EFFECTIVENESS OF THE SCRAM ALCOHOL MONITORING DEVICE: A PRELIMINARY TEST
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This article reports the results of a preliminary study of how a transdermal alcohol-detection bracelet device, the Secure Continuous Remote Alcohol Monitor (SCRAM©), might affect recidivism. The probability of recidivism for a sample of convicted driving while impaired (DWI) offenders ordered to use SCRAM was compared to that of a matched sample of non-SCRAM-using DWI offenders. Multivariate survival analysis revealed that use of the SCRAM device for 90 days or longer by offenders with at least one prior DWI offense significantly reduced the probability of recidivism. The recidivism incidence for DWI offenders while they were wearing the SCRAM device was only 3.5%, which suggests the potential usefulness of SCRAM as an effective monitoring technology. These findings provide potential supporting evidence for a minimum 90-day threshold for effective use of the SCRAM device and reveal its applicability to a target population of recidivist DWI offenders. The results must be viewed cautiously because the study was conducted in a single locale and was an uncontrolled, retrospective study. More rigorous research is needed to validate these preliminary findings.

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ARTICLE SUMMARIES

TRANSDERMAL ALCOHOL MONITORING

[10] Ethanol is excreted through the skin in sufficient quantities to reliably estimate blood alcohol concentrations (BAC).

SCRAM

[11] The SCRAM ankle bracelet draws and analyzes insensible perspiration every half hour from the air above an offender's skin. SCRAM is currently being used in 45 states by more than 5,000 offenders.

PRELIMINARY EFFECTS OF SCRAM

[12] In a preliminary study, the use of SCRAM was associated with a reduced probability of recidivism for driving while impaired (DWI) offenders who had at least one prior DWI and who used the device for at least 90 days. These results are tentative until validated by replication or a stronger design.

INTRODUCTION

The costs of driving while impaired (DWI) in terms of human and fiscal capital losses are only partially reflected in the statistics reported below by the National Highway Traffic Safety Administration (NHTSA, 2008).[1]

- Motor vehicle crashes are the leading cause of death for Americans aged 2 through 34.
- In 2006, there were 17,602 alcohol-related fatalities in motor vehicle crashes.
- Alcohol was involved in 41 percent of all fatal crashes in 2006.
- About every 30 minutes, someone is killed in the U.S. in an alcohol-related crash.
- Alcohol-related crashes in the U.S. cost the public more than $50 billion in 2000 (75% of the costs occurred in crashes when a driver or non-occupant had a blood alcohol concentration [BAC] of at least .08 grams per deciliter).
- Inpatient rehabilitation costs for motor vehicle injuries average $11,265 per patient.
- Impaired driving is the most frequently committed crime in the U.S.
- Drivers with prior DWI convictions are overrepresented in fatal crashes, and thus have a greater risk of involvement in a fatal crash.

Society has responded to this loss of human life with resources on many levels, including public education, law enforcement, and the judiciary.

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[1] http://www.nhtsa.dot.gov/staticfiles/DOT/NHTSA/Communication%20&%20Consumer%20Information/Articles/Associated%20Files/810879.pdf.

Traditional sentencing sanctions available to the judiciary have not been particularly effective against people convicted of DWI, and least so against repeat DWI offenders (Wallace, 2008). Consequently, several jurisdictions have developed sobriety courts or DWI courts, most of which are based on the drug court model, to better deal with impaired driving (Flango, 2008). An essential feature of DWI courts is intense alcohol addiction treatment and extensive court supervision. Many DWI courts also require offenders to serve some portion of their jail sentence, and jail sentences are used as a last resort for participant noncompliance with court-mandated treatment programs. Compliance with treatment and other court-mandated requirements is verified by frequent alcohol and drug testing, close community supervision, and interaction in non-adversarial court review hearings with the judge. Many judges and policymakers would like to see DWI courts expand because of their apparent success in reducing recidivism,[2] and their methods transferred to traditional courts to the extent practicable. The cost of implementing DWI courts, driven in part by the need for intensive monitoring, slows their expansion. (Flango and Flango, 2006).

