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PROPOSAL FOR IMPACT EVALUATION OF GRADUATED LICENSING SYSTEM ON YOUNG DRIVERS IN ONTARIO

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PROPOSAL FOR IMPACT EVALUATION OF GRADUATED LICENSING SYSTEM ON YOUNG DRIVERS IN ONTARIO

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ABSTRACT

Rationale:

Graduated Licensing (GLS) is a program of gradual driving exposure during the first two years of a novice driver's experience. This proposal introduces a program model by which GLS could be comprehensively evaluated.

Methods:

A program logic / conceptual framework model was developed, whereby GLS can be evaluated using five steps. First, program implementation was evaluated using focus group methodology. Second and third, knowledge acquisition and resultant driving behaviour were evaluated using data from the Mann et al. and OSDUS surveys. Fourth, ARIMA time series analysis is proposed to evaluate the impact of GLS on both collisions and lastly on young driver injuries.

Results:

Pilot data suggest that young drivers are aware of GLS restrictions but do not feel deterred from contravention. Students demonstrated an increase in knowledge about GLS but continued to contravene many GLS restrictions.

Conclusions:

This comprehensive evaluation may help policy makers improve the GLS program, to reduce young driver injuries and death.

Keywords: Graduated Licensing, Young Novice Driver, Program Evaluation, Causal Modelling, Time Series, Focus Group

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List of Abbreviations

AR: Autoregression

ARIMA: Autoregressive Integrated Moving Average

BAC: Blood Alcohol Content

CAMH: Centre for Addiction and Mental Health

CIHI: Canadian Institute for Health Information

G1: Graduated Licensing System – stage 1 restricted licence

G2: Graduated Licensing System – stage 2 restricted licence

GLS: Graduated Licensing System

GOF: Hosmer & Lemeshow Goodness of Fit test

ISS: Injury Severity Score

MA: Moving Average

MTO: Ontario Ministry of Transportation

MVC: Motor Vehicle Collision

OR: Odds Ratio

OSDUS: Ontario Student Drug Use Survey

OTR: Ontario Trauma Registry

SES: Socioeconomic Status

US: United States of America

WHO: World Health Organization

CHAPTER ONE – EXPANDED INTRODUCTION AND LITERATURE REVIEW

1.1 Outline of Thesis

This thesis proposal outlines a study design by which to comprehensively evaluate the graduated licensing system initiated in Ontario in 1994. Although there have been a number of programs built with similar graduated licensing components and a variety of acronyms, this thesis proposes an evaluation of Ontario's program and refers to the program as Graduated Licensing System (GLS). GLS programs have never been comprehensively evaluated even though several of them have been widely implemented in numerous countries and regional jurisdictions. The proposed program evaluation is designed to be a comprehensive evaluation of the GLS, involving the development of a causal model [1] [2] by which each step from the program's implementation to the resulting impact on collisions, and ultimately injuries and deaths, among Ontario's young drivers can be assessed. This form of mixed methodology approach involves the compiling of data from focus group methodology, data triangulation between two self-reported young driver surveys, and administrative data from both the Ministries of Transportation and Health in order to support the perceived causal links between the program's implementation and its outcomes of interest. This mixed methodology design [3] combines both qualitative analysis and quantitative statistical methodologies to create a unique evaluation of this program.

Policy makers typically measure program success according to some readily available measures, such as mean collision rates for GLS programs, using simple pre- and post-intervention analyses. It is reasonable to believe that the general public is interested in saving lives and preventing injuries among young drivers, so policies that reduce 'property damage only' collisions without reducing injuries and fatalities among young drivers may not be considered to be a successful program by the public.

In order to demonstrate successful program implementation, it is no longer considered sufficient to compare outcomes before and after the program's implementation and presume that any differences noted are direct results of the program's influence on the outcome being measured. Instead, the preferred methodology is to develop a conceptual framework to evaluate each of the causal links, or mediating variables, between program implementation and outcomes of interest. This framework allows the researchers to hypothesize the mechanism by which the outcome is causally linked to the related variables, and to evaluate how a program intervention might be able to impact upon the outcome in question. Given that focus group methodology is useful for the assessment of qualitative measures of program outcome, focus groups were carried out with student drivers and police officers, allowing for rich data collection regarding program implementation from the perspective of those affected by the program being evaluated. This information was gathered to provide insight into the potential reasons for successes or shortcomings of this program identified by quantitative self-reported surveys asked of adolescent students at the time of the program's implementation, as well as information obtained from large motor vehicle collision and injury administrative databases.

1.2 Motor Vehicle Collisions Among Young Drivers

Since the advent of improved standards of living in developed nations with sanitation and infection control, motor vehicle crashes have remained the leading cause of mortality among teenagers and young adults. Despite public health education programs and road safety developments, teenagers and young adults are still over-represented in motor vehicle crashes, usually as the drivers or the passengers of young drivers [4].

Motor vehicle collisions remain the leading cause of death among teenagers and young adults, representing 35% of deaths among adolescents aged 16-19 and 30% of deaths among young adult aged 20-24 [5]. Researchers have demonstrated that new or novice drivers have much higher risk of collisions and therefore injuries or death, than do more experienced drivers [4] [6]. Fortunately, there have been declines in motor vehicle crashes, fatalities and drinking with driving rates since the admonition of public health education programs, in the order of 20-55% each between 1980 and 1992 [7]. There has been concern, however, about the stalled or slowed progress in improvements in fatality and collision rates since 1992. Although the death rates among teenagers and young adults have declined only marginally, the proportion of road deaths accounted for by teenagers has actually increased and rates of alcohol-related fatalities and injuries have not changed significantly [7]. Young drivers (aged 16-19) have four to nine times the fatality rate of older drivers (aged 25-54).

1.3 Novice Driver Education

The first traffic-related prevention strategy developed was that of young novice driver education courses, often incorporated into school curricula. Traffic injury researchers speculated that students exposed to safe driving theory and techniques would be better prepared for safe driving than students not exposed to these courses. As such, driver education courses were first introduced in the 1920s. Similarly in Ontario, it was originally hypothesized that developing driver education programs to increase knowledge and controlled experience for young drivers might address some young driver risks. Unfortunately, the idea that drivers can learn and subsequently apply safe driving habits learned in a supervised setting has not been supported by studies in this field [8] [9] [7]. Instead, research findings have suggested that licensing programs incorporating incentives for participation in driver education courses have resulted in significantly higher collision rates among those drivers when compared to their age cohort by 45-51% [10] [6]. The reason for this increase in collisions and injuries is unknown, but may be related to conditions of licensure that allow young drivers having taken a drivers' education course to obtain their full licence several months sooner, making them younger and potentially more immature than their age-matched cohort [11] [6]. Also, it has been argued that the lack of impact from driver education courses may have been due to an artificially reduced rate of collisions when the programs were eliminated, because of reduced exposure to driving (often related to parental restrictions), leading in reduced risk of collision [8]. In spite of these findings, driver education courses remain a component of most introductory licensing programs, and continue to be encouraged by car insurance rebate programs. The influence of driver's education courses upon young driver collisions and injuries, and the potential explanatory theories such as driver inexperience, immaturity or under-development, is outside of the scope of this thesis proposal, and as such is not evaluated within this conceptual framework.

1.4 Rationale for Graduated Licensing System

Despite decades of driver education courses and programs, young drivers continue to be over-represented in collision, injury and death rates in all industrialized nations (drivers aged 16-19 represent 13% of drivers in Canada but 25% of all deaths and serious injuries from motor vehicle collisions) [12]. In an effort to understand the increased risk of injury and death among young novice drivers, researchers in the field speculated that the combination of young driver inexperience with exposure to high risk driving situations was primarily responsible for the ongoing high fatality and collision rates among young drivers [13]. They further hypothesized that a structured restriction of exposures to high risk driving situations (driving at night, drinking and driving, driving with young passengers and driving on highways) might be the mechanism by which the rates of collisions and fatalities could be further reduced [4]. The need for inexperienced drivers to gain experience by being gradually exposed to high risk situations, coupled with the knowledge that exposing inexperienced drivers to high risk driving situations places them at high risk for collisions, has been referred to as the "Young Drivers' Paradox" [4].

The development of the GLS was based on the research findings that a safe driving exposure better prepares young drivers than no exposure to driving hazards [4]. A number of studies in the 1970s, originating in New Zealand and North America, developed suggestions for policies whereby young novice drivers could be gradually exposed to these high risk driving situations [14] [15] [13]. Research has also demonstrated that supervised driving is relatively safe with few collisions occurring during supervision with front seat licensed passengers [16] [17].

1.5 Review of Graduated Licensing Programs to Date

A formal GLS was first implemented in New Zealand in 1987 [18], and based on initial studies that suggested a significant reduction in collisions among young drivers [18]. It has been implemented in 12 Canadian provinces and territories (Nunavut is expected to develop a similar program) as well as most American states to date [19], each incorporating similar components of graduated licensing, with multi-staged programs including an extended learner's stage with supervised driving and an intermediate or novice stage before graduating to a full unrestricted driver licence. Most current programs focus on novice drivers of any age, while the most previous learner's programs seemed to target novice drivers with an emphasis on young drivers (see Appendix 1) [6]. There are now so many GLS programs currently implemented in various jurisdictions internationally that this review is intended to be a summary, rather than an exhaustive recount of each program's analysis, in order to acquaint the reader with the existence of other GLS programs and the findings of their evaluations.

Given that most collisions for young novice drivers occur during the first six months of driving [20], it was felt that the supervised period should be extended to 12 months to allow for gradual exposure to increased high risk situations in order to foster driving skill acquisition [21]. Most of the remaining restrictions were based on the highest risk driving situations identified by research experts in the field [22], namely driving at night, driving unsupervised during the first 6-12 months, driving with distractions such as teenage passengers, drinking and driving and driving on high speed expressways or highways. No restrictions were incorporated regarding stricter penalties for speeding, despite increasing recognition of speeding as a high risk driving behaviour [19].

In Canada, the first GLS program was implemented in Ontario in April 1994, and followed by Nova Scotia in October 1994, then New Brunswick (1996), Quebec (1997), British Columbia (1998), Newfoundland (1999), Prince Edward Island (2000), the Yukon (2000), Manitoba (2003), Alberta (2003), the Northwest Territories (2005) and Saskatchewan (2005). Each Canadian province and U.S. state adopted variations of the original GLS program in New Zealand, with slightly different components for each stage of the GLS program (see Appendix 1 for key features of programs in Canada), such as restricting teenaged passengers during the initial phase of the driving process in most US state programs as well as Nova Scotia, but not Ontario until September 2005 [19]. All of these programs were implemented despite very little causal evidence to demonstrate the lasting effectiveness of a GLS policy on important outcomes such as motor vehicle collisions and related fatalities and injuries[10;18;23].

Evaluations of New Zealand's GLS demonstrated an overall 7% reduction in motor vehicle collisions involving injuries or deaths by time-series analysis [18]. Unfortunately, there has not been any significant research into determining which features of these GLS programs contribute most to the reduced collision rates, and as such there has been controversy about which features in each of the GLS programs (see Appendix 1) are beneficial for optimal GLS program development from an outcome perspective.

Ontario's GLS is a provincial initiative implemented on April 1st, 1994, that incorporates the following restrictions and applies to all new drivers and not just young novice drivers [17]:

Level One (beginning at age 16), also referred to as G1 phase:

-novice must be accompanied by licensed driver in front passenger seat, with 4 years' experience

-no other passengers are permitted in the front seat

-novice must have zero blood alcohol concentration when driving

-accompanying passenger driver must have a blood alcohol concentration less than 0.05 percent

-novice must not drive between the hours of midnight and 5:00 am

-the number of passengers is limited to the number of seatbelts in the vehicle

-novice must not drive on freeways or high-speed expressways

Level Two, also referred to as G2 phase:

-driver must have zero blood alcohol concentration when driving

-the number of passengers is limited to the number of seatbelts in the vehicle

-only one passenger aged <19 years for first six months of G2, and up to three passengers aged <19 years for second six months of G2 (restriction only applies between midnight and 5 am, immediate family members exempt). Note that this is the only restriction added after GLS implementation, on September 1, 2005.

Both levels are 12 months in duration, however the duration of Level One may be reduced to 8 months in duration, if the novice driver successfully participates in a drivers' education course. To pass from Level One to Level Two, as well as from Level Two to a Full unrestricted licence, the novice driver must pass a road test.

Studies have demonstrated that the highest rates of motor vehicle fatalities occur at night [13], specifically between midnight and 6:00 am for older teenagers aged 18 and 19, and 10:00 pm and midnight for younger teenagers aged 15 and 16 [24]. For this reason, night curfews were adopted by most GLS policies, but various jurisdictions differ in the optimal duration of this curfew (ie: Level 1 in Ontario, Levels 1 & 2 in Nova Scotia). There have been a number of studies demonstrating reductions in collisions occurring at night as a result of GLS restrictions [10] [25] [26].

Restrictions to low or zero blood alcohol concentrations while driving have been uniformly incorporated into both Level 1 and 2 GLS restrictions by most if not all regions, given the evidence that young drivers who drink are at greater risk of crash involvement than older drivers who drink [27] [10] [28]. Lastly, there is recent evidence that carrying young passengers increases the risk of motor vehicle collisions in young drivers [29], and that crash risk increases with each additional teenage passenger for young driver [30]. This restriction was incorporated into the New Zealand GLS, but not into most GLS policies in North America. In Ontario, this restriction was added 11 years after GLS implementation, where the restriction of adolescent passengers is implemented in the G2 phase unless a front licensed passenger is present, while immediate family members are exempt. The addition of adolescent passengers is graduated as well, allowing for one such passenger for the first six months of G2, and up to three for the second six months of G2. This restriction was put into practice after the focus group and survey components of this evaluation were completed, and as such this last restriction is not evaluated in this thesis proposal.

To date, GLS programs in Canada have been preliminarily evaluated in Ontario, Nova Scotia, Quebec and British Columbia. Studies completed to date for GLS programs in other jurisdictions are summarized below. Details regarding the study designs and methodological analyses are described in the Cochrane review of GLS [31]. Discussion regarding Ontario's preliminary evaluation of its GLS program is summarized last, as it is the object of this thesis proposal.

Nova Scotia's program was evaluated by Mayhew and colleagues [16], and per capita (rather than per licensed drivers) collision rates and injury crash rates dropped by 24% among young novice drivers aged 16 to 19 over the first year, but follow up studies revealed that most of these reductions (a 29% reduction) were during the six month learner phase when a front licensed passenger was required. When all novice drivers (adolescent and adult) were evaluated together, only a 9% reduction in collision rates was demonstrated overall. Conversely, the subset of older novice drivers (non-adolescent) had 24% increased collision rates by the second year [20], when licensed front passengers were no longer required.

In Quebec, the rates of collisions and injuries were calculated based on rates for adolescent drivers divided by rates for drivers over 35 years of age (not exposed to GLS) revealing a 14% reduction in injury crashes and 5% reduction in fatalities [28] among young drivers. The strength of this evaluation is the incorporation of a concurrent control of non-exposed drivers (older drivers greater than 35 years) by creating a difference in collision and injury rates between younger (or adolescent) and older drivers (see above) for each time point. The limitation of this evaluation is the short period of time immediately prior to and following GLS implementation, such that the long-term impact could not be evaluated.

British Columbia calculated pre-post crash rates per 10,000 licensed drivers and found an overall 13% reduction in collisions among novice GLS drivers [32]. Again, none of these evaluations found any benefit from participation in driver education courses. The strength of this evaluation lay in the collision rates created based on the total number of licensed drivers for each driver cohort, data which are not available for Ontario's evaluation (see below). The limitation of this evaluation is in the short period of time prior to and following the program's implementation, which is understandable considering that the province would be interested in evaluating such a program as it is unfolding.

GLS programs in the United States have been evaluated in a number of jurisdictions to date. All of them used pre-post evaluation methods, looking at statistically significant mean collision rates in the year prior to and following the program's implementation, as they are all recent programs. The denominator of the rates differs (actual counts in Michigan, rates per capita in Connecticut and rates per licensed drivers in Kentucky), and few of the evaluations use time series methodology to adjust for seasonality in the data. None of the studies incorporated adolescent perceptions of the programs or its enforcement and none added any index of novice driver contravention of the regional GLS restrictions. The following outlines the findings of these studies. An evaluation of California's GLS program using a pre-post per capita crash rate calculation for novice drivers aged 16 to 19 found a 23% reduction in injury crashes and 40% reduction in crashes resulting in death [33]. Most of the reductions in fatal and severe injury collisions occurred at night (35%). Connecticut reported a 22% decline in per capita injury crashes among 16 year old drivers [34]. Florida researchers performed a one year pre-post evaluation and demonstrated an 11% reduction in collisions among 16 year old drivers when compared to Alabama (a non-GLS state at the time of the evaluation) [35]. Evaluation of Kentucky's GLS demonstrated a 32% reduction in collision rates per licensed driver using a pre-post comparison for 16 year old drivers during the first six months of the program (which represented the learner phase with licensed front passenger) but a 3% increase in collisions the following six months without a licensed front seat passenger, with no long-term impact for older adolescent drivers [36]. Similar preliminary analyses were performed for North Carolina [37], demonstrating a 23% decline in per capita crash rates for 16 year old drivers, which was duplicated in Ohio [19].

A recent study looking at the impact of GLS in Michigan found no significant reduction in either alcohol-related or fatality collisions among young drivers [23], although the preliminary analyses did demonstrate similar reductions in per capita collision rates as the other programs outlined above. Michigan's program was the first in North America to evaluate the impact of GLS further by using time series analyses on the monthly collision rates and demonstrated an overall decline in crash rates of 25% in the year following the program's implementation [38], and 19% in a four year follow-up [39].

Utah's GLS program, like Michigan, differs from the other statistical methodologies used in that its program evaluation did in fact adjust for seasonal variation and autocorrelation between monthly collision counts by using time series methodology, where there was an overall reduction in collisions by 5% across all age groups, with no impact on injury and fatality crashes [40].

The only jurisdiction with long-term follow up data regarding GLS impacts has been New Zealand, where the program was originated in 1987. Most recent evaluations performed using pre-post regression modelling (without correction for autocorrelation) demonstrated a significantly reduced risk of being involved in night collisions, collisions with alcohol, and collisions involving 16 year old passengers [25]. These authors attributed long term success to a number of recent modifications of their GLS program, including the addition of a requirement that novice drivers in the learner phase have an 'L' on their car licence plate in order to identify them to police and improve compliance to restrictions, as well as increasing the duration of the learner phase and eliminating the 'time discount' for drivers having taken drivers education during the learner phase. Although there was a statistically significant reduction in collisions and injuries from collisions among 16 year old drivers, a study looking at the acceptance of this policy by New Zealand's teenagers revealed that the vast majority of them contravene at least one of the restrictions weekly [41]. This may very well account for its overall impact of 7% reduction in collision rates, and the tendency of the program success to regress over time, which may be the case with other programs mentioned above which have been evaluated for only one year following program implementation.

In Ontario's initial program, none of the recommendations to limit teenage passengers was incorporated into either of the G1 or G2 phases until the recent amendment in 2005. Recommendations to include the requirement of a licensed front seat passenger during G2 (during driver's first exposures to night time and highway driving) were not incorporated either, despite evidence for its benefit [31]. The Ontario program has been criticized by an international Cochrane Library review of all graduated licensing programs to date as being a 'partial GLS' because of the lack of real restrictions in the second (or G2) phase, the restrictions of which are considered standard policy in many jurisdictions [31]. A further review of each province's implementation of GLS and the perceived completeness of each province's GLS conditions is outlined in a report produced by MADD Canada [42] [43].

In summary, initial studies evaluating the impact of the introduction of the GLS policy seemed uniformly to report very large reductions in the collision and injury rates in comparison to pre-GLS rates by 31% for young novice drivers when calculated as a rate per 10,000 drivers [10] [7;44] [35]. Subsequent evaluations appear to suggest, however, that the reductions were much less than initially reported by the jurisdictions adopting this program [7], while young drivers who took driver's education courses and obtained a four month 'time discount' in the G1 phase had a 44% higher rate of overall collisions [10] [19].

Although the preliminary results of the impact of the GLS on motor vehicle collision, injury and fatality rates in Ontario had been encouraging since its introduction in April 1994 [10], the results are still very preliminary and represented data from only one year prior to and following its implementation. There has been no further research to investigate whether reported reductions in crashes and injuries could be attributed solely to a longer driver's licensing process delaying the onset of driving (accounting for a reduction in collisions in the year immediately following GLS implementation), or due to the introduction of other road safety or public education measures. There has also been no attempt to investigate the effects of GLS implementation in the context of a concurrent control group, to offset any temporal changes in collision rates occurring nationally. The 25% reduction in collision rates among young novice drivers seen in this interim evaluation [10], using a pre-post intervention analysis methodology, was accompanied by a concurrent 40% reduction in new licence applicants which could, in itself, account for a reduction in collisions in the year immediately following the GLS implementation [10]. It is important to put the relative reduction values into context given that the vast majority of these reductions represented collisions without injury or death, while the number of fatalities among all novice drivers dropped by 6%, which represented three people over the entire year in Ontario [10], the clinical significance of which needs to be determined by the tax payers and partisans of this jurisdiction.

All of these studies to date have utilized a pre-post intervention evaluation approach [1], and suffer from the same methodological limitations, in that it is difficult to infer direct relationships between the program's implementation and the outcomes of interest. Moderating and mediating variables are not explored by such preliminary evaluations. Clearly, in order to effectively evaluate the impact of this Graduated Licensing System on collisions and injuries among Ontario's young drivers, a more comprehensive conceptual framework is required in an effort to try to demonstrate a sequence of direct links between the introduction of a GLS and the resultant collision and injury rates over the long run. This thesis proposal will put forward a program evaluation to examine the long-term impact of GLS in Ontario on collisions and resultant injuries among adolescent novice drivers, in order to evaluate whether the preliminary findings for Ontario's GLS described above are sustained. Additionally, the development of a conceptual framework would be useful to explore in greater depth possible reasons to explain the findings of the evaluation. Perhaps this type of conceptual framework could then be applied to the various jurisdictions currently incorporating forms of GLS into their driver licensing process to explore whether these programs are having the intended impact upon novice drivers.

CHAPTER TWO – EXPANDED BEHAVIOURAL THEORY REVIEW

2.1 Introduction

The aim of this chapter is to provide an overview for the theoretical framework upon which GLS was developed, the psychosocial framework by which high risk driving behaviour can be understood, and ultimately the relationship between the two. This understanding is critical to interpreting findings regarding if and how well GLS works, and to developing any future program modifications with a behavioural framework in mind for the target audience. The premise upon which the GLS was developed is that human beings by nature adjust their behaviours according to rewards and punishments, as perceived by the individual [45] [46]. Consequently, if the risk of punishment for certain behaviours (such as contravention of the GLS restrictions) is felt to be swift, sure and severe, it is much less likely that the individual will be willing to risk the consequence [46] [47]. This is referred to as 'deterrence theory' and was initially applied to the study of criminology, where individuals' performance of criminal acts was influenced by their fear and perceived risk of legal consequence [46] [48].

For deterrence to occur, the criminal must both perceive a threat of legal punishment for a criminal act, and also fear the associated specific punishment [49]. With adolescents in particular, there are complex mediating variables that influence their *perception* of the actual risk of consequence that may influence their willingness to participate in risky behaviour, something that the same individual might not be willing to participate in a decade later [50]. A mediating variable is defined as a variable that occurs in a causal pathway from an independent to a dependent variable, whereas a moderating variable is a variable (often pre-existing) that is not causally linked to the independent variable and yet remains causally linked to the dependent variable [51]. An example of a mediating variable in adolescent risk-taking behaviour would be peer exposure, while an example of a moderating variable would be individual personality. In order to be able to understand the success of any program geared towards modification of adolescent behaviour, it is important to understand the common theories regarding behavioural development, with their mediator and moderator variables, as well as take into account common theories of adolescent behaviour. Overviews of both deterrence theory and adolescent risk-taking behavioural theory are provided below. These descriptions are provided in order to put the program evaluation's results within an appropriate context. As a result, they are summaries rather than exhaustive presentations of these complex theories. This background is also intended to provide the reader with an understanding of potential pitfalls for programs aimed at influencing behaviour in adolescents, and potential reasons that outcomes for adolescents may differ from what might otherwise be expected from classic deterrence theory teaching.

2.2 Deterrence Theory

The classical form of deterrence theory refers to deterrence theory as originally defined and utilized in the literature, which describes that the effectiveness of any threat of punishment for contravention is related to the target audience's perception that the punishment will be certain, severe and swift [52] [46] [47]. This comes as an extension of the classical criminology theory, where man is described as 'fundamentally hedonistic', such that the characteristics of deterrence determine whether or not man engages in criminal acts [53]. Additionally, it is believed that "delivery of a re-enforcer increases the probability of a particular behaviour, whereas the delivery of a punishment decreases the probability of that behaviour" [54]. As such, the individual's perception of that punishment is more important than the actual punishment itself, and consequently one would expect that the deterrence with have differential impacts on individuals based on their unique perceptions of punishment. This theory is valid provided that the fines and punishments are imposed as stated, so that consequence follows contravention [55], which relates to the 'sureness' of punishment.

There have been two types of deterrence described, which need to be considered individually: specific and general deterrence [46] [56]. Specific deterrence is defined as the process by which a person has been deterred from re-offending a particular violation due directly to the punishment received at the first offence or from personal experience with punishment avoidance or enforcement [46]. General deterrence on the other hand, is defined as the process by which the general population of potential offenders who have not been punished are deterred from performing particular acts as a result of threats of sanctions having been applied to other offenders for the same violation [46]. As such, the general deterrence theory states that "punishment given to criminal offenders will deter other members of society from offending" [54].

Most of the research applying deterrence theory to road safety has been in the study of drinking and driving. For example, the specific deterrence effect has been demonstrated with the application of swift and certain punishment, but less-so with threats of punishment of increased severity alone [57] [47] [58]. In contrast to specific deterrence research, more as been done with general deterrence in road safety, where the most effective programs ensured swift and certain punishments for violations, with the primary aim directed at increasing the perception of risk of apprehension for violators [46] [59].

An example of the influence of deterrence theory in the setting of a program evaluation is the evaluation of the 'Breathalyser Law' of 1969, which criminalized impaired driving with a blood alcohol limit greater than 0.08%. Researchers found a sustained 18% reduction in drinking-associated fatalities following the law's implementation [60]. Presumably, those who refrained from drinking and driving as a direct result of the law's implementation were extrinsically motivated by the deterrence effect to change their behaviour, rather than those already refraining from drinking and driving who are intrinsically motivated to do so (influenced by factors such as individual risk-taking behaviour, social norms and moral character). It is speculated that those who risked punishment did not perceive a real risk of being caught or that the conditions might not be enforced.

Critics of the deterrence theory have argued that the theory is based on the individual's perception of risk of punishment and that the development of research tools to assess individual risk perception has been lacking [61]. Additionally, it has been argued that research into this theory fails to address statutory (legislated) punishment versus actual (the potentially reduced sanction actually applied) punishment [61]. Unfortunately, most of the research on deterrence has been performed in the criminology literature using crime rates as the outcomes of interest, which are not accurate reflections of crime but rather of capture [61]. Additionally, it has been argued that classical deterrence theory on its own is too narrow in scope, addressing only fear of perceived punishment, and not many other factors that can influence social behaviour [47]. These are non-legal (or extra-legal) sanctions that can influence social and criminal behaviour, including self image, peer support, moral commitment, opportunity for crime, impulsive or compulsive behaviour among recidivists, social stigma associated with criminal activity and differential association with like-minded criminals [61] [47]. Researchers of traffic theory have also expressed concern that the implementation of any intervention is often accompanied by an initial reduction in contravention behaviour, but that over time these reductions return to pre-intervention levels (referred to as 'regression to the mean' [62] [59] This is believed to represent awareness by the target audience that the publicized certainty of punishment is greatly exaggerated, and as such deterrence effects are lost with repeated measures or analysis [62].

The hypothesized effectiveness of the GLS is based on general deterrence theory, such that fines and punishments imposed for contraventions of GLS restrictions are believed to be sufficient to deter young drivers from engaging in any such violations [63]. Consequently, program success is critically dependent upon young drivers' knowledge that these punishments exist and will be implemented. Again, for optimal deterrence according to deterrence theory, the consequences of contravention of this program must be perceived as sure, swift and severe [52] [46] [59] [1].

2.3 Social Learning Theory

Concurrent with research surrounding criminal deterrence theory, behavioural theorists such as Bandura and Akers developed theories of behavioural principles based on reciprocal relationships among behaviour, cognition and social environment [64], and described this under the general term of 'social learning theory' [65] [64]. Akers' social learning theory sought to describe the general social setting in which all behaviours occurred, and the mechanisms by which they were either rewarded or punished [48]. According to this theory, deterrence is not only a criminal theory model, but part of this larger social learning theory, incorporating some of the elements not considered by the classical deterrence theory (such as extra-legal factors described above) [48]. There are two components of social learning theory that merit particular attention in this thesis: differential association and differential reinforcement. Learning through association can be applied to general deterrence theory. Social behaviour in general is felt by Akers to be learned directly from differential association-reinforcement or indirectly from imitation of the behaviour of others with social influence [56]. As such, differential association, differential reinforcement and imitation became three of the four major components of Akers' social learning theory [56]. The fourth component of Akers' social learning theory is that of an individual's attitude toward any particular behaviour [56], which will not be discussed further in this thesis, as it is felt to be already represented by other variables within biopsychosocial behaviour development models (such as personal values), rather than being unique to deterrence theory.

Differential association can be described as the type of interaction between a person and others with whom he or she interacts, such that particular social behaviours are accepted or expected and thus reinforced by some of the persons with whom he or she interacts, while other behaviours are denounced – the degree of influence from each of these depends on the amount of social influence exerted by this person [56]. This influences the choice of persons with whom each of us maintains social interactions.

Differential reinforcement is described as the interplay between 'reinforcement' or reward of particular behaviours and 'punishment' or deterrence of other behaviours [56]. It is thought that in the balance of these inputs, an individual will seek to preferentially engage in reinforcing behaviour rather than punishing behaviour. In contrast, imitation is the mechanism by which individuals model their behaviour after someone in their social sphere of influence [56].

