Linking data from different sources to estimate the risk of a collision when using a cell phone while driving

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Text of the presentation

The objectives of the presentation are to review the methodology and results of three epidemiological studies that linked data from different sources to estimate the risk of a collision when using a cell phone while driving. Two of theses studies used the case-crossover design (Redelmeier and Tibshirani 1997, and McEvoy et al. 2005) and one used a more conventional epidemiological cohorts design (Laberge-Nadeau et al. 2003). An emphasis is put on major differences between these two designs, their strengths and weaknesses.

Redelmeier and Tibshirani (1997) used the case-crossover design to assess the risk of a motor vehicle collision if a cell phone is used while driving. The study was conducted in Toronto with persons who came to the North York Collision Reporting Centre between July 1, 1994 and August 31, 1995. Consenting drivers completed a brief questionnaire and gave access to cell phone records and police reports. From the sample of 699 drivers cell phone users who had a collision with property damage only (PDO), 157 were on the phone in the hazard interval of 9 minutes prior to the reported time of the collision, i.e. in the period of T-10 minutes to T-1 minute where T was the reported time of the collision, but did not use their cell phone in the same control time period the previous day. Also, 24 cases did not use their cell phone in the hazard period but used it in the control period the previous day.

The estimated relative risk was therefore equal to 157/24 or 6.54 (95 percent confidence interval: 4.50, 9.99). Because it was not known if the cases were driving during the control period, the estimate was adjusted based on the results of a pilot survey of 100 drivers of whom 65 percent said they were driving the previous day during the same 9 minutes period. Thus, the adjusted collision risk estimate was equal to 0.65x6.54 or 4.3 (95 percent confidence interval: 3.0, 6.5).

Laberge-Nadeau et al. (2003) used a more conventional epidemiological cohorts design to assess the relative risk. According to the research team specifications, the Société de l'assurance automobile du Québec (SAAQ) mailed out an exploratory letter, a consent form and a questionnaire to175 000 license holders of class 5 permit. A total of 36 077 (20.6%) completed questionnaires were returned to the Transportation Safety Laboratory of the Centre for Research on Transportation (CRT) with the signed consent form. The sample comprised 9 352 male drivers' cell phone users with a control sample of 13 590 male drivers' non users, and 3 339 female drivers' cell phone users with 9 797 female drivers' non users.

Therefore, this study link data from three different data sources. The questionnaire asked about driving habits, risk exposure, opinions about activities likely to be detrimental to safe driving, collisions over the past 24 months, socio-demographic information, and whether or not the respondent is a cell phone user. For cell phone users, there were additional questions about the use of the cell phone. The data file from the SAAQ covered the drivers' records (including collisions reported by the police) for the period of January 1st 1996 to August 1st 2000. The four telephone companies that were offering cell phone services in Quebec at that time (Bell mobility, Rogers At&T, Clearnet and Fido/Microcell) provided the data on the cell phone activities of the respondents. The file contained the date, time and duration of each call, if it was an emergency call (911 or *4141) or not, and if the call was made or received. The cell phone records covered a period from 12 to 25 months from August 1998 to August 2000.

The average number of crashes per annum per 100 drivers for the period 1996-1999 was obtained from the SAAQ for the non-respondents and respondents by gender. It was 2.74 for the female non-respondents compared to 2.5 for women who returned the questionnaire. For crashes with injuries, they were 0.74 and 0.68 for women non-respondents and respondents respectively. The difference was much larger for men with an average number of crashes per annum per 100 drivers of 4.36 for non-respondents (1.11 for crashes with injuries) compared to 3.46 for respondents (0.81 for crashes with injuries). There is a respondent bias for men but the difference is negligible for women.

The analysis of the responses to the questionnaire showed that compared to non-users, cell phone users are more exposed to collision: they drive more often as part of their work; they drive more kilometres per year; they drive more often after 8 pm; they manipulate more often the radio, CD or tapes; they have higher education levels.

The relative risks (odds ratio) of having at least one accident in a given year for cell phone users relative to non-users were estimated using the logistic-normal regression model, taking into account the age group. The number of men having at least one accident per year decreases from 8.43% for cell phone users 16-24 years old to 2.74% for cell phone users 55-64 years old. These numbers are lower for men non-users of cell phones, decreasing from 5.70% in the 16-24 age group to 2.33% in the 55-64 age group. The estimated relative risks (odds ratio) are relatively stable across age groups, varying between 1.44 and 1.21 with an overall relative risk of 1.38 (95% C.I.: 1.28-1.50).

The percentages of women having at least one accident per year are lower than for men, varying from 5.77% for women cell phone users 16-24 years old to 1.99% for women cell phone users 55-64 years old. For women non-users of cell phones, the percentages vary from 3.90% in the 16-24 age group to 1.80% in the 55-64 age group. However, the estimated relative risks are very similar to those of the men, varying between 1.57 and 1.12, with the same overall estimated relative risk of 1.38 (95% C.I.: 1.20-1.60). Similar results were found for crash risks with injuries; the overall relative risk, adjusted for age and year of observation, were 1.39 for women (95% C.I.: 1.06-1.82) and 1.38 for men (95% C.I.: 1.18-1.61).

Linking data from the questionnaire with SAAQ data on collisions reported by the police, they found odds ratios for a collision with PDO or injuries, adjusted for kilometres driven per year and other crash risk exposures, of 1.11 for men (95 percent confidence interval: 1.02, 1.22) and 1.21 for women (95 percent confidence interval: 1.03, 1.40). Similarly, the adjusted relative risks (odds ratio) of having at least one accident with injuries were 1.10 (95% C.I.: 0.93-1.30) for men and 1.30 (95% C.I.: 1.00-1.70) for women.

