TRAFFIC INJURY RESEARCH FOUNDATION

UNDERSTANDING BEHAVIOURAL PATTERNS OF INTERLOCKED OFFENDERS TO INFORM THE EFFICIENT AND EFFECTIVE IMPLEMENTATION OF INTERLOCK PROGRAMS:
HOW OFFENDERS ON AN INTERLOCK LEARN TO COMPLY

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UNDERSTANDING BEHAVIOURAL PATTERNS OF INTERLOCKED OFFENDERS TO INFORM THE EFFICIENT AND EFFECTIVE IMPLEMENTATION OF INTERLOCK PROGRAMS: HOW OFFENDERS ON AN INTERLOCK LEARN TO COMPLY

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EXECUTIVE SUMMARY

In a growing number of jurisdictions around the world an increased demand for the use of alcohol interlocks is evident. In order to inform decision-making regarding the use of interlocks in programs it is crucial that program administrators and practitioners understand behavioural patterns of offenders on an interlock. Insight into compliance rates of interlocked offenders throughout their time on the interlock can guide administrators with regard to program development and implementation, particularly in relation to logistical aspects of programs and the requisite resources to support it.

The objectives of this study are to shed light on the behavioural patterns of offenders on an interlock, specifically with respect to their compliance with device requirements and program rules and to illustrate how such knowledge can be used to inform the implementation and delivery of interlock programs. This study was conducted for the Dutch Ministry of Transport to provide empirical information needed to inform the implementation of the Dutch interlock program.

The sample used in this study consists of 7,743 interlocked offenders who were randomly drawn from a population of 30,000 offenders who had an interlock installed during a time period of up to three years, more precisely at some point between 2006 and 2008. Data were provided by Smart Start Inc., an interlock provider based out of Texas and represented in about 30 U.S. states at the time of sampling.

A variety of indicators have been calculated including the percent of offenders who blow failed tests, the percent of failed tests, circumvention rates, violations when starting the car, violations when conducting a retest, and blood alcohol concentrations of interlocked offenders, as well as trends in these indicators over time.

Descriptive statistics including counts and percentages, along with 95% confidence intervals (95%-CI) and two-sample tests of proportions and two-sample t-tests for means have been calculated. To account for attrition, comparable statistics have been calculated for subpopulations of offenders who participate at least 18 months, 21 months and 24 months.

The results reveal that offenders tend to blow fails or violate the conditions of the interlock program at a relatively high rate at the beginning of their participation and this behaviour quickly diminishes after having been on the interlock for a while. During the first several months offenders have more failed tests, more failed tests at the higher blood alcohol concentration levels, more violations when starting the car, more violations when conducting a retest, and more circumvention attempts.

Such behaviour can be the result both from offenders not being familiar with the technology and therefore not knowing how to use it properly as well as wanting to "try out" the devices to see if violating the conditions will result in a response or consequence. Once offenders experience the negative consequences of this behaviour as a result of the incapacitating features of this technology and/or ongoing monitoring

and realize that such consequences are consistently applied following violations, they begin to change their behaviour. As such, a learning effect kicks in relatively quickly after beginning to use the interlock device.

It is further illustrated how these findings have affected the implementation of the Dutch interlock program. It is explained that this effort was based on a comprehensive "systems improvement" approach. The adoption of this approach has impacted the implementation of the Dutch program in several ways. First, the results of this study were used to optimize the Dutch reinforcement scheme for non-compliant behaviour. Second, the results from this research also proved useful in terms of allocating resources for the delivery of the program. Third, a minority of offenders has been identified that is clearly resilient to the described learning effect and this finding further stimulated discussions regarding the reinforcement scheme of the Dutch program and has helped to create rules that reflect this.

To conclude, some recommendations for further research are formulated.

1.0 INTRODUCTION

1.1 Background

Alcohol interlocks were first developed in the 1960s as a tool to prevent drunk driving and have been commercially available for more than 30 years. Early devices were performance-based systems, which required the driver to perform a perceptual or motor task that was designed to detect impairment prior to driving. While these devices were sensitive to individual variations in performance and impairment, they were incapable of discriminating between drivers with low to moderate blood alcohol concentration (BAC) levels. In the 1970s, new devices that were based on breath alcohol concentration measurement were developed and proved to be considerably more reliable than the earlier performance-based devices in accurately discriminating between drivers above and below a specified BAC threshold limit. These modern devices, which are widely available today, are designed to incapacitate drunk driving offenders by preventing them from starting a vehicle when their BAC (measured using the breath alcohol concentration) is in excess of the pre-set limit (see http://aic.tirf.ca for an overview of the history of interlocks).

Research shows that alcohol interlocks reduce recidivism among both first offenders and repeat offenders, including hardcore offenders (also known as persistent/chronic drinkers and repeat offenders who repeatedly drive after drinking with extremely high BACs and are resistant to change this behaviour). More than 10 strong evaluations of interlock applications have reported reductions in recidivism ranging from 35 – 90% (Voas and Marques 2003; Vezina 2002; Tippetts and Voas 1997; Coben and Larkin 1999) with an average reduction of 64% (Willis et al. 2005).

As a consequence, in the past two decades there has been tremendous growth in alcohol interlock programs for impaired driving offenders. At present a majority of jurisdictions in the United States (U.S.) and Canada have some form of alcohol interlock program in place. Several jurisdictions in Australia also have an interlock program including New South Wales, Victoria, Queensland, South Australia, and, more recently, the Northern Territory is conducting a pilot program. In Europe, Sweden has been a forerunner in terms of interlocks and has had a program for several years. In recent years Finland and France have passed legislation and implemented an interlock program. Other European jurisdictions (such as Belgium, Spain, Norway, Germany, the Netherlands, Slovenia and Israel) have organized pilot projects and/or have passed enabling legislation (Belgium). Finally, several European jurisdictions are preparing legislation and the implementation of interlock programs, for example in the Netherlands (an international inventory of interlock programs is available at http://iiip.tirf.ca/).