Differential association, differential reinforcement and imitation are components of social learning theory that are not specifically addressed in general deterrence theory, and can be considered as some of the extra-legal factors mentioned above. The incorporation of these components in behavioural analysis could help to predict whether an individual would engage in illicit behaviour [48]. As such, Akers' social learning theory seems to advance the understanding of complex social behaviour regarding illicit activity, beyond the simple constructs of deterrence theory, based on punishment avoidance in the setting of fear of swift, sure and severe punishment for criminal behaviour. It incorporates social interactions and the influence of peers, family and social groups on an individual's behaviour, based on the factors described above. The limitation of this theory in the understanding of *adolescent* high risk behaviour is that the theory is not developed for adolescents in particular.

2.4 Adolescent Risk-Taking Behaviour Theory

Understanding the complex social factors that moderate behaviour in adolescents can be difficult, and may explain why many intervention programs built on sound behavioural theories fail to impact adolescent behaviour in particular, such as traditional smoking cessation education programs [66] and drinking and driving programs [67]. It has become evident that adolescent behaviour is affected by a broad range of social factors, including family relationship deficiencies, community and school climates and peer relationships [68]. Peer groups offer acceptance and identity for developing adolescents, but they also promote social norms regarding values and behaviours, which in the absence of firmly rooted family values and relationships, can determine adolescent behavioural choices [69]. This is particularly true in the North American culture, where the influence of family is often supplanted for 'extended family', meaning neighbourhood groups, peers and other social circles [69]. For this reason, cross-sectional studies such as pre-and post- intervention analyses are insufficient in studying adolescent behaviours as they do not address the context in which the intervention is being received. As such, program evaluations are unable to detect where the program has failed in achieving its outcome of interest.

The reason for the over-representation of adolescents in motor vehicle collisions and injuries seems to be related to their engagement in risky behaviour relative to older drivers [70]. Adolescence is a volatile time of transition from childhood to adulthood, requiring the development of self-identity and independence. Risk-taking behaviour is necessary at certain stages of adolescent maturation as a normative process, but when not balanced with maturation and protective factors, can become detrimental [68].

The adolescent is a unique entity, where peer pressure drives behaviour that may or may not be culturally or socially accepted. The adolescent may be unable to balance perceived risks and benefits accurately, as lack of maturity can cause the adolescent to underestimate the negative consequences that may accompany the behaviour, perpetuating a "beat the odds" mentality [71] [72]. Only once the maturation of adolescence has occurred, does the idea of 'deterrence for risk of negative social implication' come into play (for example, refraining from drinking and driving in order to avoid injury to self and others) [71]. For this reason, imposing and enforcing driving restrictions on young adolescents may not be as effective as they are designed to be. Adolescents must believe that the program has value for them, that the negative consequences are not desirable, and that the punishment for contravention is swift, sure and severe [53]. The effectiveness of any deterrence program can only be enhanced if the 'negative' consequences are also deemed 'negative' by the target audience. This idea has encouraged a number of schools to participate in a number of intervention programs designed to demonstrate the very real consequences of restriction contravention [73].

Risk taking behaviours have been defined in traffic research as being a deliberate set of behaviours with a high likelihood of negative outcome, similar to 'thrill seeking' [70], rather than unintended exposure to risk. Since many risk-taking behaviours co-exist, it is difficult to know if they occur simultaneously or in sequence (such that one or more risk behaviours might appear early on in adolescence, making risk-taking adolescents identifiable at an earlier age [71]). Although this idea is appealing to researchers given the complexity of adolescent behavioural theories, the findings of research to date seem to suggest instead that there are a number of inter-related factors that increase the likelihood of risk-taking behavioural development: young age at initiation of any risk behaviours (or exposure to risk behaviours of peers), low self expectations for education performance, general social behaviour (such as conduct disorder), peer influence (peers already engaging in risky behaviours), authoritative or permissive parenting influences (lack of closeness with family) and neighbourhood influences (high-density urban, poor neighbourhoods with high minority populations) [71]. These factors represent individual, familial, peer and community influences, all inter-related to determine which adolescents will be at greatest risk of considering and engaging in high-risk adolescent behaviour.

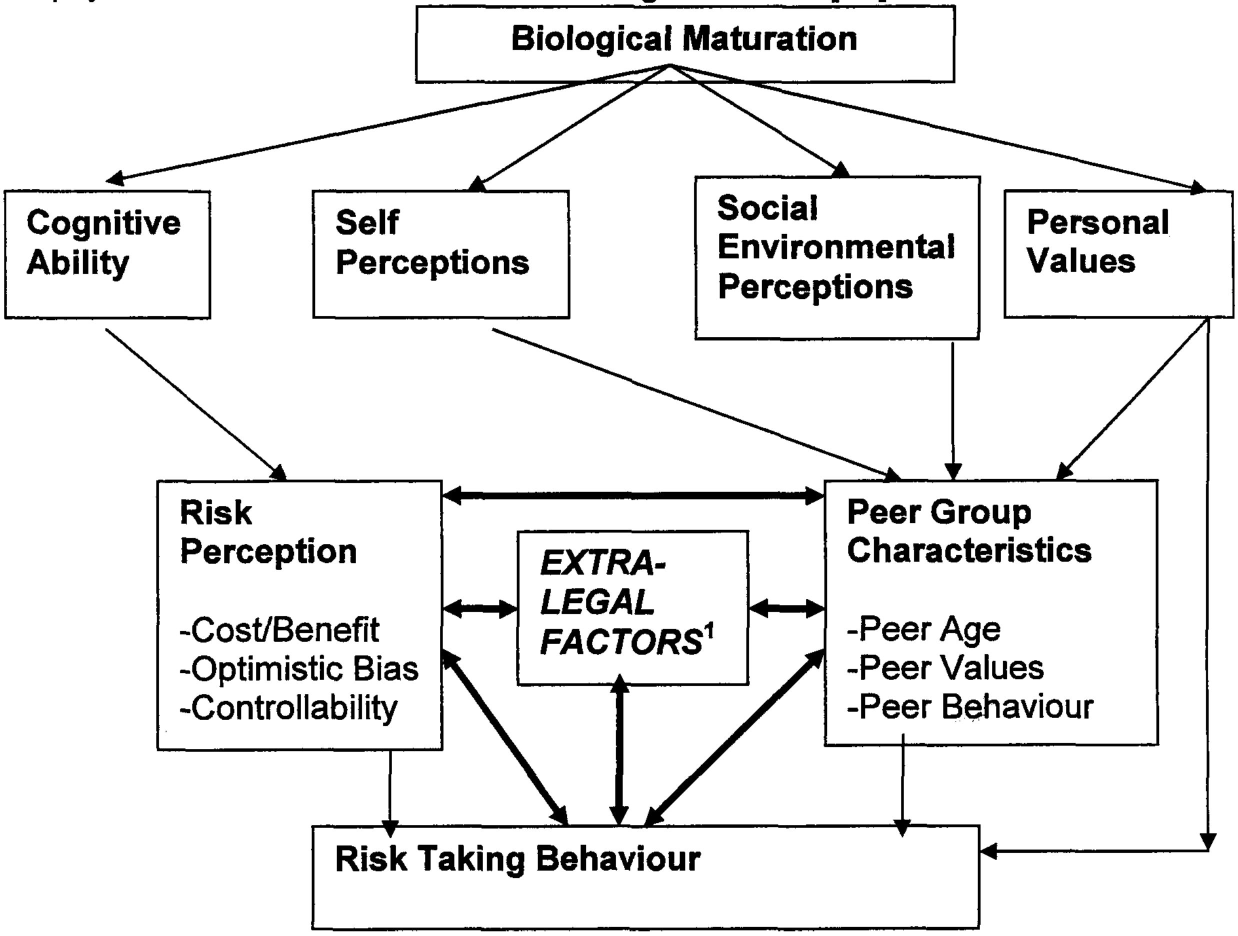
The clustering of risky driving behaviours (impaired driving, driving without seatbelts and speeding) prompted researchers to coin the term *'problem behaviour syndrome'*, based on Jessor's Problem Behaviour Theory [74]. This theory postulates three areas of psychosocial influence on the adolescent: the Personality System (low self-esteem, less religiosity, tolerance of deviance, high independence), the Perceived Environment System (perceived social norms and expectations, and exposure to sanctions) and the Behaviour System (drug use and sexual involvement, general deviant behaviour). Within each of these systems, there are a number of variables that are either precipitating or protective for problem behaviour involvement [74]. Researchers termed the *'problem behaviour* syndrome' as a syndrome with the notion that these inter-related behaviour risks (social, psychological and behavioural) actually represent a lifestyle of characteristics where normative behaviour regresses into reckless behaviour of adolescence, which is significantly related to risk of traffic collisions and injuries among adolescent drivers [70].

As an extension of this original theory by Jessor [74], Irwin & Millstein [75] developed a biopsychosocial model that suggests the primary predictor of behavioural outcome is the adolescent's biological maturation. This in turn affects the adolescent's cognitive ability, self-perceptions, personal values (such as independence and achievement goals) as well as the social and environmental contexts (and the individual's perceptions of the same). All of these in turn also influence the adolescent's own risk perceptions of any given behaviour engagement as well as their peer group characteristics, both of which ultimately determine their level of risk-taking behaviour [75] (see Figure 2.1). Others later expanded on predisposing factors (endogenous ones such as immaturity, depression, hormonal or gender effects, and exogenous ones such as school failure or poverty) and protective factors for this model (endogenous ones such as valued achievement, religiosity, and exogenous ones such as intact family/authoritative parenting), the sum of which ultimately determine likelihood of risk-taking behaviour by the adolescent [76].

Although there are a number of other models (such as other biopsychosocial and intersecting social ecosystem models) attempting to explain adolescent behaviour development [77] [68] [78], none incorporates the factors explaining deviant behaviour risk as well as Irwin & Millstein's model (see Figure 2.1), and for this reason, this discussion focuses on this model, recognizing that a great deal of research and numerous models have been published in this field.

Given that Akers' social learning theory identified social behaviour development factors particularly relevant to deviant behaviour development which were not addressed specifically in Irwin and Millstein's model, Figure 2.1 was modified by the author of this thesis to incorporate the influence of 'extra-legal factors' identified in the social learning theory (see Section 2.3) and to develop a new model based on the amalgamation of the Irwin & Millstein adolescent risk taking behaviour development theory and Akers' social learning and criminal development theory. The influence of extra-legal factors, differential association and differential reinforcement as well as imitation were all incorporated in the model (each represented by bolded arrows as described in Figure 2.1 legend) in an attempt to develop the most comprehensive model of risk-taking behaviour development among adolescents.

Figure 2.1. Model of adolescent risk-taking behavour development based on biopsychosocial causal model of risk-taking behaviour [75].



[1]The influence of 'extra-legal factors' [47] was added by the author of this thesis, and refers to the factors of social learning which are not addressed in classic general deterrence theory, specifically differential association, differential reinforcement and imitation. The relationships between extra-legal factors on risk perception and peer group characteristics and their collective reciprocal relationships with risk-taking behaviour (bolded arrows) were also likewise added based on Akers' social learning theory [56], where the relationship within risk-taking behaviours can be attributed to differential reinforcement, while the relationship between risk-taking behaviour and peer group characteristics as well as between peer group characteristics and risk perception can be attributed to differential association and imitation. The non-bolded arrows represent relationships between what one could term 'legal factors', or factors which are part of the biopsychosocial model of risk-taking behaviour for adolescents.

2.5 Summary

It is clear from Figure 2.1 that the inter-relationships of factors contributing to a decay from normative adolescent behaviour development to deviant high-risk behaviour development are quite complex. It would be next to impossible to address each of these comprehensively when undertaking a program evaluation analysis aimed at understanding the program's success or failure in influencing high risk behaviour among adolescents, such as GLS or other road safety initiatives, and would be beyond the scope of this project proposal.

Knowledge regarding existing models of adolescent behaviour is useful in this program evaluation for the purposes of contextual interpretation of the study findings, such that any discrepancies between the implementation of the program being evaluated (GLS) and the outcome in question (collision and injury rates) can be discussed within the context of risks and protective factors aimed at deviant adolescent behaviour. This also provides potential targets for program improvements in future studies, with the hopes of yielding successful behavioural interventions. This is especially true for components of intervention programs where the links between variables (such as the link between the adolescent knowledge of the program being evaluated and the resultant behaviour) may seem to be causally related, and yet there is clearly a more complex relationship with numerous influencing factors, leaving researchers to wonder 'why don't adolescents do what they know they should do, or what is good for them?'.

This proposed GLS program evaluation will represent the first comprehensive GLS program evaluation with a comprehensive conceptual framework in the literature to date. The adolescent behaviour theory and deterrence theory reviews with the conceptual biopsychosocial model outlined in Figure 2.1 are intended to allow for interpretation of the research outcomes from this proposal, in order to gain a more complete understanding of any successes or failures discovered by the evaluation. Understanding the variables driving adolescent behaviour and the premise upon which various programs were developed is useful for interpreting reasons behind any program's inability to influence adolescent behaviour, providing a rich discussion regarding the program as it exists, rather than the intended program's outcomes. Any discrepancy between the intended outcome of the program and the true outcome should cause program implementers to re-evaluate the actual and perceived enforcement (by punishment) of the program on the targeted cohort. While the evaluation of all behavioural variables defined in Figure 2.1 is limited by data available from sources utilized for this project proposal, the modified biopsychosocial model will be useful for researchers in future studies to identify the characteristics of adolescents engaging in deviant behaviour as well as of recidivists, against which different targeted programs could be developed in the future.

CHAPTER THREE – EXPANDED REVIEW OF PROGRAM EVALUATION AND CAUSAL MODELLING THEORY

3.1 Introduction

Program evaluation is a methodological tool whereby various statistical methods are used to evaluate the impact of a program of interest on an outcome of interest. Traditionally, only the intervention and the outcome were measured, and the impact observed was assumed to be causal [79], however health outcomes researchers have been increasingly expanding this research field to develop 'cause-and-effect links' in the form of a number of steps, each linked to the next, so that at the completion of the model, the intervention effect can with confidence be causally linked to the outcome being measured [79] [2] [1].

3.2 The 'Black Box Paradigm'

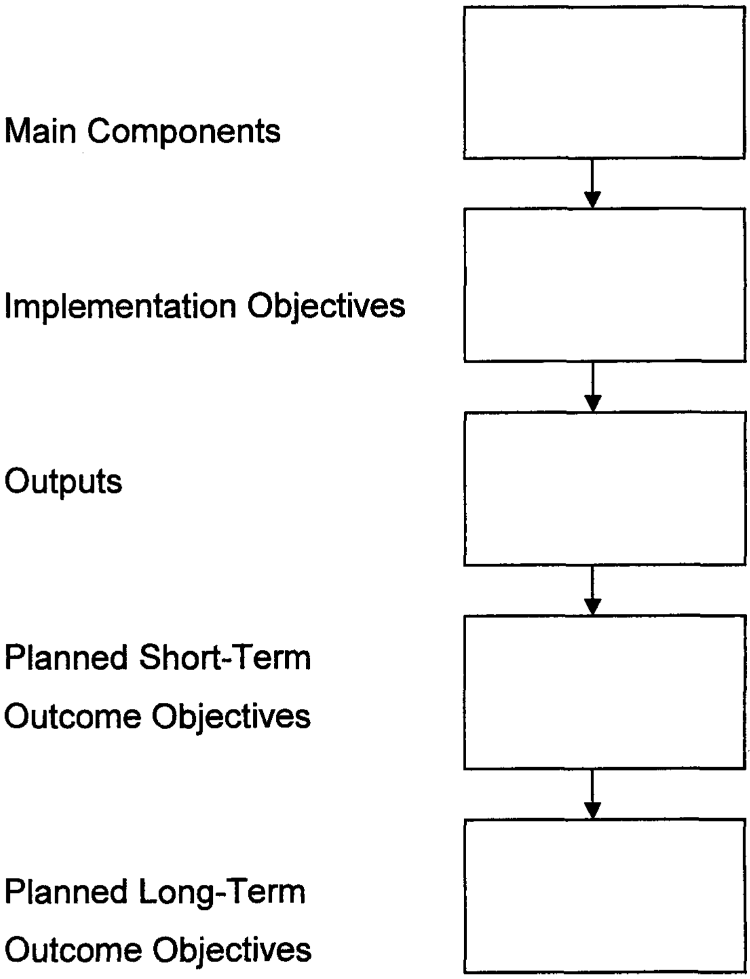
The 'black box paradigm' was first described as the method-oriented evaluation that lacked a theory-driven approach, and as such was characterized as being focussed on the overall relationship between inputs and outputs of an intervention without understanding the causal links lying in between [79]. This has been a long-standing feature of most health services evaluations to date [1], however the interpretation of the information produced by these evaluations lacks validity. The use of a theoretical causal model to explain why changes in outcome might be expected as a result of an intervention is a research tool that has been demonstrated to not only enhance the validity of the research, but also to provide a comprehensive model by which stakeholders can understand the program evaluation methodology as well as be able to put the evaluation's findings into context [80] [2] [81] [1].

3.3 Theory Behind Causal Model Building

A program evaluation should seek to understand why an intervention is likely to achieve its hypothesized goals [2]. The key to program evaluation is to eliminate rival hypotheses that could explain the relationship between the program in question and the desired outcome (ideally data exist in order to test all elucidated rival hypotheses). There are three fundamental requirements for causal inference: the cause must precede the effect, the cause and effect must be correlated and there must be no known rival hypotheses [82]. When a program logic model, or causal model, is developed, each step is causally linked to the preceding step, such that when all steps involved in the program are accounted for, the link between the implementation of the program and the desired outcome can be demonstrated to be causal (Figure 3.1). Rather than testing a one-step model then, the investigators create a complex chain of causal linkages among all the variables involved between the intervention and the outcome of interest [2], within the context of the theory behind the program being evaluated. This can be contrasted to the "Black Box Paradigm", where the pre-test assumption exists that the intervention causes the outcome, and consequently only the outcome is measured. The intervening or mediating variables are all assumed to be in existence and functioning as hypothesized, but are never tested, and any moderating variables are not identified. This 'black box' approach becomes flawed when the desired outcome is not achieved by a particular program, and it becomes impossible to determine whether it was the entire program that failed to achieve the outcome, or whether a particular intervening variable involved did not achieve its goals [1].

Figure 3.1

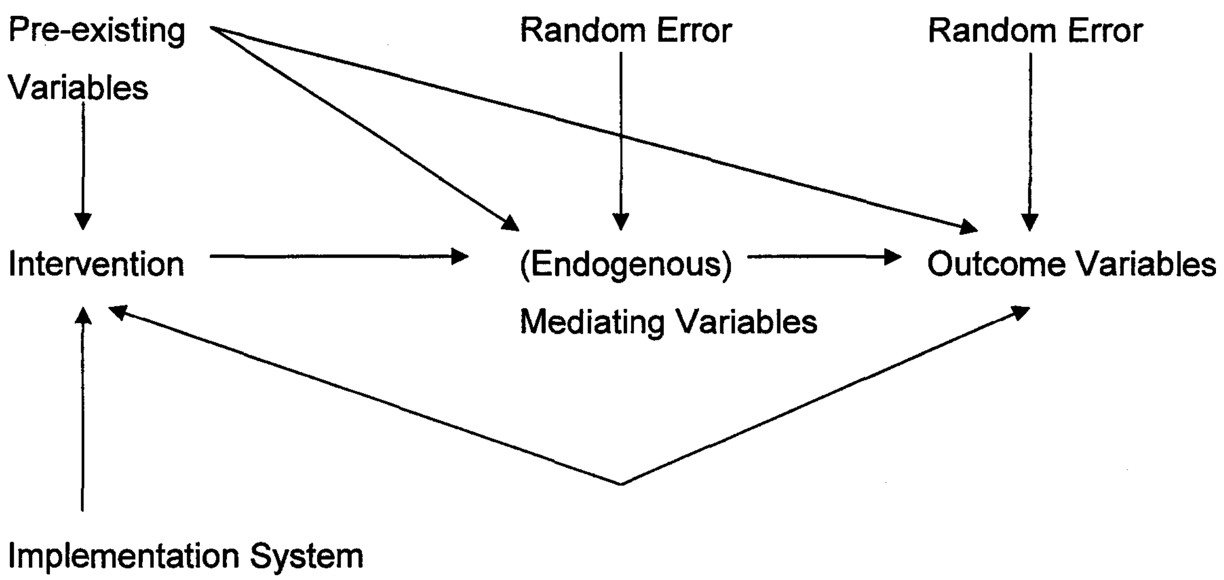
Program Logic Models for Program Planning and Evaluation [83][1].



[1]This schematic outlines a generic sequence of mediating variables between program inputs and outputs to be considered when building a conceptual framework for program evaluations.

Figure 3.2

Representation of Generic Causal Model. [79][1].



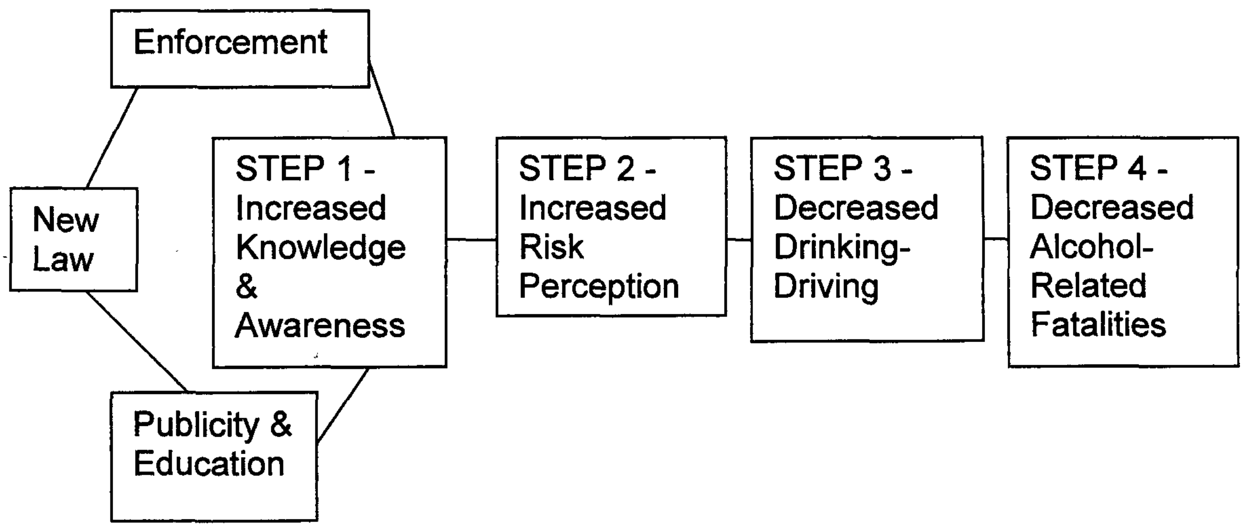
[1]This schematic outlines a framework for causal model building, where multiple variables are seen to influence the outcome under evaluation, including causally linked mediating intervening variables as well as undefined exogenous variables. These can often only be defined as random error in the analyses of such program evaluations as these exogenous variables can be difficult to define, and more difficult to capture and evaluate.

For all program evaluations, Figure 3.2 demonstrates the theoretical framework upon which individual causal models can be developed [80] [79] [84] [1]. Between the intervention and the outcome of interest, as many mediating variables exist as are believed to be part of the causal link of events based on knowledge of the program's target group, or the nature of the intervention being tested. At each point, a certain amount of random error could exist, and any extraneous findings may also be attributed to pre-existing variables (also classed as moderating exogenous variables). This model demonstrates that there are complex relationships between a number of potential sources that could impact the final outcomes of interest, and that each of these need to be addressed in a comprehensive evaluation, in order to be confident in the interpretation of the program's evaluation. This is particularly true when describing interventions in adolescent behaviour, which are affected by a number of complex social influences. Causal models have been commonly applied to road safety interventions [59] and are useful models for program planning and evaluation [83]. An example of this is seen in the program evaluation for Ontario's 12 hour administrative driving suspension law (Figure 3.3) [59].

A comprehensive program analysis of any program whose targeted cohort is the adolescent must therefore include contextual analyses such as focus groups, in order to provide an understanding of the program's perceived successes or failures based on the analysis. Specifically, programs such as Graduated Licensing, where the program's success is critically dependent upon its deterrent impact on adolescent behaviour due to fear of negative consequence, must evaluate whether this premise is founded in the adolescent social world. The causal model designed for this program evaluation was created using the base model for causal modelling of program evaluation as outlined by Vingilis and collegues [1]. This base model has been tested by numerous peer reviewed program evaluations [59] [1] (Figure 3.2).

Figure 3.3

Evaluation of effectiveness of Ontario's 12 hour Administrative Driving Suspension Law [59][1].



[1]This causal model created by Vingilis and colleagues demonstrates a model based on a conceptual framework designed to evaluate the impact of the implementation of the 12 hour administrative driving suspension law on driving-related fatalities in Ontario. The causal links between individual perception and knowledge and their influence on behaviour were links incorporated into this thesis' GLS program evaluation proposal.

3.4 Introduction of Causal Model For Graduated Licensing System

Figure 3.4 represents a causal model in its entirety, developed for this thesis and designed to permit an impact evaluation of the Graduated Licensing Program. The theoretical causal model suggests four sources of potential causal impact on the final outcomes of interest [1]: exogenous or moderating variables, implementation system (the program itself), endogenous or mediating variables and random error (Figure 3.2). The implementation and endogenous variables can be tested, while allowing for an acceptable level of random error. If the causal model is correctly developed, then any discrepancy between the expected program outcome and the resultant outcome can be attributed to the untested exogenous variables (in this case representing factors influencing adolescent behaviour such as peer pressure, other concurrent programs influencing adolescent behaviour, historical changes in the outcome as a consequence of time, etc) or to random error not otherwise specified.

The following chapters will outline each causal step in the model one by one, along with the proposed methodology for evaluating that step. The model was developed using a similar framework as seen in Figure 3.3, where the assessment of knowledge and perception/enforcement of the program are the first two steps in the program. There is clear support in the literature to justify the need to evaluate the enforcement of the program by police and the perceptions of the program by students based on evidence that most young drivers contravene the restrictions of such programs [41] [85]. Support in the literature for the causal link between program enforcement and knowledge acquisition is provided by other program evaluations which demonstrated varying levels of knowledge acquisition based on different methods of knowledge dissemination, and must be evaluated before presuming its existence in the evaluation of resultant behaviour [8] [9] [1]. The causal link between knowledge and behaviour is supported by other program evaluations and additionally by our understanding of knowledge of normative behavioural expectations as one key factor influencing adolescent behaviour (see Chapter 2) [59] [24] [75]. The final links between young driver behaviour and both collision counts and injury counts are straight forward measures of behavioural outcomes, as seen in other program evaluations [59], and represent the tangible measures of successful behavioural modification by GLS upon young drivers. Once each causal link has been established, it will then be possible to describe the causal relationship between the implementation of the program in question and the outcomes of interest. The evaluation of GLS using this causal model is the purpose of this study, and will be completed using a mixed methodology approach, incorporating specific analyses including multiple logistic regression, time series methodology of two administrative data sources, as well as quantitative Student's T-test methodology in a combination of survey data, and qualitative analysis of focus group data.

This study proposes to link our current understanding of driving behaviour among young novice drivers to an accepted conceptual framework of social deterrence theory relating to adolescent high-risk driving behaviour, in order to understand in detail all potential variables involved in producing the undesirable outcomes of interest (injuries and deaths among young novice drivers in Ontario). At each intervening variable in the conceptual framework, our model will utilize available or surrogate measures from a variety of data sources in an effort to qualify or quantify the influences of each on the final outcome of interest. This will help to validate our proposed model, which could then be used for the purposes of evaluating GLS programs in other jurisdictions.

3.5 Potential Threats to Internal Validity

In evaluation methodology, validity threats are key factors to identify [82]. Threats to internal validity refer to non-causal assumptions made in the design of the program logic model, and include the following potential threats to internal validity for this particular program evaluation:

(i) History (the presence of unknown concurrent confounders, or exogenous variables not controlled for in the concurrent control groups in another age cohort, such as environmental or legislative changes)
(ii) Testing (the possibility of an effect of pre-test on post-test results, in the knowledge survey)
iii) Statistical regression to the mean (that the influence of GLS on collision and injury rates may only be observed for a few years following its implementation- for this reason, 5 years of data post-GLS implementation were selected, in an effort of uncover this, if it exists)
(iv) Maturation (that the delay in getting a driver's licence due to GLS policy means that applicants for full licence are older and thus potentially more mature as the sole factor influencing changes in collision and injury rates).

The effect of history is controlled for by concurrent controls in the data analysis stage, hopefully for unknown exogenous variables as well as known ones. The effect of maturation is not really considered a potential threat to internal validity in this example, although it is included as one in the theory of threats to validity. It may not be so in this particular program evaluation for the simple reason that it is a desired effect of the program, and may be the important mechanism by which the program gains most of its success.

