Evaluation of an Adolescent Hospital-Based Injury Prevention Program

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Background: **IMPACT (Impaired Minds Produce Actions Causing Trauma) is an adolescent, hospital-based program aimed to prevent injuries and their consequences caused by alcohol or drug impairment and other high-risk behaviors. The overall objective of this evaluation was to determine the effect of the program on students' knowledge and behavior regarding drinking and driving, over time.**

Methods: **A randomized control trial between students randomly selected to attend IMPACT and those not selected served as a control group. Students completed a questionnaire before the program and at three posttime periods (1 week, 1 month, and 6 months). Panel data models were used to analyze the effects of the experiment on students' knowledge of alcohol and crash issues and negative driving behaviors (no seat belt, driving while using a cell phone, involved in conversation, eating, annoyed with other drivers, and drowsy). Descriptive statistics and logistic regression models were used to analyze the effect of IMPACT on students' influence on friends and family about road safety.**

Results: **This study consisted of 269 students (129 IMPACT; 140 control) with an overall response rate of 84% (range, 99% presurvey to 71% at 6 months). The IMPACT group had a 57%, 38%, and 43% increase in the number of correct answers on alcohol and crash issues during the three time periods, respectively ($p < 0.05$). Students in the IMPACT group would try to influence friends and family to improve their road safety twice as often as 1-week postprogram (odds ratio 1.94, confidence interval 1.07, 3.53). The models did not suggest that the program had an effect on negative driving behaviors. Men and students who drove more frequently had worse driving behavior.**

Conclusions: **Our evaluation demonstrates that the IMPACT program had a statistically significant, positive effect on students' knowledge of alcohol and crash issues that was sustained over time. IMPACT had an initial effect on students' behaviors in terms of peer influence toward improving road safety (i.e., buckling up, not drinking, and driving) 1 week after the program, but this effect diminished after 1 month. Other negative driving behaviors had low prevalence at baseline and were not further influenced by the program.**

Key Words: **Evaluation, Injury prevention, Randomized control trial.**

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Injury is a significant public health problem for all ages, but it is of particular concern in pediatric populations. The explorations, experimentation, and risk-taking behavior of children and adolescents put them at significant risk for injury. As a result, injury is the leading cause of mortality in children in many countries[1–3] and accounts for 30% of deaths in young Canadians.[4] Of all types of injury, motor vehicle collisions (MVC) are the most significant. They are the leading cause of death under the age of 20 years in both the United States[5] and Canada.[6]

Youth are at an elevated risk for MVC-related injury as passengers or pedestrians[7,8] and also, when of age, as drivers. Age, maturity, and inexperience put adolescent drivers, their passengers, and others on the roadways at high risk for crash and injury.[9] Other characteristics and developmental factors in adolescence may lead to increased risk-taking behavior and injury including an unrealistic sense of competence, control, optimism, invulnerability, poor judgments about negative consequences,[10] and sensation seeking.[11] These behaviors are, in part, because of neural immaturities in the adolescent brain in areas underlying executive function.[12,13] This type of behavior is highly correlated to injury, specifically MVC,[14] and may also involve the use of alcohol or drugs.

Alcohol and drugs are important, highly prevalent risk factors for injury associated with up to eight times higher risk of injury mortality.[15,16] A recent survey of drug use by Ontario students found that in our region of Southwestern Ontario, 66% of students in grades 7 to 12 reported drinking alcohol in the past year, and 32% reported using cannabis. This same study found that 14% of all Ontario drivers in grades 10 to 12 reported driving within 1 hour of consuming two or more alcohol drinks.[17] Trauma Centre data corrobo-

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rated these self-reported data with 18% of teenagers involved in a major MVC being positive for alcohol, with a mean blood alcohol concentration of 20.0 mmol/L.[18] In a regional analysis, the highest rate of MVC-related hospitalization in Southwestern Ontario was in the 15- to 19-year-old group at 58.3/100,000 population. This was also the highest rate for 15- to 19-year-old groups across all other regions of the province.[19]

These statistics, in addition to the personal experiences of physicians, nurses, and other healthcare professions treating teenagers injured in drinking and driving crashes and by other mechanism provided the rationale for the development of an injury prevention program to ultimately decrease these traumatic events. IMPACT (Impaired Minds Produce Actions Causing Trauma) is an adolescent, hospital-based program for high-school students that aimed to prevent injuries and their consequences caused by alcohol or drug impairment and other high-risk behaviors. The overall objective of this evaluation is to determine the effect of the program on students' knowledge and behavior regarding drinking and driving, over time.

METHODS

Intervention Description

IMPACT is the cornerstone injury prevention initiative of the Trauma Program at the London Health Sciences Centre in London, Ontario, Canada. The program takes students through the journey of a trauma patient from resuscitation in the emergency department, through intensive care unit stay to discharge. IMPACT uses a collaborative approach by a multidisciplinary team including nurses, physicians, police officers, paramedics, and social workers, all of whom share personal experiences while dealing with trauma and injured patients. All the healthcare professionals involved with IMPACT are volunteers, but it still costs approximately $50,000 to cover the costs of program coordination, volunteer incentives, and other associated costs.[20] A complete description of the program and program history can be found at http://www.lhsc.on.ca/trauma/injury/program.htm and http://www.lhsc.on.ca/trauma/injury/history.htm, respectively.