Historically, participation in these programs — at least in North America — has been a function of an impaired driver's criminal status. Mandatory participation was frequently targeted towards repeat and high BAC offenders — those deemed to be the greatest risk to the public and who had the highest probability of re-offending. The participation of first offenders in interlock programs was often on a voluntary basis.

More recently, in the U.S. a new trend in alcohol interlock programs has emerged as several states have introduced legislation making it mandatory for all convicted drunk driving offenders to install an interlock device on their vehicle. Since 2005, mandatory first offender alcohol interlock legislation has been passed in a number of American jurisdictions, including Alaska, Arizona, California (pilot program), Colorado, Hawaii, Louisiana, Nebraska, New Mexico, New York, Utah, and Washington. A few other states have also implemented first offender interlock legislation, however participation of first offenders has not been made mandatory. These jurisdictions include Illinois and Arkansas.

This trend in interlock legislation appears to continue in 2010 as more jurisdictions propose laws relating to the use of interlocks among first offenders — either all first offenders or just high-BAC first offenders. States proposing mandatory legislation for interlock use for first offenders include: Florida, Iowa, Kentucky, Massachusetts, Missouri, Mississippi, Ohio, Pennsylvania, Rhode Island, Tennessee, and Virginia. Those states proposing voluntary first offender interlock legislation include Alabama, Indiana and Vermont.

This activity is in response to a growing demand for the increased use of interlocks. More jurisdictions around the world are either considering the use of interlocks or have already undertaken necessary steps to use this technology. Jurisdictions that have used interlocks for a few or more years are currently expanding or considering the expansion of their program by also making first offenders eligible to participate, either on a mandatory or voluntary basis.

In light of this trend it is crucial that program administrators and practitioners be able to effectively utilize knowledge about behavioural patterns of offenders on an interlock. An intimate understanding of how interlocked offenders behave while in the program is essential to the creation of reasonable, realistic and achievable expectations regarding program features and offender performance. Such knowledge can also be useful to anticipate workload among practitioners managing the interlock program and supervising offenders to identify appropriate responses to events. Ultimately, insight into compliance rates of interlocked offenders throughout their time on the interlock can be crucial for program administrators to inform decision-making about the operational features of programs and the requisite resources to support it. In other words, understanding behavioural patterns of interlocked offenders is necessary to allocate resources accordingly for the effective and efficient implementation and delivery of the program.

1.2 Objectives

The objectives of this study are to shed light on the behavioural patterns of offenders on an interlock, specifically in terms of their compliance with device requirements and program rules and to illustrate how such knowledge can be used to inform the implementation and delivery of an interlock program. More precisely, this study reveals how such indicators as percent of offenders who blow failed tests, percent of failed tests, circumvention rates, violation rates and BACs change over time and can impact resource allocation.

While there is a reasonably large body of research in the field of interlocks, efforts to date have predominantly focused on the effectiveness and efficacy of interlocks by comparing experimental groups (on the interlock) with control groups (not on the interlock). However, more research into behavioural patterns of interlocked offenders per se, with the specific aim of providing evidence to support the efficient and effective implementation of interlocks is needed. For example, previous research suggests that a high rate of BAC fail readings from the alcohol interlock data recording device, particularly in excess of 0.02%, is predictive of the likelihood of recidivism (Marques et al. 2003; Beirness and Marques 2004); that the presence of two or more elevated BAC test results during the early morning hours further bolsters the predictive model regarding the likelihood of future driving while impaired (DWI) offences (Beirness and Marques 2004); and that more prior DWI's, more interlock warnings and failures logged during the first five months of interlock usage predict more than 60% of future repeat DWI violations (Marques et al. 2001). Such research findings have led to the idea of compliance based removal of offenders from the interlock program — i.e., as long as the offender cannot demonstrate compliance while on the interlock, program participation should be extended. Other research by these authors used interlock data to show that many interlocked offenders blow fails in the early morning hours and, as a consequence, are locked out from their vehicle in the morning. Such findings have been used to date to help develop programs. Nevertheless, it can be argued that today there is ample research showing that "interlock programs work" but more research is needed to better understand "how interlock programs work best". For example, a better understanding of effective sanctioning and reinforcement schemes would be useful. Also, more insight is needed into how long offenders should ideally be required to participate in an interlock program. The purpose of this study was to continue along this line of research by focusing on the behaviour of interlocked offenders while they are on the device.

It warrants mentioning that this study was commissioned by the Dutch Ministry of Transport in 2008 to provide empirical information needed to inform the preparation of the implementation of the Dutch interlock program — the program is underway and scheduled to begin in 2011 (see Vissers 2009 for a full report on how the results from this study have been used to inform the implementation of the Dutch program). This effort is part of a comprehensive "systems improvement" approach. According to the "systems improvement" paradigm "it is imperative that agencies have an understanding of the entire delivery system and their respective role within that system. A successful implementation strategy is based upon streamlined delivery of the countermeasure..." (Robertson et al. 2009: p. 27). The knowledge that was generated in this research provided the different stakeholders involved in the implementation of the interlock program with a more intimate understanding of the functioning of an interlock program based on empirical data. As such, this knowledge was used to enhance the understanding of typical behavioural patterns of offenders on an interlock and to anticipate the level of resources needed and their distribution over time to efficiently implement and deliver the Dutch program in the long term.

2.0 METHODS

2.1 Sample

The sample used in this study consists of 7,743 interlocked offenders who were randomly drawn from a population of 30,000 offenders who had an interlock installed during a time period of three years, more precisely at some point between 2006 and 2008. Data were provided by Smart Start Inc., an interlock provider based out of Texas and represented in about 30 U.S. states at the time of sampling. Due to attrition not all 7,743 offenders stay equally long in the interlock program (see attrition rates in Tables 3 and 4) — strategies to deal with attrition are described later (see 2.3 and 3.3). Average program participation was nine months. The minimum time an offender was on the program was 2.5 months and the maximum time was 2.5 years.