Technology, however, is now providing judges with improved monitoring capabilities. One of the newest monitoring technologies being used in the battle against DWI is transdermal

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[2] See: http://www2.potsdam.edu/hansondj/DrivingIssues/2007 0705120731.html that contains an article by David J. Hanson entitled "DWI/DUI Courts Work." Flango and Flango (2006) note that the drop in recidivism rates for courts that track these statistics appear to be impressive, but many courts do not yet report recidivism rates. Some DWI courts have been established too recently to develop a track record. Wallace (2008) also notes the need to evaluate the effectiveness of DWI courts. He recognizes that Mothers Against Drunk Driving (MADD), the Governor's Highway Safety Association, and the Highway Safety Committee of the International Association of Chiefs of Police consider DWI courts to be a useful tool in the struggle against impaired driving.

(i.e., through the skin) alcohol monitoring (Hawthorne and Wojcik, 2006). Judges may be less familiar with transdermal methods of alcohol monitoring than with more conventional blood, breath or urine testing methods.

TRANSDERMAL ALCOHOL MONITORING

Despite the failure of traditional methods of sanctioning offenders to impact DWI recidivism, new technologies have made possible transdermal methods of alcohol monitoring that show promise for producing such impacts. The first practical device that utilized transdermal alcohol testing was an alcohol "sweat patch." The sweat patch is applied to the user's skin for a period of several days where it absorbs sweat excreted through the skin. The patch is removed and analyzed using separate equipment to determine the amount of ethanol that each sweat patch had absorbed. These results are then tied to the consumption of alcoholic beverages.

[10] A significant amount of research was performed with the sweat patch between 1980 and 1984 (Phillips and McAloon, 1980; Phillips, 1980, 1982, 1984a, 1984b). This research concluded that there was a statistically significant linear relationship between the concentration of ethanol in sweat and the average concentration of ethanol in blood (BAC).[3] Results of this testing were 100% sensitive and specific; i.e., the testing clearly differentiated drinkers from nondrinkers and had no false positives (Phillips and McAloon, 1980).

While sweat patch research focused on ethanol concentrations in liquid sweat, other research was conducted in

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[3] Blood Alcohol Concentration, or BAC, is the amount of alcohol per fixed unit of blood. It is usually defined as grams of ethanol per deciliter of blood (g/dL) or percent weight of ethanol per volume of blood (%w/v). For example, 0.05 g/dL is the same as 0.05%.

the late 1980s that measured the ethanol concentration in vapors formed above the skin. Since that time, researchers have performed significant transdermal alcohol measurement research using a number of different research techniques with very consistent results. Based on the published literature, Hawthorne and Wojcik (2006) concluded that ethanol is excreted through the skin in sufficient quantities to reliably estimate BAC.

There are currently two transdermal measuring devices—the Wrist Transdermal Alcohol Sensor (WrisTAS) by Giner, Inc. and the Secure Continuous Remote Alcohol Monitor (SCRAM) bracelet by Alcohol Monitoring Systems, Inc. The former device, though clinically tested, is not yet commercially available, perhaps because it is not yet sufficiently water or tamper resistant (Robertson, Vanlaar, and Simpson, 2006).

[11] The SCRAM ankle bracelet has been commercially available since 2003 (www.alcoholmonitoring.com). It consists of a transdermal sensor attached to the ankle that detects alcohol from continuous samples of vaporous or insensible perspiration (sweat) collected from the air above the skin and transmits data for remote monitoring via the Web (Robertson, Vanlaar, and Simpson, 2006). Anti-circumvention features include a tamper clip, an obstruction sensor, a temperature sensor, and communication status monitoring to ensure that the bracelet is functioning properly and transmitting information on the designated offender. Robertson, Vanlaar, and Simpson (2006) note that the SCRAM bracelet contains an electrochemical alcohol sensor that draws a sample of insensible perspiration every half hour from the air above an offender's skin. The sample is analyzed for ethyl alcohol. The SCRAM also contains a flash memory chip to store alcohol readings, a device to detect tampers, and remote transmit features to transfer readings by means of a wireless radio frequency to the SCRAM modem at scheduled times.

The SCRAM device was tested by the Michigan Department of Corrections, which concluded that:

> the [SCRAM] product is able to detect circumvention of alcohol test sampling, reliably ensures that test samples are from the intended test subjects, and detects drinking episodes around the clock regardless of a subject's schedule or location (Bock, 2003:4).

SCRAM is currently being used in 45 states by more than 5,000 offenders.

METHODOLOGY AND RESEARCH DESIGN

The National Center for State Courts (NCSC) was contracted by Alcohol Monitoring Systems to conduct a comparative evaluation of the effectiveness of the SCRAM bracelet in reducing DWI recidivism while it is being worn and after its removal. The objective of the study was to determine the factors that influence the effectiveness of the SCRAM bracelet so that a more extensive, experimental study could be designed later.