For this study, small groups of grade 11 students were selected to attend the program at our hospital. They participated in a series of educational sessions of varied teaching styles, including a mock resuscitation in the emergency department, presentations, bedside visits with a trauma patient and family in the intensive care unit, a previous trauma patient as a guest speaker, games to review facts, and discussions. A debriefing session occurred the day following the program. Figure 1 depicts the program logic model. A causal model of the program is presented in Figure 2.

Design, Setting, and Subjects

This was a randomized control trial, with half of the students randomly selected to attend IMPACT, whereas the remaining students served as the control group. During the 2002–2003 school year, seven secondary schools from the Thames Valley Board of Education participated in this outcome evaluation of the IMPACT program. To participate, students must have returned a signed parental consent form and must have been present on the day of the survey. The Injury Prevention Educator went out to the schools before the program and then at three posttime periods (1 week, 1 month, and 6 months) to have the students complete a questionnaire. Responses were kept confidential and anonymous, but each student was given a code to allow tracking of subsequent survey responses.

In addition to the outcome evaluation described herein, a process evaluation was undertaken for the volunteers and staff participating in the program. These forms allowed us to monitor the implementation and delivery of the IMPACT Program and the quality of the presentation, measured on a five-point Likert scale.

Survey Instrument and Testing

A 50-item questionnaire was designed and administered to the students at the four time periods. Questions were taken or adapted, where possible, from recognized, validated instruments,[17] or previous evaluations.[21] The remaining questions were developed by a panel of evaluation, injury prevention, and trauma experts to ensure high face validity.

There were multiple choice questions regarding student demographics, driving and licensure details, negative driving behaviors, driving infractions, alcohol and drug use, drinking and driving, alcohol-related crash experience, drinking and driving knowledge, attitudes, perceptions, and behaviors. Likert scales were used where appropriate. There were also two open-ended questions to allow for additional comments. A copy of the questionnaire can be found at http://www.lhsc.on.ca/trauma/injury/eval.htm.

Before using the questionnaire, it was pretested through a focus group conducted with a heterogeneous group of students ranging in age from 15 years to 20 years, with some of the students having recently attended the IMPACT program. The students were given some background information on IMPACT and the evaluation and then asked to critique the questionnaire to ensure that the questions made sense, the wording was clear, none of the questions were too sensitive to answer, and comment on the format of the survey. All of the comments were incorporated into a revised questionnaire. In addition to the students' comments, their responses to the questionnaire were also reviewed. Distribution of the responses indicated that the knowledge questions were at an appropriate level of difficulty, and that the students' various perceptions and attitudes were covered in the choice of responses available.

Finally, a pilot test of this evaluation was undertaken. There were many lessons learned through the evaluation of school experiences with IMPACT. The feedback obtained from this pilot was used to address issues including recruit-