2.2 Data

Data logged by the alcohol interlock devices from the sample of offenders have been used in this study. A variety of events are typically logged and stored including providing a breath sample when trying to start the car; providing a breath sample after having started the car (also known as a running retest); results from these breath samples, expressed as a BAC (a "fail" or "failed test" means a test with a BAC at or over a preset level; for the purpose of this study the threshold used was 0.02%); attempts to skip the running retest and attempts to circumvent the interlock (e.g., by push starting the car). Over 15 million such events were generated by the interlock devices used with the sample of 7,743 offenders; these events have all been included in the analyses.

2.3 Data analysis

The analyses that have been conducted examined a two-year period. While data from participants between 2006 and 2008 were available, i.e., three years worth of data, offenders did not participate for as long as three years (the maximum time on the interlock in our sample was 2.5 years as mentioned previously). As such, a sliding window of a maximum of two years has been used for the analyses, individualized per offender (so the longest tracking period was two years but because not all offenders participate as long as two years the tracking period for some was shorter). The earliest time this sliding window commenced for any respondent was 2006 and the latest it could end was 2008. Behavourial patterns have also been investigated in time blocks of three or six months to reveal changes over time.

To deal with attrition subpopulations have been created of offenders who participated at least 18 months (901 offenders in total) and at least 21 months (625 offenders in total). Results from these subpopulations are not affected by attrition, i.e., all 901 offenders and 625 offenders participated for as long as 18 and 21 months respectively. Comparable analyses were conducted using a subsample of offenders who participated

at least 24 months but the results were not significant due to a lack of statistical power (only 50 offenders participated for that long).

Descriptive statistics including counts and percentages, along with 95% confidence intervals (95%-CI) and two-sample tests of proportions and two-sample t-tests for means have been calculated. All analyses have been carried out with Stata 10 MP for Windows (parallel edition for two cores; 64-bit operating system). Given the large amounts of data such techniques as sorting and indexing have been used to facilitate the efficient processing of the data (see e.g., Vanlaar 2008).

3.0 RESULTS

3.1 The percent of offenders who pass and fail tests

As can be seen in Table 1, overall 29% of offenders pass tests during the study period (24 months). Conversely, 71% of offenders blow fails during this time. In other words, the majority of offenders on the interlock can be expected to attempt to start the car or to provide a breath sample after having started the car when having consumed alcohol.

Table 1: Overall distribution of the number and percent of offenders who blow fails (BAC>=0.02%) during study period (24 months)

	Number and Percent	
	#	%
0 fails	2,248	29.0
1 fail	896	11.6
2 fails	532	6.9
3 fails	521	6.7
4 fails	380	4.9
5 fails	276	3.6
6-10 fails	967	12.5
11-20 fails	828	10.7
>20 fails	1,095	14.1
Total	7,743	100.0

3.2 The number and percent of fails

Table 2 contains the number and percent of failed tests, aggregated over all offenders included in the sample and broken down by duration (maximum of 12 months versus a maximum of 24 months of participation). A total of 75,874 fails has been logged in the first 12 months of being on the program out of well over 13 million tests; this translates to 0.58% of all tests. While the number of fails is higher in a time span of 24 months, the percent of failed tests is actually a little bit lower (0.56%) due to the higher volume of tests (15.4 million).

Table 2: The number and percent of failed tests (BAC>=0.02%)

	# tests >= 0.02%	Total # tests	Percent
12 months	75,874	13,067,489	0.58
24 months	85,793	15,403,640	0.56

3.3 Distribution of offenders who blow fails over time

Table 3 reveals that as time goes by the percent of interlocked offenders who blow fails decreases. As can be seen, 54.0% (95%-CI: 52.9-55.1) of offenders blow fails during their first three months of participation in the program whereas this percent decreases to 22.2% (95%-CI: 19.0-25.7) during the last three months of participation (i.e., months 22 through 24). It warrants mentioning that the total number of respondents in the sample also decreases over time, more precisely 7,743 offenders were included at the outset while the results at the end are only based on a sample of 625 offenders. This is because most offenders only participate in the interlock program for a period of time shorter than 24 months; some of them are only ordered to participate for less than one year while others drop out or are removed from the program early for a variety of reasons. Nevertheless, the pattern of a decreasing trend is clear and emerges already during the first 12 months when the total sample size is still as high as 3,418. Note that the percent increases somewhat in the sixth block of three months, although this does not change anything to the overall pattern — this increase can likely be explained by the decreasing sample size and less robust results as a consequence.

Table 3: Distribution over time of offenders who blow fails (BAC>=0.02%)

	# of offenders who blow fails	N	Percent	95%-CI
Months 1-3	4,180	7,743	54.0	52.9-55.1
Months 4-6	3,212	6,230	51.6	50.3-52.8
Months 7-9	2,141	4,638	46.2	44.7-47.6
Months 10-12	1,575	3,418	46.1	44.4-47.8
Months 13-15	818	2,591	31.6	29.8-33.4
Months 16-18	495	1,249	39.6	36.9-42.4
Months 19-21	309	901	34.3	31.2-37.5
Months 22-24	139	625	22.2	19.0-25.7

In Table 4 results from Table 3 are broken down according to the number of failed tests per six months. The percent of drivers who do not blow a failed test increases from 35.6% (95%-CI: 34.5-36.7) in the first six months of participation to 61% (95%-CI: 57.8-64.2) in the last six months of participation (note that the percent during the third six months is slightly higher than during the last six months but the difference is not significant; Z=0.85, p=0.39). Tables 5 and 6 contain the same information but allow distinguishing between fails when starting the car (Table 5) and fails when conducting a retest (Table 6). The patterns in these tables are comparable to the pattern in Table 4.