3.6 Potential Threats to External Validity

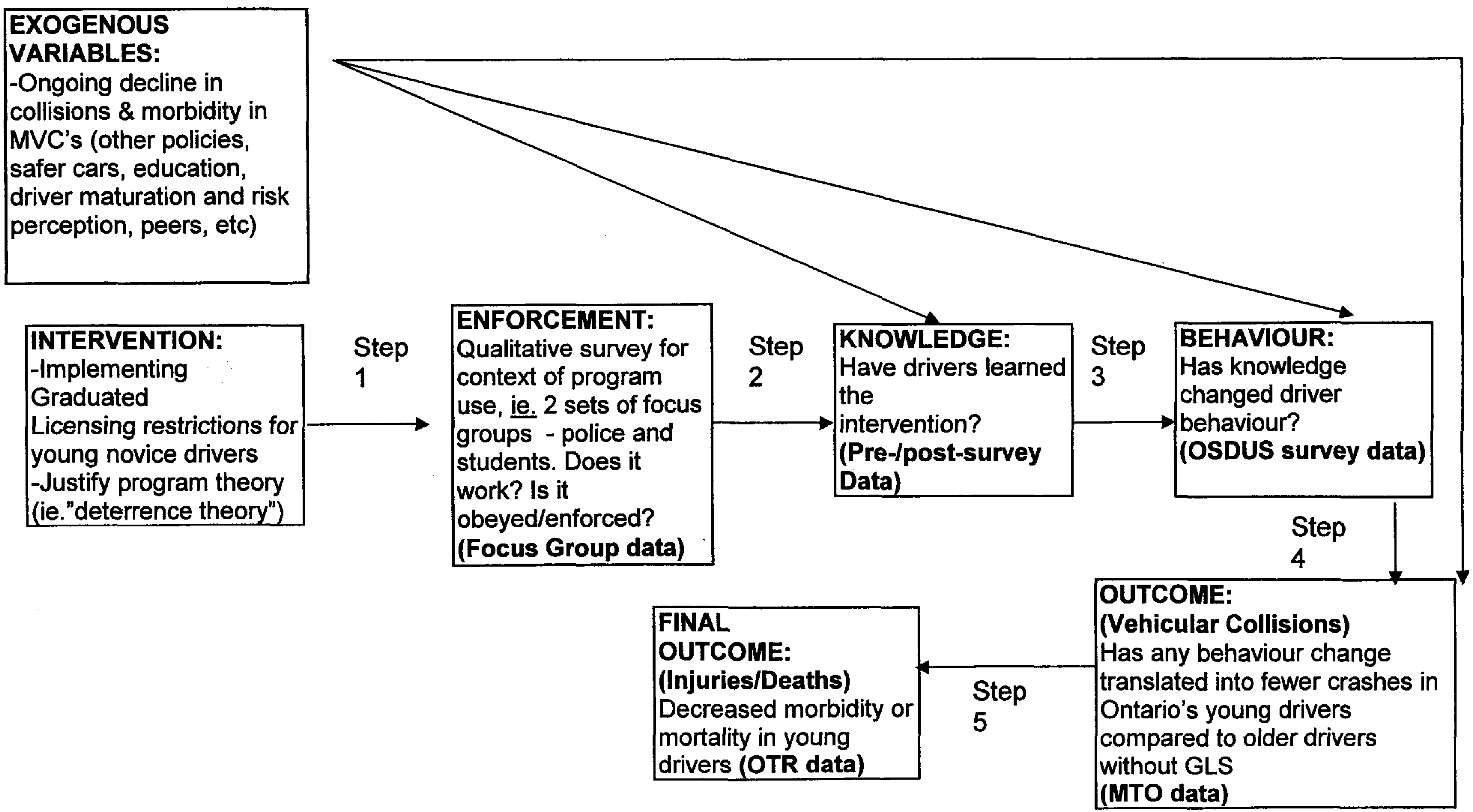
Potential threats to external validity refer to methodology details of the program evaluation which could affect its generalizability. For this particular program, the potential threats to external validity are mainly limited to one: multiple program interference. There are always a number of educational and behaviour modification programs in play, in an effort to increase driver safety. These include MADD, drivers' education courses, administrative drivers' licence suspension laws and other student programs. If any of these is felt to potentially have a great influence on the outcome of interest, they are best managed by being incorporated into the analysis, as would be done for the driver suspension laws into the Time Series Analysis, in addition to the use of concurrent controls, namely older drivers in the same province who would not have been exposed to the GLS program, but who presumably are equally exposed to other exogenous variables. In this manner, this is not felt to represent a significant threat to this program evaluation.

3.7 Strength of Causal Model Evaluation

Given that the design of this program evaluation is a causal model, it establishes causal links between the input (program of interest), any mediating variables, and the output (outcome of interest). This lends strength to this evaluation, and will be more informative in terms of determining the impact of the Graduated licensing program on young driver safety. This can be compared to the "Black Box Paradigm", referred to in the introduction of this program proposal, which evaluates only the input and output, and makes causal assumptions about all intervening and/or mediating variables, and does not address the issue of potential exogenous variables. Because this causal model cannot possibly test every potential exogenous variable for a confounding effect upon the outcome under evaluation, the results of this program evaluation will need to be interpreted in the context of findings from the qualitative analyses of young drivers and police officers as well as the theory behind high risk adolescent behaviour and deterrence theories outlined in Chapter 2.

FIGURE 3.4 : CAUSAL MODEL -

IMPACT EVALUATION OF GRADUATED LICENSING PROGRAM



CHAPTER FOUR – PROPOSED PROGRAM EVALUATION OF GRADUATED LICENSING IN ONTARIO

4.1 Introduction/Background Data

Despite numerous public education and prevention measures in traffic safety, young drivers continue to be over-represented among those injured or killed in motor vehicle collisions in Ontario [4]. Many public health initiatives resulted in an initial decline in morbidity and mortality for adolescents involved in motor vehicle collisions between 1980 to 1992 [7]. However, despite ongoing efforts, there has been very little impact made since then in the reduction of young driver collisions and injuries [7], with collisions representing 35% of deaths among adolescents aged 16-19 and 30% of deaths among adolescents aged 20-24 [5]. This prompted the Ontario Ministry of Transportation to adopt a Graduated Licensing System (GLS), first introduced in New Zealand in 1987 [18], and widely adopted over most US and Canadian states and provinces, as well as a number of European nations [16] [28] [32] [86] [18] [87] [88] [25]. Despite the widespread acceptance of this method of graduated exposure of young novice drivers to high risk driving situations (with variations on specific restrictions incorporated into the GLS for each jurisdiction (see Appendix 1)), there has never been a long-term comprehensive evaluation of the program's effectiveness. The various GLS program evaluations have mostly involved the comparison of collision rates one year prior and one year following GLS implementation [16] [28] [32] [86] [18] [87] [88], with the exception of New Zealand's long-term follow-up analysis, where the impact of GLS on collision rates was much less long-term than the interim analyses had suggested [18]. See Chapter One for a more complete overview of GLS program evaluations to date, and Chapter Two for a review of adolescent risk-taking behaviour theory and potential pitfalls of programs aimed at behaviour modification, with a summary of deterrence theory to justify the premise of GLS as based on general deterrence theory.

4.2 Project Rationale

This thesis proposes an evaluation of Ontario's GLS program using a causal program logic model [79] [59] (see Figure 3.4), where the program's implementation and the outcome variables of interest (collisions and injuries among young drivers in Ontario) are evaluated to determine whether they might be causally linked. Each step in the causal model will be evaluated using varied data sources, in a mixed methodology approach [3], allowing for the triangulation of data when available, such that there can be reasonable confidence that the outcome findings are causally related to the introduction of this program. This method is well established in program evaluation research [59] [79]. Using this method, this program evaluation will be able to overcome the 'black box paradigm' limitation of other GLS evaluations to date (see Chapter 3), where the outcome of a pre-post evaluation is presumed to be related to the program under study.

4.3 Objective

The primary objective of this proposal is to determine whether introduction of the GLS program has directly led to a reduction in collisions and injuries among young drivers in Ontario. The secondary objectives of this study are the evaluation of young driver and police officer perception of the program's implementation and effectiveness, self-reported young driver knowledge about the GLS restrictions and young driver behaviour regarding these during the G1 and G2 phases of their licensure, and hypothesis generation to justify the outcomes of the primary objective.

4.4 Hypothesis

The hypothesis of this program evaluation is that comprehensive evaluation by multi-method analyses will fail to demonstrate a statistically significant reduction in collisions and motor vehicle injuries among Ontario's young drivers as a direct result of GLS implementation. It is speculated that this finding will be attributed to a lack of significant change in young driver behaviour despite GLS introduction.

4.5 Research Questions

The research questions for this project are divided below into each of the five steps outlined in the program evaluation causal model outlined in Figure 3.4.

Step 1: What are the perceptions of GLS implementation among police officers enforcing this program? What are the perceptions of the GLS program among student drivers under this program? What is the risk perception surrounding contravention of GLS restrictions among young student drivers? What are the perceived strengths and weaknesses of components of this program?

Step 2: Can it be demonstrated that students acquired the knowledge regarding GLS and its restrictions once the program was implemented?

Step 3: Did introduction of this program result in a change in self-reported behaviour regarding contravention of GLS restrictions among young student drivers as representatives of young novice drivers in Ontario? Was this change in self-reported behaviour sustained over several years after the program's implementation?

Step 4: Was there a reduction in collisions among young drivers in Ontario as a direct result of introduction of the GLS program? Which subgroup of drivers demonstrated a sustained reduction in collision rates?

Step 5: Was there a reduction in injuries resulting from motor vehicle collisions among young persons in Ontario as a direct result of introduction of the GLS program?

4.6 Project Design

Figure 3.4 outlines a causal program logic model designed for this proposal to evaluate Ontario's GLS program comprehensively. This study is the first to address the evaluation of any GLS using a comprehensive evaluation tool [10] [23], allowing for the assessment of related issues such as young driver knowledge acquisition and compliance to its restrictions. Additionally, this is the first study to use multiple data sources to address whether the program has had its intended impact on both collision rates and injuries and fatalities among young drivers. The only other long-term evaluation of GLS was done in New Zealand [18], where the researchers were able to cross-link collision and injury databases, something that Canada has been reluctant to do for privacy and information protection reasons.

There are no publications to date using focus group methodology in order to elicit police and young driver impressions of the GLS, its implementation and its strengths and weaknesses, and no studies known to date having performed pre- and post-GLS surveys in order to obtain knowledge change as a result of the program's intervention. In this mixed methodology program evaluation, each step in the causal model will be evaluated using very different methods: qualitative focus group methodology to assess perceptions regarding program implementation and effectiveness, survey methodology to assess knowledge acquisition as a result of the program, and resultant behavioural change using multiple logistic regression analyses, and time series methodology to evaluate the impact of GLS on collision rates and injury rates for a number of young driver subgroups.

4.7 Development of Conceptual Framework

Chapter three outlined the rationale for use of causal program logic modelling as a conceptual framework for this GLS program evaluation. Other researchers have demonstrated similar models for program evaluations, outlining a number of mediating variables between the program's implementation and the program's outcomes of interest – namely, perception of program implementation, knowledge acquisition and behaviour [59] [1]. There is clear support in the literature to justify the need to evaluate the enforcement of the program by police and the perceptions of the program by students based on evidence that most young drivers contravene the restrictions of such programs [41] [85]. Support in the literature for the causal link between program enforcement and knowledge acquisition is provided by other program evaluations which demonstrated varying levels of knowledge acquisition based on different methods of knowledge dissemination, and must be evaluated before presuming its existence in the evaluation of resultant behaviour [8] [9] [1]. The causal link between knowledge and behaviour is supported by other program evaluations and additionally by our understanding of knowledge of normative behavioural expectations as one key factor influencing adolescent behaviour (see Chapter 2) [59] [24] [75]. The final links between young driver behaviour and both collision counts and injury counts are straight forward measures of behavioural outcomes, as seen in other program evaluations [59], and represent the tangible measures of successful behavioural modification by GLS upon young drivers. Once each causal link has been established, it will then be possible to describe the causal relationship between the implementation of the program in question and the outcomes of interest.

4.8 Project Feasibility

Demonstration of support for this project in the form of University of Western Ontario Research Ethics Board approval, letters of support outlining data provision for survey data analyses and the provision of administrative data from Ontario's Trauma Registry through the Canadian Institute of Health Information and the Ontario Ministry of Transportation is all provided in Appendix 2.The feasibility for conducting this comprehensive GLS evaluation is also demonstrated by the successful acquisition of required data in order to perform each of the analyses described in this thesis (see Appendix 3 for preliminary evaluation of collision and injury data for proposed time series analyses), as well as the pilot studies for focus group analysis (see Chapter 5) and survey data collection and analyses (see Chapter 6).

4.9 Analytical and Statistical Methodology

In order to evaluate the GLS program causal program logic model (see Figure 3.4) comprehensively, a mixed-methodology evaluation design is proposed utilizing both quantitative and qualitative methods [3] [1]. This approach will permit the triangulation of data from a variety of sources, wherever available, and methods in the setting of a conceptual causal framework [3]. This is important since there is no single data source that can address all variables within the proposed causal model. The analytical and statistical methodology is outlined below for each step in the five step causal program logic model introduced for this program evaluation in Chapter 3 (see Figure 3.4).

Step 1 – Program Intervention and Enforcement:

The first step in any program evaluation is to demonstrate that the intervention being evaluated is actually being implemented [1]. The intervention in this program, GLS, is a legislated policy incorporated into the Ontario Provincial Traffic Act in 1994, and as such the program intervention is not called into question. It is not possible to obtain a valid provincial driver's licence without going through the Ontario Ministry of Transportation, where the restrictions of the G1/G2/Full licence stepwise process are incorporated into their licensing policy for novice drivers. The question under study in this step of the evaluation is rather *how* the program is implemented, from a stakeholder perspective, including law enforcement officers and young drivers.

Qualitative focus group methodology, described extensively elsewhere as a qualitative research tool [89] [90]; (also outlined in further detail in Chapter 5) is proposed to assess whether the GLS program is implemented by police officers and whether it is perceived to be implemented by young novice drivers in Ontario. A pilot study has already been performed in order to demonstrate study feasibility for this component of the program evaluation (see Chapter Five for presentation of pilot data methodology and results). In order to explore this comprehensively, further focus group research is required, utilizing grounded theory [91], by conducting representative focus groups with varied police units throughout Ontario, including Northern Ontario, greater Toronto area, Southwestern Ontario, with urban and rural (Ontario Provincial Police) police units at each geographic site. The selection of specific police forces will be determined based on the largest police force within each geographic region described above, totaling six. Permission to conduct focus groups will be obtained from the Police Chief at each local police department, and the Chief will identify which uniform or patrol officers will participate in the focus groups. Police officers with no experience in issuing traffic tickets will not be included. Letters of information for participation will be provided in advance to the police officers identified. Based on the experience from the pilot data, police officers will not be offered financial remuneration for their participation.

Similarly, focus groups involving young novice drivers will be conducted by involving the largest school boards in each of the six geographic regions outlined above at the discretion of the local school boards. The principal investigator will request that each school board provide two possible schools from which at least two classrooms of grade 11-12 students could be identified for possible involvement. The teachers from each of these classrooms will be contacted, and will be provided with letters of information for their students and consent forms to be completed by their parents prior to involvement (see Appendix 4 for letter of information/consent forms). Any classroom size inequities between geographic regions will be balanced by involving more than two grade 11-12 students in those schools, in essence over-sampling the classroom units from smaller schools in order to balance total student numbers from each regions. Students willing to participate will be scheduled into focus groups with the principal investigator, involving approximately eight students per focus group, dividing female and male student drivers in order to minimize social inhibition in discussion. Questions asked to both police officer and male and female student drivers will include the same questions as those used for the pilot focus group sessions (see Chapter 5 and Appendix 5), except with the addition of baseline questioning of each participant at the beginning of the focus group, asking each about their peer group, and their perception of the influence of their peers' behaviour on their own. The focus group questions will then be presented in a semi-structured open-ended format. Focus groups will be conducted until saturation of all elucidated themes has occurred in accordance with qualitative Grounded Theory analysis [91]. It is speculated that 3-4 focus groups per cohort per region will be needed to fulfill this requirement. Further focus groups may be organized if there are a number of views and opinions which are elicited but not explored due to time or situational constraints, until all of the major themes surrounding enforcement and risk perception of the GLS program are identified. The focus groups will all be conducted locally for the cohort under study by the principal investigator with a research assistant present. The sessions will each be recorded with two voice-activated recording devices as well as notes regarding non-verbal communication recorded by the research assistant.

Qualitative data obtained from all focus groups will be transcribed *verbatim* by a transcriptionist familiar with focus group research, and data will be broken down and coded, with themes identified from focus group transcriptions manually, and confirmed internally by agreement with a research assistant who will attend and assist with the conduct of the focus groups. Individual themes identified will be developed based on coded data elements and subsequently grouped, with supporting illustrative quotes extracted from the transcriptions.

Step 2 – Young Student Driver Knowledge Acquisition

The second step in this program evaluation and a next step in many program evaluations is to demonstrate that the program which was implemented (see Step 1) actually has an impact on the knowledge of said program among the target recipients.

This portion of the analysis has been completed using the Centre for Addiction and Mental Health (CAMH) Mann et al. 1993 and 1995 surveys of young driver knowledge and behaviour, and is described in Chapter 5. The survey was conducted using grade 11 and 12 students from seven schools selected from two Ontario regions based on school board permission and consent from the students' parents (see Chapter 5 for survey methodology). Both the 1993 and 1995 surveys represent independent cross-sectional surveys of adolescent students of driving age as representatives of young drivers. A Knowledge Score was calculated using the survey results by summing the number of restrictions that the students correctly identified, out of a possible of nine true-false questions (four of which were true GLS G1 restrictions). The four correct restrictions comprising the Knowledge Score (out of four) were:

- must drive with licensed front passenger
- must not drive at night (12pm to 5am)
- must have zero blood alcohol content
- no 400-series highway driving

The mean knowledge scores, before and after GLS implementation, are compared for each age cohort, gender and licence types using an independent two-tailed Student's T-test (significance $\alpha=0.05$). This statistical method was selected given that mean knowledge scores for each pre-GLS and post-GLS cohorts were obtained from different student cohorts in 1993 and 1995 respectively.

This knowledge score will be obtained again in the definitive proposed study as part of the questions added to the Ontario Student Drug Use Survey (see Step 3 below).

Step 3 – Young Student Driver Behaviour

The third step of this program evaluation and the next reasonable step in most program evaluations is to evaluate whether the knowledge acquired as a result of implementing the program under evaluation (see Step 2) has had any impact upon the resultant behaviour among the program's target audience. The 2001 Ontario Student Drug Use Survey (OSDUS), Canada's longest ongoing school survey, was used for the pilot study component of this evaluation, and this biennial survey will continue to be used for the full study proposed for this program evaluation. Methodological details regarding this survey are described in Chapter 6, and the relevant survey questions are outlined in Appendix 6. The pilot study also evaluated self-reported young student behaviour in relation to contravention of GLS restrictions since its implementation in 1994 using the behavioural data from the CAMH Mann et al. 1995 survey. The relevant questions from this study are also outlined in Appendix 6.

Using CAMH's Mann et al. 1995 survey, a Behaviour Score, measuring contravention of the GLS restrictions, was created by summing the number of restrictions that the students admitted to contravening out of four in total: no 400-series highway driving, no driving between 12am-5am, no driving with licenced front passenger, zero blood alcohol content (BAC). The Behaviour Score was then collapsed to a dichotomous score to compare the proportion of students who received a perfect score (contravened zero of the possible four GLS restrictions) with those who self-reported having contravened at least one of the GLS restrictions. Simple and multiple logistic regression models were then developed to determine which covariates might influence the odds of contravening any of the four GLS, using covariates which are speculated to influence this outcome (see Conceptual Framework above), namely age, gender, licence type and post-GLS knowledge score. This analysis represented the pilot study portion of this analysis, the findings of which are outlined in Chapter Six.

Using the 2001 OSDUS survey data, the OSDUS Score was developed (representing the mean number of GLS conditions that the students self-reported having contravened at least once during the possession of their current licence type, which includes 5 possible contraventions for G1 licensees (no 400-series highway driving, no driving between 12am-5am, driving with licensed front passenger, zero blood alcohol content, only as many passengers as seatbelts) and 2 possible contraventions for G2 licensees (zero blood alcohol content and only as many passengers as seatbelts). A score was created by differentiating those who had never contravened any of the restrictions versus those who had contravened at least one of the contraventions listed for each licence type.

A surrogate measure of socioeconomic status (SES) was developed for this thesis using information obtained in the survey, based on types of questions used for other SES surrogate scores, such as the World Health Organization (WHO). The SES score was created by scoring the participant's mother's level of education, the participant's father's level of education, the number of vehicles owned by the participant's family, the number of computers owned by the participant's family and the self-reported level of family wealth by the participant. The total score was divided roughly into thirds in accordance with the frequency distribution of the score into three main groups. This was used as a covariate, in addition to other variables such as age and gender. See the methodology section of Chapter Six for further details.

Using this OSDUS 2001 survey data, simple and multiple regression models were then created for G1 and separately for G2 drivers, to determine which covariates (age, gender, SES) might significantly impact upon the odds of contravening at least one of the GLS restrictions.

Given the success in using the OSDUS survey data from 2001 for the pilot study, the questions regarding driver licence type and contravention of any of the G1 or G2 restrictions (see Appendix 6) will be added to the 2009 survey in order to have a comparator and measure of knowledge within the same survey source. The simple and multiple logistic regression models created for the 1995 Mann et al. data will be used for these data in order to explore which covariates influenced the odds of contravention of each of the GLS restrictions, and separate models will be created as were for the OSDUS portion of the pilot study to evaluate which covariates influenced the odds of contravention of any of the restrictions for both G1 and G2 drivers. Mean behaviour scores will also be compared using multiple analysis of variance methodology, to explore changes in behaviour score among these cross-sectional studies over time, adjusting for covariates speculated to influence the outcome (age, gender, licence type, knowledge score and SES).

Based on the model of adolescent risk-taking behaviour development outlined in Figure 2.1, the influence of other factors on behaviour will be explored in this survey portion of the definitive study outlined in this thesis, including questions asking students to estimate on their perception of the extent to which they are influenced by their peers and their peers' behaviour, and how often they have engaged in behaviour because of peer influence or in order to influence observing peers, as well as to estimate the extent to which they contravene their parents' rules, and how 'close' they describe their family nest. Additionally, specific questions regarding their perception of risk of apprehension with contravention of GLS will be added, asking students to rate the extent to which they feel that they could get caught if they contravened each of the five GLS G1/G2 restrictions based on their current licence type at the time of the survey completion. Finally, a question asking students about their perception of risk of apprehension with contravention after having been already caught by police will be added with the same format as above. The questions surrounding self-reporting the number of times they have been caught contravening any of the

GLS restrictions and what they were within the last 12 months of the current licence type will be added from the Mann et al. study to the OSDUS study. A question will also be added asking whether the charge was upheld and resulted in conviction, and what the resultant penalty was. In this fashion, the information gleaned about adolescent risk-taking behaviour development can be further explored within the confines of an existing and well-developed province-wide student survey. Given that these are new questions not previously explored by these surveys, this researcher will examine how these variables have been evaluated in other research fields, and will use this to refine the questions, the psychometric properties of which will then be validated using focus group methodology. As such, the final regression models exploring the predictive variables for GLS restriction contravention will include variables such as age, gender, extent of peer influence, extent of peer imitation, apprehension counts in 12 months, perception of risk, perception of risk post-apprehension (if appropriate), licence type, knowledge of restrictions, family relationship score (1-5), licence type at present, time in that licence type (in months), and SES. This will allow for the refining of the adolescent behaviour development model and for the development of an ultimate causal model including all of these explored variables.

<u>Step 4 – Impact of GLS on Collision Counts using Ministry of Transportation Data</u>

The fourth step in this program evaluation and the next reasonable step in most program evaluation models is to evaluate the impact of any behavioural changes (see Step 3) resulting from program implementation upon intermediate outcomes of interest, which in this case in represented by collision rates among young drivers in Ontario.

It has been suggested by researchers in the field of traffic safety, that observational before-after studies are flawed unless a time-series methodology is used [92], due to such seasonal fluctuations in repeated measures of road safety such as collision rates. Consequently, interrupted time series ARIMA (autoregressive integrated moving average) modelling will be used to determine the impact of the introduction of GLS on collision counts among young drivers, while adjusting for seasonal variability. ARIMA modelling is useful in the analysis of repeated measures over time, where the data points are time-dependent and autocorrelated. The advantage of this statistical methodology lies in its ability to smooth fluctuations in variance between data points and subsequently control for seasonal and non-seasonal autocorrelation in order to perform a regression-type analysis, since one statistical condition required for linear regression is the absence of autocorrelation between data points. Total counts (individual level data on each collision in Ontario from 1990-1999 inclusively have already been obtained from the Ontario Ministry of Transportation (MTO) (see Appendix 7 for MTO administrative database details)) were obtained all ages. Data subsets were then created based on age groups (16-19 years, 20-24 years and 30-34 years), creating age cohorts of young drivers exposed currently to GLS as well as those in the next age cohort having previously been exposed to the same program, and a third cohort having never been exposed to GLS since its introduction (functioning as a concurrent cohort in order to control for other programs affecting general road safety, such as improved vehicle and road engineering, air bags, public education programs etc. Further subsets were created based on the covariates of interest (see Table A5.1) in order to avoid non-seasonal covariate analysis complexities.

Collision rates will be calculated by dividing monthly collision counts by each age cohort's annual population counts provided by Statistics Canada [5] and presenting the data as monthly collision rates per 100,000 population, given that records of the total number of learner permits prior to GLS introduction were not kept by the Ontario Ministry of Transportation. According to the MTO, total G1 novice driver counts following GLS implementation were also unreliable, however this will be re-explored, as it would be more accurate to use the age-matched driving cohort as the rate denominator rather than estimates based on per population counts, if there is any opportunity to access this data. Otherwise, the above approach of per capita collision rates have been used in this field by other researchers [23] acknowledging that no method is without its limitations.

Statistical analysis of collision counts will be performed using the SAS statistical software package version 8.2 for the time series analysis using PROC ARIMA. In order to evaluate whether there are other exogenous variables potentially resulting in a reduced monthly collision rates over time, three dates felt to be important to the reporting of collisions will all be evaluated to assess their impact on collision rates using time series methodology[93] (personal communication, London Police Department 2006).

1. Introduction of graduated licensing program – April 1, 1994
2. Introduction of Administrative Drivers Licence Suspension for Drinking Drivers with Blood Alcohol Counts $\geq$ 0.08 mg/dl – November 29, 1996
3. Initiation of Police Department Accident Support Services (Self-Reporting Centres) for collisions with < $750.00 in property damage without personal injury – July 26, 1996

The graphical display of the relevant data subsets are presented in Appendix 3. The ARIMA model will be used to correct for seasonality, with the seasonality lag adjusted according to autocorrelation and partial autocorrelation plots (exploring variation within series) and cross-correlation plots (exploring interaction between intervention and series counts). Each series will be evaluated using both 'step impact without delay' and 'ramp effect without delay' since we know the implementation of the program was immediate on April 1, 1994 but the effect could have been immediate or gradual. There were 3.4 million collisions from 1990-1999 in Ontario alone across all age groups (see Table A5.1). Adjustments will be made for the degree of non-seasonal and seasonal differencing (represented by symbols 'd' and 'D' respectively), the order of the non-seasonal and seasonal moving-average (represented by symbols 'p' and 'P' respectively) and non-seasonal and seasonal auto-regressive processes (represented by symbols 'q' and 'Q' respectively to develop the best-fit model represented as ARIMA(p,d,q)(P,D,Q) [94]. At the completion of each model development, the data residuals will be examined to ensure no remaining autocorrelation patterns are evident (see Appendix 8 for full statistical time series methodology). The model will also be further adjusted to optimise the Adjusted R^2 for best fit within the constraints of the adjustments described above.

For subgroup analyses, the collision counts will be stratified by age-group. As already mentioned, three age-groups were selected – the subgroup of interest were drivers aged 16-19 years (given that this represents the age-group of most young novice drivers undergoing the GLS system) as well as teens at risk of adolescent risk-taking behaviour, with documented increased rates of collisions according to Ontario's Interim Analysis of the Graduated Licensing Program [10]. The second cohort were drivers aged 20-24, representing the next age-group, in case the increase in the duration of the licensing program under the GLS program was causing a lag effect in licensure and a shift in collisions to the next age cohort. The third age group was drivers aged 30-34, as drivers young enough to be subject to other concurrent changes in programs aimed at reducing collisions, but old enough to have not been subject to GLS during the entire 10-year period under study. Subgroup time series analyses will be performed upon each age cohort, licence type, each year of young drivers (age 16, 17, 18, 19), licence type and collisions at night, and those involving serious injuries. The graphical displays of these subgroup collision monthly counts are shown in Appendix 3 (Figures A3.1-A3.4).

<u>Step 5 – Impact of GLS on Injury Counts using Ontario Trauma Registry Data</u>

This final step in the program evaluation is designed to evaluate the impact that the program's implementation (seen in all the previous steps) has had on the ultimate outcome of interest, namely injury and fatality rates among young novice drivers in Ontario. Individual level data for injuries sustained as a result of motor vehicle collisions have already been obtained from the Ontario Trauma Registry (OTR) database through the Graduate Student Data Access Program at the Canadian Institute for Health Information (CIHI) for 1992 to 1999 inclusive (see Appendix 7 for OTR database details). 1992 was the first full year for this administrative database.

Separate time series analyses will be performed using the same proc ARIMA methodology described in Step 4 and in Appendix 8. This time series analyses will be performed for patients stratified by covariates that could influence exposure to high-risk driving situations (age and gender). Data subsets were further stratified to evaluate whether injury counts were moderated by GLS introduction for driving situations contravened by GLS for G1 drivers according to data elements captured by the OTR database: wearing seatbelts and no night driving (midnight to 5am). Blood alcohol content by patients from motor vehicle collisions was not collected with sufficient reliability to be evaluated in this study. As such, the data subsets to be evaluated using time series methodology for this study will include all motor vehicle injury patients, injuries among females aged 16-19, among males aged 16-19, as well as females and males aged 30-34 (again for the purposes of providing a form of concurrent control, drivers exposed to other programs and road safety and vehicle safety initiatives), injuries among people wearing versus not wearing seatbelts (a condition of G1 licensure), injuries at night during G1 driving curfew hours, injuries determined to be severe according to the injury severity score (ISS) and injuries among young drivers resulting in fatalities (the latter two representing an assessment of GLS introduction on significant secondary outcome measures from a population health perspective). The monthly injury counts for these driver cohorts are presented in Appendix 3, Table A3.2, and representative graphical display of these data are presented in Appendix 3, Figures A3.5-A3.8. For the sake of simplicity and accuracy, each collision subgroup was plotted independently (rather than the inclusion of time-independent covariates).

The statistical method proposed for this analysis is Seasonal Intervention ARIMA Time Series Analysis and will be the same as the methodology described for Step 4 (see above, as well as Appendix 8 for further details), where the mean monthly injury rates (calculated per 100,000 population for each age cohort as described in Step 4 above) will be plotted from 1992-1999 inclusive. If any statistically significant impact on collision rates is identified from the three potential impacting dates in Step 4, these will also be included in the intervention step and ramp effects analyses as described above: April 1994 (GLS introduction), July 1996 (initiation of London Police Accident Reporting Centre to process property damage only collisions) and November 1996 (Administrative Driver's Suspension Law).

4.10 Justification for Proposed Collision and Injury Data Analyses

Collision data from Ontario's Ministry of Transportation were obtained from 1990 to 1999 inclusive, representing approximately 3.2 million collisions. Data were subdivided as described in the methodology section of this proposal by covariates such as age, gender, licence type and plotted by monthly collision counts (see Table A5.1), in order to determine visually whether it appears as though the intervention in question (introduction of GLS in April 1994) resulted in a change in collision counts. Plots are included in Appendix 3 (Figures A3.1-A3.4) and suggest that no overall impact upon collision counts is evident as a result of GLS introduction, however in subgroups such as 16 and 17 year olds, reduction in collisions are evident (during the G1 phase when drivers require a front seat licensed passenger at all times), which seemed to be lost in 18 and 19 year olds (perhaps with introduction of the G2 phase, when front seat licenced drivers are no longer a requisite for licensure). Completion of proper time series analyses among these covariate cohorts will be of interest to determine whether GLS has had any statistical influence on collision counts once seasonal variability has been adjusted for.