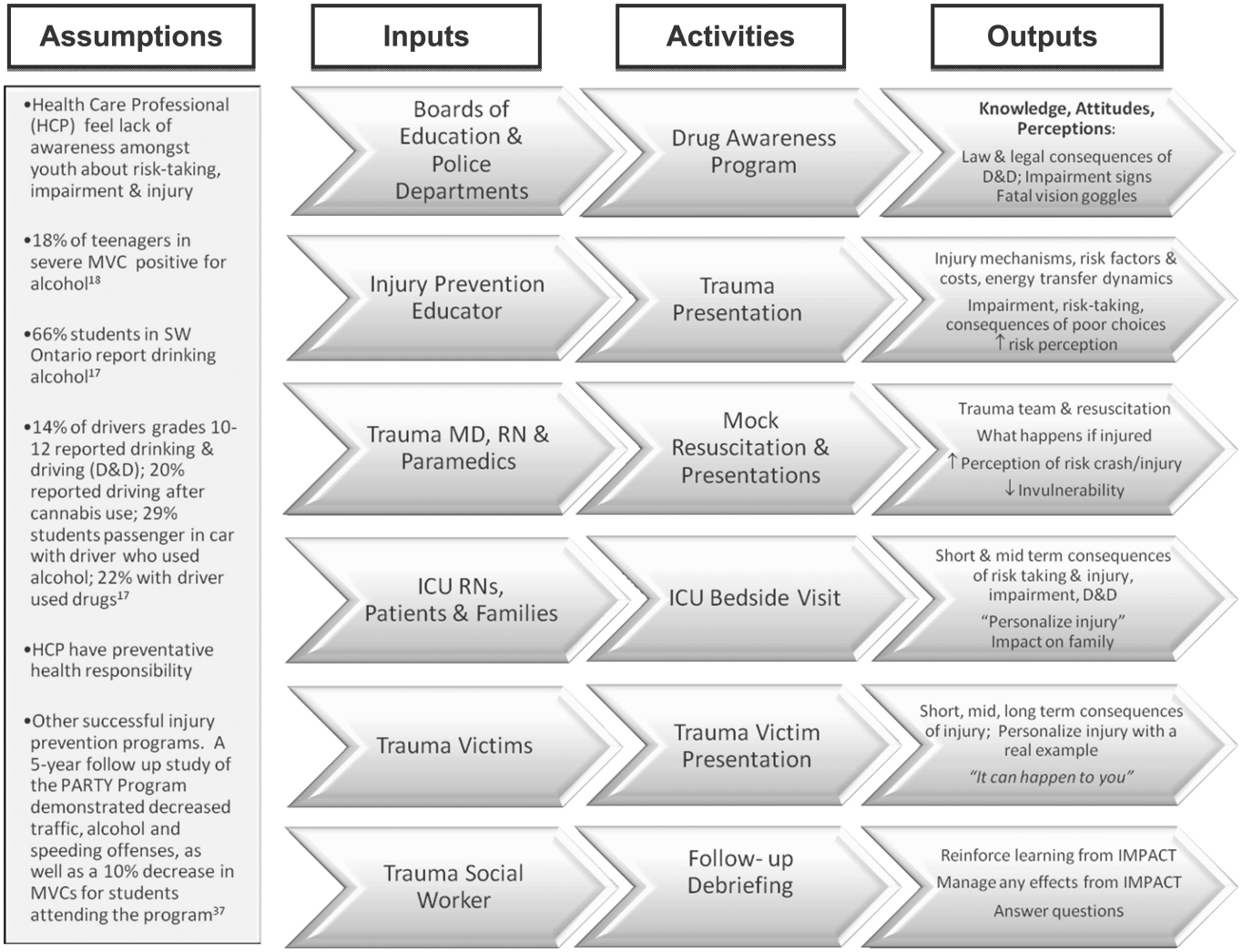

Fig. 1. *The program logic model for the IMPACT program.*

Fig. 2. *A causal model for desired effect of the IMPACT program.*

ment, randomization, scheduling, and follow-up through additions and modifications of our evaluative process.

Analysis

Three main student aspects were evaluated from the questionnaire: knowledge, negative driving behavior, and influence on family and friends. The following explains the measures, models, and analytical techniques used for each aspect. Additional information on each model including the definition, type, and coding scheme for each variable included in the three models for knowledge, negative driving behavior, and influence on family

and friends can be found at http://www.lhsc.on.ca/trauma/injury/eval.htm.

Knowledge

Measures

The dependent variable was derived from the number of correct answers for the knowledge questions in the questionnaire about crash and impairment issues, and ranges from 0 to 6. Two main independent variables and their interaction are included: IMPACT intervention, time effects, and the effects of IMPACT over time. The gender of the student and his or her school were included to control for the effect these factors may have on knowledge.

Models

Panel data and hierarchical linear models were used to analyze the effects of the experiment on students' knowledge of crash and impairment issues. Both techniques are appropriate for handling longitudinal data and were applied to the four time period unbalanced sample. Panel data models have been used by economists and are part of the econometrics field.[22,23] Hierarchical linear modeling or multilevel modeling has been commonly used in educational research[24,25] based on the nested or clustered nature of the data (i.e., measurements within individuals, individuals within schools, schools within countries). In our model, two levels were used: (1) interindividual (changes in individual students over time from baseline to 6-month follow-up); and (2) intraindividual (between students). Note that there were not enough schools to allow for a third level (i.e., school nesting), but school is accounted for as a student characteristic in level 2.

A series of different panel models and hierarchical linear models were estimated using STATA and HLM 6.04, respectively, for different specifications. As all models were in agreement with the effect, the results of only one model, the linear panel model, are presented.

The panel data random effects model was applied to the following specification that allows for the effects of the IMPACT program to vary over time in a nonlinear fashion:

$$y_{it} = \alpha_1 + \alpha_2 impact_i + \alpha_3 TIME_{it} + \alpha_4 impact_i TIME_{it} + \alpha_5 female_i + \alpha_6 SCHOOL_i + \varepsilon_{it}, \quad (1)$$

where y is the number of correct answers on crash and health issues; *impact* is 1 if the student is in the impact group and 0 if in the control group; *TIME* is a matrix time indicator consisting of three dichotomous "dummy" variables for the 1 week, 1 month, and 6 months postintervention; *female* is 1 if the student is female and 0 if male; and *SCHOOL* is a matrix consisting of six dichotomous "dummy" variables for schools 2 to 7.

In Eq. 1 α_4 captures the effect of the program on students' knowledge of crash and health issues. The significance and sign of α_4 indicate the effect of the intervention, so if positive, IMPACT has a positive effect on the knowledge of students on crash and health issues.