Table 4: Distribution over time of offenders who blow fails (BAC>=0.02%), broken down by the number of fails

	Number, Percent and 95%-CI		
	#	%	95%-CI
Months 1-6			
0 fails	2,755	35.6	34.5-36.7
1 fail	974	12.6	11.8-13.3
2 fails	605	7.8	7.2-8.4
3 fails	521	6.7	6.2-7.3
4 fails	373	4.8	4.4-5.3
5 fails	260	3.4	3.0-3.8
6-10 fails	897	11.6	10.9-12.3
11-20 fails	711	9.2	8.5-9.8
>20 fails	647	8.4	7.7-9.0
Total	7,743	100.0	
Months 7-12			
0 fails	2,081	44.9	43.4-46.3
1 fail	632	13.6	12.7-14.6
2 fails	357	7.7	6.9-8.5
3 fails	244	5.3	4.6-5.9
4 fails	188	4.1	3.5-4.7
5 fails	142	3.1	2.6-3.6
6-10 fails	430	9.3	8.5-10.1
11-20 fails	307	6.6	5.9-7.4
>20 fails	257	5.4	4.9-6.2
Total	4,638	100.0	
Months 13-18			
0 fails	1,621	62.6	60.7-64.4
1 fail	276	10.7	9.5-11.9
2 fails	159	6.1	5.2-7.1
3 fails	97	3.7	3.0-4.5
4 fails	79	3.1	2.4-3.8
5 fails	52	2.0	1.5-2.6
6-10 fails	135	5.2	4.4-6.1
11-20 fails	93	3.6	2.9-4.4
>20 fails	79	3.1	2.4-3.8
Total	2,591	100.0	
Months 19-24			
0 fails	550	61.0	57.8-64.2
1 fail	129	14.3	12.1-16.8
2 fails	49	5.4	4.1-7.1
3 fails	30	3.3	2.3-4.7
4 fails	29	3.2	2.2-4.6
5 fails	10	1.1	0.5-2.0
6-10 fails	46	5.1	3.8-6.8
11-20 fails	36	4.0	2.8-5.5
>20 fails	22	2.4	1.5-3.7
Total	901	100.0	

Table 5: Distribution over time of offenders who blow fails (BAC>=0.02%) when starting the car, broken down by the number of fails

	Number, Percent and 95%-CI		
	#	%	95%-CI
Months 1-6			
0 fails	3,175	41.0	39.9-42.1
1 fail	979	12.6	11.9-13.4
2 fails	663	8.6	7.9-9.2
3 fails	525	6.8	6.2-7.4
4 fails	398	5.1	4.7-5.7
5 fails	269	3.5	3.1-3.9
6-10 fails	799	10.3	9.6-11.0
11-20 fails	531	6.9	6.3-7.4
>20 fails	404	5.2	4.7-5.7
Total	7,743	100.0	
Months 7-12			
0 fails	2,348	50.6	49.2-52.1
1 fail	652	14.1	13.1-15.1
2 fails	344	7.4	6.7-8.2
3 fails	258	5.6	4.9-6.3
4 fails	171	3.7	3.2-4.3
5 fails	131	2.8	2.4-3.3
6-10 fails	368	7.9	7.2-8.7
11-20 fails	211	4.6	4.0-5.2
>20 fails	155	3.3	2.8-3.9
Total	4,638	100.0	
Months 13-18			
0 fails	1,748	67.5	65.6-69.3
1 fail	293	11.3	10.1-12.6
2 fails	148	5.7	4.8-6.7
3 fails	103	4.0	3.3-4.8
4 fails	48	1.9	1.4-2.4
5 fails	49	1.9	1.4-2.5
6-10 fails	94	3.6	2.9-4.4
11-20 fails	70	2.7	2.1-3.4
>20 fails	38	1.5	1.0-2.0
Total	2,591	100.0	
Months 19-24			
0 fails	588	65.3	62.1-68.4
1 fail	136	15.1	12.8-17.6
2 fails	37	4.1	2.9-5.6
3 fails	26	2.9	1.9-4.2
4 fails	24	2.7	1.7-3.9
5 fails	15	1.7	0.9-2.7
6-10 fails	40	4.4	3.2-6.0
11-20 fails	22	2.4	1.5-3.7
>20 fails	13	1.4	0.8-2.5
Total	901	100.0	

Table 6: Distribution over time of offenders who blow fails (BAC>=0.02%) when conducting a retest, broken down by the number of fails

	Number, Percent and 95%-CI		
	#	%	95%-CI
Months 1-6			
0 fails	4,682	60.5	59.4-61.6
1 fail	996	12.9	12.1-13.6
2 fails	552	7.1	6.6-7.7
3 fails	320	4.1	3.7-4.6
4 fails	201	2.6	2.2-3.0
5 fails	187	2.4	2.1-2.8
6-10 fails	433	5.6	5.1-6.1
11-20 fails	255	3.3	2.9-3.7
>20 fails	117	1.5	1.3-1.8
Total	7,743	100.0	
Months 7-12			
0 fails	3,042	65.6	64.2-67.0
1 fail	587	12.7	11.7-13.6
2 fails	273	5.9	5.2-6.6
3 fails	177	3.8	3.3-4.4
4 fails	114	2.5	2.0-2.9
5 fails	71	1.5	1.2-1.9
6-10 fails	197	4.3	3.7-4.9
11-20 fails	118	2.5	2.1-3.0
>20 fails	59	1.3	1.0-1.6
Total	4,638	100.0	
Months 13-18			
0 fails	1,983	76.5	74.9-78.2
1 fail	249	9.6	8.5-10.8
2 fails	112	4.3	3.6-5.2
3 fails	50	1.9	1.4-2.5
4 fails	44	1.7	1.2-2.3
5 fails	28	1.1	0.7-1.6
6-10 fails	70	2.7	2.1-3.4
11-20 fails	40	1.5	1.1-2.1
>20 fails	15	0.6	0.3-1.0
Total	2,591	100.0	
Months 19-24			
0 fails	706	78.4	75.5-81.0
1 fail	85	9.4	7.6-11.5
2 fails	30	3.3	2.3-4.7
3 fails	22	2.4	1.5-3.7
4 fails	20	2.2	1.4-3.4
5 fails	11	1.2	0.6-2.2
6-10 fails	16	1.8	1.0-2.9
11-20 fails	7	0.8	0.3-1.6
>20 fails	4	0.4	0.1-1.1
Total	901	100.0	

Tables 7 and 8 contain comparable results as Table 4 but for offenders who participated 18 months (Table 7 — 901 offenders in total) and 21 months (Table 8 — 625 offenders in total). Contrary to previous tables, there is no attrition in these tables, i.e., all 901 offenders and all 625 offenders participate during the full 18 months and 21 months respectively. These tables allow controlling for length of participation and have been presented to rule out the explanation that the emerging trends from Table 4 would merely be the result of an artifact of the data (for example offenders who participate for only 6 months may differ in terms of compliance with program rules from participants who participate longer and this could distort the findings from Table 4).