Injury data were obtained from the Ontario Trauma Registry, initiated in 1992, and provided for this project from 1992 to 1999 inclusive from the comprehensive database which captures every motor vehicle injury with an injury severity score greater to or equal to 12 (see Appendix 7) seen at any of Ontario's lead trauma hospitals. Individual information on driver licensure and vehicle seating position of each injured person is not reliably captured by this database, providing information different from that obtained from the MTO. Monthly injury counts were plotted in Appendix 3 subdivided by covariate cohorts of interest, such as age, gender, injury severity and fatality (see Table A3.2). In none of the injury plots was there any visual change in injury counts from April 1994, which might lead to an expectation of statistical significance using time series analyses, however most of the monthly injury counts are so low as to bring into question the validity of time series analysis with monthly frequency counts less than five.

Appropriate analyses of collision and injury rates will hopefully provide accurate analyses of the final outcome measures of this program, adjusting for seasonal variations, as the goal of reduced exposure to high risk driving by GLS is clearly aimed at reducing collisions with the goal of reducing injuries and deaths among young drivers [9] [19].

4.11 Proposal Study Limitations

In the generation of a causal model, there is always the concern regarding the potential presence of exogenous variables, which could in themselves explain the observed outcome of interest (Figure 3.4). With regards to the Graduated Licensing Program, the potential exogenous variables include: ongoing changes in injuries and fatalities as a function of time and influenced by factors other than GLS implementation (ie. such as other safety policies, safer cars, increasing education, programs against drinking and driving, changes in program implementation by police and changes in economy, such as recessions). Another potential exogenous variable to consider is the change in time and funds required to apply for a licence since GLS implementation, which could delay or reduce the number of licence applicants in the 16-19 age group. This would become a maturation variable. Other exogenous variables could include variables influencing adolescent risk-taking behaviour based on the model described in Figure 2.1, such as peer influence and behaviour and change in cost-benefit perception for risk-taking behaviour as well as changes in social perception of these risk-taking behaviours. Any of these exogenous variables could affect mediating variables, such as behaviour, as well as the intermediate and final outcomes of interest. These are all difficult variables to capture, but would be of interest for future sociological studies as follow-up to this comprehensive evaluation. Despite exhaustive research of relevant variables in the creation of the causal model, there exists the possibility that there could be other exogenous or intermediary variables which are not included or considered in the program's evaluation.

One potential limitation of this study is that collision counts were obtained from the database of Ontario's Ministry of Transportation, which relies on collision information collected by Police reports. It is suspected that a number of collisions (particularly property damage only collisions) are not captured by this system particularly among young drivers who have a great deal to lose financially in terms of insurance rates for each reported collision, particularly in the era of 'no fault' insurance. Despite this, MTO collision database remains the most comprehensive database regarding collisions available for analysis. In order to confirm reliability of these findings, these results will be compared with injury data obtained from a different data source (Ministry of Heath). This will help to capture collisions resulting in injury or death, which are the outcomes that are considered significant from a population perspective. In addition, given that there were no comprehensive records kept by the Ontario MTO for number of learners' permits distributed prior to 1994, and questionable record keeping regarding G1 and G2 licensure rates, denominator calculations using rates per licensed drivers are not possible and population-based rates are required. The potential limitation of using age-based rate calculations is that the younger age cohort (aged 16-17) may have fewer licensed drivers than the older adolescent age cohorts (aged 18-19).

Another potential limitation of this study is that the OTR administrative database captures persons injured with an injury severity score of greater than or equal to 12 (see Appendix 7 for description of OTR calculation of injury severity score (ISS)). As such, persons with trivial injuries managed at peripheral hospitals are not captured by this database. OTR captures these data in their Minimal Data Set. This is likely not to be of great significance from a population health perspective, however these data also do not capture persons who die at the scene. OTR keeps a separate database (Coroner's Death Data Set) for persons who die at the scene of an accident and never arrive to hospital. Fortunately, information regarding collisions resulting in death are captured by the MTO and are evaluated using this data source (see Chapter 6).

The final limitation is that the majority of this evaluation will be performed on the basis of secondary data, already in existence, and collected for other purposes. All secondary data sources are susceptible to missing data, bias in data collection strategies etc. In the evaluation of a program already in place, it is not possible to do any pre- post-program studies, and so we are limited to secondary data sources. It would be unreasonable to collect all of the required data individually, given that they are already being collected by large agencies familiar with these data. It is important to note however, that each of these databases have been used in numerous peer-reviewed publications, giving evidence of the data's high quality in terms of completeness and utility [98] [10] [95] [59].

Any potential limitations of this program evaluation are outweighed by the potential benefits and strengths of a causally developed program logic model in the evaluation of the impact of Graduated Licensing policy on young drivers in Ontario.

CHAPTER FIVE: PILOT STUDY ASSESSING ATTITUDES OF YOUNG DRIVERS AND POLICE OFFICERS TOWARD GRADUATED LICENSING SYSTEM

5.1 Introduction

The first step in any program evaluation is the demonstration that the intervention being evaluated is actually being implemented [1]. Given that GLS is a legislated policy incorporated into Ontario's provincial laws, the presence of the program intervention is not really called into question. It is not possible to obtain a valid provincial driver's licence without going through the Ontario Ministry of Transportation, where the restrictions of the G1/G2/Full licence stepwise process are incorporated into their policy. The question of greater importance in this evaluation is not *if* the program intervention is present, but rather *how* it is being implemented, both from the law enforcement perspective as well as the young driver perspective (see Step 1 in Figure 3.4).

This pilot project component of the proposal outlined in this thesis required a qualitative evaluation of the program, which involved conducting a number of focus groups with a variety of young drivers and police officers across various jurisdictions in Ontario. This chapter presents the pilot study in which this methodology was utilized for both young student drivers and police officers in London Ontario, to demonstrate the feasibility of this component of the evaluation, in addition to providing a rich insight into the potential successes and weaknesses of the program being evaluated.

This current study was performed as a pilot study with two goals in mind: firstly to demonstrate the feasibility of this qualitative component of the research proposal and secondly to begin to identify potential themes surrounding our understanding of the performance of GLS as a road safety initiative.

5.2 Methodology

Qualitative methodology varies immensely from quantitative research, in that the former allows for the exploration of ideas, perceptions, experiences and opinions from subjects of interest. As a research method, it relies heavily on inductive reasoning processes in order to be able to interpret and frame the meanings of information derived from the process [101], rather than deductive reasoning seen in quantitative and statistical analyses. It also allows for the observation and field evaluation of participants in action. This method has evolved as a means to address the inherent difficulties in presenting this type of research in a quantifying yet meaningful manner [89], while capturing the unique and numerous views that can be expressed from research participants. This is a particularly useful tool for the purposes of exploring beliefs and views regarding the effectiveness or limitations of program implementation [89], or any research topic that is not quantitative or able to be rendered into numerical form [101].

The advantage of using the focus group methodology with this study, is that data can be triangulated [89] using a mixed methodology approach, or synthesized with data obtained by quantitative means, so that the qualitative methodology provides the context by which the views of subjects affected by the program in question can be understood.

This pilot study was evaluated using phenomenology analysis, which involved evaluating focus group data elements based on how they reflect the individual's experience [89]. The first step involves 'Epoche', meant to represent a phenomenological attitude shift, where the researcher made every effort to eliminate personal bias related to GLS. The next step was phenomenological reduction, where brackets were placed to dissect events identified in the focus group discussions. Personal experiences or key phrases were identified, bracketed, interpreted according to the subject's perspective, with meaning inspected for further insight into essential or recurring features of GLS. At this point, all of the data were 'horizontalized', or given equal weight [89], overlapping or irrelevant data were discarded, and invariant themes were enhanced and portrayed using textural portrayal. Finally, the findings were synthesized so that the deeper meanings of the experience described by participants could be illustrated. In other words, in conducting focus groups with persons affected by the GLS program, it was possible to understand their perspectives on the program and its implementation, understanding that these stakeholders may have very different viewpoints and priorities than others, even those who designed the program. The advantage of the phenomenological qualitative research method is that it allows the researcher the opportunity to understand each participant's actual experience with the program, by interpreting their exact words, and by making explicit their perceptions of and experiences with the program being evaluated [104].

Given the intent of this study to supplement quantitative data sources and to provide a contextual framework for which to discuss these findings, it was determined that a homogeneous sampling of each group of participants would be sufficient to demonstrate proposal feasibility. This meant that subjects were grouped separately by occupation and gender, a strategy which is felt to optimize discussion and interaction between participants [89].

Three focus groups were conducted by the researcher, with audio tape and verbatim transcription. The first focus group involved a group of six London Police Department Uniform Division (traffic police) police officers. This was designed to provide a contextual setting surrounding the implementation of this program, with the hopes of identifying any limitations or difficulties for its implementers. This group was selected in order to demonstrate feasibility in conducting focus group research with police officers, and was utilized to represent a purposive sampling of Ontario's traffic police officers. The participants were selected by London's Chief of Police, based on their experience with traffic enforcement, allowing for a wide variety of experience to

GLS enforcement among the officers. The focus group was conducted at the London Police Headquarters, with the permission of the London Police Chief and Public Relations Officer. Officers were recruited by attending a staff meeting where the Chief described the study and made a request for participation. Financial remuneration for participation was declined by the Police Chief on behalf of all participants.

The second and third focus groups were conducted with young student drivers. They were performed using the same qualitative survey techniques as described above to speak with high school students, in their capacity as young drivers. The purpose of these focus groups was to gain an appreciation for whether the students felt that the restrictions were being enforced and adhered to by young drivers, and specifically whether young drivers felt deterred from high risk driving situations based upon the conditions built into the GLS program. A purposive sample of Ontario's young drivers was recruited for participation in this study through the Research Office at the Thames Valley District School Board. The Research Office selected one school that they believed most represented the desired study group (a combination of urban and rural students, male and female students). The school selected was Medway High School in London Ontario. The grade 12 teachers were then asked by the school's guidance counselor to recruit student participants on behalf of the principal investigator. Consent was obtained from each student and their parent/guardian prior to their participation in the student focus groups (letter of information and consent in Appendix 4). In order to optimize open and candid discussion during each focus group, gender-specific focus groups were organized, with one focus group comprised solely of young driving women and a second focus group comprised solely of young driving men.

The purpose and methodology of the study were explained to the students, and those who agreed to participate were reimbursed $10.00 for their time. The focus groups were conducted in a classroom at the students' school, each during a lunch hour, where the principal investigator functioned as the group moderator. The sessions lasted approximately one hour, and both sessions were audio taped and run by the principal investigator, with an assistant present to ensure proper functioning of audio recording devices.

Common to both police officer and young driver focus groups, all three focus group sessions began with an introduction to the purpose of the focus group as well as the GLS program under examination. Participants were reminded that each session was being recorded. The participants were asked to identify themselves demographically (years of traffic enforcement for the officers, and age, licence type and urban density for student drivers). Participants were then asked to describe their experiences with the GLS, and their thoughts on the program's implementation and enforcement. In a semi-structured but open-ended format (see Appendix 5), prompting questions were used during discussion lulls to ask participants to discuss their thoughts on the GLS restrictions and the program's effectiveness. The audio tapes were transcribed verbatim by a transcriptionist familiar with focus group research. The data elements were coded and emerging themes were developed by the researcher alone, given that this pilot study was conducted as part of a graduate thesis project. Ideas raised by participants were included for analysis if mentioned more than once or with the agreement of other participants (verbal or non-verbal if captured by the principal investigator at the time of focus group). Approval for this pilot study was obtained from the Research Ethics Board for the Review of Health Sciences Research Involving Human Subjects Committee at the University of Western Ontario (see Appendix 2).

5.3 Results

Demographic data relating to all participants are outlined in Appendix 5. In the police officer focus groups, six officers participated – all of whom were male. Four officers were general patrol officers (includes traffic) (whose main duties involve police enforcement using police vehicles) and two were uniform officers (whose main duties involve police enforcement on foot patrol through various city districts). Their mean number of years in the police force for participating officers was 11.3 years (range 2.5 to 25 years). In the focus group composed of young female drivers, nine students participated, with a mean age of 17 years (range 16-18). Five students were in their fifth year of high school (grade 13 equivalency), the remaining being balanced between grade 11 and 12. Seven of nine students classified their living community as 'rural', with the other two citing their living community as 'city living'. Every student had a driver's licence: one had an unrestricted full G licence, one held a G1 licence and the remaining seven held G2 licences. In the focus group composed of young driving men, eight students participated, with a mean age of 17 years (range 16-18). The school grades of the students were equally balanced from grades 11-13. Five of the eight students described their living environment as 'city living', the remaining living in rural residences. None of the male students held an unrestricted G licence. Two of the male students held a G1 licence while six held G2 licences.

Six themes emerged from the qualitative interviews (see Appendix 5):

Theme 1 – "Young drivers don't plan driving well". Students expressed lack of responsibility for finding themselves in high risk driving situations, justifying their driving at night with a G1 licence as 'better than' having their passengers drive home drunk. They did not express an interest in having other designated drivers like their parents drive them home. The police officers had similar impressions, voicing concern that 16 year olds felt experienced enough to consider themselves to be designated drivers. The majority of students explained that for those that live in the country or away from bus routes, they felt obligated to drive given geographical constraints and lack of viable alternatives. All of the justifications were delivered with matter-of-factness, supporting their situational driving decisions. Student drivers did however express uniformly that those who lived in the country or city outskirts felt pressured by their parents to obtain their full unrestricted licence, as a matter of convenience.

Theme 2 – "Most collisions are not GLS-related". Students and police officers agreed that most of the collisions among young drivers were accounted for by driving errors such as speeding, which are not addressed within GLS restrictions. None of the students felt that drinking and driving was much of a real issue in terms of road safety for young drivers any longer, something that police officers also corroborated. The male students also recognized that as young drivers they often made ill-experienced driving choices, such as swerving, driving many teens home, etc.

Theme 3 – "Rules are to keep honest people honest". Students felt that police presence was predictably located and as such was easily avoided to evade detection. They felt that those who were going to contravene driving restrictions would continue to do so. The police acknowledged that the young drivers who intend to contravene restrictions (recidivists) are not influenced by traffic fines and police presence.

Theme 4 – "Restrictions should be tougher". All students expressed that the road safety tests were too easy, feeling that anyone could pass regardless of knowledge or ability, when even the students themselves felt they should have failed. The Driver's Education course was felt to have no significant knowledge enhancement for students, who expressed their motivation to be driven purely by the financial incentives of reduced insurance rates. The police and the majority of students felt that the G2 driving phase did not add anything to safety or graduated exposure for novice drivers. Police officers felt that the restrictions should be even tougher.

Theme 5 – "Enforcement depends on officer and judge". Although police officers uniformly denied any gender-based leniency in the issue of fines for driving infractions, both male and female driving students felt that women were preferentially provided with leniency in this regard. All students felt that they were unfairly targeted for investigation by police, while the police officers all described pulling teenage G1 drivers over very infrequently, particularly when they were accompanied by adult front seat passengers (although driving without a front seat licensed passenger was the GLS restriction most commonly contravened by G1 drivers according to police officers). Officers described a non-descript 'feeling' as being the main reason for pulling over non-speeding teenage drivers. However, although the officers initially denied ever demonstrating leniency to teenage drivers, later in the focus group interview, some of the officers admitted to having let teenage drivers drive home without imposing required fines. More important to the officers was the feeling that their attempts at enforcement were not supported by the traffic courts and appointed Justices of the Peace (judges). The officers described many situations when they imposed a fine, but the accused denied the claim, requiring officers to spend a great deal of time in court providing witness to the claim, and hearing many excuses. Most officers felt that the judges listened to the excuses, and reduced or dismissed the fines, referring to the process as a 'kangaroo court', so much so that GLS drivers were able to accumulate many traffic convictions with zero remaining points on their licence, yet without losing their licence to drive. They expressed significant frustration at the process.

Theme 6 – "Deterrence is not perceived". Both the police officers and students alike felt that there was no perceived punishment severe enough to deter any driving offences by young drivers. Students described driving more cautiously but continuing to contravene GLS restrictions, and driving around known police 'hangouts'. They expressed no fear and no concern regarding being caught contravening any of the GLS restrictions, and expressed that they all had done so (most commonly driving without a front licensed passenger and driving after midnight during their G1 phase). Police were convinced that automatic driving suspensions are more effective than imposition of any fines, and that young drivers have no fear of arrest. They felt that the laws and the way they are imposed (see above regarding the handling of traffic offences by the courts) are superficial, with no substance.

5.4 Discussion

The results of these focus groups indicate that significant disparities exist between the police officers' and teen drivers' perceptions regarding consistent implementation of the GLS driving restrictions. Both stakeholders felt that the licence acquisition process was too easy, and that there were no significant consequences (or deterrence effect) to contravention of these restrictions. Both groups felt that the primary contravention by adolescents resulting in ticketing was speeding, a condition not specifically addressed by the GLS system. Both groups felt that young novice drivers do contravene the restrictions regularly, most notably the driving without a licensed front passenger, but the teens also felt that driving at night and or driving with more passengers than seatbelts was also often done, while the police officers felt that alcohol-related offences were the next most common contravention.

From the information gleaned from these focus groups, it is clear that the officers are all well informed on the conditions of the GLS program, while the teen drivers had varying levels of understanding regarding the different restrictions in the G1 phase. Both groups discussed their impression that the overwhelmingly most frequent cause of collisions and injuries among young drivers was speed. Importantly, both groups admitted to regular contravention of the GLS restrictions by young novice drivers, that most G1 drivers contravened at least one or two of the conditions (driving without a front licensed passenger and driving after midnight), which leads one to question whether the program can be successful if the restrictions are being contravened on a regular basis. Most importantly, this qualitative study revealed that neither the student drivers nor the police believed that there was any perceived notion of consequence for contravention of GLS restrictions, even among recidivists. Deterrence is the critical theory upon which GLS was based, and these findings cast serious doubt to whether the program can achieve its intended impact if the students do not feel deterred by the punishments imposed for contravention of the rules of GLS (either because the rules are not imposed by police, police can be easily avoided, or the fines are not upheld at the level of the courts).

The findings of this pilot study correlate well with recent reports in the drinking and driving literature, where the low risk of perception and the resultant loss of deterrence was described in a media release report [105], where 20% of offenders apprehended were repeat offenders, who usually received minimal penalties and had their licences reinstated after each offence [105]. Additionally, it was felt that the number of drinking drivers captured was a small fraction of offenders, but even among this group, only one quarter of those charged had their offences come to court, and a quarter of those in court received a conviction [105]. There was some mention by the author of these reports Dr. R. Solomon, that a survey had been conducted among British Columbia police officers, where it was reported that 40% of the officers were reluctant to lay drinking and driving charges due to ongoing frustration with the court system, the time wasted by officers to attend and defend the charges, and the proportion of charges dismissed by the courts [105]. This sentiment was also shared by the police officers in this pilot study, and will be explored further in the definitive program evaluation outlined in this thesis.

The main limitation of this study was that qualitative focus group methodology is particularly prone to subjectivity bias, and phenomenology analysis is not immune to this bias. As such, these studies are ideally conducted with at least three coders interpreting the data and coming to agreement together in the assignment of emerging themes in order to provide validity of the theme determinations and data coding. Further focus groups should then be conducted in order to test the evolving hypotheses to provide for data reliability. Given that this pilot study was conducted as part of a Master's Thesis, the analysis was done by the graduate student rather than as a collaborative project, and as such, could have been subject to interpretation bias.

While focus group methodology has the potential of providing a great deal of rich data elicited by participant interaction (engaging a number of participants in a single setting), it can be limited by participant polarization, lack of group dynamic or discussion, and limited resources [90]. A final limitation of this study is that the number and timing of the focus groups was limited by that permitted by the research office of the Thames Valley School Board as well as the London Police Department's Police Chief. The full project proposal will include purposive samples of participants throughout Ontario, in order to allow for more comprehensive hypothesis generation and validation of the hypotheses raised by these preliminary focus groups. It is expected that these further focus groups will yield further information and themes regarding young student driver and police officer perspectives regarding contravention of GLS restrictions, the lack of deterrence effect, and perceptions about strengths and weaknesses of GLS as a road safety initiative.

5.5 Relating Focus Group Pilot Study to Proposal

The primary purpose of the pilot study was to test the focus group format and obtain preliminary data surrounding the implementation and risk perception aspects of this evaluation. Findings from the pilot study focus groups suggested that Police officers do not uniformly apply punishment for young drivers who contravene the GLS restrictions, mostly based on the perception that their imposed punishments are not upheld by the courts and thus have no deterrent effect. Students reported that they did not feel that the risk of punishment for contravention of GLS restrictions was high, nor that that severity of punishment was great, and many described situations where they had knowingly contravened the GLS driving restrictions for G1 or G2 licensure.

Grounded theory methodology remains is one of the most rigorous qualitative methods [91] [102], involving systemic analysis of the data in order to generate theory derived directly from the data. This method of constant comparisons requires the breakdown, coding and categorizing of bits of data obtained from focus groups, field study, interviews or observations. Coding is meant to be iterative and inductive, yet able to reduce all of the various pieces of information gleaned from subjects into units [103]. From this process arise themes and hypotheses, which are then used to repeat further analyses and focus groups, in an effort to exhaust any further themes identified by subjects in the field of study. This is the method that will be used to analyze the focus group data obtained from the full research proposal outlined in Chapter 4, expanding on the number of focus groups and conducting them in varied jurisdictions across Ontario.

CHAPTER SIX: PRELIMINARY EVALUATION OF IMPACT OF GRADUATED LICENSING SYSTEM IMPLEMENTATION ON YOUNG DRIVER KNOWLEDGE AND BEHAVIOUR USING SURVEY METHODOLOGY

6.1 Introduction

In order to understand any studies evaluating the GLS outcomes of interest (collision and injury rates among young drivers), it is first necessary to demonstrate that the persons targeted by this intervention can demonstrate acquisition of knowledge regarding the program (see Step 2 in Figure 3.4), its implementation and its regulations (including restrictions and consequences of restriction contraventions). If the targets of the intervention program are not aware of the restrictions in place at each of the licensing steps, it follows that they are at high risk of unknowingly contravening these restrictions, thus jeopardizing the program's effectiveness. Secondly, it is critical to determine whether the program's introduction has influenced young driver behaviour (see Step 3 in Figure 3.4). Although a critical step (and causally linked to the outcome of interest in program evaluation), the acquisition of knowledge is not necessarily sufficient to result in the success of any program being evaluated. This is particularly true in programs targeting adolescents, where one may be able to demonstrate knowledge acquisition on a test following a particular training exposure without any resultant impact on their behaviour [106]. Previous program evaluations, such as school smoking cessation, alcohol abstinence and zero tolerance drinking and driving programs, have demonstrated that with any program relying on a change in behaviour contrary to peer-accepted social norms, the program's outcome can be met with disappointing results, even if it can be demonstrated that the required knowledge has been acquired by the target cohort [107] [73] [108].

The *a priori* hypothesis for this study was that there would be a significant increase in the mean GLS knowledge score (described below) following implementation of GLS when compared prior to its implementation. There are a number of variables which are hypothesized to influence this relationship, including age (relating to the biological maturation of the adolescent), gender (relating to degree of inherent risk-taking behaviour and peer influence as well as personality) and licence type (due to situational opportunity for risk-taking behaviour), based on the model of adolescent risk taking behaviour developed in Figure 2.1 [75] [70]. These variables are therefore also hypothesized to influence behaviour and are included in such analyses described below, as is the knowledge score obtained from this portion of the analysis (a surrogate for the variable termed 'cognitive ability' in Figure 2.1, which includes cognitive intelligence as well as knowledge baseline and acquisition ability) [68].

The primary objective of this study, therefore, was to determine the impact of GLS implementation upon the change in knowledge of young drivers regarding the driving restrictions contained within this program, stratified by the variables described above: age, gender and licence type, demonstrated to influence high risk driving behaviour among adolescents [70]. The objective of the second component of the GLS evaluation was to explore the self-reported contravention behaviour among young drivers regarding the driving restrictions contained within this program, adjusting for the covariates age, gender, licence type and knowledge about GLS restrictions.

6.2 Methodology

6.2.1 CAMH Survey Methodology (Mann et al, 1993, 1995 & 1998)

The Centre for Addiction and Mental Health (CAMH) is a non-profit government subsidized research agency involved in extensive clinical and epidemiologic research, particularly in the area of alcohol and drug use among adolescents and adults in Ontario. In 1993 and 1995, CAMH conducted an anonymous self-report survey among adolescent students in order to evaluate among other things, student knowledge and behaviour relating to GLS. This survey was then repeated with minor modifications to the survey questions in 1998, within the same school regions as a follow-up survey to different students by the same methodology. A total of 1856 students were sampled (1157 in 1993, 699 in 1995 and 834 in 1998).

The Province of Ontario was subdivided into north and south regions, and seven Ontario public high schools were selected from these two regions – four in the north and three in the south, so that schools selected would represent both primarily rural and primarily urban student demographic. In both regions, schools were selected non-randomly according to permission from the school boards.

Parental consent forms and copies of the questionnaire were given to all students in the grade 11 and 12 classes in all participating schools on the condition that they met driver licence eligibility criteria. Students who returned a signed parental consent form and returned the questionnaire were paid $5.00 for their cooperation. This survey was completed by willing students who belonged to the classrooms selected by the school principals for each school volunteered by the respective school boards during the school years 1993-1994, 1995-1996 and again in the winter of 1998. Note that the GLS program was implemented in April 1994. A total of 1157 students participated in the pretest, and 699 different students participated in the posttest and 834 students participated in the 1998 follow-up survey. The 1998 survey data were not used in the analysis of the knowledge score. The response rates for the pretest (1993) and posttest (1995) were 67% and 68.4% respectively. The response rate of students to the 1998 survey was not retained by the survey investigators and thus not available to the investigator for this analysis, but is estimated to be similar to the two previous surveys. The questionnaire obtained descriptive information, driver licensure information, drinking and drug use behaviour, and knowledge/attitudes regarding graduated licensing restrictions. Additionally, the survey asked students to report on whether they had ever been stopped by police for contravening any of the

GLS driving restrictions. The survey was completed by students during classroom time, while supervised by their primary teacher, and collected by the study coordinators.

6.2.2 OSDUS Survey Methodology (2001)

The Ontario Student Drug Use Survey (OSDUS) is a biannual survey of adolescents developed and conducted by the Centre for Addiction and Mental Health (CAMH) Foundation in Ontario since 1977 [96]. This survey represents Canada's longest on-going school survey, and is administered by the Institute for Social Research at York University on behalf of the Centre for Addiction and Mental Health. The intention of this survey was to utilize anonymous self-report survey methodology to determine the behaviour of adolescents regarding drug and alcohol use as well as other behaviours that might be considered as socially unacceptable, including drinking and driving.

CAMH conducted the OSDUS in the fall of 2001 using a random survey of young persons, conducted in an anonymous fashion so that the students could report freely on whether they have engaged in illegal activity. The target population* included all students enrolled in the public and Catholic regular school systems. The school selection method employed was a two-stage stratified cluster sample design, where the clustering was by provincial region and the two-stage sampling represented the school and the classroom in each school. All students in grade 7 through 13 within selected schools were invited to participate in the survey. The school represented the primary sampling unit, and students in Northern Ontario were over-sampled due to this region's small population in order to provide balanced regional estimates. The identifying variables such as region and school were not made available for this particular evaluation, and as such cluster analyses were not feasible. The students represent a sampling of young novice drivers exposed to the GLS.

The OSDUS survey had a good response rate of 77%, randomly surveying 6,564 students from 111 schools. The questionnaires were distributed to students during classroom time. The surveys were self-completed by the students anonymously, and collected that same day by the survey administrators. The bulk of the questionnaire addressed questions regarding drug use, illegal behaviour, and alcohol consumption, in addition to demographic data. Questions regarding the contravention of the GLS restrictions and their current driver's permit level written by the principal investigator were added to the 2001 questionnaire for the purpose of the current GLS program evaluation. The schools were divided in half, with one half receiving one survey, and the second receiving a different survey. The questions relating to graduated licensing were only present in the Form B survey (see Appendix 6), and all analyses were performed on these results.

6.2.3 Analytical Methodology

The OSDUS and Mann surveys are complementary and allow for the triangulation of data from two different survey sources. The Mann et al. survey evaluated self-reported knowledge level and contravention behaviour by students who were exposed to a new set of driving restrictions prior to and following the GLS implementation in 1993 and 1995 respectively (measuring covariates such as age, gender, licence type, having taken driver's education course and self-reported penalties for contravention of any GLS restrictions). The OSDUS survey did not incorporate knowledge questions regarding GLS restrictions, but collected additional data with regards to surrogate measures of socioeconomic status, and asked students to self-report contravention of any of the restrictions several years after its implementation to explore sustainability of any behavioural change. The student samples are different in these two surveys, using slightly different survey methodologies, however useful descriptive information can be gained by exploring information from a variety of sources.

A 'Knowledge Score' was calculated using the Mann and Colleagues 1993 and 1995 survey results, and was developed by summing the number of restrictions that the students correctly identified in each of those two surveys, out of a possible total of nine true/false questions (four of which were true GLS G1 restrictions) (see Table 6.2). The four correct restrictions comprising the Knowledge Score (out of four) were:
-must drive with licensed front passenger
-must not drive at night (12pm to 5am)
-must have zero blood alcohol content
-must not drive on 400-series highways
The mean knowledge scores, before and after GLS implementation, are compared for each age cohort, gender and licence types using an independent two-tailed Student's T-test (significance α=0.05). It is important to note that in the original survey, a total of nine items were listed in this knowledge question, five of which were incorrect options, but were placed to maximize the reliability of this knowledge question for correct GLS restrictions. For this pilot study, it was decided to use a score tabulated based on the correct four options only, rather than creating a scale based on all nine items, including answers to the incorrect five other options, appreciating that there is a risk in doing so that the reliability of the score may be reduced.