Negative Driving Behavior

Measures

The dependent variable was the negative driving behavior score. This score is derived from six items related to driving behavior: driving while talking on a cell phone, driving while involved in a conversation, driving while eating, being annoyed with other drivers, driving when feeling drowsy, and seat belt usage. These aspects are measured on a five-point Likert scale (1 = never, 2 = rarely, 3 = sometimes, 4 = almost always, and 5 = always) in terms of the frequency in which they are performed. For example, the frequency in which a driver drives while talking on a cell phone, involved in a conversation, while eating, and so on. The negative driving score is a simple sum of these six variables. Thus, it is a count variable with values from 6 to 30.

Models

As with the knowledge analysis, a series of different panel models and hierarchical linear models were estimated for different specifications. As all models were in agreement with the effect, the results of only one model, the linear panel model, are presented.

The panel data random effects models was applied to the following specification:

$$y_{it} = \alpha_1 + \alpha_2 impact_i + \alpha_3 TIME_{it} + \alpha_4 impact_i TIME_{it} + \alpha_5 control_i + \varepsilon_{it}, \quad (2)$$

where y is the negative driving behavior score; *impact* and *TIME* are defined the same as in Eq. 1, with the interaction between these three variables and IMPACT accounting for the effects of the IMPACT program over time. *Control* includes the following control variables: student gender, length of time with driver's license, whether the student has completed a driver's education program, the frequency of driving, where the student drives (i.e., city, rural areas), and the school in which the student is enrolled. These were included to control for the effect that these aspects may have had on the dependent variable.

In Eq. 2, α_4 captures the effect of the experiment on students' driving behavior. The significance and sign of α_4 indicate the effect of the intervention, so if negative, IMPACT has a negative effect on the negative driving behavior score, or a positive effect on driving behavior.

Effect of IMPACT on Students' Influence on Family and Friends

Measures

This dependent variable measured whether the student tried to influence friends and family regarding road safety in the past month; for example, buckling up, not drinking and driving, and concentrating when driving. This variable is dichotomous and takes the value of 1 if the student tried to influence friends and family, and 0 if not.

Analytical Techniques

Both descriptive statistics and regression models were used to analyze the effect of IMPACT on students' influence on friends and family about road safety. First, the percentage of students in the control and IMPACT group who have tried to influence friends and family in the past month regarding road safety was calculated over time. Second, multiple logistic regression was used, where a Logit model estimated the effect of IMPACT in a multivariate framework and taking into account the longitudinal nature of the data. This model was appropriate for estimating a dependent variable that is dichotomous.[22,23]

The Logit model estimated here has the following specification:

$$P(y_{it} = 1) = \frac{\exp(\alpha_1 + \alpha_2 impact_i + \alpha_3 TIME_{it} + \alpha_4 impact_i TIME_{it})}{1 + \exp(\alpha_1 + \alpha_2 impact_i + \alpha_3 TIME_{it} + \alpha_4 impact_i TIME_{it})}, \quad (3)$$

where y is 1 if the student has tried to influence friends and family about road safety, and 0 if not; *impact* and *TIME* are defined the same as in Eq. 1, with the interaction between these three variables and IMPACT accounting for the effects of the IMPACT program over time.

In Eq. 3, α_4 captures the direction (positive or negative) of the program's effect on students' influence on friends and family about road safety. The marginal effect was the slope of the probability curve, and the probability of a student to influence family and friends on road safety, which varied as a result of the IMPACT program, was assessed. The odds ratio of interest was the odds a student in the IMPACT group tried to influence family and friends on road safety compared with a student in the control group, controlling for the various confounding variables.

RESULTS

This study included 269 students (129 IMPACT; 140 control) with an overall response rate of 84% (99% presurvey; 84% 1-week postsurvey; 80% 1-month postsurvey; 71% 6-months postsurvey). Schools were encouraged to participate by making the evaluation a competition process within the school, with the highest response rate receiving a school award presented to the principal and an appreciation pizza lunch for the students. Our winning school had completion rates between 98% and 100% during the four survey time periods.

The IMPACT and control groups had similar age and driver's license characteristics but there was a significant difference in gender (Table 1). Nearly half of the IMPACT group were men, whereas 34% of the control group were men. The regression analyses controlled for gender effects, so this difference is not expected to influence the results. Student driving characteristics between the two groups were not statistically different at baseline (Table 2).

Table 1 Demographics of the IMPACT and Control Groups at Baseline

Characteristic	IMPACT Group (n = 129)	Control Group (n = 140)	*p*
Mean age (yrs)	16.1	16.2	>0.05
Male, n (%)	63 (48.8)	48 (34.3)	0.02
Drivers license			>0.05
General license, n (%)	1 (0.8)	1 (0.7)	
G, level 1, n (%)	49 (40.0)	54 (38.6)	
G, level 2, n (%)	12 (9.3)	14 (10.0)	
Other, n (%)	2 (1.6)	2 (1.4)	
No license, n (%)	65 (50.4)	69 (49.3)	

Table 2 Drive Characteristics of Licensed Student in the IMPACT and Control Groups at Baseline