Both tables confirm the trend that emerged in Table 4, more precisely offenders become more compliant as time goes by. To illustrate, Table 7 shows that 53.2% of offenders blow zero tests of at least 0.02% during the first 3 months (95%-CI: 49.8-56.5) while this percent increases to 60.3% (95%-CI: 57.0-63.5) in months 16-18. The difference is highly significant (Z=-3.04; p=0.002).

Table 7: Distribution over time of offenders who do not blow fails (BAC<0.02%), subsample of offenders who participate 18 months (N=901)

	Number	Percent	95%-CI
Months 1-3	479	53.2	49.8-56.5
Months 4-6	470	52.2	48.8-55.5
Months 7-9	483	53.6	50.3-56.9
Months 10-12	499	55.4	52.1-58.7
Months 13-15	518	57.5	54.2-60.7
Months 16-18	543	60.3	57.0-63.5

Table 8 shows this percent increases from 55.7% (95%-CI: 51.7-59.6%) in the first three months to 64.5% (95%-CI: 60.6%-68.2%) in months 19-21. This difference is also significant (Z=-2.46; p=0.014).

Table 8: Distribution over time of offenders who do not blow fails (BAC<0.02%), subsample of offenders who participate 21 months (N=625)

	Number	Percent	95%-CI
Months 1-3	348	55.7	51.7-59.6
Months 4-6	332	53.1	49.1-57.1
Months 7-9	339	54.2	50.2-58.2
Months 10-12	342	54.7	50.7-58.7
Months 13-15	373	59.7	55.7-63.6
Months 16-18	384	61.4	57.5-65.3
Months 19-21	403	64.5	60.6-68.2

These analyses were replicated with a subpopulation of 50 offenders who participated at least 24 months. A comparable trend was found, more precisely 74% (95%-CI: 61.8-86.2) of offenders do not blow fails in the first three months and this increases to 86% (95%-CI: 76.4-95.6) in months 22-24. However, these results

are not stable due to the small sample size (n=50) and the difference between the first and the last time interval is not significant (Z=-1.50, p=0.134), most likely due to a lack of statistical power.

3.4 Distribution of offenders who blow a very high number of fails over time

Table 4 also reveals that the percent of drivers who blow a very high number of fails (i.e., at least 6 failed tests) decreases over time, more precisely from 29.2% (95%-CI: 28.1-30.1) in the first six months (11.6%+9.2%+8.4%) to 11.5% (95%-CI: 9.5-13.8) in the last six months (5.1%+4.0%+2.4%). These results illustrate that, despite a learning effect among the majority of offenders, there seems to be a group of offenders that is particularly resistant to learning to blow fewer fails.

Similar patterns as in Tables 3 and 4 were found when accounting for attrition (results not shown in tables). For example, when looking at the subpopulation of 901 offenders who participate 18 months, the percent of offenders blowing at least six fails decreases from 25.6% (95%-CI: 22.7-28.5) in the first six months to 19.0% (95%-CI: 16.5-21.7) in the third six months. This difference is significant (Z=3.37; p=0.001). When looking at this trend using three month time blocks rather than six month time blocks the results are similar (a significant decrease from 12.7% to 9.8%; Z=-36.30; p=0.000).

Further analysis of the subsample of offenders who still blow at least six fails after 18 months (104 offenders in total — results not shown in table) showed that 68.2% of those offenders blew at least six fails from the outset of their participation. Conversely, 31.8% of those who blew at least six fails after 18 months of participation blew fewer fails at the outset of their participation. While these results are only based on a sample of 104 offenders, they do suggest two things: one, that a minority of offenders fail many tests from the outset and this remains unchanged during their time on the interlock; and two, the performance of certain offenders deteriorates as they progress through the program.

3.5 Average number of failed tests per offender over time

Table 9 contains the average number of fails per offender over time. Comparable to previous results, the average number of fails per offender decreases over time from 3.86 fails (95%-CI: 3.66-4.06) in the first three months of participation to 0.94 fails (95%-CI: 0.68-1.20) in the last three months of participation at the end of the two-year window (note that the confidence intervals do not overlap meaning the difference is significant). In other words, on average an offender on an interlock can be expected to blow about four fails when first entering the program and this occurs just one time after 21 months of participation.

Table 9: Average number of fails (BAC>=0.02%) per offender over time

	# fails	Total # offenders	Average # of fails per offender	95%-CI
Months 1-3	29,890	7,743	3.86	3.66-4.06
Months 4-6	22,141	6,230	3.55	3.30-3.80
Months 7-9	13,851	4,638	2.99	2.75-3.23
Months 10-12	9,992	3,418	2.92	2.63-3.21
Months 13-15	4,481	2,591	1.73	1.48-1.98
Months 16-18	2,983	1,249	2.39	1.82-2.96
Months 19-21	1,870	901	2.06	1.47-2.65
Months 22-24	585	625	0.94	0.68-1.20

Tables 10 and 11 contain the same information but distinguish between fails when starting the car and fails when conducting a retest. Trends comparable to the trend emerging from Table 9 can be seen in these additional tables.