Two 'Behaviour Scores' were created to evaluate self-reported young driver behaviour in relation to contravention of the GLS restrictions since the program's implementation in 1994. The first such behaviour score was developed from Mann and colleagues' 1995 survey data, the first survey to explore young driver behaviour following implementation of GLS during the prior year. This score was calculated out of four possible answers in total, each representing four G1 GLS restrictions. The four restrictions are the same as the four listed above and utilized to calculate the knowledge score. The second behaviour score was developed from the 2001 Ontario Student Drug Use Survey (OSDUS) [96], Canada's longest ongoing school survey, in order to evaluate self-reported young driver behaviour in relation to contravention of GLS restrictions since the program's implementation in 1994. This second behaviour score was created by summing the number of restrictions that the students carrying a G1 licence admitted to contravening out of five in total: no 400-series highway driving, no driving between 12am-5am, no driving with licensed front passenger, zero blood alcohol content (BAC) and driving with the number of passengers limited to the number of seatbelts in the vehicle (this last restriction is the only limitation which is in addition to the four restrictions evaluated in the 1995 Mann and colleagues behaviour score). The behaviour score was then recalculated for students carrying a G2 licence, summing the number of restrictions that these students reported having contravened out of two in total: zero blood alcohol content (BAC) and driving with the number of passengers limited to the number of seatbelts in the vehicle. The restriction regarding the number of teenage passengers (one during G1 and up to three during G2) was added after this study was complete and as such was not included in this analysis at all.

For both behaviour scores (1995 Mann and colleagues and 2001 OSDUS), the score for each student was collapsed to a dichotomous score to compare the proportion of students who received a perfect score (contravened zero of the GLS restrictions) with those who self-reported having contravened at least one of the GLS restrictions, and adjusted for age, gender, licence type and knowledge score (rationale outlined above). The behaviour scores were collapsed to a dichotomous variable due to the difference in denominators between the two surveys, and between G1 and G2 drivers within the one OSDUS survey, in order to standardize and clarify interpretation of the behaviour scores across the different studies. The author of this thesis was particularly interested in students who broke any one of the restrictions, rather than the number of restrictions contravened per se.

Given that the two behaviour scores are derived from different survey sources, it is not methodologically correct to use statistical tools for comparison of data between the two surveys. Having said that, there is great interest in evaluating the behavioural trends over time, and assessing whether decay in learned behaviours [20] regarding contravention of GLS restrictions can be displayed. As such, the contravention rates of each GLS restriction are listed for the purposes of discussion regarding potential trends in contravention rates (see Section 6.3), and for hypothesis generation for future research (see Chapter 4).

Using the Mann et al. 1995 survey data, simple and multiple logistic regression models were developed to assess the odds of contravention of each of the four GLS restrictions, with contravention of each GLS representing a separate dichotomous outcome. The multiple logistic regression models included the variables believed to influence the outcome of GLS contravention, namely age, gender, licence type and knowledge score (as justified above). None of the variables were added or deleted by backward or forward elimination techniques in order to avoid the risk of adding error to the effect estimates with such adjustment techniques. As such the multiple logistic regression models were first created with every covariate listed, with interaction terms from these covariates also included. Given that none of the interaction terms was significant, they were dropped from the regression models and the covariates were all included (rather than backwards or forwards elimination methodologies) in order to obtain odds ratios and 95% confidence intervals, so that the odds ratios would be adjusted for by the presence of the covariates felt to influence the outcome of GLS restriction contravention. The appropriateness of this model was tested using the Hosmer & Lemeshow goodness of fit test, the p-value of which is included for each regression model.

Using the 2001 OSDUS survey data, the OSDUS Score (which is the second behaviour score described above) was developed (representing the mean number of GLS conditions that the students self-reported having contravened at least once during the possession of their current licence type, meaning 5 possible contraventions for G1 licensees (no 400-series highway driving, no driving between 12am-5am, driving with licenced front passenger, zero blood alcohol content, only as many passengers as seatbelts) and 2 possible contraventions for G2 licensees (zero blood alcohol content and only as many passengers as seatbelts)). A score was created by differentiating those who had never contravened any of the restrictions versus those who had contravened at least one of the restrictions listed for each licence type. The rationale for this approach is described above.

A surrogate measure of socioeconomic status (SES) was developed using information obtained in the survey, based on types of questions used for other SES surrogate scoring the participant's mother's level of education (completed college or university =1, otherwise=0), the participant's father's level of education (completed college or university=1, otherwise=0), the number of vehicles owned by the participant's family (2 or more vehicles=1, otherwise=0), the number of computers owned by the participant's family (2 or more computers=1, otherwise=0) and the self-reported level of family wealth by the participant (above average or higher=1, otherwise=0). The total score was divided roughly into thirds in accordance with the frequency distribution of the score into three main groups. This was used as a covariate, in addition to age and gender, based on research implicating SES as a covariate in adolescent behaviour [70] [71]. Simple logistic regression models were then created for each of the five GLS restrictions evaluated from the OSDUS survey for G1 and then G2 drivers, using the covariates SES, age and gender separately. The methods used to build the multiple logistic regression models were the same as used above. The models were also tested using the Hosmer & Lemeshow goodness of fit test.

This method of multiple sources of data analyses allowed for complementary data from different sources, strengthening the argument that the students who contravene these restrictions differ from those who do not, regardless of the type of survey utilized to obtain the data. The results of these analyses were compared to normative values available in the literature from adolescent surveys in other GLS program evaluations in descriptive terms in the discussion section. All statistical analyses were performed using the SAS software, version 8.2.

6.3 Results

Baseline demographic data representing numbers and proportions of student participants in each database, stratified by age, gender and licence type are presented in Table 6.1. With regards to evaluating the change in knowledge following GLS program implementation, there was a significant increase in mean GLS knowledge score following the introduction of GLS when compared to pre-GLS baseline (see Table 6.2) for all subgroups, with the exception of 19 year olds (of which there were only 29 students).

The proportion of students in the 1995 post-test group who contravened any G1 restrictions represented 36% of the posttest group (699 in total) (Table 6.3), however only 9 students (3 females and 6 males) reported having been caught by police for having contravened any of these G1 restrictions (1.2%) and only 3 students (1 female and 2 males) reported having been caught by police for having contravened any of the G2 restrictions (0.43%). In the 1998 follow-up group, six students reported having been caught by police for contravening any G1 restrictions (0.72%), while 11 reported having been caught for contravening any G2 restrictions (1.32%). The question of whether students had been caught for contravening any of the GLS restrictions was not posed in the OSDUS survey. Given that so few G1 and G2 students self-reported having been caught by police for contravening any of the GLS restrictions, this variable was not evaluated statistically. In the regression modeling evaluating variables predicting for whether students contravened any of the GLS restrictions, one would expect a confounding relationship between self-reported contravention and self-reported interaction with police for the same. Table 6.3 reports the number of students who self-reported having contravened any of Ontario's G1 or G2 GLS restrictions in each of the surveys described above.

Table 6.1: Baseline demographic data for Mann et al. and OSDUS survey data, demonstrating frequency distributions for each survey. The four surveys outlined below represent four separate cross-sectional studies, three Mann and colleagues surveys from 1993, 1995 and 1998 and the fourth is the 2001 OSDUS survey. Statistical analyses were not done given the different survey sources.

	Mann et al. N (% of total)- Pre-GLS 1993 Survey N=1157	Mann et al. N (% of total) – Post-GLS 1995 Survey N=699	Mann et al. N (% of total) – 1998 Survey N=834	OSDUS* N (% of total)- N=1970
Age				
16	464 (40.1%)	314 (45%)	270 (32.5%)	284 (14.4%)
17	519 (44.9%)	332 (47.6%)	410 (49.3%)	235 (11.9%)
18	150 (13%)	44 (6.3%)	139 (16.7%)	153 (7.8%)
19	21 (1.8%)	8 (1.2%)	13 (1.6%)	49 (2.5%)
Gender				
Male	619 (53.6%)	398 (56.9%)	426 (51.2%)	963 (48.9%)
Female	536 (46.4%)	301 (43.1%)	406 (48.8%)	1005 (51.1%)
Licence Type				
None	417 (36%)	2 (0.3%)	26 (3.1%)	1273 (69.2%)
Lerner's (pre-GLS)	494 (42.7%)	N/A	N/A	N/A
G1 (post-GLS)	N/A	389 (56.3%)	473 (56.7%)	258 (14%)
G2 (post-GLS)	N/A	297 (43%)	390 (46.8%)	229 (12.4%)
Full	246 (21.3%)	3 (0.4%)	5 (0.6%)	44 (2.4%)

*OSDUS survey included students aged 12-19, however only students aged 16-19 are represented here, which is why the % students does not reach 100%. Only students aged 16-19 are used from this study for all analyses.

Table 6.2: Baseline demographic data comparing mean knowledge score (number of correct GLS conditions out of 4 correct). Data are from Mann et al 1993 (pre-GLS) and 1995 (post-GLS) surveys only.

	Variable	Pre-GLS Score+	Post-GLS Score+	P-value
Age	16	2.84± 1.35	3.64 ± 0.79	<0.0001*
	17	2.62 ± 1.39	3.62 ± 0.84	<0.0001*
	18	2.47 ± 1.47	3.68 ± 0.64	<0.0001*
	19	2.57 ± 1.03	3.25 ± 0.89	0.11++
Sex	Female	2.79 ± 1.33	3.70 ± 0.72	<0.0001*
	Male	2.60 ± 1.41	3.58 ± 0.86	<0.0001*
Licence	None	2.37 ± 1.41	3.91 ± 0.30	0.0004*++
	Partial	2.74 ± 1.40	3.67 ± 0.72	<0.0001*
	Full	2.76 ± 1.34	3.56 ± 0.92	<0.0001*++

[1]Partial=G1/G2/lerner's permit

+indicates GLS score presented as mean score +/- standard deviation.

++indicates cells with fewer than five individuals, and therefore statistical analysis should be interpreted with caution as data unlikely to be normally distributed.

* indicates significant difference between pre and post-GLS knowledge scores using independent two-tailed Student's T-test analyses (significance value α=0.05). P-values greater than 0.05 are rounded to two decimal places and those less than 0.05 are rounded to three decimal places.

Table 6.3: Number of students self-reported having contravened each of the GLS restrictions for each data source from both survey sources[1] (Mann et al, OSDUS) since the introduction of GLS in 1994.

GLS Restrictions	Mann et al: 1995 Number of Students (%) N=699 #responders =699	Mann et al: 1998 Number of Students (%) N=834 #responders =827	OSDUS G1 - Number of Students (%) N=258 #responders =258	OSDUS G2 – Number of Students (%) N=229 #responders =222
Driven without licensed front passenger	157 (22.5%)	178 (21.3%)	102 (44.2%)	N/A
Driven on 400-series highways	133 (19.0%)	175 (21.0%)	42 (18.3%)	N/A
Driven between 12am and 5am	149 (21.3%)	204 (24.5%)	46 (20.0%)	N/A
Driven after any amount alcohol (BAC >0)	89 (12.7%)	131 (15.7%)	15 (6.5%)	53 (23.9%)
Driven without seatbelt use by other passengers	N/A	N/A	62 (27.0%)	93 (41.9%)
Total	251 (35.9%)	339 (40.9%)	226 (87.6%)	100 (45%)

[1]Each survey represents an independent cross-sectional survey of students (grades 11 and 12 for Mann et al survey and ages 16-19 for OSDUS survey). Given that the data represent different student populations, statistical analyses were not performed.

In none of the multiple logistic regression models evaluating contravention of GLS restrictions using Mann's 1995 survey data, was the student's knowledge score of the GLS driving restrictions found to significantly influence the odds that the students contravened the restriction being evaluated (Tables 6.4), with the exception of the multiple logistic regression evaluating the odds of driving on 400-series highways during G1 licensure (Table 6.4B). Table 6.4A illustrates findings from the simple and multiple logistic regression models for those who self-reported not having complied with the zero BAC level while driving. Gender was the only covariate found to significantly influence the odds of self-reported contravention in both the simple and multiple logistic models. Table 6.4B illustrates findings from the simple and multiple logistic regression models for those who self-reported not having complied with the restriction prohibiting driving on 400-series highways. Again, gender significantly influenced the odds of self-reporting this contravention in both the simple and multiple logistic regression models, and knowledge score significantly influenced the odds of self-reported contravention only in the multiple logistic regression model as mentioned above. Table 6.4C illustrates findings from the simple and multiple logistic regression models for those who self-reported not having complied with the restriction requiring a licensed front seat passenger while driving. For this restriction, both gender and licence type were significant when evaluated using both simple and multiple logistic regression modeling. Table 6.4D illustrates findings from the simple and multiple logistic regression models for those who self-reported not having complied with the restriction prohibiting driving between midnight and 5AM. Again, gender was the only covariate found to significantly influence the self-reported odds of contravention of this restriction using both simple and multiple logistic regression modeling.

In all of the models described above, being male was the gender which predicted for contravention of all of the GLS restrictions by simple and multiple regression analyses (displayed as female gender resulting in a decreased odds of contravention). Two hundred and fifty-one students admitted to having contravened at least one of the G1 driving restrictions out of 699 students in the 1995 posttest sample (35.9%). In Mann's 1998 follow-up survey database, 40.9% of students admitted to having contravened at least one of the GLS restrictions during the G1 phase of their driver's licence (see Table 6.2).

The OSDUS survey data were used to evaluate the odds of contravention of any of the GLS restrictions versus none, with one model examining G1 drivers and a second model examining G2 drivers. For G1 drivers, simple and multiple logistic regression models were created using whether or not they self-reported having contravened any one of the restrictions listed in Table 6.2 versus none, adjusting for the covariates felt to influence the outcome under evaluation: age, gender, SES surrogate score. As mentioned in the methods section, none of the interaction terms included in the original multiple logistic regression model were significant and were excluded from the final model, which included all covariates together. In Table 6.5A, the results of the simple and multiple logistic regression models are displayed. Gender was the only covariate found to significantly influence the odds of contravention of any G1 GLS restrictions by both simple and multiple regression modeling. Again, female gender was found to be protective against contravention of any of these G1 restrictions (or conversely male gender inferring an increased risk of contravention).

The same simple and multiple logistic regression models were developed for G2 drivers, with the results displayed in Table 6.5B. As with the other models created and described above, the same covariates were used as above, and all interaction terms were tested in a multiple logistic regression model including the interaction terms involving SES, but none of these was significant and as such no interaction terms were included in any of the final OSDUS models. As with G1 drivers, gender was found to significantly influence the odds of self-reported contravention of any of the G2 restrictions using both simple and multiple logistic regression modeling. In this analysis however, age alone was also found to significantly influence the odds of contravention of the G2 restrictions using both

Table 6.4A: Simple and multiple logistic regression analyses demonstrating odds that students self-reported NOT having complied with G1/G2 zero blood alcohol content while driving with a restricted driver's licence[1].

([2]N = 89/698) Variable	**Simple Logistic Regression** **O.R.[3] (95%CI)**	**P-value**	**Multiple Logistic Regression** **O.R. +/- (95%CI)**	**P value**	**GOF[4] P value**
Age	1.24 (0.89-1.72)	0.20	1.21 (0.84-1.74)	0.30	
Gender	2.57 (1.54-4.26)*	<0.001*	2.52 (1.52-4.20)*	<0.001*	
Licence	1.12 (0.73-1.71)	0.61	1.03 (0.64-1.65)	0.90	
Knowledge Score	0.84 (0.66-1.07)	0.16	0.87 (0.68-1.12)	0.29	
					0.18

[1]Data source: Mann et al. survey 1995.

[2]N=number of students reporting positively out of total number of respondents.

[3]O.R. = odds ratio. Note that the odds ratios are reported based on odds of outcome with decreasing age, male gender, with increasing licensure (none toward G2) and increasing knowledge score.

[4]GOF = Hosmer & Lemeshow Goodness of Fit test

* indicates statistical significance. P-value significance is calculated using α=0.05. P-values greater than 0.05 are rounded to two decimal places and those less than 0.05 are rounded to three decimal places.

Table 6.4B: Simple and multiple logistic regression analyses demonstrating odds that students self-reported NOT having complied with G1 restriction prohibiting driving on any 400-series highways while holding a G1 restricted driver's licence[1].

([2]N=133/ 699) Variable	Simple Logistic Regression		Multiple Logistic Regression		
	O.R.[3] (95%CI)	**P- value**	**O.R. +/- (95%CI)**	**P value**	**GOF[4] P value**
Age	1.20 (0.90-1.59)	0.22	1.05 (0.76-1.45)	0.79	
Gender	1.83 (1.22-2.73)*	0.003*	1.94 (1.29-2.90)*	0.001*	
Licence	1.42 (0.98-2.04)	0.06	1.47 (0.98-2.22)	0.07	
Knowledge Score	1.27 (0.96-1.68)	0.09	1.34 (1.01-1.78)*	0.04*	
					0.92

[1]Data source: Mann et al. survey 1995.
[2]N=number of students reporting positively out of total number of respondents.
[3]O.R. = odds ratio. Note that the odds ratios are reported based on odds of outcome with decreasing age, male gender, with increasing licensure (none toward G2) and increasing knowledge score.
[4]GOF = Hosmer & Lemeshow Goodness of Fit test
* indicates statistical significance. P-value significance is calculated using α=0.05. P-values greater than 0.05 are rounded to two decimal places and those less than 0.05 are rounded to three decimal places.

Table 6.4C: Simple and multiple logistic regression analyses demonstrating odds that students self-reported NOT having complied with G1 restriction requiring a front seat licensed passenger while driving at all times with a G1 restricted driver's licence[1].

([2]N=157/698)	**Simple Logistic Regression**		**Multiple Logistic Regression**		
Variable	**O.R.[3] (95%CI)**	**P-value**	**O.R. +/- (95%CI)**	**P value**	**GOF[4] P value**
Age	1.19 (0.91-1.55)	0.21	1.03 (0.76-1.40)*	0.84	
Gender	1.49 (1.03-2.15)	0.034*	1.56 (1.08-2.27)*	0.02*	
Licence	1.45 (1.03-2.04)	0.033*	1.50 (1.02-2.20)*	0.04*	
Knowledge Score	1.21 (0.94-1.55)	0.14	1.26 (0.98-1.62)	0.07	
					0.97

[1]Data source: Mann et al. survey 1995.

[2]N=number of students reporting positively out of total number of respondents.

[3]O.R. = odds ratio. Note that the odds ratios are reported based on odds of outcome with decreasing age, male gender, with increasing licensure (none toward G2) and increasing knowledge score.

[4]GOF = Hosmer & Lemeshow Goodness of Fit test

* indicates statistical significance. P-value significance is calculated using α=0.05. P-values greater than 0.05 are rounded to two decimal places and those less than 0.05 are rounded to three decimal places.

Table 6.4D: *Simple and multiple logistic regression analyses demonstrating odds that students self-reported NOT having complied with the G1 driving restriction prohibiting driving between midnight and 5 AM while holding a G1 restricted driver's licence*[1].

([2]N=149/ 698)	**Simple Logistic Regression**		**Multiple Logistic Regression**		
Variable	**O.R.[3] (95%CI)**	**P-value**	**O.R. +/- (95%CI)**	**P value**	**GOF[4] P value**
Age	1.07 (0.81-1.40)	0.65	1.05 (0.77-1.43)	0.77	
Gender	2.36 (1.59-3.51)*	<0.001*	2.44 (1.64-3.64)*	<0.0001*	
Licence	0.99 (0.70-1.40)	0.95	1.02 (0.69-1.51)	0.98	
Knowledge Score	1.20 (0.93-1.54)	0.16	1.26 (0.97-1.63)	0.08	
					0.92

[1]Data source: Mann et al. survey 1995.
[2]N=number of students reporting positively out of total number of respondents.
[3]O.R. = odds ratio. Note that the odds ratios are reported based on odds of outcome with decreasing age, male gender, with increasing licensure (none toward G2) and increasing knowledge score.
[4]GOF = Hosmer & Lemeshow Goodness of Fit test
* indicates statistical significance. P-value significance is calculated using α=0.05. P-values greater than 0.05 are rounded to two decimal places and those less than 0.05 are rounded to three decimal places.

simple and multiple logistic regression modeling, with older age being protective against contravention of G2 GLS restrictions. It is worth noting that in none of these models was SES found to be significant in influencing young driver self-reported contravention, neither as a single variable nor as part of a model including age and gender.

Using the OSDUS survey data, 226 out of 258 students carrying a G1 licence, or 88% of them, admitted to having contravened at least one of these driving restrictions, while 100 of the 222 G2 drivers, or 45% of them, admitted to contravening at least one of their driving restrictions. The numbers of students who self-reported having contravened any of the restrictions are listed in Table 6.3.

6.4 Discussion

The Mann et al. 1993 and 1995 surveys demonstrate that knowledge is acquired by young student drivers as a result of GLS implementation, which is a critical initial step needed prior to any impact evaluation addressing outcomes thought to have occurred as a result of the program. Implementation of the GLS program is associated with significantly higher mean knowledge scores among students surveyed after GLS was implemented when compared to students surveyed prior to program initiation.

Using Mann's 1995 survey, simple and multiple logistic regression modeling was used to evaluate which covariates might influence the odds of contravention of any of the four G1 restrictions. Uniformly, the odds of contravention of each of the G1 restrictions were significantly lower among females. Using the OSDUS 2001 survey, female gender was protective against the odds of contravening any of the G1 restrictions, while older age and female gender were protective against the odds of contravening any of the G2 restrictions, both by simple and multiple logistic regression models. In no regression models was SES or knowledge

Table 6.5A: Simple and multiple logistic regression analyses demonstrating odds that G1 drivers contravened any of the G1 GLS restrictions[1].

([2]N=32/258)	**Simple Logistic Regression**		**Multiple Logistic Regression**		
Variable	**O.R.[3] (95%CI)**	**P-value**	**O.R. +/- (95%CI)**	**P value**	**GOF[4] P value**
Age	1.0 (0.73-1.38)	0.90	1.10 (0.80-1.52)	0.55	
Gender	2.06 (1.26-3.36)*	0.038*	2.07 (1.26-3.39)*	0.004*	
SES	0.04 (0.001-1.41)	0.07	0.05 (0.001-1.82)	0.10	
					0.91

[1]Data source: OSDUS survey 2001.

[2]N=number of students reporting positively out of total number of respondents.

[3]O.R. = odds ratio. Note that the odds ratios are reported based on odds of outcome with decreasing age, male gender, and increasing SES.

[4]GOF = Hosmer & Lemeshow Goodness of Fit test

* *indicates statistical significance.* P-value significance is calculated using $\alpha=0.05$. P-values greater than 0.05 are rounded to two decimal places and those less than 0.05 are rounded to three decimal places.

Table 6.5B: Simple and multiple logistic regression analyses demonstrating odds that G2 drivers contravened any of the G2 GLS restrictions[1].

([2]N=149/ 698)	Simple Logistic Regression		Multiple Logistic Regression		
Variable	**O.R.[3] (95%CI)**	**P- value**	**O.R. +/- (95%CI)**	**P value**	**GOF[4] P value**
Age	1.88 (1.37-2.57)*	<0.0001*	1.81 (1.32-2.49)*	0.0003*	
Gender	2.23 (1.37-3.62)*	0.001*	2.01 (1.23-3.28)*	0.005*	
SES	0.44 (0.04-5.48)	0.53	0.41 (0.03-5.22)	0.49	
					0.53

[1]Data source: Mann et al. survey 1995.

[2]N=number of students reporting positively out of total number of respondents.

[3]O.R. = odds ratio. Note that the odds ratios are reported based on odds of outcome with decreasing age, male gender, and increasing SES.

[4]GOF = Hosmer & Lemeshow Goodness of Fit test

* indicates statistical significance. P-value significance is calculated using α=0.05.). P-values greater than 0.05 are rounded to two decimal places and those less than 0.05 are rounded to three decimal places.

about GLS significant in influencing the odds of GLS restriction contravention (with the one exception of 400-series driving for G1 licensees using multiple regression modeling only, recognizing that when evaluating knowledge alone, it failed to significantly influence the outcome measure on its own, and so this finding is to be interpreted with caution).

It is very difficult to obtain accurate reports of illegal or undesirable behaviours among adolescents [2], justifying the rationale for obtaining this information in an anonymous self-reported fashion, where one would expect to obtain more information than might have been admitted to in a public forum. This is particularly true of the 'socially undesirable' behaviours such as drinking and driving, even among peer groups [2].

It was not possible to capture pre-GLS contravention behaviour, since prior to April 1994, the GLS restrictions were not in place for students to contravene. Consequently, an effort was made to estimate pre-GLS young novice driving behaviour. There are two reports in the literature involving questionnaires of the driving teen as well as their parents by telephone, but none with anonymity, raising the concerns outlined above [85] [72]. A few reports indicated estimates of young teen driving behaviour (as captured by collisions involving these driving behaviours [10] rather than self-reporting of such behaviours). The vast discrepancy found in Mann's surveys between contravention of restrictions and rates of students caught by police for such contravention would suggest that this is an unreliable estimate. As such there is no good baseline measure of behaviour prior to implementation of GLS. Using reports from New Zealand, where GLS was initiated in 1987, the researchers reported that the vast majority of young novice drivers contravened at least one of the GLS restrictions weekly [41], despite the finding that the proportion of young driver crashes that occurred at night dropped from 37% to 27% following GLS implementation based on absolute collision counts [18]. Ontario's interim evaluation [10] demonstrated a decrease in collisions involving alcohol of 19% among young drivers following

GLS implementation, based on collision rates using per 10,000 licensed drivers. Additionally, the same interim evaluation reported a 48% decrease in night time collisions among young drivers in the one year following the GLS implementation, and a 22% decrease in collisions on 400-series highways among young novice drivers. The estimates of behaviour based on resultant collisions involving those behaviours are gross underestimates of behaviour based on findings of this study and speak to the need for a causal model program evaluation where causal links are established between program implementation and outcome evaluation, rather than assuming that any changes in outcome are direct results of program implementation.

An evaluation of Nova Scotia's GLS program (similar to Ontario's, established in October 1994) by teen and parent non-anonymous telephone survey in 1998 [85] demonstrated that only 9% of young drivers admitted to driving without supervision during the G1 phase, and only 2% admitted to drinking and driving. However, 40% admitted to having violated the night driving restriction [85]. The reliability of these findings is questionable given that adolescents knew their parents were being interviewed by the same interviewer as well, even with promised confidentiality. An adolescent telephone survey conducted following Florida's GLS implementation (of teens alone, not including their parents), teens self-reported a decrease in drinking and driving from 24% to 20% following implementation of their GLS in 1996 [35]. This last report is most in keeping with the findings of this current program evaluation, where young student drivers self-reported contravention behaviour. As such, it is reasonable to utilize a rate of 24% as contravention of drinking and driving rates prior to administration of GLS. With this pre-GLS estimate and the findings of this study, there is no evidence that introduction of GLS had any impact on driving behaviour at all. Given that the other GLS restrictions (no night driving and no 400-series highway driving) were not restrictions prior to GLS implementation, there are no normative values to estimate behaviour of these prior to 1994. The need for a front licensed passenger was a condition of the 'learner's permit' phase of licensure prior to

1994, however there are no known publications addressing contravention of this behaviour in a self-reported and anonymous fashion prior to the GLS implementation.

In summary, these findings indicate that despite knowledge of the GLS driving restrictions at each stage of the licensing process as evidenced by a significant increase in mean knowledge score, this did not translate into a visible impact on behaviour. Overall, the individual student's knowledge score did not significantly influence the odds of contravention of the GLS restrictions according to both survey databases. If anything, there is a trend over time toward increase in self-reported contraventions of any of the GLS restrictions between 1995 and 2001 according to both data sources (see Table 6.3). The finding could be due to social acceptance among peers or among students themselves for contravention of these restrictions, or real increased contravention behaviours over time, which may represent a pattern of decay in behavioural change, where initial program impacts are felt to diminish over time. This is speculated to be due to a change in risk perception such that the students increasingly see their changes of being caught as being lower than they initially thought. In other words, the students come to realize that the consequences of contravention (which need to be swift, sure and severe in order to create fear of punishment according to deterrence theory) are not as likely as they are initially made to seem by either word of mouth or public policy advertisements [73]. This certainly seems to be a valid assumption on the part of students in these databases, such that on average 1% of students admit to having been caught by police, while 40-86% of them are contravening at least one of these restrictions, often on a regular basis (according to focus group surveys conducted among young student drivers, see Chapter 5). According to the focus group research involving police officers who lay such charges, most of the students who are charged with GLS contraventions do not end up with any court-imposed fines/consequences, and many of the charges are dropped by the courts, negating any of the intended 'deterrence' effects of the GLS conditions.

The main limitation of this study is a conceptual one – that it was not possible to ask students to self-report contravention to a set of restrictions that were not restrictions prior to the program's implementation. As such, it is not possible to get a baseline pre-GLS behaviour score in order to do standard pre-post intervention analyses.

The primary statistical limitation of this study is that the OSDUS survey was designed as a cluster sample analysis, with over-sampling of Northern Ontario schools, however the weighted adjustment and clustering information was not available for this pilot study, which is likely to have resulted in biased estimates using the unadjusted survey data.
Other limitations of this study include the self-reported nature of the surveys, and so it is not known to which degree the changes over time are influenced by social acceptance of GLS contravention behaviours rather than true behaviours. An important statistical limitation was that the two studies were not adjusted for clustering effect by provincial school board region and by school (as the data required to identify each student's school and region were not provided), and it is possible that some component of the behaviours reported are influenced by peers or cultural norms in the same classroom or same school/region more than would be expected from random effects.

One final potential limitation of this study is that there were other covariates of interest that were unfortunately not captured by this survey, such as a surrogate measure for socio-economic status within the Mann et al. data, resulting in the need for additional survey sources such as the OSDUS survey. As well, these surveys grouped together students who admitted to having contravened each of the GLS restrictions at least once, with those who might have been habitual restriction breakers. These data remain useful for the purposes of this analysis however, given that in terms of risk of serious injury and death by young inexperienced and unlicensed drivers, it "only takes once" for dire circumstances to occur. These surveys were more useful in the determination of prevalence rather than incidence, implying that if there exist students who are willing to contravene the restrictions even once, the deterrence theory driving implementation of the GLS program is not effective.