Drive Characteristic	IMPACT Group (n = 64)	Control Group (n = 71)	*p*
Time with license, n (%)			>0.05
<6 months	26 (40.1)	35 (49.3)	
6 months to 12 months	27 (42.2)	28 (39.4)	
1 year to 2 years	6 (9.4)	3 (4.2)	
2 years to 3 years	3 (4.7)	4 (5.6)	
Not answered	2 (3.1)	1 (1.4)	
Taken a driver's education program, n (%)	33 (51.6)	38 (53.5)	>0.05
Frequency of driving, n (%)			>0.05
Never	3 (4.7)	5 (7.0)	
Once a month	1 (1.6)	8 (11.3)	
Once a week	13 (20.3)	13 (18.3)	
Several times weekly	30 (45.9)	32 (45.1)	
Every day	15 (23.4)	12 (16.9)	
Not answered	2 (3.1)	1 (1.4)	
Most of driving, n (%)			>0.05
Rural/country roads	6 (9.4)	7 (9.9)	
City/town streets	43 (67.2)	37 (52.1)	
Equal combination	13 (20.3)	23 (32.4)	
Not answered	2 (3.1)	4 (5.6)	

The process evaluation indicated that the IMPACT program was implemented as planned, without any omission or major changes. All components of the program received a high mean quality assessment greater than 4 (good) on a five-point scale (5 = very good), range, 4.1to 4.83.

Knowledge Results

The estimates from the specification are presented in Table 3. A linear regression model measured the relationship between number of correct scores on the crash and impairment questionnaires. The model tested for statistically significant differences between the IMPACT and control groups over time, controlled for gender effects and tested for differences between schools.

After 1 week, 1 month, and 6 months, students in the IMPACT group achieved 1.59 (95% CI = 1.09; 2.07), 1.08 (95% CI = 0.74; 1.42), and 1.19 (95% CI = 0.84; 1.54), respectively, points higher than students in the control group (Table 3). Results from the model indicate that being in the

Table 3 Number of Correct Answers on to the Crash and Impairment Questionnaire

Variable	β	Percent Change in Score	95% CI	
			Upper	Lower
Intercept	1.58		1.09	2.07
IMPACT	0.13	4.8	−0.16	0.43
Time 2	0.49	17.5	0.26	0.71
Time 3	0.66	23.5	0.43	0.89
Time 4	0.55	19.7	0.31	0.79
IMPACT time 2	1.59	56.6	1.25	1.92
IMPACT time 3	1.08	38.5	0.74	1.42
IMPACT time 4	1.19	42.6	0.84	1.52
Female	−0.03	−1.2	−0.27	0.21
School 1 (reference group)	—	—	—	—
School 2	0.39	13.9	−0.26	1.04
School 3	0.30	10.6	−0.20	0.80
School 4	0.42	15.0	−0.10	0.94
School 5	0.50	17.9	−0.05	1.05
School 6	0.35	12.6	−0.13	0.84
School 7	0.48	17.1	−0.01	0.97

The overall R^2 of the random effects linear model is 0.33.

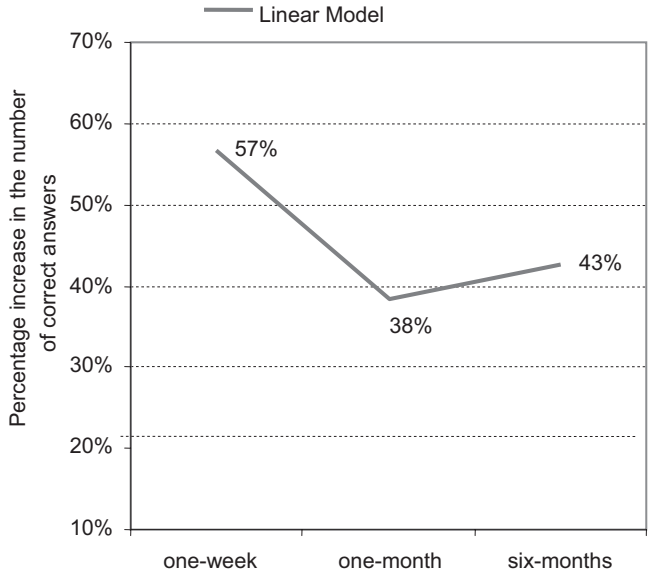

Fig. 3. *Effect of IMPACT on knowledge of crash and impairment issues. Percentage increase in the number of correct answers caused by IMPACT Linear Model.*

IMPACT group increased the expected number of correct answers in crash and impairment issues, and this increase was sustained during the three time periods.

Figure 3 and Table 3 depict the effect of IMPACT on changes in students' knowledge of crash and impairment issues with the interaction terms 1 week (impact time 2, 57%), 1 month (impact time 3, 39%), and 6 months (impact time 4, 43%) measuring the positive effect of IMPACT on knowledge over time. Estimates from the specification suggest that IMPACT has a strong initial effect on students' knowledge of crash and impairment issues, which seem to diminish somewhat over time. The loss of some knowledge over time was expected.