A secondary analysis, using the data from all three sources, compared the sole users of cell phone according to their frequency of cell phone use. For each cell phone user, the number of calls made and received and the presence or absence of at least one accident in a given month, were computed. The unit of analysis was driver-month. The overall trend is that the risk of having an accident increases with the total number of calls suggesting a dose-response relationship. Note that the reference group, chosen as men-months with fewer than 14 calls per month, has a similar collision rate as the non users. The relative risks are 2.78, 3.55 and 3.33 for those with a total number of calls between 193 and 258, 259 and 384, and 385 or more, respectively. The adjusted odds ratios vary between 2.21 and 2.73.

The same analysis was repeated for women only users of the cell phone. Even if they are less numerous and the frequency of calls is less than the men's total number of calls, it shows similar trends. Female cell phone users who make and receive a total of 115 calls or more in a month have a relative crash risk of 2.31, compared to the reference group (fewer than 20 calls per month). The adjusted odd ratio is 2.60.

A re-analysis of the data of the cell phone users was performed using the case-crossover methodology. The previous day was chosen for the control day and the hazard and control period was T-10 to T-1 minute where T was the time of the collision reported by the police. All emergency calls were removed from this analysis because they were likely made after the collision. A total of 407 collisions were reported by the police (292 PDO and 115 with injury) during the two year period for which cell phone records were available from the cell phone companies. The relative risk, unadjusted for intermittent driving, was 5.13 (95 percent confidence interval: 3.13, 8.43). This estimate is similar to the estimate found by Redelmeier and Tibshirani (1997).

A recent study published by McEvoy et al. (2005) also used the case-crossover design. Participating drivers owning or using a cell phone were recruited between April 2002 and July 2004 in one of three major hospital emergency departments in Perth, Western Australia, after being involved in a car crash with mild to moderate injury. Data from interviews with 456 drivers, emergency response records, medical records and cell phone records were used to assess the time of the crash and the presence or absence of cell phone activities up to 10 minutes before the collision and in the control periods. Three control intervals were used (24 hours, 72 hours and 7 days before the collision). Only drivers who reported driving during at least one of the three control intervals were retained in the analysis (456 = 61% of the 744 drivers interviewed with available cell phone records). The estimated odd ratio was 4.1 (95 percent confidence interval: 2.2, 7.7).

Note that from the cell phone records, 40 of the 456 drivers used their cell phones during the hazard interval (up to 10 minutes before the collision). However, only 32 of them reported in the interview using their cell phone during the trip (not only up to 10 minutes) before the collision. Is the difference due to self report bias by the drivers or errors in the exact time of the collisions with cell phone calls made after the collision misclassified as occurring before the collision?

All three studies reported no significant difference in the relative risks between using a hand held and a hands free cell phone.

There are major differences between the case-crossover design and the two cohorts design. The case-crossover design attempts to estimate the relative risks when the driver is having a cell phone communication while driving. The same driver is used as his own control in the estimation of the risk. There is no or minimal difference in the other collision risk exposure between the hazard interval and the control interval. The two cohorts design is comparing the overall collision rates of the group of cell phone users versus the non users, adjusted for risk exposure variables because the level of collision exposure is different in the two groups. There is no attempt in this latter design to model cell phone usage while driving.

However, there are potential problems with the case-crossover methodology applied in this setting. Aside from not knowing if the cases were driving during the control period, two other important features of the case-crossover design are important to consider. Firstly the exact time of the collision is unknown, so it is difficult to avoid completely the misclassification of a call into the at risk period when it was made or received after the collision (can lead to an over estimation of the real risk). Secondly the proper choice of the length of the hazard period for which the driver is at risk. A greater length will give smaller estimate of the relative risk (can lead to an under estimation of the real risk).

The distribution of the last two digits of the collision time reported by the police for a sample of 2062 collisions taken from the two cohorts in Laberge-Nadeau et al. (2003) shows that in 77 percent of the cases, the last two digits are a multiple of five minutes. Three decades ago, Baker (1971) reported the same preference with 77 percent recorded collision times being a multiple of 5 minutes and 42 percent a multiple of 15. These data show that the collision time is constantly rounded up (or down), and therefore reported with imprecision.

The distribution of the difference between the time of 104 emergency cell phone calls and the time of the collision in the police report shows that in 61% of these cases the times of the collisions written in the police reports are after the exact time of the collision. This time imprecision can easily lead to misclassification of phone calls being made just before the collision while, in fact, the phone calls were made right after the collision. This problem is enhanced by the fact that a motor vehicle crash naturally leads to additional phone calls right after the event and these calls are not necessarily made to emergency services.

<u>Conclusion</u>. Linking different data sources (police records, cell phone records and self reported data) is helpful to estimate the real association (not necessarily the causal relation) between the use of cell phones while driving and collisions. The three epidemiological studies showed a significant increased risk. The difficulty is in determining the exact magnitude of the real risk.

The relative risk estimates of 1.1 and 1.2 from the two cohorts' comparison might be seen as an estimate of the magnitude of the public health problem. This relative risk will however increase with increasing exposure to cell phone communications by drivers. This relative risk is not the relative risk of having a collision when the driver is exposed to a cell phone communication. This latter risk is probably higher, but is it as high as 4 as suggested by the case-crossover estimates?

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