6.5 Relating Pilot Knowledge/Behavioural Survey Data to Proposal

Despite knowing the rules of GLS restrictions, more and more students admitted to contravening the restrictions as time from its introduction increased (see Table 6.3) (a finding consistent with other reported studies evaluating self-reported contravention of GLS restrictions in other jurisdictions [97] [85] by non-anonymous telephone questionnaire methodology. The most recent survey used in this study was in 2001, which demonstrated that 85% of students in the G1 phase admitted to having contravened the restrictions at least once. Of interest, 6.5% of G1 novice drivers drove after drinking alcohol, but almost 25% admitted to doing so during their G2 licence phase. This suggests that the deterrence theory is not having the impact expected, once students recognize that the vast majority of contraveners are not being punished as advertised, such that the severity, consistency and immediacy of punishment for contravention is not evident to students (evidence of failure of the deterrence theory component of this program). This is speculated to lead to a decay in learned behavioural change, where the initial impact of program introduction decreases over time, leading to minimal long-term impacts by the program's introduction. This has been seen in a number of other programs, such as the only long-standing pre-post evaluation of a GLS program in its site of origin, New Zealand [18].

In order to further evaluate both the knowledge regarding GLS restrictions and self-reported contravention of these restrictions, the proposal for a comprehensive program evaluation outlined in Chapter 4 describes the development of further questions for students, which would be added to the OSDUS survey in 2009, and analyzed using their weighted adjustments for proper cluster analysis in order to avoid errors from biased estimates.

Internal consistency will be assessed by calculating Cronbach's alpha achieved for all 9 items in Mann's original knowledge question. The final number of items to be retained in the knowledge score will be determined by the combination of items resulting in the highest alpha value. Additionally, the questions will be expanded in order to ensure testing of both knowledge and behaviour for all licence types. Finally, the restriction regarding the limiting of teenage passengers during the G2 phase of licensure will also be added and evaluated in this comprehensive evaluation planned for 2009 within the OSDUS survey. Further questions to address the influence of peers and other factors identified in the biopsychosocial model are described in Chapter 4.

CHAPTER SEVEN: SIGNIFICANCE OF PROPOSED EVALUATION

Motor vehicle collisions remain the leading cause of death for North Americans in the first four decades of life, and young drivers are over-represented in this cohort, as such any initiative aimed at lowering the mortality and morbidity associated with motor vehicle collisions would be expected to have an enormous societal impact. Although GLS was introduced as a program aimed at exposing high risk driving situations to new drivers in a graded way, its impact in Ontario has not been evaluated in a long-term setting, nor has the program in general terms ever undergone a comprehensive evaluation to determine which components contribute to the program's successes or lack thereof. This is the first causal program logic model developed for the purposes of evaluating GLS programs, Ontario's in particular.

The preliminary pilot studies reported here have illustrated some findings to suggest that there may be discrepancies between the program's intent and its outcomes. For example, despite knowing the rules of GLS restrictions, an increasing proportion of students (according to pilot survey and focus group data, see Chapters 5 & 6) admitted to contravening the restrictions as time from its introduction passed (a finding consistent with other reported studies evaluating self-reported contravention of GLS restrictions in other jurisdictions [9] [99]. The most recent survey used in this study was in 2001, which demonstrated that 87% of students in the G1 phase admitted to having contravened the restrictions at least once. Of interest, 6.5% of G1 novice drivers drove after drinking alcohol, but almost 24% admitted to doing so during their G2 licence phase. This suggests that deterrence theory is not having the impact expected, since students recognize that the vast majority of contraveners are not being punished as advertised, such that the severity, consistency and immediacy of punishment for contravention is not evident to students (evidence of failure of the deterrence theory component of this program). This may lead to a decay in behavioural change, where the initial impact of a program's introduction decreases over time, leading to minimal long-term impacts by the program's existence. This has been seen in a number of other programs, such as the only long-standing pre-post evaluation of a GLS program in its site of origin, New Zealand [18].

It is also important to highlight the preliminary analyses of proposal data which suggest that collisions occurring during high-risk driving circumstances when G1 licensed drivers are prohibited from driving were largely unaffected by the introduction of GLS (see Appendix 3), including collisions involving drinking and driving, driving on 400-series highways and driving at night, which represent the majority of young novice driver fatalities [10]. This suggests that the young novice drivers determined to contravene GLS restrictions will not obtain benefit from the protective effect of graduated exposure to these driving situations. Clearly, the fact that a large proportion of young novice drivers self-report contravening these restrictions regularly (see Chapter 6) explains why there seems to be limited reductions in collision rates in these driving situations. Also, variables such as gender were extremely important, such that the elimination of a front licensed passenger during the transition from G1 to G2 for males was associated with a significant increase in collision counts, something not seen for female drivers. This can be correlated back to other research that demonstrated that females were better at demonstrating acquisition of knowledge regarding the GLS restrictions, and that male gender was a predictive covariate for contravention behaviour of these restrictions, regardless of acquired knowledge of the restrictions. Clearly there are exogenous variables not captured by the causal model for evaluating GLS (see Figure 3.4), such as peer influence upon young males, and the need to demonstrate high-risk driving behaviour in this cohort, which circumvents deterrence theory upon which GLS was designed (see Chapter 2).

The Ontario Government may have been politically motivated to implement this program since voters tend to view positively all efforts made to increase safety for young drivers, as it is with drivers' education courses, despite the lack of evidence to support this impression. There may also be financial incentives for these stakeholders to demonstrate the effectiveness of this program, given that it has now become so popularized and publicly funded, and incorporated into provincial and state policies across North America. There may be internal motivation by the Ministry of Transportation to demonstrate the effectiveness of the program that they have implemented provincially.

Further cost effectiveness evaluations are required to demonstrate the cost to tax payers as a result of the program's implementation. Even in the absence of any benefit by the program, the greater concern is whether the program's implementation has led to harm. It is postulated that allowing young novice drivers to advance from G1 to G2 phase 4 months early as a result of taking a driver's education course, is potentially harmful, with a 51% increase in collisions seen among these drivers [10], and a significant increase in G2 collisions among male drivers. This is supported by extensive research that has demonstrated that there is no benefit to young drivers who take Driver's Education courses, in terms of collision and injury rates (a consistent finding since the implementation of school-based driver education courses in the 1960's) [9]. In fact, allowing students to advance to higher risk driving situations at a younger (thus less mature) age, where there is clearly greater contravention of driving restrictions, there could be very real harm to Ontario's young drivers. For this reason, completion of this comprehensive GLS program evaluation will be very beneficial in quantifying the impact that this program has had on collision and injury rates among Ontario's young drivers.

The findings of the definitive study outlined in this proposal will allow the researchers to further expand on the proposed causal model outlined in Figure 3.4, in order to include factors identified in the adolescent risk-taking behavioural development model in Figure 2.1, and develop the ideal causal model for program evaluation of GLS. Depending on the findings of Step 3 (behavioural survey data), added factors such as peer influence and family structure and influence, perception of risk, actual apprehension rates and resultant outcomes (such as conviction or fine or none), and subsequent effect on perception or risk, will be added as moderating exogenous variables in the Figure 3.4, allowing for an 'ideal conceptual model of GLS program evaluation'. This may allow for further insight into adolescent risk-taking behaviour and recidivism, by potentially illuminating subgroups within young drivers who are differentially deterred by the GLS restrictions [100]. This model could then be taken to other jurisdictions and applied repeatedly in order to obtain comprehensive information data about the impact of GLS on collision and injury counts in other states and provinces in North America.

References

1. Vingilis E and Pederson L. Using the right tools to answer the right questions: the importance of evaluative research techniques for health services research in the 21st century. *The Canadian Journal of Program Evaluation* **16**:1-26, 2001.

2. Petrosino A. Answering the *why* question in evaluation: the causal-model approach. *The Canadian Journal of Program Evaluation* **15**:1-24, 2000.

3. Greene JC, Caracelli VJ, and Graham WF. Toward a Conceptual Framework for Mixed-Method Evaluation Designs. *Educational Evaluation and Policy Analysis* **11**:255-274, 1989.

4. Mayhew DR and Simpson HM. New to the Road. Young drivers and novice drivers: similar problems and solutions? 1-180. 1990. Ottawa,Ontario, Traffic Injury Research Foundation.

5. Statistics Canada. The Leading Causes of Death at Different Ages. [84F0503XPB]. 2002. Ottawa, ON, Statistics Canada.

6. Mayhew DR, Singhal D, Simpson HM, and Beriness DJ. Deaths and Injuries to Young Canadians from Road Crashes. 2004. Ottawa, Ontario, Traffic Injury Research Foundation.

7. Mayhew DR and Simpson HM. Youth and Road Crashes. Reducing the Risks from Inexperience, Immaturity and Alcohol. 1-10. 1999. Ottawa, Ontario, Traffic Injury Research Foundation.

8. Robertson LS and Zador PL. Driver education and fatal crash involvement of teenaged drivers. *American Journal of Public Health* **68**:959-965, 1978.

9. Mayhew DR, Simpson HM, Williams AF, and Ferguson SA. Effectiveness and Role of Driver Education and Training in a Graduated Licensing System. *Journal of Public Health Policy* **19**:51-67, 1998.

10. Boase P and Tasca L. Graduated Licensing System Evaluation: Interim Report '98. 410, 1-28. 1998. Toronto, Ontario, Safety Policy Branch, Ontario Ministry of Transportation.

11. Ferguson SA, Leaf WA, Williams AF, and Preusser DF. Differences in young driver crash involvement in states with varying licensure practices. *Accident Analysis & Prevention* **28**:171-180, 1996.

12. Transport Canada. Canadian Motor Vehicle Traffic Collision Statistics: 2002. 2004. Ottawa, ON, Transport Canada.

13. Williams A, Lund A, and Preusser DC. Night driving curfews in New York and Louisiana: Results of a questionnaire survey. *Accident Analysis & Prevention* **17**:461-466, 1985.

14. Warren RA and Simpson HM. The Young Driver Paradox. 1976. Ottawa, Ontario, Traffic Injury Research Foundation.

15. Robertson WW and Finnegan MA. Teenage driver safety: should graduated drivers licensing be universal? *Clinical Orthopaedics and Related Research* **409**:85-90, 2003.

16. Mayhew DR, Simpson HM, des Groseillers M, and Williams AF. Impact of the graduated driver licensing program in Nova Scotia. *Journal of Crash Prevention and Injury Control* **2**:179-192, 2001.

17. Williams AF and Mayhew DR. Graduated Licensing: a Blueprint for North America. 1-11. 1999. Arlington, Virginia, Insurance Institute for Highway Safety and Traffic Injury Research Foundation.

18. Langley JD, Wagenaar AC, and Begg DJ. An evaluation of the New Zealand graduated driver licensing system. *Accident Analysis & Prevention* **28**:139-146, 1996.

19. Mayhew DR, Simpson HM, and Singhal D. Best Practices for Graduated Driver Licensing in Canada. 2005. 171 Nepean Street, Ottawa, Ontario, Traffic Injury Research Foundation.

20. Mayhew DR, Simpson HM, and Pak A. Changes in collision rates among novice drivers during the first months of driving. *Accident Analysis & Prevention* **35**:683-691, 2003.

21. McKnight AJ and Peck RC. Graduated driver licensing: What works? *Injury Prevention* **8**:ii32-ii38, 2002.

22. Hedlund J and Compton C. Graduated driver licensing research in 2003 and beyond. *Journal of Safety Research* **35**:5-11, 2004.

23. Shope JT, Molnar LJ, Elliott MR, and Waller PF. Graduated driver licensing in Michigan: Early impact on motor vehicle crashes among 16-year-old drivers. *The Journal of American Medical Association* **286**:1593-1599, 2001.

24. Williams AF, Preusser DF, Ulmer RG, and Weinstein HB. Characteristics of fatal crashes of 16-year-old drivers: implications for licensure policies. *Journal of Public Health Policy* **16**:347-360, 1995.

25. Begg DJ, Stephenson S, Alsop J, and Langley J. Impact of graduated driver licensing restrictions on crashes involving young drivers in New Zealand. *Injury Prevention* **7**:292-296, 2001.

26. Mayhew DR, Simpson HM, Desmong K, and Williams AF. Specific and long-term effects of Nova Scotia's graduated licensing program. *Traffic Injury Prevention* **4**:91-97, 2003.

27. Mayhew DR, Donelson AC, Beirness DJ, and Simpson HM. Youth, alcohol and relative risk of crash involvement. *Accident Analysis & Prevention* **18**:273-287, 1986.

28. Bouchard J, Dussault C, Simard R, Gendreau M, and Lemire AM. The Quebec Graduated Licensing System for Novice Drivers: A Two-Year Evaluation of the 1997 Reform. 1-8. 2000.

29. Chen LH, Baker SP, Braver ER, and Li G. Carrying passengers as a risk factor for crashes fatal to 16- and 17-year-old drivers. *Journal of the American Medical Association* **283**:1578-1582, 2000.

30. Chen L-H, Bracer ER, Baker SP, and Li G. Potential benefits of restrictions on the transport of teenager passengers by 16 and 17 year old drivers. *Injury Prevention* **7**:129-134, 2001.

31. Hartling L, Wiebe N, Russel K, Petruk J, Spinola C, and Klassen TP. Graduated driver licensing for reducing motor vehicle crashes among young drivers (Crochrane Review). *The Cochrane Library*1-33, 2004.

32. Simpson HM and Mayhew DR. Reducing the Risks for New Drivers: A Graduated Licensing System for British Columbia. 1992. Ottawa, Ontario, Traffic Injury Research Foundation.

33. Rice TM, Peek-Asa C, and Kraus JF. Effects of the California graduated licensing program. *Journal of Safety Research* **35**:375-381, 2004.

34. Ulmer RG, Ferguson SA, Williams AF, and Preusser DF. Teenage crash reduction associated with delayed licensure in Connecticut. *Journal of Safety Research* **32**:31-41, 2001.

35. Ulmer RG, Preusser DF, Williams AF, Ferguson SA, and Farmer CM. Effect of Florida's graduated licensing program on the crash rate of teenage drivers. *Accident Analysis & Prevention* **32**:527-532, 2000.

36. Steenbergen LC, Kidd PS, Pollack S, McCoy C, Pigman JG, and Agent KR. Kentucky's graduated driver licensing program for young drivers: barriers to effective local implementation. *Injury Prevention* **7**:286-291, 2001.

37. Foss R, Feaganes JR, and Rodgman EA. Initial effects of Graduated Driver Licensing on 16-year-old crashes in North Carolina. *The Journal of American Medical Association* **286**:1588-1592, 2001.

38. Elliott MR and Shope JT. Use of a Bayesian changepoint model to estimate effects of a graduated driver's licensing programme. *Journal of Data Science* **1**:43-63, 2003.

39. Shope JT and Molnar LJ. Michigan's graduated licensing program: evaluation of the first four years. *Journal of Safety Research* **35**:337-344, 2004.

40. Hyde LK, Cook LJ, Knight S, and Olson LM. Graduated driver licensing in Utah: Is it effective? *Annals of Emergency Medicine* **45**:147-154, 2005.

41. Begg DJ, Langley JD, Reeder AI, and Chalmers DJ. The New Zealand graduated driver licensing system: Teenagers' attitudes towards and experiences with this car driver licensing system. *Injury Prevention* **1**:177-181, 1995.

42. Solomon R and Pitel SGA. Rating the Provinces and Territories: The 2006 Report Card. A comprehensive review of provincial and territorial impaired driving laws. Available at: http://www.madd.ca/english/research/rtp.html. 9-1-2006.

43. Solomon R and Chamberlain E. Youth and Impaired Driving in Canada - Opportunities for progress. Available at: http://www.madd.ca/english/research/pubs.html . 8-1-2006.

44. Foss RD and Evenson KR. Effectiveness of graduated driver licensing in reducing motor vehicle crashes. *American Journal of Preventive Medicine* **16**:47-56, 1999.

45. Erickson EH. Toys and Reasons: Stages in the Ritualization of Experience. 1977. New York, Norton.

46. Homel. Policing the drinking driver: random breath testing and the process of deterrence. 1986. Canberra, Federal Office of Road Safety.

47. Vingilis E, Blefgen H, Colbourne D, Culver P, Farmer B, Hackett D, Treleaven J, and Solomon R. The adjudication of alcohol-related criminal driving cases in Ontario: A survey of Crown attorneys. *Canadian Journal of Criminology* **October**:639-649, 1990.

48. Akers RL. Rational Choice, Deterrence and Social Learning Theory in Criminology: The Path Not Taken. *Journal of Criminal Law and Criminology* **81**:653-676, 1990.

49. Gibbs JP. Deterrence theory and research. *Nebraska Symposium on Motivation* **33**:87-130, 1985.

50. Akers RL and Lee G A. Longitudinal Test of Social Learning Theory: Adolescent Smoking. *Journal of Drug Issues* **26**:317-343, 1996.

51. Last JM. A Dictionary of Epidemiology. 4. 2001. Oxford University Press.

52. Silberman M Toward a theory of criminal deterrence. *American Sociological Review* **41** :442-461, 1976.

53. Webb SD. Deterrence Theory: A Reconceptualization. *Canadian Journal of* Criminology. **22**;23-35,1980.

54. Brennan PA and Mednick SA. Learning Theory Approach to the Deterrence of Criminal Recidivism. *Journal of Abnormal Psychology* **103**:430-440, 1994.

55. Chambliss W and Seidman RB. *Law, Order and Power.* Massachusetts: Addison-Wesley Publishing Company, 1971.

56. Akers A. Social Learning Theory of Crime. *Criminological Theory: Past to Present.*Sage Publications, Inc., 1994.

57. Nichols JL and Ross HL. The Effectiveness of Legal Sanctions in Dealing with Drinking Drivers. *Alcohol, Drugs and Driving* **6**:33-60, 1990.

58. Shepherd JP. Criminal deterrence as a public health strategy. *Lancet* **358**:1717-1722, 2001.

59. Vingilis E, Blefgen H, Lei H, Sykora K, and Mann R. An evaluation of the deterrent impact of Ontario's 12-hour licence suspension law. *Accident Analysis & Prevention* **20**:9-17, 1988.

60. Asbridge M, Mann RE, Flam-Zalcman R, and Stoduto G. The criminalization of impaired driving in Canada: assessing the deterrent impact of Canada's first Per Se law. *Journal of Studies on Alcohol* **65**:450-459, 2004.

61. Gibbs JP. Punishment and Deterrence: Theory, Research and Penal Policy in Law and the Social Sciences. Lincoln: University of Nebraska Press. 1986.

62. Ross HL, McCleary R, and Epperlein T. Deterrence of Drinking and Driving in France -- An Evaluation of the Law of July 12, 1978. *Law and Society Review* **16**:345-374, 1982.

63. Jones RK and Jocelyn KB. Management of the traffic crash risk: a conceptual framework. *Journal of Safety Research* **10**:148-161, 1978.

64. Bandura A. Self-efficacy: toward a unifying theory of behavioural change. *Psychological Review* **84**:191-215, 1977.

65. Akers R. Deviant Behaviour: A Social Learning Approach. 1977. Belmont, CA, Wadsworth Publishing Company.

66. Rooney BL and Murray DM. A meta-analysis of smoking prevention programs after adjustment for error in the unit of analysis. *Health Education Quarterly* **23**:48-64, 1996.

67. Greening L and Stoppelbein L. Young drivers' health attitudes and intentions to drink and drive. *Journal of Adolescent Health* **27**:94-101, 2000.

68. DiClemente RJ, Ponton LE, and Hansen WB. New directions for adolescent risk prevention and health promotion research and interventions. In DiClemente RJ, Hansen WB, and Ponton LE (Eds.), *Handbook of Adolescent health Risk Behavior.* New York: Plenum Press, 1996. Pp. 413-420.

69. Gibbons FX, Helweg-Larsen M, and Gerrard M. Prevalence estimates and adolescent risk behaviour: Cross-cultural differences in social influence. *Journal of Applied Psychology* **80**:107-121, 1995.

70. Wurst T. "Harcore" problem groups among adolescents: Their magnitude and nature, and the implcations for road safety policies. R-2002-25. 2002. Leidschendam, SWOV Institute for Road Safety Research, The Netherlands.

71. Lerner RM and Galambos NL. Adolescent development: Challenges and opportunities for research, programs, and policies. *Annual Review of Psychology* **49**:413-446, 1998.

72. Williams AF, Nelson LA, and Leaf WA. Responses of teenagers and their parents to California's graduated licensing system. *Accident Analysis & Prevention* **34**:835-842, 2002.

73. Mann RE, Vingilis E, Leigh G, Anglin L, and Blefgen H. School-based programmes for the prevention of drinking and driving: issues and results. *Accident Analysis & Prevention* **18**:325-337, 1986.

74. Jessor R and Jessor SL. Problem Behavior and Psychosocial Development: A Longitudinal Study of Youth. 1977. New York, Academic Press.

75. Irwin CE and Millstein SG. Risk-taking behaviors and biopsychosocial development during adolescence. *Emotion, cognition, health and development in children and adolescents: A two way street*75-102, 1986.

76. Irwin CE and Ryan SA. Problem Behaviour of Adolescents. *Pediatrics in Review* **10**:235-246, 1989.

77. Bronfenbrenner U. The ecology of human development. 1979. Cambridge, MA, Harvard University Press.

78. Newmark-Sztainer D. The social environments of adolescents: Associations between socioenvironmental factors and health behaviours during adolescence. *Adolescent Medicine: State of the Art Reviews* **10**:41-55, 1999.

79. Chen H. Theory-driven evaluations. 1990. Newbury Park, CA, Sage Publications.

80. Chen H-T. The conceptual framework of the theory-driven perspective. *Evaluation and Program Planning* **12**:391-396, 1989.

81. Vingilis E and Burkell J. A Critique of an Evaluation of the Impact of Hospital Bed Closures in Winnipeg, Canada: Lessons to Be Learned from Evaluation Research Methods. *Journal of Public Health Policy* **17**:409-425, 1996.

82. Campbell DT and Stanley JC. Experimental and Quasi-Experimental Designs for Research. 1966. Chicago, Rand McNally.

83. Rush B and Ogborne A. Program logic models: expanding their role and structure for program planning and evaluation. *The Canadian Journal of Program Evaluation* **6**:95-106, 1991.

84. Lipsey MW. Practice and malpractice in evaluation research. *Evaluation Practice* **9**:5-24, 1988.

85. Mayhew DR, Simpson HM, Ferguson SA, and Williams AF. Graduated licensing in Nova Scotia: a survey of teenagers and parents. *Journal of Traffic Medicine* **26**:37-44, 1998.

86. Rosenbaum R, Hemsley G, and Duncan D. Ontario's probationary driver program: Continuing evaluation. 1985.

87. Agent KR, Steenbergen L., Pigman JG, Kidd PS, McCoy C, and Pollack SH. Impact of the partial Graduated License Program in Kentucky on teen motor vehicle crashes. TRB Record . 2000.

88. Cooper D, Gillen D, and Akins F. Impacts of California's Graduated Licensing Law of 1998. 2004. Berkeley, California, Institute of Transportation Studies, University of California at Berkeley.

89. Patton MQ. Qualitative Evaluation and Research Methods (2nd ed.). 1990. Newbury Park, CA, Sage Publications Inc.

90. Morgan DL. Focus groups as qualitative research. 1997. Thousand Oaks, CA, Sage Publications Inc.

91. Corbin J and Strauss AL. Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology* **13**:3-21, 1990.

92. Hauer E. Observational Before-After Studies in Road Safety: Estimating the Effect of Highway and Traffic Engineering Measures on Road Safety. 1997. Elsevier Science Ltd.

93. Mann RE, Smart RG, Stoduto G, Adlaf EM, Vingilis E, Beirness D, and Lamble R. Changing drinking-and-driving behaviour: the effects of Ontario's administrative driver's licence suspension law. *Canadian Medical Association Journal* **162**:1141-1142, 2000.

94. Box GEP and Jenkins GM. Time Series Analysis Forecasting and Control (2nd ed.). 1976. San Francisco, Holden-Day.

95. Mann RE, Stoduto G, Anglin L, Pavic B, Fallon F, Lauzon R, and Amitay OA. Graduated licensing in Ontario: impact of the 0 BAL provision on adolescents' drinking-driving. *Alcohol, Drugs and Traffic Safety*1055-1060, 1997.

96. Paglia A and Adlaf EM. Secular Trends in Self-reported Violent Activity Among Ontario Students, 1983 - 2001. *Canadian Journal of Public Health* **94**:212-217, 2003.

97. McCartt AT, Leaf WA, Farmer CM, Ferguson SA, and Williams AF. Effects of Florida's graduated licensing program on the behaviors and attitudes of teenagers. *Journal of Safety Research* **32**:119-131, 2001.

98. Adlaf EM, Mann RE, and Paglia A. Drinking, cannabis use and driving among Ontario students. *Canadian Medical Association Journal* **168**:565-566, 1999.

99. McCartt AT, Shabanova VI, and Leaf WA. Driving experience, crashes, and traffic citations of teenage beginning drivers. 1-16. 2001. 1005 N. Glebe Rd., Arlington, VA, Insurance Institute for Highway Safety.

100. Mann RE, Smart RG, Stoduto G, Adlaf EM, Vingilis E, Beirness D, Lamble R, and Asbridge M. The Effects of Drinking-Driving Law: A Test of the Differential Deterrence Hypothesis. *Addiction* **98**:1531-1536, 2003.

101. Thorne S. Data analysis in qualitative research. *Evidence-Based Nursing* **3**:68-70, 2000.

102. Glaser BG. The Grounded Theory Perspective: Conceptualization Contrasted with Description. 2001. Mill Valley, CA, Sociology Press.

103. Walker D and Myrick F. Grounded Theory: An Exploration of Process and Procedure. *Qualitative Health Research* **16**:547-559, 2006.

104. Morse JM and Richards L. Read me first for a user's guide to qualitative methods. 2002. Thousand Oaks, CA, Sage Publications Inc.

105. Solomon R. Fuelled by Alcohol. W-Five. Available at: http://www.ctv.ca/servlet/ArticleNews/story/CTVNews/20071221/wfive_fuelledbyalcohol_071221/20071229?hub=WFive.Accessed on: December 30, 2007.

106. Mayhew DR, Simpson HM, Ferguson SA, and Williams AF. Graduated licensing in Ontario: a survey of parents. *Journal of Traffic Medicine* **27**:71-80, 1999.

107. Jason LA, Berk M, Schnopp-Wyatt DL, and Talbot B. Effects of Enforcement of Youth Access Laws on Smoking Prevalence. *American Journal of Community Psychology* **27**:143-160, 1999.

108. Steptoe A, Wardle J, Fuller R, Davidsdottir S, Davou B, and Justo J. Seatbelt Use, Attitudes, and Changes in Legislation: An International Study. *American Journal of Preventive Medicine* **23**:254-259, 2002.

109. Box GEP and Tiao G. Intervention Analysis with Applications to Economic and Environmental Problems. *JOurnal of the American Statistical Association* **70**:70-79, 1975.

110. Box GEP and Cox DR. An analysis of transformations. *Journal of Royal Statistical Society* **25**:211-252, 1964.

APPENDIX 1

Table 1A and 1B – Key Features of the Learner System of GLS Programs in Canadian Provinces and Territories (ie. G1)

Table 2A and 2B – Key Features of the Intermediate Stage of GLS Programs in Canadian Provinces and Territories (ie. G2)

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Table 1A – Key Features of Lerner GLS Stages in Canada

Component	BC	AB	SK	MB	ON	QC	NL
Effective Date	1998	2003	2005[1]	2003	1994	1997	1999
Entry Age	16	14	16[2]	16[3]	16	16	16
Entry Tests:							
Vision	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Knowledge	Yes	Yes	Yes	Yes	Yes	Yes	Yes[4]
Parental Consent:	Yes	Yes	Yes	Yes	No	Yes	Yes
Age applied	under 19	under 18	under 18	under 18	N/A	under 18	under 19
Minimum Duration:							
Without Driver Ed	12 mo	12 mo	9 mo	9 mo	12 mo	12 mo	12 mo
With Driver Ed	9 mo	N/A	9 mo	N/A	8 mo	8 mo	8 mo
Maximum Duration	2 years	None	None	None[5]	5 years[6]	None	2 years
Supervisor:							
Age	25 or over	18 or over	N/S*	N/S	N/S	N/S	N/S
License type	Class 1-5	Fully licensed	Class 5 +[7]	Fully licensed	Fully licensed	Fully licensed	Class 5
Time licensed	N/S	N/S	1 year[8]	3 years	4 years	2 years	4 years
BAC level	N/S	N/S	<.04	<.05	<.05	<=.08	<.05
Minimum Driving	None	None	None	None	None	None	None
Driver Education:							
Voluntary	Yes	Yes	No[10]	Yes	Yes	Yes	Yes
BAC Level	Zero	Zero	Zero	Zero	Zero	Zero	Zero
Night Restrictions	12am - 5am	12am - 5am	None	None	12am - 5am	None	12am - 5am

Table 1A: Key Features of Lerner GLS Stages in Canada (continued)

Component	NB	NS	PEI	YK	NWT
Effective Date	1996	1994	2000[1]	2000	2005[1]
Entry Age	16	16	16[3]	15	15
Entry Tests:					
Vision	Yes	Yes	Yes	Yes	Yes
Knowledge	Yes	Yes	Yes	Yes	Yes
Parental Consent:	Yes	Yes	Yes	Yes	No
Age applied	under 18	under 18	under 18	under 18	N/A
Minimum Duration:					
Without Driver Ed	12 mo	6 mo	6 mo	6 mo	12 months
With Driver Ed	4 mo	3 mo	6 mo	N/A	N/A
Maximum Duration	None	1 year	1 year	None	None
Supervisor:					
Age	N/S	N/S	N/S	N/S	N/S
License type	Fully licensed	Fully licensed	Same vehicle[7]	Same vehicle[7]	Class 5[7]
Time licensed	N/S	N/S	4 years	2 years[8]	2 years
BAC level	N/S	N/S	<.08	N/S	N/S
Minimum Driving	None	None	None	50 hours[9]	None
Driver Education:					
Voluntary	Yes	Yes	Yes[11]	Yes	Yes
BAC Level	Zero	Zero	Zero	Zero	Zero
Night Restrictions	None	None	None	12am - 5am	11pm-6am

Table 1B – Key Features of G1 or Lerner GLS Stages in Canada

Component	BC	AB	SK	MB	ON	QC
Passenger Restrictions:						
Number	2	N/A	N/A	N/A	N/A	N/A
Incl. supervisor	Yes	N/A	Yes	N/A	N/A	N/A
Limit to # seatbelts	N/A	Yes	Yes[12]	Yes[12]	Yes	N/A
L Sign/Plate	Mandatory	None	None	None	None	None
Road Restriction	None	None	None	Yes[15]	Yes[16]	None
Penalties For GDL Violations	Yes[17]	Yes[18]	Yes[18]	Yes	Yes[19]	Yes[20]
Lower Demerit Point Threshold	2-6 instead of 15-19	8 instead of 15	Yes[24]	Yes[24]	9 instead of 15	4 instead of 15
Suspensions/ Prohibitions	Yes[27]	Yes[28]	Yes[28]	Yes[29]	Yes[30]	Yes[31]
Start Stage Over/ Extended Period	No	No	Yes[36]	No	No	No[36]
Driver Improvement	None	Yes[40]	Yes[41]	Yes[41]	Yes[42]	Yes[43]
Other Features	None	None	Yes[47]	Yes[47]	None	Yes[48]
Minimum Exit Age	16 & 9 mo	16	16	16 & 3 mo	16 & 8 mo	16 & 8 mo

* N/A means not applicable and N/S means not specified.

