending police officer, under which drivers are more and less likely to be found culpable, respectively. Among drivers who crashed, Asbridge et al. observe a greater proportion of cellphone users under culpable conditions than under non-culpable conditions. In terms of crash risk, there are at least two possible explanations for this. Perhaps cellphone use increases crash risk, and does so more under culpable conditions. Alternatively, cellphone use decreases crash risk, and does so more under non-culpable conditions. However, Asbridge et al. ignore the second scenario by assuming that under non-culpable conditions, cellphone users and non-users share the same crash risk.

Finally, Asbridge et al. assume that cellphone use is independent of driving conditions, which is unrealistic even if culpability and cellphone use at the time of the crash are ascertained independently by objective standards. More plausibly, occasional cellphone users are most likely to use phones under apparently safe road or traffic conditions, and least likely to use them under the hazardous conditions that disproportionately generate non-culpable crashes. Hence, the rate of cellphone use observed in non-culpable crashes might not be representative of cellphone use under the full range of non-culpable conditions, or of use under culpable (safer) conditions. Indeed, a higher rate of cellphone use in culpable than non-culpable crashes would follow even in the absence of a causal effect of cellphone use on crash risk. Thus, culpability analysis should not be used to infer crash risk.

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