Table 10: Average number of fails (BAC>=0.02%) when starting the car per offender over time

	# fails	Total # offenders	Average # of fails per offender	95%-CI
Months 1-3	20,826	7,743	2.69	2.55-2.83
Months 4-6	14,965	6,230	2.40	2.23-2.57
Months 7-9	9,190	4,638	1.98	1.82-2.14
Months 10-12	6,844	3,418	2.00	1.80-2.20
Months 13-15	2,842	2,591	1.10	0.94-1.26
Months 16-18	1,977	1,249	1.58	1.13-2.03
Months 19-21	1,374	901	1.52	1.03-2.01
Months 22-24	413	625	0.66	0.45-0.87

Table 11: Average number of fails (BAC>=0.02%) when conducting a retest per offender over time

	# fails	Total # offenders	Average # of fails per offender	95%-CI
Months 1-3	9,064	7,743	1.17	1.09-1.25
Months 4-6	7,176	6,230	1.15	1.05-1.25
Months 7-9	4,661	4,638	1.00	0.90-1.10
Months 10-12	3,148	3,418	0.92	0.81-1.03
Months 13-15	1,639	2,591	0.63	0.52-0.74
Months 16-18	1,006	1,249	0.81	0.65-0.97
Months 19-21	496	901	0.55	0.42-0.68
Months 22-24	172	625	0.28	0.20-0.36

3.6 Distribution of BAC over time

In Table 12 the distribution of BAC over time is presented. This table contains the number of tests by BAC category, the percent of tests in each BAC category and the average number of tests per offender for each BAC category. For example, during the first three months a total of 4,767,684 tests were delivered with a BAC below 0.02%; this accounts for 99.38% of all tests taken by all 7,743 offenders during the first three months of their participation. This translates into an average of 615.7 tests below the pre-set threshold of 0.02% per offender.

Table 12: Distribution of BAC over time — Total number of BAC tests (#), percent of BAC tests (%) and average number of BAC tests per offender by BAC category and time

	#	%	Average
Months 1-3			N=7,743
0.00%<=BAC<0.02%	4,767,684	99.38	615.7
0.02%<=BAC<0.05%	23,853	0.50	3.1
0.05%<=BAC<0.10%	4,862	0.10	0.6
0.10%<=BAC<0.40%	1,175	0.02	0.2
	#	%	Average
Months 4-6			N=6,230
0.00%<=BAC<0.02%	3,683,866	99.40	591.3
0.02%<=BAC<0.05%	18,471	0.50	3.0
0.05%<=BAC<0.10%	2,977	0.08	0.5
0.10%<=BAC<0.40%	693	0.02	0.1
Months 7-9			N=4,638
0.00%<=BAC<0.02%	2,570,566	99.46	554.2
0.02%<=BAC<0.05%	11,893	0.46	2.6
0.05%<=BAC<0.10%	1,596	0.06	0.3
0.10%<=BAC<0.40%	362	0.01	0.08
Months 10-12			N=3,418
0.00%<=BAC<0.02%	1,969,404	99.50	576.2
0.02%<=BAC<0.05%	8,601	0.43	2.5
0.05%<=BAC<0.10%	1,088	0.05	0.3
0.10%<=BAC<0.40%	303	0.02	0.09
Months 13-15			N=2,591
0.00%<=BAC<0.02%	1,007,056	99.56	388.7
0.02%<=BAC<0.05%	3,916	0.39	1.5
0.05%<=BAC<0.10%	435	0.04	0.2
0.10%<=BAC<0.40%	130	0.01	0.05
Months 16-18			N=1,249
0.00%<=BAC<0.02%	668,967	99.56	535.6
0.02%<=BAC<0.05%	2,647	0.39	2.1
0.05%<=BAC<0.10%	288	0.04	0.2
0.10%<=BAC<0.40%	48	0.01	0.04
Months 19-21			N=901
0.00%<=BAC<0.02%	475,772	99.61	528.0
0.02%<=BAC<0.05%	1,692	0.35	1.9
0.05%<=BAC<0.10%	151	0.03	0.2
0.10%<=BAC<0.40%	27	0.01	0.03
Months 22-24			N=625
0.00%<=BAC<0.02%	174,436	99.67	279.1
0.02%<=BAC<0.05%	500	0.29	0.8
0.05%<=BAC<0.10%	62	0.04	0.1
0.10%<=BAC<0.40%	23	0.01	0.04

In light of previous results it is not surprising to see that the percent of tests below the limit of 0.02% increases over time, from 99.38% (95%-CI: 99.37-99.38) to 99.67% (95%-CI: 99.64-99.69). However, the table also reveals that there is a notable decrease in each of the categories of failed tests, including the very high BAC ranges.

3.7 Distribution of attempts to circumvent the interlock over time

Table 13 contains the distribution over time of the number of occasions that offenders tried to circumvent the interlock device, e.g., by trying to start the car without providing a breath sample. The average number of times per offender is also included. As can be seen, a decreasing trend over time is apparent, from an average of 0.23 (95%-CI: 0.18-0.28) times per offender at the beginning to an average of 0.07 (95%-CI: 0.03-0.11) times per offender at the end. The difference is significant (t=1.85, p=0.03).

Table 13: Distribution over time of the number and average number of attempts to circumvent the interlock

	# circumvention attempts	# offenders	Average # circumvention attempts per offender	95%-CI
Months 1-3	1,777	7,743	0.23	0.18-0.28
Months 4-6	1,198	6,230	0.19	0.15-0.23
Months 7-9	636	4,638	0.14	0.09-0.19
Months 10-12	381	3,418	0.11	0.08-0.14
Months 13-15	383	2,591	0.15	0.08-0.22
Months 16-18	205	1,249	0.16	0.10-0.22
Months 19-21	97	901	0.11	0.06-0.16
Months 22-24	42	625	0.07	0.03-0.11

3.8 Distribution of violations over time when starting the car and when conducting a re-test

Table 14 contains data looking at violations over time when providing breath samples to start the car. The average number of violations per offender decreases from 1.04 (95%-CI: 0.98-1.09) to 0.19 (95%-CI: 0.13-0.25). Of interest, the trend appears to be less stable during months 10-12, 13-15 and 16-18 although the overall trend is obvious. The confidence intervals of the average number of violations per offender at the beginning versus the end of the tracking period do not overlap; the decrease over time is significant (t=8.08, p=0.000).