Table 1B – Key Features of G1 or Lerner GLS Stages in Canada (continued)

Component	NL	NB	NS	PEI	YK	NWT	NU
Passenger Restrictions:							
Number	1[13]	1	1	1[14]	2	1	N/A
Incl. supervisor	Yes	Yes	Yes	Yes	Yes	Yes	N/A
Limit to # seatbelts	N/A	N/A	N/A	Yes	N/A	N/A	N/A
L Sign/Plate	Mandatory	None	None	None	Mandatory	None	None
Road Restriction	None	None	None	None	None	None	None
Penalties For GDL Violations	Yes[21]	Yes[19]	Yes	Yes[18]	Yes[22]	Yes[23]	None
Lower Demerit Point Threshold	6 instead of 12	Yes[25]	Yes[26]	6 instead of 12	7 instead of 15	Yes[25]	None
Suspensions/ Prohibitions	Yes[32]	Yes[32]	Yes[33]	Yes[34]	Yes[35]	Yes[23]	N/S
Start Stage Over/ Extended Period	Yes[37]	Yes[38]	Yes[39]	Yes Admin.	Yes[22]	No[36]	N/A
Driver Improvement	Yes[44]	None	Yes[45]	Yes[46]	None	None	None
Other Features	Yes[49]	None	None	Yes[50]	Yes[51]	None	None
Minimum Exit Age	16 & 8 mo	16 & 4 mo	16 & 3 mo	16 with DE 16 & 6 mo without DE	16	16	16

Table 2A: Key Features of the Intermediate GLS Stages in Canada

Component	BC	AB	SK	MB	ON	QC	NL
Minimum Entry Age	16 & 9 mo	16	16	16 & 3 mo	16 & 8 mo	16 & 8 mo	16 & 8 mo
Entry Requirements: Road test	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parental Consent:	No	No	No	No	No	Yes	No
Age applied	N/A	N/A	N/A	N/A	N/A	under 18	N/A
Minimum Duration:	24 mo	24 mo	18 mo[2]	15 mo	12 mo	24 mo[2]	12 mo
Maximum Duration	5 years	None	None	None	5 years[4]	24 mo[2]	12 mo[5]
BAC Level	Zero	Zero	Zero	Zero	Zero	Zero	Zero
Night Restrictions	None	None	None	None	None	None	12am - 5am[6]
Passenger Restrictions: Number	1[7]	N/A	1[7]	Yes[8]	Yes[9]	N/A	N/A
Limit to # seatbelts	N/A	Yes	Yes[8]	Yes[8]	Yes[9]	N/A	Yes
N Sign/Plate	Mandatory	None	None	None	None	None	None
Road Restriction	None	None	None	None	None	None	None
Penalties for GDL Violations	Yes[11]	Yes[12]	Yes[12]	Yes	Yes[13]	Yes[14]	Yes[15]
Lower Demerit Point Threshold	2-6 instead of 15-19	8 instead of 15	Yes[17]	Yes[18]	9 instead of 15	4 instead of 15	6 instead of 12

Table 2A: Key Features of Intermediate GLS Stages in Canada (continued)

Component	NL	NB	NS	PEI	YK	NWT	NU
Minimum Entry Age	16 & 8 mo	16 & 4 mo	16 & 3 mo	16	16	16	N/A
Entry Requirements: Road test	Yes	Yes	Yes	Yes	Yes	Yes	Yes[1]
Parental Consent: Age applied	No N/A	No N/A	No N/A	Yes under 18	Yes under 18	No N/A	N/A N/A
Minimum Duration:	12 mo	12 mo[3]	24 mo	24 mo	18 mo1	2 mo	N/A
Maximum Duration	12 mo[5]	20 mo	5 years	N/A	N/A	None	N/A
BAC Level	Zero	Zero	Zero	Zero	Zero	Zero	N/A
Night Restrictions	12am - 5am[6]	None	12am - 5am[6]	None	12am - 5am[6]	None	N/A
Passenger Restrictions: Number Limit to # seatbelts	N/A Yes	N/A N/A	Yes[8] Yes[8]	1st yr-3 pass 2nd year	Yes[10] Yes	Yes[8] Yes[8]	N/A N/A
N Sign/Plate	None	None	None	None	None	None	N/A
Road Restriction	None	None	None	None	None	None	N/A
Penalties for GDL Violations	Yes[15]	Yes[13]	Yes	Yes[13]	Yes[16]	Yes[14]	N/A
Lower Demerit Point Threshold	6 instead of 12	Yes[19]	Yes[20]	1st yr - 6 instead of 12 2nd yr - 9 instead of 12	7 instead of 15	Yes[17]	N/A

Table 2B: Key Features of Intermediate GLS Stages in Canada

Component	BC	AB	SK	MB	ON	QC
Suspensions/ Prohibitions	Yes[21]	Yes[22]	Yes[23]	Yes[24]	Yes[25]	Yes[26]
Start Stage Over/ Extend Stage	Yes	No	No[30]	No	No	No[31]
Driver Improvement	None	Yes[33]	Yes[34]	Yes[35]	Yes[36]	Yes[37]
Other Features	None	Yes[40]	Yes[41]	Yes[41]	None	None
Exit Requirements:						
Road test	Yes	Yes	No	No	Yes	No
Course	No	No	No	No	No	No
Minimum Exit Age	18 & 9 mo	18	17 & 6 mo[43]	17 & 6 mo[44]	17 & 8 mo	18 & 8 mo

* N/A means not applicable.

Table 2B: Key Features of Intermediate GLS Stages in Canada (continued)

Component	NL	NB	NS	PEI	YK	NWT	NU
Suspensions/ Prohibitions	Yes[27]	Yes[27]	Yes[28]	Yes[28]	Yes[29]	Yes[14]	N/A
Start Stage Over/ Extend Stage	Yes	Yes[32]	Yes	Yes Admin.	Yes[16]	No[30]	N/A
Driver Improvement	Yes[38]	None	Yes[39]	Yes[39]	None	None	N/A
Other Features	Yes[40]	None	Yes[40]	None	Yes[42]	None	N/A
Exit Requirements: Road test Course	No[5] No	No No	No Yes	N/A N/A	No No	No No	Yes[1] N/A
Minimum Exit Age	17 & 8 mo	18	18 & 3 mo	18	17 & 6 mo	17	N/A

APPENDIX 2

April 10, 2002

Muriel Brackstone
Departments of General Surgery and Epidemiology
University of Western Ontario London, ON N6A 5C1

Dear Dr. Brackstone:

Your project, entitled "Impact Evaluation of Graduated Licensing Program on Young Drivers in Ontario" has been approved by Operations Services. As you are no doubt aware, the continued willingness of our faculty to participate in these studies is greatly enhanced by pertinent feedback of findings. I would suggest, therefore, that you make definite plans to provide the appropriate feedback to the schools involved. The system also expects a copy of your final report for our research files.

Best of luck with your study. I will be in contact regarding school selection. If I can be of further assistance, please feel free to call me.

Sincerely,

Steve Killip Ph.D., Coordinator
Research and Assessment Services
Thames Valley District School Board

Cc: L Hutchinson, Superintendent of Education

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Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. K.N. Speechley
Review Number: 08648E
Revision Number:
Protocol Title: Impact evaluation of graduated licensing program on Young Drivers in Ontario
Department and Institution: Paediatrics, Children's Hospital of Western Ontario
Sponsor: CHILD HEALTH RESEARCH INSTITUTE
Approval Date: 19-Mar-02
End Date: 30-Jun-02
Documents Reviewed and Approved: UWO Protocol, Letters of Information, Consent Form
Documents Received for Information:

This is to notify you that the University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has received and granted full board approval to the above named research study on the date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

This approval shall remain valid until end date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the HSREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the HSREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;

b) all adverse and unexpected experiences or events that are both serious and unexpected;

c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval

Members of the HSREB who are named as investigators in research studies do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

Karen Kueneman, BA (Hons). Ethics Officer HSREB (Expedited)

Chair of HSREB (Expedited): Dr. Paul Harding

April 17, 2002

Muriel Brackstone MD, PhD (Candidate)
Departments of General Surgery and Epidemiology
University of Western Ontario

Dear Muriel,

I am delighted that you will be conducting thesis research on the effects of Ontario's Graduated Licensing system (GLS) on Ontario's young drivers. This is a very important topic, and I am writing to confirm that we are happy to provide you with our Graduated Licensing study database for use in your work.

As you know, we collected information from students with a drivers license (including a learners permit or Graduated License) in grades 11 and 12 in seven Ontario secondary schools. We collected these data on three occasions: 1994 (before GLS was introduced), 1996 (the first post-test after GLS was introduce) and 1998 (the second post-test after GLS was introduced). In the questionnaire we obtained information about demographic characteristics of the students, driving behaviour, knowledge of GLS, and other measures. Parental consent was obtained for all participants. The data will be provided to you in anonymized data sets at no charge.

I hope this arrangement is agreeable to you. Again, I think your thesis is addressing a very important topic for the health of young people, and I would greatly appreciate it if you could keep me informed of your findings.

Yours sincerely,

Robert E. Mann, PhD
Senior Scientist
Centre for Addiction and Mental Health

Associate Professor
Department of Public Health Sciences
University of Toronto

Centre for Addiction
and Mental Health
[illegible] Russell Street
Toronto Ontario
Canada [illegible]
Tel [illegible]

Centre de toxicomanie
et de santé mentale
[illegible], rue Russell
Toronto (Ontario)
Canada [illegible]
Tél [illegible]

www.camh.net

April 26, 2002

To Muriel Brackstone

This letter is to confirm approval of your use of the Ontario Student Drug Use Survey for the purpose of your thesis.

Edward M. Adlaf, Ph.D.
Research Scientist & Head, Population & Life Course Studies
Centre for Addiction & Mental Health &
Department of Public Health Sciences,
Faculty of Medicine, University of Toronto
Voice:
email:

Addiction Research Foundation
Fondation de la recherche
sur la toxicomanie

Clarke Institute
of Psychiatry
Institut psychiatrique Clarke

Donwood Institute
Institut Donwood

Queen Street Mental
Health Centre
Centre de santé mentale
de la rue Queen

*A World Health Organization
Centre of Excellence
Un Centre d'excellence de
l'Organisation mondiale
de la santé*

*Affiliated with the
University of Toronto*

*Affilié à l'Université
de Toronto*

Better understanding, prevention and care
Mieux comprendre - prévenir – soigner

Muriel Brackstone

From: Haroun, Antoine (MTO) [
Sent: Februarv 25. 2002 10:51 AM
To:
Subject: Description of the Data Files

Description of the Data Files...

> Hello Muriel,
>
> Please find attached the description of the data files and format
> (fixed format - ASCII file).
>
> Antoine
>
> <<Description of the Data Files.doc>>

DESCRIPTION OF THE DATA FILES.

Variable Name	Description	Characteristic	
----	Record Number	NUM	(5)
B02	Microfilm Number	CHAR	(9)
B04	Accident Date	NUM	(6)
B09	Total Driver Vehicles	NUM	(3)
B10	Total Involved Persons	NUM	(3)
B11	Total Fatalities	NUM	(3)
B12	Road Jurisdiction	NUM	(1)
B13	Classification of Accident	NUM	(1)
B18	Day of Week	NUM	(1)
B19	Time of Accident	NUM	(4)
B20	Time Police Arrived	NUM	(4)
B26	County	NUM	(2)
B27	Municipality	NUM	(4)
B28	Highway Number and Suffix	NUM	(5)
D06	Class of Licence	CHAR	(3)
D08	Licenced to Drive	NUM	(1)
D09	Driver Suspended	NUM	(1)
D10	Vehicle Class	CHAR	(1)
D11	Driver Province or State	NUM	(2)
D12	Driver Age	NUM	(2)
D13	Driver Sex	CHAR	(1)
D16	Driver Condition	NUM	(1)
D17	Breath Test Code	CHAR	(1)
D18	Driving Restriction (Cond/Endorse)	CHAR	(3)
D19	Police Charge	NUM	(1)
D27	Number of Occupants	NUM	(2)
TOTAL			(70)

LONDON
Health Sciences Centre

trauma

August 28, 2001

Dr. Muriel Brackstone

Dear Dr. Brackstone,

I am writing to confirm that we have received the 92-99 data (inclusive) from The Ontario Trauma Registry (OTR).

It is available for your research use and we are looking forward to collaborating with you on your thesis titled "Impact Evaluation of Graduated Licensing Program on Young Drivers in Ontario".

Sincerely,

Joyce Williamson
Data Analyst, Trauma Program
London Health Sciences Centre

APPENDIX 3

Table A3.1 Estimated effects of GLS on collision counts in Ontario: interrupted ARIMA time-series analyses

Collision Data Models	**Mean Pre-GLS crashes**	**Mean Post-GLS crashes**	**% Diff.**	**Beta Estimate +/- S.E.**	**Time Series p-value**
All Collision Counts	26733	26013	-2.7%		
All collisions – female only	9075	9424	3.8%		
All collisions – male only	17656	16588	-6.4%		
16 year old collisions only	446	161	-177%		
17 year old collisions only	715	623	-14.8%		
18 year old collisions only	797	715	-11.5%		
19 year old collisions only	799	718	-11.3%		
Sum collisions 16-19 yr	2757	2217	-24.4%		
Sum collisions 20-24 yr	4022	3405	-18.1%		
Sum collisions 30-34 yr	3609	3468	-4.1%		
16-19 yr male collisions	1821	1431	-27.3%		
30-34 yr male collisions	2372	2221	-6.8%		
16-19 yr female collisions	940	785	-19.7%		
30-34 yr female collisions	1237	1248	-0.9%		
Collisions for all G1 drivers	92	17	-441%		
Collisions for all G2 drivers	92	98	6.5%		
All males with G1 Licence	50	11	-355%		
All males with G2 Licence	50	83	66%		
All females with G1 Licence	42	5	-740%		
All females with G2 Licence	42	15	-180%		

All 16 yr old – night crashes	25	9	-178%		
All 17 yr old – night crashes	52	39	-33.3%		
All 18 yr old – night crashes	66	55	-20%		
All 19 yr old – night crashes	78	71	-9.9%		
All G1 drivers- night crashes	6	2	-200%		
16-19 yr – 400Hwy crash	118	103	-14.6%		
G1 drivers- 400Hwy crash	3	0.7	-23.3%		
All collisions with fatalities	98	85	15.3%		
16-19 yr with fatalities	10	8	-25%		
All G1 & G2 driver fatalities	0.7	0.9	28.5%		
16-19 yr with +BAC test	77	50	-54%		
All G1 drivers +BAC test	4	4	0		

Collision graphs representing collision counts by month obtained from Ontario's Ministry of Transportation, spanning 1990 to 1999 inclusive.

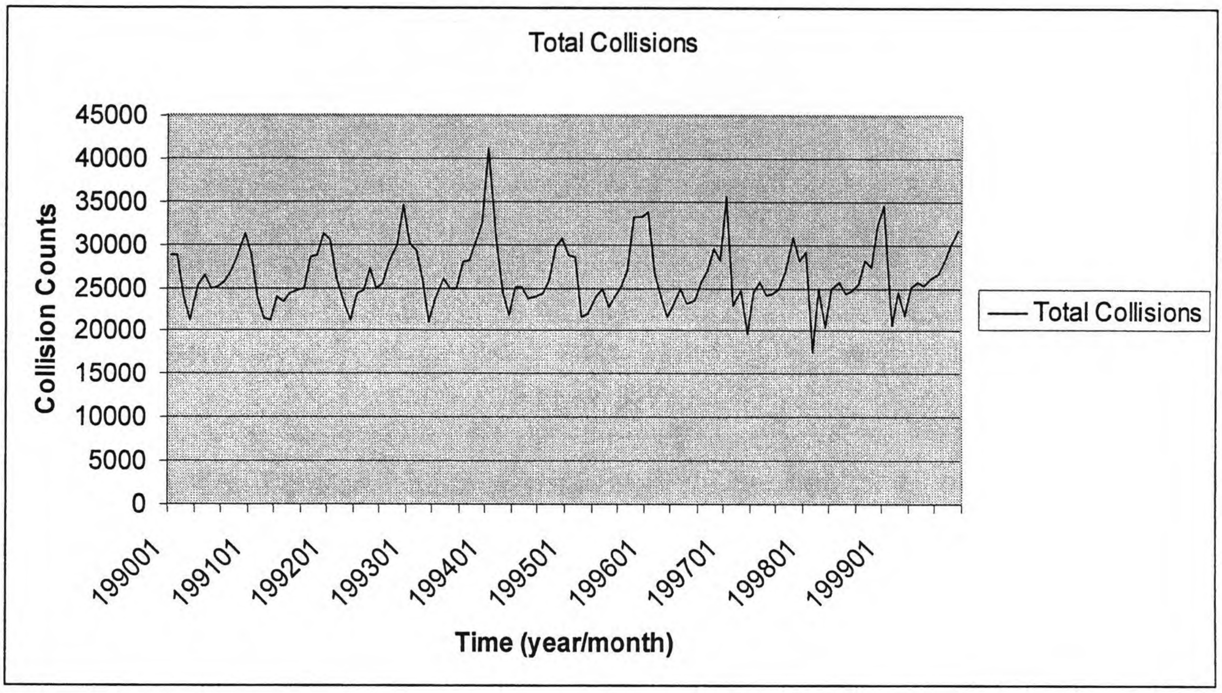

Figure A3.1: Total collision counts for all of Ontario's drivers from 1990 to 1999. Monthly counts are charted, with annual seasonal trends evident over the 10-year period.

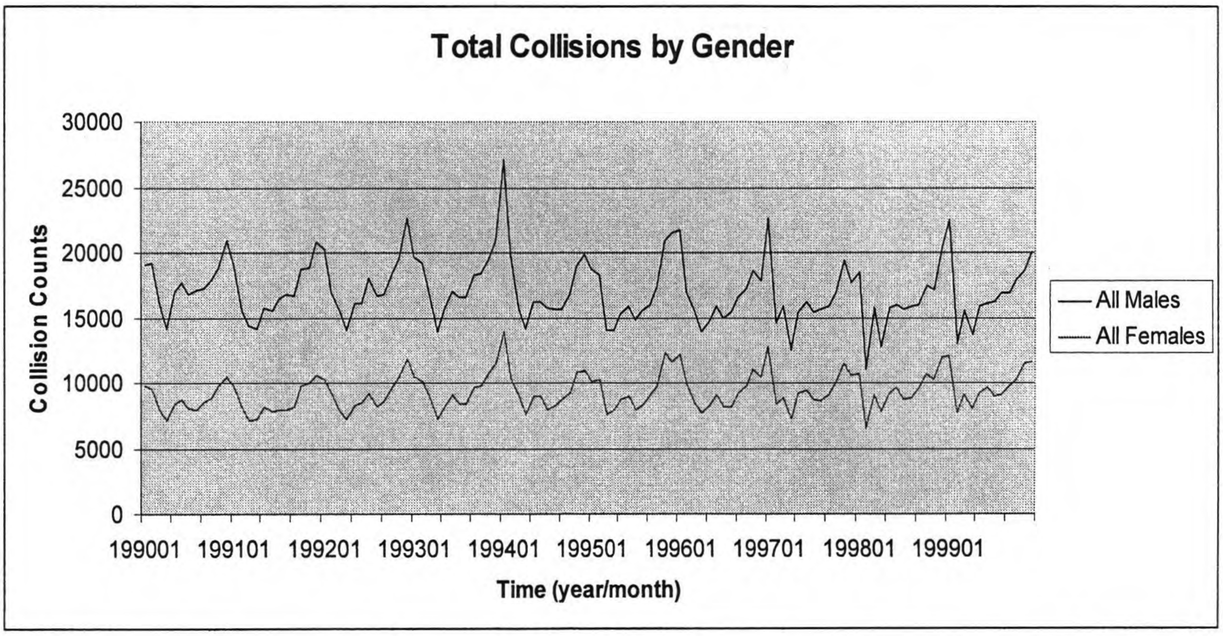

Figure A3.2: Total collision counts separated by gender for all of Ontario's drivers from 1990 to 1999.

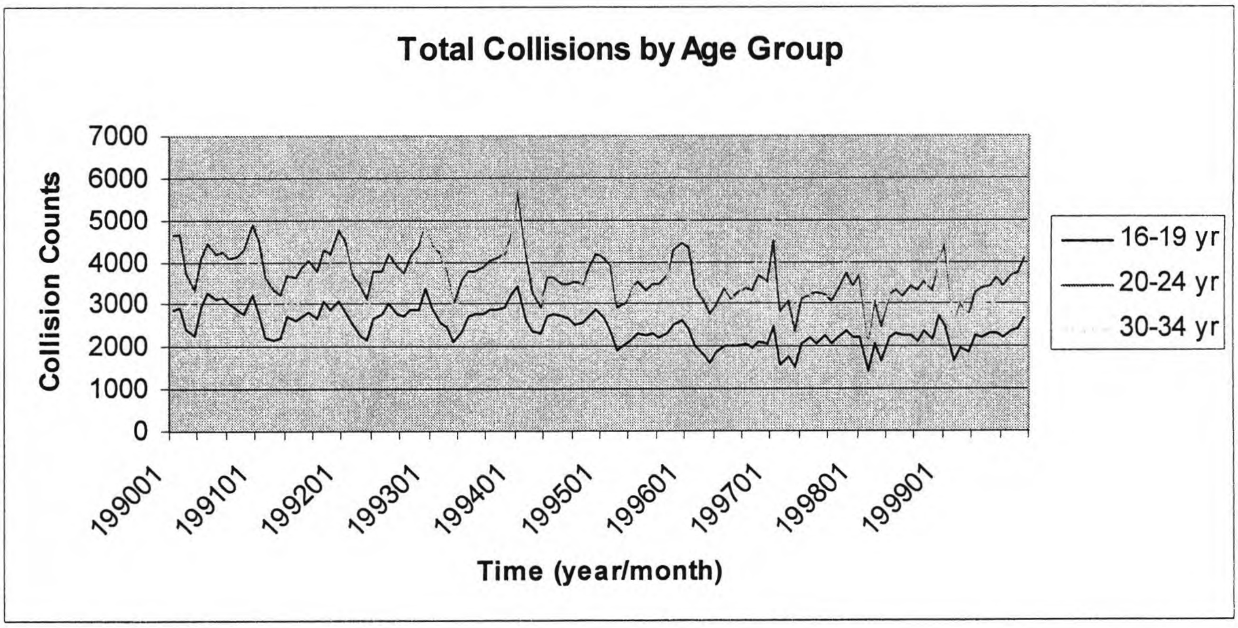

Figure A3.3: Collision counts for drivers aged 16-19, 20-24, and 30-34 by month over the years 1990 to 1999.

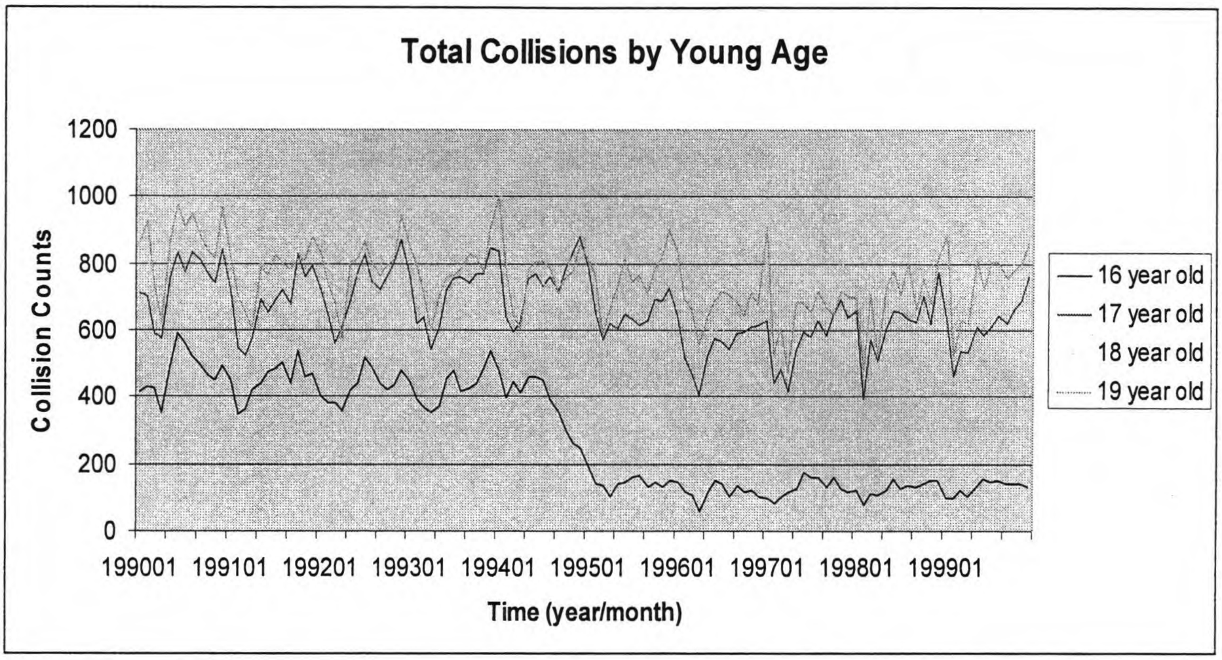

Figure A3.4: Total collision counts plotted by month and subdivided by 16, 17, 18, 19 year olds from 1990 to 1999 inclusive.

Table A3.2: List of OTR Injury Data Subsets Analyzed by SARIMA Time Series Methodology.

Injury Data Subset	Pre-GLS Mean Injuries/month	Post-GLS Mean Injuries/month	Beta Estimate	P-value
All MVC Injuries	101.1	91.8		
Females 16-19yr	4.6	4.0		
Males 16-19yr	8.2	7.4		
Females 30-34yr	4.2	4.2		
Males 30-34yr	10.3	8.8		
Seat-belted 16-19yr	4.4	5.1		
Non-belted 16-19yr	8.4	6.2		
Night MVC Injuries 16-19yr	4.3	4.0		
MVC Fatalities 16-19yr	1.7	1.3		
MVC Fatalities 30-34yr	1.4	1.4		
Severe Injuries ISS>30	4.0	3.7		

Graphs representing injury counts resulting from motor vehicle collisions obtained from the Ontario Trauma Registry for 1992 (inception of database) to 1999 inclusive.

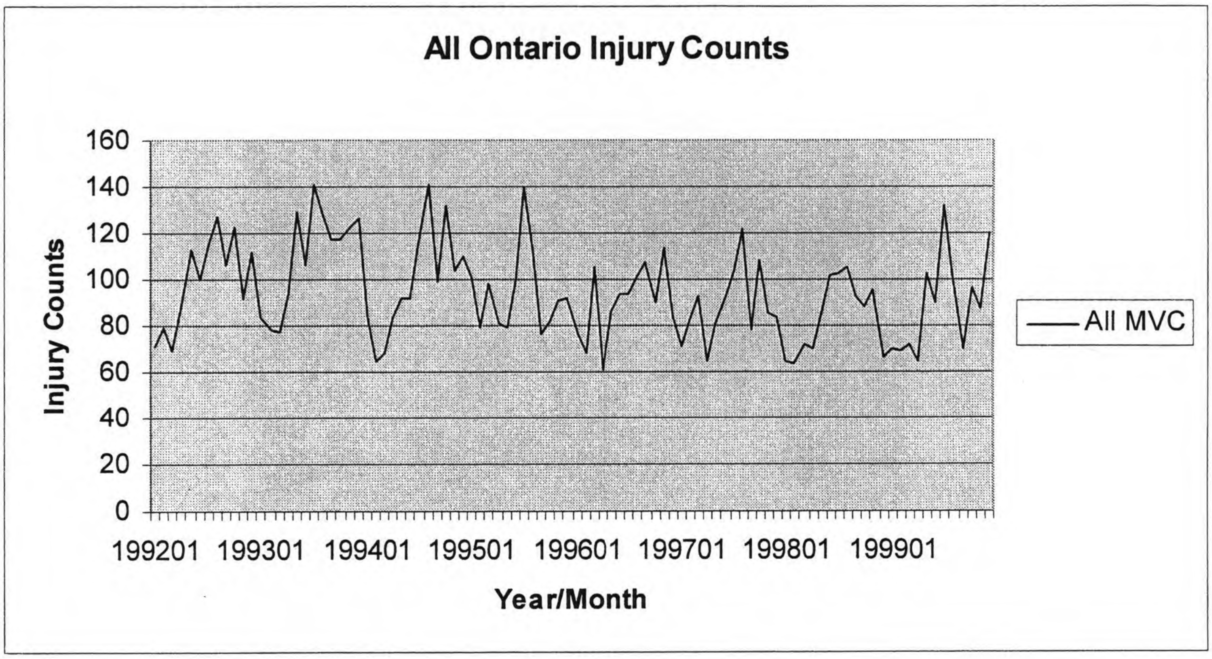

Figure A3.5: Plot of total monthly injury counts for all injuries sustained in Ontario as a result of motor vehicle collisions across all ages from January 1992 to December 1999, inclusive.