Table 4 Negative Driving Behavior Score

Variable	β	SE	CI	
			Upper	Lower
Intercept	11.89	1.81	8.35	15.42
IMPACT	−0.02	0.55	−1.10	1.06
Time 2	0.01	0.33	−0.63	0.66
Time 3	0.05	0.33	−0.60	0.70
Time 4	0.41	0.23	−0.26	1.08
IMPACT time 1 (reference group)				
IMPACT time 2	0.08	0.49	−0.87	1.04
IMPACT time 3	−0.10	0.49	−1.06	0.87
IMPACT time 4	−0.12	0.50	−1.10	0.86
Female	−1.25	0.48	−2.20	−0.30
License long	−0.59	0.39	−1.35	0.17
Education	0.63	0.31	0.02	1.24
Frequency	0.49	0.30	−0.09	1.08
City	−0.46	0.33	−1.10	0.19
School 1 (reference group)				
School 2	−1.68	1.90	−5.14	2.04
School 3	0.89	1.77	−2.58	4.35
School 4	1.63	1.82	−1.93	5.19
School 5	−0.99	1.84	−4.60	2.62
School 6	−0.11	1.79	−3.62	3.41
School 7	0.40	1.77	−3.07	3.87

The overall R^2 of the random effects linear model is 0.14.

Negative Driving Behavior Results

The estimates from this model are presented in Table 4. The negative driving behavior score was modeled under the assumption that the data were normally distributed. In Table 4, the β values represent the unstandardized regression coefficients, and the SE values measure the variation in the negative driving behavior score because of a one-unit change in the negative driving behavior score.

There were no significant differences between the IMPACT and control group with respect to driving behavior at 1 week, 1 month, and 6 months after the intervention (Table 4). The various models and specifications applied consistently suggest that the intervention did not have an effect on driving behavior. Secondary results from this study suggest that the driving behavior of women is better than that of men, irrespective of their participation in the IMPACT program.

Results on the Effect of IMPACT on Students' Influence on Family and Friends

Table 5 presents the percentage of students in the control and IMPACT group who have tried to influence friends and family toward improving road safety (i.e., buckling up, not drinking and driving). The last row of Table 5 presents the percentage of change in behavior between the IMPACT and control group. The statistically significant increase of 20% for the IMPACT group at 1-week postintervention suggests

Table 5 Percent of Students Who Influence Friends and Family About Road Safety

	Survey Time									
	Presurvey		1-wk Postsurvey		1-mo Postsurvey		6-mo Postsurvey		Total	
	%	N	%	N	%	N	%	N	%	N
IMPACT group	50.9	58	69.9	65	60.9	53	59.8%	49	59.8%	225
Control group	46.9	60	50.4	58	53.6	59	54.3%	50	51.0%	227
Difference (IMPACT − control)	3.0%		19.5%*		7.3%		5.4%		8.8%	

* $p < 0.05$.

that the IMPACT program had a statistically significant positive effect on students' peer influence about road safety.

Multiple logistic regression was also undertaken with the logit model measuring changes in the student's behavior regarding influencing changes in road safety for friends and family. The findings indicate that the IMPACT program had an effect on students' influence on friends and family about road safety significantly 1 week after the program. The odds that students in the IMPACT group would try to influence friends and family to improve their road safety 1-week postprogram was double that of students in the control group (odds ratio 1.94, CI 1.07–3.53). There were no longer-term effects in 1 month and 6 months after the IMPACT program.

DISCUSSION

Injuries are predictable and preventable. Previous research has estimated that 30% to 90% of all deaths are preventable in the preinjury phase.[26–28] Therefore, it has been speculated that further decreases in traumatic morbidity and mortality will not come from improvements in the delivery of care, but by preventing these injuries from occurring in the first place.[29]

For adolescents, MVC are the most significant mechanism of injury.[5,6] Their inexperience, invulnerability, and risk-taking behavior, including substance use, are major contributors to crashes and subsequent injury.[9,10,12,30] Alcohol and other drugs are the leading risk factors for injury from all types of mechanism, including MVC, and as such need to be targets for injury prevention programs.[30] Programs for adolescents that involve both prevention of MVC and impairment are particularly needed. This was the rationale behind the development of the IMPACT program.

IMPACT is a comprehensive, socially relevant program with varied teaching methods targeted to youth at a time, when their driving habits and substance use are being initiated. These are all characteristics consistently associated with effective injury prevention programs.[31] Since its inception in 1989, London Health Sciences Centre has hosted the program to approximately 25 students from 12 to now 21 schools each year. Based on these numbers, we think that IMPACT has affected the lives of more than 7,000 teenagers to date.