Table 14: Distribution over time of the average number of violations when starting the car

	# violations	# offenders	Average # violations per offender	95%-CI
Months 1-3	8,053	7,743	1.04	0.98-1.09
Months 4-6	4,962	6,230	0.80	0.75-0.85
Months 7-9	3,080	4,638	0.66	0.60-0.72
Months 10-12	2,309	3,418	0.68	0.61-0.75
Months 13-15	1,008	2,591	0.39	0.34-0.44
Months 16-18	625	1,249	0.50	0.40-0.60
Months 19-21	405	901	0.45	0.31-0.59
Months 22-24	117	625	0.19	0.13-0.25

Table 15 contains comparable data about violations when conducting a retest. The average number of violations when conducting retests decreases from 0.17 violations per offender (95%-CI: 0.14-0.20) to 0.03 violations (95%-CI: 0.01-0.05). The difference between both is statistically significant (t=2.27, p=0.02).

Table 15: Distribution over time of the average number of violations when conducting a running retest

	# violations	# offenders	Average # violations per offender	95%-CI
Months 1-3	1,338	7,743	0.17	0.14-0.20
Months 4-6	840	6,230	0.13	0.10-0.16
Months 7-9	541	4,638	0.12	0.09-0.15
Months 10-12	314	3,418	0.09	0.07-0.11
Months 13-15	247	2,591	0.09	0.06-0.12
Months 16-18	157	1,249	0.13	0.08-0.18
Months 19-21	25	901	0.03	0.01-0.05
Months 22-24	21	625	0.03	0.01-0.05

4.0 DISCUSSION

4.1 Limitations

When interpreting the results from this study, some limitations have to be borne in mind. First, the data used in the analyses come from only one vendor. While this vendor was represented in about 30 states at the time of drawing the sample for this study, a sample from several vendors may have been more robust. Unfortunately obtaining information from more than one vendor proved to be not feasible. On the other hand, while there are certainly differences between vendors in terms of how they manage their respective programs, to some extent it can perhaps be argued that programs across vendors can essentially be considered comparable from a conceptual or theoretical point of view because interlocks from different vendors function and are managed in a comparable fashion. Therefore, to a certain extent, comparable patterns across vendors would be expected. Nevertheless, it is recommended that the results from this study be replicated using independent data sources to bolster the conclusions.

Another limitation is that no demographic information was available so breaking down results according to gender, age, postal code, etc. was not possible. Also, the data are aggregated and come from many different

jurisdictions. While state-specific variables regarding violations were available, details about program rules for each of the jurisdictions and an indication of jurisdiction were not. In essence, this means it was not possible to distinguish between different types of offenders with respect to the type of program they participated in, notably voluntary versus mandatory programs and judicial versus administrative programs. While there are no two interlock programs that are alike, these dimensions have been suggested previously as a meaningful scheme to classify interlock programs (see Beirness and Simpson 2003). It can be argued that aspects such as mandatory versus voluntary participation provide useful information regarding the type of offender and underlying reasons why this offender is on the interlock. For example, an offender who is in a mandatory program likely differs from an offender who is in a voluntary program, at least with respect to his/her offending that led to being on the interlock. It is plausible to assume that different types of offenders behave differently while on the interlock, e.g., less versus more resistant. Perhaps voluntary offenders would be less resistant to participating and, as a result, learn faster how to behave and comply with program rules compared to mandatory offenders. Unfortunately, it was not possible to test such hypotheses regarding the profile of offenders so only generic conclusions about failing tests and violation of the program conditions can be drawn. Augmenting the results from this study with such information would be useful to better understand behavourial patterns of offenders on an interlock.

On the other hand, in this study subsamples have been created of offenders according to their length of participation because it is assumed that length of participation correlates to a certain degree with the type of offender and program. One subsample consisted of 901 offenders who participated 18 months, another subsample consisted of 625 offenders who participated 21 months, and a third subsample consisted of 50 offenders who participated 24 months. Analyses have been replicated using these subsamples and this effectively allowed controlling for length of participation and, as a consequence, a host of confounding variables related to length of participation. This also makes it possible to rule out the explanation that the findings are the result of an artifact in the data (by virtue of participants gradually discontinuing participation over time which changes the composition and the nature of the group of subjects over time).

Finally, as explained in the objectives section, findings from this study are fairly novel. While our findings were consistent across the different subsamples we examined and while there is some anecdotal evidence from practitioners in the field of interlocks and other monitoring technologies (e.g., GPS monitoring for sex offenders or home electronic alcohol monitoring) that appears to be in line with our findings, attempts to replicate and further refine our findings are highly recommended.

4.2 Results

The behavioural patterns emerging from this study are clear, regardless of the indicator that is used. Offenders tend to blow fails or violate the conditions of the interlock program at a relatively high rate at the beginning of their participation and this behaviour quickly diminishes after having been on the interlock for a while. During the first several months offenders have more failed tests, more failed tests at higher BAC levels, more violations when starting the car, more violations when conducting a retest, and more

circumvention attempts. Such behaviour can be the result both from offenders not being familiar with the technology and therefore not knowing how to use it properly as well as wanting to "try out" the devices to see if violating the conditions will result in a response or consequence. Once offenders experience the negative consequences of this behaviour as a result of the incapacitating features of this technology and/or ongoing monitoring and realize that such consequences are consistently applied following violations, they begin to change their behaviour. As such, a learning effect kicks in relatively quickly after beginning to use the interlock device.