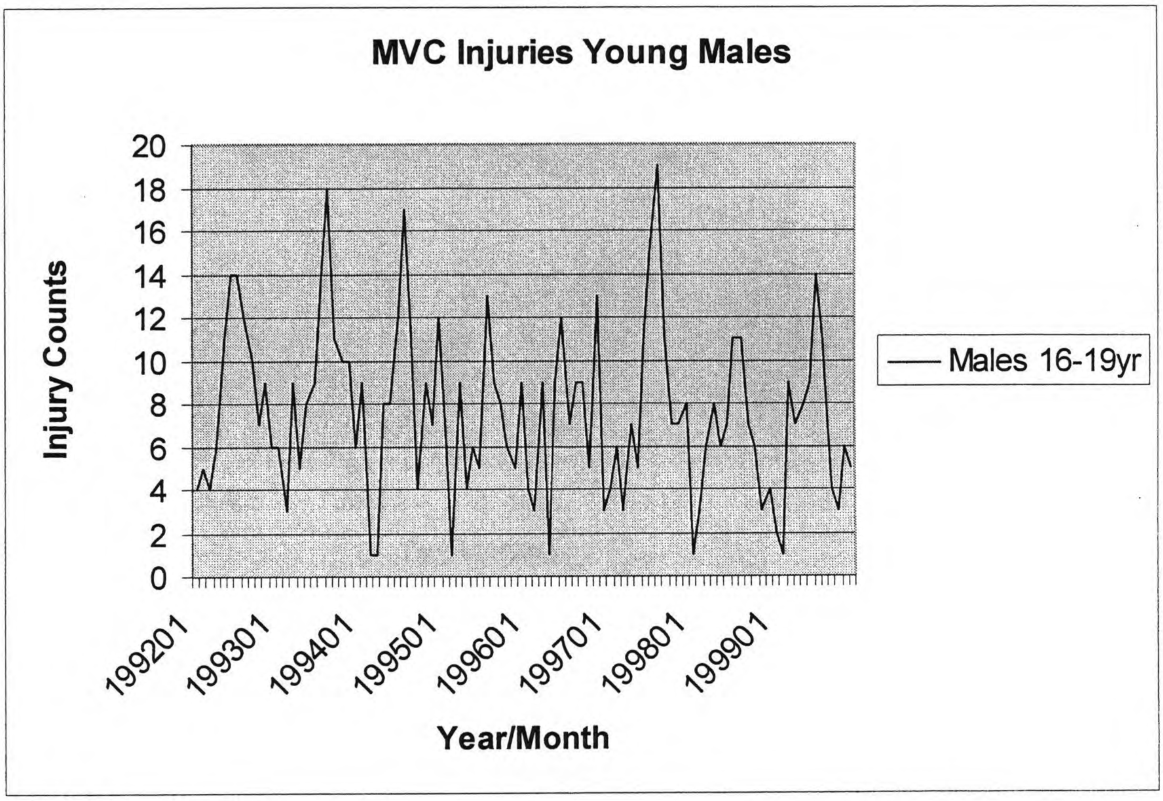

Figure A3.6: Plot of monthly injury counts for injuries sustained to men aged 16-19 in Ontario as a result of motor vehicle collisions (1992 to 1999).

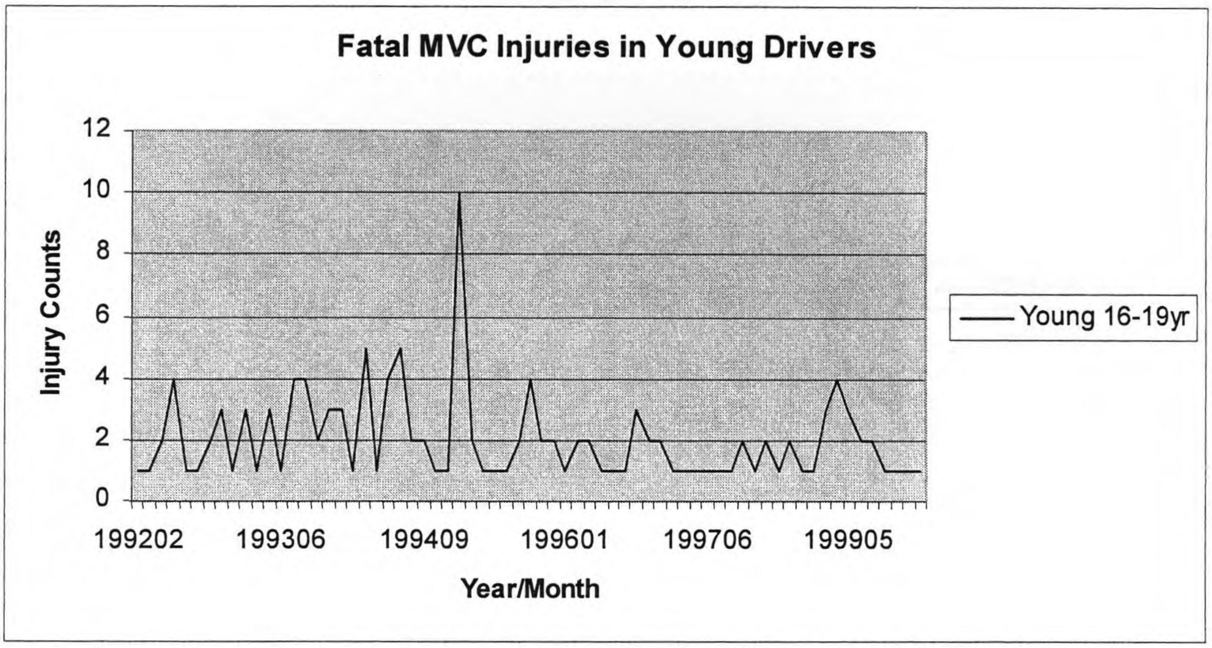

Figure A3.7: Plot of monthly injury counts for injuries among young drivers aged 16-19 (licence type not recorded in this database) whose injuries resulted in death (1992 to 1999).

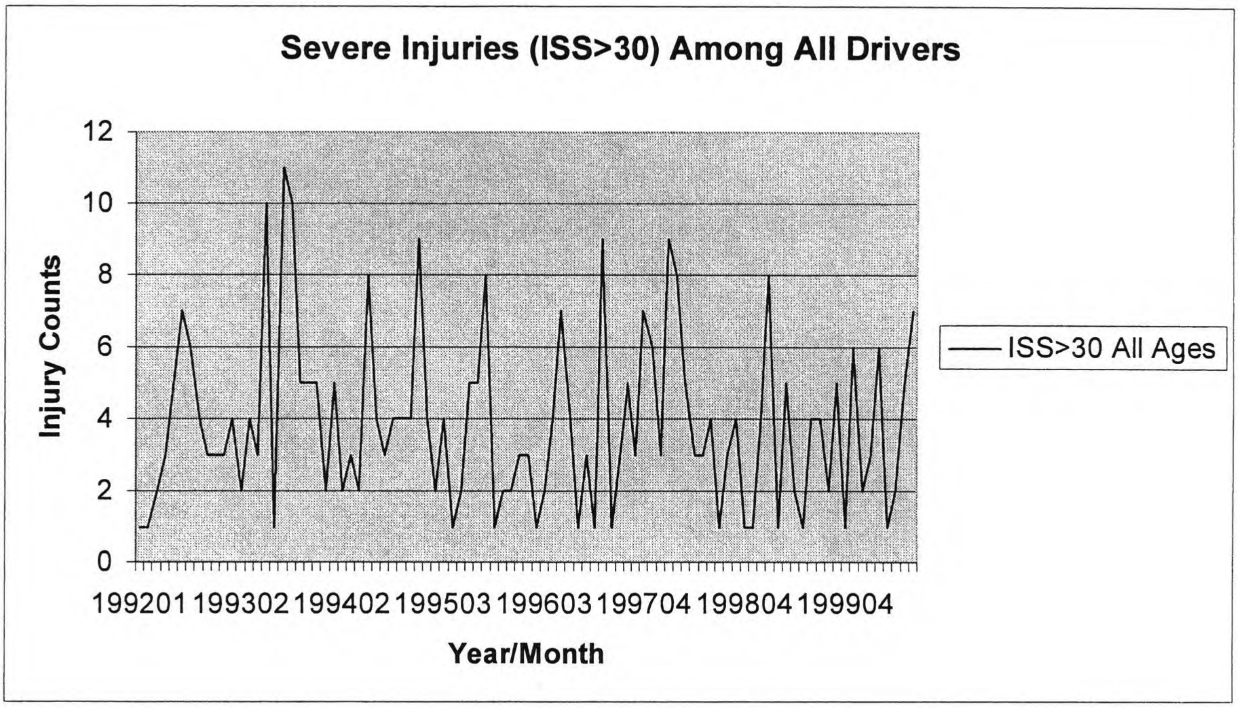

Figure A3.8: Plot of monthly injury counts for all drivers in Ontario for whom injuries sustained were considered severe (ISS>30) (1992 to 1999).

APPENDIX 4

Letter of Information and Consent Form for Students

Dear Student,

Researchers in the Department of Epidemiology and Biostatistics at the University of Western Ontario are conducting a research study entitled "Impact Evaluation of Graduated Licensing Program on Young Drivers in Ontario". This research is designed to study how the Ontario Government's Graduated Licensing Program, a program which allows young drivers to get their driving license over a two year period, is affecting the number of car accidents, injuries and deaths among Ontario's young drivers. The principal researchers involved in this study are Dr. Muriel Brackstone, Graduate Student and Dr. Kathy Nixon Speechley, Associate Professor, both in the Department of Epidemiology and Biostatistics.

The objective of this study is to inform the public and Ontario Ministries of Transportation and Health of the study results, with the ultimate goal of ensuring that the Graduated Licensing Program is as effective as it can be in saving lives and preventing injuries among young drivers.

We are interested in your views about the Graduated Licensing Program, whether you think it is working, as well as what you like and don't like about the program. For this reason, we are inviting your participation in this research. If you agree to participate, you will be asked to attend and participate in a research focus group, which is an interactive group of 6-10 participants, led by Dr. Brackstone at your school during a convenient time for all participants. During this focus group meeting, participants will be asked a number of general questions regarding the Graduated Licensing Program to start a discussion, and to hear the variety of views held by the participants. The session will be audio taped, so that the ideas discussed can be later reviewed. Your school has been selected for participation in the study in consultation with your District School Board. You are eligible to participate if you are an English-speaking student between the ages of 16-19 years. In another part of the project, we will be interviewing police officers regarding the same issues.

You will not be required to be involved in any further studies, nor will you be contacted in the future in relation to this study. Student participants under the age of 18 are required to provide this letter of information to their parent(s)/guardian(s) in order to obtain their written consent as evidenced by their signature below. Each participant is also required to sign below to demonstrate a willingness to participate in this study. You will be given a copy of this letter to keep.

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your academic status. You will be compensated $10.00 as a token of appreciation of your time which will be about one hour, regardless of whether you the session, or decide to withdraw during the session.

All information will be in the form of overall ideas raised by participants, and there will not be any identifying information other than the average age and gender of involved students, as well as each city and region where the focus groups have taken place.
The particular school, class or participant names will never be revealed. All research documents will be stored in a locked office, and once the research is completed, all consent forms and audio tapes will be destroyed.

There will be no direct benefits to individual participants as a result of the study. The study may result in improvements to the Graduated Licensing Program and may influence changes to reduce car accidents, injuries and deaths among young drivers in Ontario. There are no known risks to participating in this study.

Should you have any further questions/concerns regarding this research study, feel free to contact Dr. Muriel Brackstone directly at the University of Western Ontario, Department of Epidemiology and Biostatistics, at (519) 685-8500. If you have any questions about the conduct of this study or your rights as a research subject you may contact Susan Hoddinott, Director, Office of Research Ethics, The University of Western Ontario, at (519)661-3036.

CONSENT FORM

I have read the Letter of Information, have had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction.

Name of Participant: ______________________________

Signature of Participant: ____________________________

Date:____________________

For participants less than 18 years of age:

Name of Parent/Guardian: __________________________ (please print)

Signature of Parent/Guardian: _________________________

Date: ___________________

APPENDIX 5

Semi-structured interview script for Police Officers

We are interested in understanding the experiences of police officers regarding Graduated Licensing, issues surrounding its enforcement and young driver adherence to its restrictions. Please feel free to add anything that you might feel is important for us to know regarding your experiences with GLS, the experiences of other Police Officers you know, your perceptions of young driver adherence and its impact overall.

(i) As you probably all know, graduated licensing has replaced the older learner's permit for getting a driver's licence. What are your opinions about that?

(ii) What are your opinions about the restrictions on drivers in the G1/G2 phases of the GLS program?

-Do you think most young drivers know what the restrictions are?

-What are the restrictions?

(iii) How do you feel about each of the GLS (each named) restrictions?

(iv) What are your personal experiences regarding what occurs when young drivers are pulled over and found to be breaking one of the Graduated Licensing restrictions?

-How common of a problem do you think this is?

-What should the police response to breaking these restrictions be?

(v) Are there any difficulties or frustrations that any of you have experienced with giving fines to young drivers who break the restrictions, or with making the fines stick in the legal setting?

Semi-structured interview script for high school students:

We are interested in understanding what young students who are learning to drive understand about Graduated Licensing in Ontario, and what their perceptions of the program are. We are interested in any views about the program as a whole, any parts of it, how it is enforced by police and how young drivers respond to that. Please feel free to add anything that you think is important for us to know about your experiences with the GLS program, or experiences of others you know about.

(i) As you probably all know, graduated licensing has replaced the older learner's permit for getting a driver's licence. What can any of you tell me your opinions about that?

(ii) What are your opinions about the restrictions on drivers in the G1/G2 phases of the GLS program?

-Do you think most young drivers know what the restrictions are?

-What are the restrictions?

(iii) Can any of you tell me about any instances you experienced where a young driver (yourself or other) didn't keep the driving restrictions?

(iv) What do you perceive are the consequences of breaking the restrictions?

-How common of a problem do you think this is?

-What do you think the police response to this is it?

-What should their response be?

(v) How do each of you feel about each of the GLS restrictions (each raised)?

Table A5.1: DEMOGRAPHIC DATA ON FOCUS GROUP PARTICIPANTS:

FOCUS GROUP 1 (Nov. 13, 2002): Medway High School Senior Girls

Age	Grade	Where living	Type of Licence
18	OAC	Rural	G2
18	OAC	Town (Arva)	G
18	OAC	Rural	G2
18	OAC	Rural	G2
17	G12	Rural	G1
16	G11	Rural	G2
17	G12	City	G2
17	G12	Rural	G2
17	OAC	Rural	G2

FOCUS GROUP 2 (Nov. 13, 2002): Medway High School Senior Boys

Age	Grade	Where living	Type of Licence
16	G11	Rural	G1
16	G11	City	G1
18	OAC	City	G2
16	G12	City	G2
16	G12	City	G2
18	OAC	Town	G2
17	G13	Rural	G2
18	G13	City	G2

FOCUS GROUP 3 (Nov. 13, 2002): London Police Officers

Primary dept.	Years in dept
General patrol	2.5 yrs
General patrol	10 yrs (now traffic for 1 yr)
General patrol	21 yrs (now traffic for 10 yrs)
Uniform	6.5 yrs
Uniform	3 yrs
General patrol/Traffic	over 25 yrs

Table A5.2: Themes and Illustrative Quotes

Themes	Illustrative Quote
"kids don't plan driving well"	Female Student: "it's a problem for parties – at 2 or 3 am, you get into trouble, and you have to drive without parents" Male Student: "having extra people in the car is better than driving drunk" Male Student: "..because there is no one else that can drive and they have to get them all home" Male Student: "17 year olds do stupid things". Male Student: "If you can't drive anyone (G1 phase), you are going to have many more teenagers drive themselves home". Male Student: "Kids would drive home – they'd have to, especially in the country". Police: "..they are not going to get their mom and dad to come to the party so they can drive". Police: "they are not planning it well enough".
"most collision causes are not GLS-related"	Female Student: "I think most of the accidents have nothing to do with (GLS) at all". Female Student: "wasn't their fault, had nothing to do with them being drunk… most of them aren't alcohol-related". Female Student: "I don't think at all they didn't have enough experience at all". Female Student: "They (police) probably think we're immature because of the number of accidents". Male Student: "..I was speeding. It was right after I got my G2". Police: "the vast majority of (students) think it (drinking) isn't cool anymore". Police: "most tickets are for speeding".

"rules are to keep honest people honest"	Female Student: "most of our friends drive off the roads before they have their G1". Female Student: "I'm not going to drink and drive". Female Student: "I think there is probably quite a few people who drive with one beer in their system". Female Student: "whether or not you get a ticket, you still end up speeding". Female Student: "..but the police officers aren't around, ..like near my house". Male Student: "I think ... in the country, you've got way more room to go faster and hide on dirt roads". Police: "Some do it on a continual basis, and those are the ones you want to catch". Police: "if they (young drivers) are going to have a bad record, they are not really going to care about it. They are going to go out and drive anyway". Police: "...for the ones you change...then down the road drives with it anyway – you aren't going to get those kids".
"restrictions should be tougher"	Female Student: "In New Brunswick after 4 months, you can drive alone. I'm jealous of that, but it's not that safe". Female Student: "the road test is pretty easy". Female Student: "One thing I think they should change is like what it is when you have to go to get a test, it's easy for anyone to pass". Female Student: "I think that when you take your test, the number of errors should be lower, because ... I had 17 errors and I still passed". Male Student: "...Driver's Ed. – it's a joke, you don't learn anything, but you do it for insurance purposes". Police: "I don't think (G2) is teaching the kids anything". Police:"(to make it better I suggest) tougher enforcement".

"enforcement depends on officer and judge"	Female Student: "Cops are more tolerant if you are a woman. Women are 'sweet talked'". Male Student: "Girls get warnings the first time, then with guys, some get warnings and some get tickets". Male Student: "The police should be more lenient. They're too suspicious when they see teens". Police: "I just lay the charge and get their parents to pick them up". "It depends on who the officer is and stuff". Police: "traffic court is nothing more than Kangaroo Court". Police: "some people have 0 points and they still manage to get three traffic convictions". Police: "...it comes down to the Justice of the Peace...he (accused) confuse the judge with cockamamie excuses". Police: "there's supposed to be an accompanying suspension to the Ministry of Transportation – I don't think it's happening – the Justice of the Peace drops it down". Police: "I've let people off on occasion, if you live right around the corner – Fine, I did it".
"deterrence is not perceived"	Female Student: "...but the police officers aren't around". Female Student: "...you know the spots where they hide so you just slow down there". Male Student: "people are a lot more like cautious because you don't want to lose your licence (but still break rules)". Male Student: "There are so few people who break the law and get caught, so I don't think it's a big worry". Male Student: "If they're breaking (the rules) now, they don't have a fear of getting caught". Police: "automatic suspension is more effective than fines" Police: "there's no fear of arrest". Police: "In this province, our government is notorious for coming up with laws that are little more than face paint".

APPENDIX 6

PRE-POST GLS SURVEY (R. Mann, CAMH)

Q1. What is your age?

Q2. What is your sex?

Male

Female

Q4. What grade are you in?

Grade 9

Grade 10

Grade 11

Grade 12

Grade 13

Q8. What Licence type do you currently have?

Q8A. G1: level one to drive a car

Q8B. G2: level two to drive a car

Q8C: M1: level one to drive a motorcycle

Q8D: M2: level two to drive a motorcycle

Q8E: I don't have a graduated licence

Q10A: I have a full unrestricted licence to drive a car

Q10B: I have a full unrestricted licence to drive a motorcycle

Q10C: I don't have a full unrestricted licence

Q11E: I was never under the graduated licence system

Q1A. Have you ever taken a Driver Education Course?

Yes

No

Q39A. Which of the following are restrictions for G1 drivers?

Q39AA. New drivers must have Zero Blood Alcohol Content when driving.

-True

-False

-Don't Know

Q39BA. New drivers must not drive during snowstorms.

-True

-False

-Don't Know

Q39CA. New drivers must not drive on 400-series highways.

-True

-False

-Don't Know

Q39DA. New drivers must be accompanied by a front seat licenced driver.

-True

-False

-Don't Know

Q39EA. New drivers must wear a Name Tag identifying them as a new driver.

-True

-False

-Don't Know

Q39FA. New drivers must undergo a special driving test every 6 months.

-True

-False

-Don't Know

Q39GA. New drivers must not drive between midnight and 5 am.

-True

-False

-Don't Know

Q39HA. New drivers must have a special road safety kit in their car.

-True

-False

-Don't Know

Q39IA. New drivers must not drive before 12 noon or after 10 pm.

-True

-False

-Don't Know

Q39B. Which of the following possible G1 restrictions have you ever NOT complied with during the G1 phase of your driving licence?

Q39AAB. You haven't complied with the zero blood alcohol content while driving.

-Yes

Q39BAB. You haven't complied with the snowstorm restriction.

-Yes

Q39CAB. You haven't complied with the 400-series driving restriction.

-Yes

Q39DAB. You haven't complied with having a front seat licenced driver restriction.

-Yes

Q39EAB. You haven't complied with wearing a new driver name tag.

-Yes

Q39FAB. You haven't complied with a special driving test every 6 months.

-Yes

Q39HAB. You haven't complied with carrying a special road safety kit in your car.

-Yes

Q39IAB. You haven't complied with not driving before 12 noon or after 10 pm.

-Yes

Q39AAC. Have you ever been caught by police for breaking any of the GLS level 1 (G1) driving restrictions?

-Yes

-No

Q39AB. Have you ever been caught by police for breaking any of the GLS level 2 (G2) driving restrictions?

-Yes

-No

2001 ONTARIO STUDENT DRUG USE SURVEY

Q1. How old are you?

Q2. What is your gender?
-Male
-Female

Q3. What grade are you in?
-Grade 6
-Grade 7
-Grade 8
-Grade 9
-Grade 10
-Grade 11
-Grade 12
-Grade 13 (OAC)

Q21. Describe your family's financial situation:
-well above average
-somewhat above average
-about average
-somewhat below average
-well below average

Q22. How far did your father go in school?
-graduated from university
-attended university
-graduated college
-attended college
-graduated high school
-attended high school
-did not attend high school
-don't know
-don't have a father

Q23. How far did your mother go in school?
-graduated from university
-attended university
-graduated college
-attended college
-graduated high school
-attended high school
-did not attend high school
-don't know
-don't have a mother

Q25. How many automobiles does your family have?
-none
-one
-two or more

Q27. How many computers does your family have?
-none
-one
-two or more

Q88 [1995, 1998 surveys]. What type of Driver's Licence do you have NOW?
-I have no driver's licence of any type
-I have a full graduated driver's licence
-I have a level one G1 restricted driver's licence
-I have a level two G2 restricted driver's licence
-I don't know

Q88 [1993 survey]. What type of Driver's Licence do you have NOW?
-I have no driver's licence of any type
-I have a full driver's licence
-I have a learner's permit (or probationary licence)
-I don't know

Q89B. Have you ever driven without a fully-licenced front driver while holding a G1 restricted licence?
-Yes
-No

Q89C. Have you ever driven after drinking any amount of alcohol while holding a G1 or G2 restricted licence?
-Yes
-No

Q89D. Have you ever driven between midnight and 5AM while holding a G1 restricted licence?
-Yes
-No

Q89E. Have you ever driven without requiring each passenger to wear a seatbelt while you are driving, while holding a G1 or G2 restricted licence?
-Yes
-No

Q89F. Have you ever driven on any high speed expressways (400-series highways) while holding a G1 restricted licence?
-Yes
-No

QForm. Which questionnaire are you completing (A or B)?
-A
-B

APPENDIX 7

Ministry of Transportation Database

The Ontario Ministry of Transportation maintains an administrative database of all reported collisions in Ontario. Additionally driver information is retained for demographic information. The data requested were individual-level data, for all driver ages, their licence status, any collisions, details surrounding the collisions (such as whether there were any injuries and/or deaths), age and gender. All collisions were recorded as individual entries, and all of these were obtained from the Ontario Ministry of Transportation from 1990 to 1999 inclusive, representing 3.1 million collisions in total.

Ontario Trauma Registry Database

The Ontario Trauma Registry represents a data registry developed and maintained by the Canadian Institute for Health Information (CIHI). The registry was initiated and 1992 represents the first full year of data collection by CIHI from all twelve of Ontario's lead trauma hospitals. These data represented information collected at an individual level on injuries among patients admitted to lead trauma hospitals (a lead trauma hospital is a hospital with all subspecialty services available, which is able to provide tertiary level medical care and act as a referral site for peripheral hospitals, such that patients may be sent to obtain definitive treatment for their injuries), and included variables such as time of accident, involvement of alcohol, whether the injury was caused by a motor vehicle collision, and details regarding the injuries sustained such as injury severity etc. It is not be possible to determine the licence status of injured drivers from the Trauma Database, and linkage with the Ontario Ministry of Transportation data could not be obtained given issues of patient confidentiality. The data kept for each patient used an encrypted patient identification code unique to each patient, with each entry representing an injury requiring admission to a lead trauma hospital.

A large number of variables are collected for each injury, including specific information regarding the date, time, nature and location of injury, transfers from peripheral hospitals, vital signs and specific codes for each injury type, characteristics of the individual such as age, gender, involvement of alcohol, seatbelt, vehicle type and location of patient in the vehicle, and in-hospital course including surgeries, ICU stays, injury severity as calculated by Injury Severity Score (ISS) and follow-up measures of outcome. The ISS greater or equal to 30 was selected to differentiate severe from non-severe injuries, as this represented the cutoff used in for severe injuries by the Ontario Trauma Registry. ISS is calculated based on the sum of the square of score for each of the three most injured body regions (head, thorax, abdomen, pelvis, extremities, superficial tissues), with each potential injury being scored between 1 and 6, with one representing any minor injury (such as scratch or bruise) and 6 representing injuries not compatible with life (such as aortic avulsion or transsection of brainstem).

APPENDIX 8

Time Series Theory

Time series methodology is a statistical tool that examines changes in one time-dependent variable over time. This methodology is use to examine trends in a particular variable over time, as well as for forecasting future trends. Additionally, this method may be utilized to examine the impact of an intervention event on the variable in question, which is termed an Intervention analysis [109]. The intention of time series analysis is to develop a model which predicts variable outcome over time, adjusting for non-independence among data points (a violation of statistical assumptions built into linear regression modeling, such as seasonal correlation between data points). This technique allows for a 'smoothing out' of fluctuations in time-dependent outcome so that any changes in time that remain are due to the intervention being examined.

In order to develop a time series model, one must identify and estimate a seasonal ARIMA (Autoregressive Integrated Moving Average) model for the pre-intervention data points, and incorporate this model into a model testing the impact of the intervention on the time-dependent variable in question.

The first statistical manipulation of time-dependent data is a proper variance stabilization technique, which is necessary to equilibrate fluctuating variances with changing mean values (which in our time series represent collision frequencies) at each time point, t. In other words, Var (Zt) = f (μ_t), where μ_t represents mean collision counts at time t, and f represents a 'function of'. In order to keep the variance stable over time, the pre-intervention data are transformed using Box Cox transformation [110] using the following transformations:

Values of (λ) lambda	Transformation
-1.0	$1/Z_t$
-0.5	$1/\sqrt{1/Z_t}$
0	$\ln(1/Z_t)$

0.5 $\sqrt{1/Z_t}$

1.0 $1/Z_t$ (representing no data transformation)

The transformation step (or lambda value) producing the lowest residual mean square error term is selected as the appropriate data transformation required to stabilize the pre-intervention data variance.

Once variance stability is demonstrated, the next step is to 'difference' the data points, which produces model stationarity by smoothing any time-dependent trends in data. This differencing is performed between data points or lags 1,2,... as well as lags 12, 12+1, 12+2,.. to address seasonal trends. The time series is first evaluated with the non-seasonal differencing lag d=0, as well as the seasonal differencing lag D=0. The decay rate of the autocorrelation coefficients is evaluated at lags 1,2,.., as well as at lags 12, 12+1, 12+2,.., with the goal of demonstrating exponential decay of autocorrelation and partial autocorrelation coefficients produced by the time series model. For simplicity in defining the equation, a shift operator is used to describe the drift resulting from autocorrelation between time points, such that:

$Z_{t-1}=BZ_t$

Consider $W_t=(1-B)^d(1-B^{12})^D Z_t$

Where d, D may be 0,1,2 in most cases. Z_t represents the time series. The variable W is used to represent the Z_t time series with model stationarity achieved.

Case 1 (determining differencing value for lags 1,2,..):

$W^{(d)}_t=(1-B)Z_t = Z_t-BZ_t = Z_t-BZ_t = Z_t - Z_{t-1}$

Case 2 (determining differencing value for lags 12, 12+1, 12+2,..):

$W^{(D)}_t=(1-B^{12})\,W^{(d)}_t = W^{(d)}_t - B^{12}\,W^{(d)}_t = W^{(d)}_t - W^{(d)}_{t-12}$

Once the differencing is performed, the time series is fitted to an ARMA model. The time series will continue to be expressed by the term Z_t for simplification, with the assumption that the correct Box Cox transformation and differencing processes have been performed. In general model building, it is necessary to include both AR (autoregression) and MA (moving average) terms in the time series model, which can be described as:

$Z_t = \mu + \varphi_1(Z_{t-1} - \mu) + \ldots + \varphi_p(Z_{t-p} - \mu) + e_t - \theta_1 e_{t-1} - \ldots - \theta_q e_{t-q}$

where φ represents non-seasonal AR coefficients and θ represents non-seasonal MA coefficients. The terms p and q represent non-seasonal AR and MA factors, respectively.

This general ARMA equation can also be expressed as

$(Z_t - \mu) - \varphi_1(Z_{t-1} - \mu) - \ldots - \varphi_p(Z_{t-p} - \mu) = e_t - \theta_1 e_{t-1} - \ldots - \theta_q e_{t-q}$

Using the backshift operator B (where $B = Z_t - Z_{t-1}$),

$(1 - \varphi_1 B - \ldots - \varphi_p B^p)(Z_t - \mu) = (1 - \theta_1 B - \ldots - \theta_q B^q)e_t$

Noting that $\varphi_p(B)(Z_{t-\mu})=\theta_q(B)e_t$

and $\varphi_p(B) = 1- \varphi_1(B) - \ldots - \varphi_p B^p$

and $\varphi_q(B) = 1- \varphi_1(B) - \ldots - \varphi_q B^q$

where e_t = white noise, or error term (μ=0, SE=σ^2).

This can be further simplified using Φ to symbolize the AR terms and Θ to symbolize the MA terms in the following :

$\Phi_p B\ (Z_{t-1} - \mu) = \Theta_q(B)e_t$

This process is repeated to test for seasonal AR and MA factors, such that the same above formulae are utilized, replacing p for P, q for Q and B for B^{12}.

These processes are combined in general to create a final seasonal ARIMA model where the model terms can be written in simplified code: ARIMA (p,d,q)

(P,D,Q)s, where 's' signifies the seasonal lag for the time series. Generally speaking, any data transformation performed is stated prior to the ARIMA term.

Once the seasonal ARIMA model is fitted to the pre-intervention data, the entire model is tested against the post-intervention data, to determine whether the intervention being tested significantly explains any aberrations noted between the two time periods within the data set.