The results of our evaluation demonstrate that the group of students participating in IMPACT had increased knowledge on crash, injury, and impairment questions compared with the control group, which was sustained over time. This is important because enhanced knowledge is the first step in changing attitudes, perception of risk, and eventually behavior to ultimately decrease injury and death. Other similar adolescent programs designed to decrease risk-taking and drinking and driving have also demonstrated this gain in knowledge.[32,33]

Translating increased knowledge and awareness into changes in behavior is a critical, but difficult step to detect. We asked several questions on negative driving behaviors and tested for differences between the two groups, over time, but were unable to detect a significant difference. We know from our process evaluation that the program was implemented as planned without any component missing, so that does not explain our findings. Our results may be limited by the items used to construct the negative driving behavior score, the amount of data, the time span for which the groups of students were followed, and levels of negative driving behaviors in the students at baseline. Student had low levels of these negative behaviors at baseline (11.4 in the IMPACT group and 11.8 in the control group on a scale starting at 6 and increasing to a maximum of 30). It may be that our construct was not sufficiently responsive to detect low-level changes in behavior. A recent review[34] of school-based programs for reducing drinking and driving, and riding with drinking drivers also failed to find sufficient evidence as to the effectiveness of these programs for decreasing self-reported negative driving behaviors, including drinking and driving. They were, however, able to demonstrate significant reduction in students riding with a drinking driver.[34]

A limitation of this study, as with all questionnaires, is that self-reported data are subject to the usual biases including the effect of time on people's ability to accurately recall events.[35] Although diminished in anonymous questionnaires, some students will still want to respond in a socially acceptable manner, even if it does not accurately reflect their behavior.[36] This may be particularly true for sensitive questions involving underage drinking, illicit drug use, and drinking and driving.

It is, however, encouraging that long-term behavioral changes have been reported in a similar hospital-based adolescent MVC and impairment prevention program in Canada, PARTY (Prevent Alcohol and Risk Related Trauma in Youth). PARTY reported statistically significant decreased traffic, alcohol, and speeding offenses in the group attending

the PARTY program, as well as a 10% decrease in collisions, when compared with a control group.[37] This was a longitudinal study with a median follow-up time of 5 years.[37] Other evaluations of comprehensive alcohol prevention programs for high school students have also demonstrated a greater effectiveness on longer-term evaluation (24 months postsurvey) compared with a 2-month, short-term follow-up.[38] Previous research has identified a "sleeper effect," which may be occurring in these types of programs causing a delayed increase in the impact of a persuasive message.[39] This is a common effect, especially when the student perceives the message to be delivered by a noncredible source.[40] So, it may be that in our evaluation, the 6-month follow-up period was simply not long enough to detect a change in behavior, as there is the potential for the effect of our persuasive message to increase over time.[40]

Our study was able to demonstrate one statistically significant positive change in behavior. The odds that students in the IMPACT group would try to influence family and friends about road safety issues including buckling up, not drinking and driving were twice as high than that of the control group within a week of the program. Although this was only a short-term change, it is important that the teenagers were impacted by the program, enough to be concerned about their peer's health and well-being. Research has shown that one of the most important factors in an adolescent's decision to drink and drive, or ride with a drinking driver is the influence of friends and peers.[41] The fact that students in the IMPACT group have increased their attempts to influence their family and friend on these issues suggests that IMPACT has an effect in these teenagers' social networks, beyond just those students participating in the program. This may account for some of the leveling off in the differences between the two groups in terms of knowledge and behaviors over time. Furthermore, as all data have random error, one must also consider regression to the mean (RTM) as a possible explanation for this leveling off of the effect, as opposed to real change. RTM is a common statistical phenomenon in which changes in a variable are followed by measurements that are closer to the mean. It occurs when repeated measurements are taken on the same individual.[42] The effects of RTM are reduced by randomly allocating students to two groups (intervention and control), as well as minimizing any effect through the analysis.[42] We used both these techniques in this RCT. Booster sessions provided to the students, such as a "refresher presentation," may serve to remind students of the intervention and help to lengthen the time the program has a measurable effect.

It is interesting to note that previous surveys have indicated that youth are more willing than adults to take measures to influence peers and protect their friends in drinking and driving situations. It appears that even though they may not be able to recognize their own vulnerability to alcohol, they are able to recognize when their friends are impaired and are unable to drive safely.[43,44] It is plausible that although IMPACT is increasing knowledge and awareness, it is not increasing the students own perception of risk as much as desired to result in noticeable behavioral changes.

Limitations of this evaluation have been previously noted, but the major strength lies in the study design. As a RCT, the groups are formed randomly and are very unlikely to be systematically different before the intervention.[45] This design provides the strongest evidence for causation, and the greatest assurance that any differences in the outcome variables are caused by the intervention, namely the IMPACT program.[46] Evaluation is an ongoing, iterative process and we plan to continue to evaluate, refine, and improve IMPACT to ultimately decrease drinking and driving, injuries and deaths in youth.

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DISCUSSION

Dr. Marla Vanore (Philadelphia, Pennsylvania): Thank you to the Association for the privilege of discussing this paper and thank you to the authors for such and important, well-conceived, and well-executed study. This abstract measures the effect of a hospital-based injury prevention program.

The program, which is named IMPACT, is aimed at adolescents and attempts to decrease injuries caused by driving while impaired by drugs, alcohol, or taking part in other high-risk behaviors.