The results also suggest that the notion of "non-compliance" requires serious consideration when designing an interlock program. While modern interlock devices certainly make it difficult for offenders to circumvent the technology or violate program conditions without detection, these devices still require human interaction in terms of monitoring. Without adequate staff in place to respond to violations the noticeable behavourial patterns from this study — i.e., the learning effect — would likely not be as apparent, simply because the success of an interlock program is predicated on the idea of offenders knowing that someone will be monitoring behaviour 24/7 using a device that can record every event that occurs when the offender's vehicle is in use. Without adequate resources to monitor non-compliance, a learning effect may be less likely to occur. Furthermore, without accounting for a short delay in compliance before the learning effect kicks in, optimal delivery of the interlock program may be compromised. For example, if this delayed learning effect is ignored then offenders may be prematurely removed from the program for non-compliance before they will have had a chance to learn how this technology works and modify their behaviour. Given the evidence that is available about this proven technology that shows how effective it is in terms of reducing recidivism this could lead to sub-optimal outcomes.

While more research in terms of effective and efficient reinforcement schemes to accommodate delays in learning is needed — both in terms of penalties and reinforcements — the current results do bear relevance on the delivery of interlock programs. Given the behavourial patterns that can be expected from offenders on an interlock, a graduated scheme of responses seems appropriate.

As mentioned previously, this study was undertaken on behalf of the Dutch Ministry of Transport in 2008 to provide empirical information needed to inform the preparation and implementation of the Dutch interlock program and was based, in part, on a comprehensive "systems improvement" approach. The adoption of this approach has impacted the implementation of the Dutch program in several ways.

First, the results of this study were used to optimize the Dutch reinforcement scheme for non-compliant behaviour. Before this study was conducted, the draft scheme that was being considered did not take into account that there typically is a higher number of violations at the outset of program participation. As such, the proposed scheme was rigid and did not leave sufficient flexibility for dealing with offenders and would likely have resulted in offenders being prematurely removed from the program. This can be problematic because it quickly leads to taking the most extreme measure possible for dealing with non-compliance from the outset — i.e., removal from the program — which does not leave enough leeway to enable offenders

to learn compliance. The results from this study effectively provided the insights needed to support the implementation of a graduated reinforcement scheme. To illustrate, the Dutch program will treat violations differently depending on how long an offender has been participating and when they are committed. During the first six months there will be more leniency toward violations because the offender has to learn how to properly use the interlock. During the second six months and the third six months, the offender will be expected to learn to separate drinking from driving, with increasing expectations in terms of compliance. During the fourth six months the offender will be expected not to violate any conditions; under this zero-tolerance regime participation will be extended by six months in case of violations. It should be noted that certain violations are considered to be unforgiveable in the Dutch program and would lead to removal from the program anyway, regardless of how long a participant has been in the program. Such violations include attempts to circumvent the interlock or tamper with the device.

Second, the results from this research also proved useful in terms of allocating resources for the delivery of the program. Knowing when offenders will need more intensive monitoring and follow-up and how workload will be affected is crucial to inform staff allocations. It is important to realize that such intensive monitoring and follow-up at the outset of participation is not representative of the level of monitoring and follow-up needed later downstream when a large majority of offenders learn to be compliant. This means that maintenance levels of follow-up will suffice after a while and that intensive support will no longer be needed for a majority of offenders. Such knowledge can also be useful to create buy-in among staff because it reveals how workload can be managed. Better understanding of workload and resource allocation issues will become especially relevant given the trend that is emerging in North America regarding first offender programs, as described in the introduction (see also Robertson et al. 2010 for more information about workload and resource allocation issues).

Third, despite the fact that the large majority of offenders exhibit continued compliance after a short initial period of non-compliance, there is a minority that is clearly resilient to the identified learning effect. The data in this study are too limited to unequivocally distinguish between a group of offenders who may simply be non-compliant from the outset versus a group whose performance actually deteriorates during their participation. However, it is clear that a minority of offenders will be non-compliant for the duration of the program. This finding further stimulated discussions regarding the reinforcement scheme of the Dutch program and has helped creating rules that reflect this. More precisely, one rule in particular states that non-compliance will lead to an extension of the program until the offender can demonstrate continued compliance (extending program participation will continue as long as necessary although certain violations can lead to removal from the program as explained previously). This decision was primarily based on Marques et al.'s (2001, 2003) findings regarding compliance based removal and our results about a minority of resilient offenders further bolster this need. Our results about this minority can also be interpreted as a confirmation of the need for combining the interlock with additional measures such as treatment to better tailor the measure to the profile of the offender. Previous research has shown that coupling the interlock with treatment can lead to better results (see e.g., Beirness et al. 2003). In this regard, the Dutch program

includes a treatment component that will be administered during the first few months of participation. This involves a three day group session focusing on the physiological effects of alcohol on the body and resulting crash risks as well as more intensive rehabilitation if needed.

Finally, it warrants mentioning that more detailed results were obtained in this study, e.g., results that did not account for false positive tests have also been analyzed because such false positives can affect workload (see Vanlaar and Robertson 2008 for more information about this).

5.0 CONCLUSION

In conclusion, this study extended existing knowledge and generated new knowledge that can be utilized by jurisdictions that are considering the implementation of an interlock program or that are considering the expansion of their existing interlock program. Such knowledge can inform decision-making in relation to specific program features. This was demonstrated in this study for example by adjusting the sanctioning scheme. However, this is only the tip of the iceberg in terms of knowledge needed to design an effective program in an efficient fashion. This report underscores the relevance of research to inform practices and the need for strong linkages between researchers and practitioners to improve program outcomes. More research is needed regarding the many aspects involved in the implementation and delivery of an interlock program. Enhancing the understanding of the described learning effect is needed to further improve program implementation and delivery. The following research questions can be used to further refine the findings from this study:

- Are there different learning curves according to type of violation?
- Does type of program have an impact on the shape of the learning curve?
- What is the profile of the persistent offender who is resistant to compliance?
- Are there different types of persistent offenders, for example persistent offenders whose performance does not change dramatically throughout their participation versus persistent offenders whose performance becomes even worse?
- How does length of participation affect performance?
- Does the learning effect differ according to gender, age, mandatory and voluntary participation, etc.?
- What can we learn from such findings in terms of features of a good interlock program?

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