As you heard, questionnaires were designed and given to school students before the intervention and at three times post-intervention. The study findings were an increase in knowledge as compared to controls, but this was mainly at the one-week mark and decreasing over time.

A very small change in behavior and this, I think, is significant, that it was self-reported behavior and it still showed very little change and an increase in attempts to influence others, again mainly at one week and decreasing over time.

I have to say that these are important, though discouraging, results for three reasons. As the researchers state in the paper, they felt that all aspects of their program had been handled correctly and the questionnaire study design and analysis seem to be of a very high quality with an excellent response rate and finally, this type of program is used, usually under different names, in a number of different locations and in slightly different formats and so it's very common. I have a number of questions for the author.

You state that this was a randomized control trial with half of the students selected to attend the program and half used as controls. Was randomization done by school or by student? It sounds as though it was done by student, in which case how did you control for students in the control group

being influenced by those who attended IMPACT? Have you considered doing the study where one school acts as the control and an evenly matched group of students at a neighboring school attends the program?

Second, did the control students receive some other sort of intervention or nothing at all? Could they have been affected in some way that caused their scores to improve? Third, the different schools were encouraged to compete for the highest response rate. Do you feel that this had an effect on how the students responded? I'm just trying to get at the point of really no change in behavior in the self-reported questionnaire.

Neither myself nor others at my hospital who do quite a bit of research were familiar with the types of analytical techniques that were used and I believe in the paper it was mentioned that they're used mainly in economics and education research. We found them a little difficult to follow and can you comment on why you selected those particular techniques?

Fifth, do you have a standardized definition of influencing friends and family? Again, in the paper, there was a lot of emphasis on the fact that this really did change, but we question whether or not this was left up to the students to define. Did it include acting as a role model or simply having a casual conversation with somebody else?

Again, much of your conclusions were focused on the fact that the students reported that they did this and so it would be very important to define this clearly and consistently and to evaluate how this definition would affect the results.

Finally, can you say what you feel that you learned from the study and how you would

Dr. Tanya C. Stewart (London, Canada): Thank you very much for your comments and questions. I would start with the question regarding randomization. The students were individually randomized to receive the intervention or the control group and we did it different at different schools.

Sometimes it was just one or two classes that we randomized and other times it was all Grade 11 that we randomized. We did not randomize by school. By randomizing by school, there can be other issues as far as within the analysis, like nesting within schools, because individuals at different schools may act differently.

I know we did have more rural school and their behavior tends to be different than students right in the city and so that's why we didn't do it that way.

The control students did receive a drug and alcohol awareness program that is put on in the school by the police officers. They talk mainly about the legal consequences of drinking and driving, but not specifically injuries or crashes. If anything, it should have sort of heightened their awareness to drinking and driving and crash issues, but we still were able to demonstrate an effect with our knowledge.

We did have a competition to increase our response rate and I really think it did help to increase the response rate. The school that won had a 98 percent response rate over the four time periods. Overall, we had a 98 to 71 percent, but I don't think it influenced how the students would respond to the questions, because we still would go into the school and everyone still had to go in there and sit down and do the questionnaire and so I don't think it affected their responses, but it's something we could ask about in the future.

Regarding our analysis, as you can imagine, we had nearly 300 students over four time periods and so we had over a thousand data points and we wanted to ensure that the analysis was done correctly and in a way that we wouldn't have an effect of multiple comparisons and so it was our statistician methodologist that suggested these methods.

They are sophisticated and state-of-the-art in the statistical community. They have been used in trauma research before. There's a paper just coming out with Dr. Robert Mann, who used this analysis as well and we are encouraging our statistician to write a paper on the technique and how it's used in injury research, but it's appropriate for longitudinal data with repeated measures and it can also allow you to control for the different confounders and so that's why we used that.

Regarding standard definitions, in particular influencing family and friends, we had the definition in there and we had some examples in the definition, like buckling up and not drinking and driving. This was a question that was previously validated in an evaluation that was done several years ago and we, again, did pretest the questionnaire and ask the students if anyone found it confusing or if anything was ambiguous, but it is true that we really need to make sure that it is a real clear definition.

Finally, what we have learned from this evaluation, I think, as far as outcomes, we've learned that we have increased the knowledge and that's sustained over time and we had some initial behavior changes.

As suggested by a question in one of the earlier presentations, one of the things we are considering is these booster presentations, where we would, potentially in Grade Twelve, while the students are still in high school, do another presentation and maybe just come to the school and try to reinforce what we've taught them and then evaluate that as well.

Regarding other logistics of the evaluation, if we were to do it again, we would try to have even higher numbers, because originally we wanted to look at differences between drinking and driving within the students, but once you get your responses, you see half don't have their license, less drink, and even less drink and drive.

By the time we got down to that level, we just didn't have the numbers or the power to look at that comparison and so we would like to increase our numbers. We would also like to follow the students for longer than six months. Again, we did it to try to keep it within the same school year, so we didn't lose students, but if we could follow their driver's license or health card, that would be ideal, to have a longer follow-up.