Data on the treatment group (i.e., SCRAM users) were obtained from the SCRAM service provider in North Carolina (Rehabilitation Support Services of North Carolina, Inc.). Inclusion in the treatment group was based on two criteria: 1) the offenders must use the SCRAM (after conviction) as a condition of court-ordered sentences and 2) the convictions had to occur in North Carolina between April 1, 2005 and July 31, 2007. These criteria resulted in a sample of 114 SCRAM users. Vantage Point Services, a private firm, was hired to provide criminal history data from North Carolina's Statewide Criminal Information System on the sample of SCRAM users, and also to provide similar data on a randomly selected pool of 3,000 DWI offenders who did not use

SCRAM. Data for the two groups included offender demographics, conviction offenses, prior offense history, and post-conviction offense history. Additionally, the dates that the SCRAM anklets were placed on the offenders and subsequently removed were collected for SCRAM users. Information about treatment, probation and community-service status, participation in DWI court, and other aspects of post-conviction supervision and service provision, unfortunately, were unavailable for both groups.

From the pool of comparison group offenders, matches were identified as precisely as possible for each SCRAM user. By making the comparison group as similar as possible on relevant characteristics to the treatment group, internal validity was maximized. This permitted us to draw inferences about the effectiveness of SCRAM in reducing post-sentencing recidivism. Matches for each SCRAM user were selected from the large pool of other DWI offenders based upon the following variables:

- Age
- Race
- Sex
- Conviction county
- Number of prior DWI offenses
- Number of prior offenses

A match was identified for each SCRAM user in the same county where the SCRAM user's conviction occurred. Offenders were then matched in accordance with gender and were within three years of age of each other. Offenders were subsequently matched by race, number of prior DWIs, and finally by the number of prior offenses. Two hundred sixty-one matched cases were selected from the pool of approximately 3,000 DWI offenders.

The matching process eliminated or attenuated most differences between the two groups, as reported in Table 1. Despite the matching, however, some differences persisted; notably, an under-representation of Hispanics among the SCRAM users and a higher average number of prior DWIs for the SCRAM users as compared to the matched comparison group. The requirement to match within each county made it difficult to find perfect matches for the other variables. The multivariate analysis employed statistical controls for these persistent differences.

Table 1. Comparison of SCRAM Users to Matched Comparison Group

	SCRAM Users	Matched Comparison Group	Significant Difference?
Average Age (years)	32.8	33.6	No
% White	72.8%	62.4%	
% African American	20.2%	21.5%	Yes (p< .044)
% Latino	7.0%	16.1%	
% Female	11.4%	13.4%	No
Average # of Prior DWIs	2.2	1.5	Yes (p< .000)
Mecklenburg County	79.8%	85.8%	No
Average Number of Prior Offenses	7.5	6.1	Yes (p< .043)
Average Number of Charges	1.2	1.5	Yes (p< .016)

To determine whether SCRAM use influenced the probability of recidivism, a multivariate survival analysis was conducted to identify factors influencing recidivism, including the use of the SCRAM device. Multivariate analysis has the advantage of controlling for more than one potential confounding factor at a time. Confounding factors are factors other than the SCRAM intervention that could potentially explain differences in recidivism rates between the SCRAM users and the matched comparison group, including differences in age or gender. Since the probability of recidivism may change differently over time for SCRAM users than for the matched comparison group, a survival analysis was required. Survival analysis originated in the medical field where survivors were patients who survived a particular medical treatment over an extended period of time. In the current study, "survivors" are DWI offenders who were not caught re-offending. A survival analysis technique known as multivariate Cox regression was used to analyze the recidivism data by statistically controlling for known confounds to detect differences in the probability of recidivism over time between SCRAM users and the matched comparison group.

Recidivism for the comparison group was defined operationally to occur when there was an arrest for any offense after the arrest date for the offense that produced the conviction that led to inclusion in the comparison group (the conviction had to occur between April 1, 2005 and July 31, 2007) and when the arrest for the later offense resulted in a conviction. Time-to-recidivism, in this case, was the number of days between the two arrest dates.

Recidivism for SCRAM users occurred when there was an arrest for any offense after the arrest date for the offense that produced the conviction resulting in a SCRAM disposition (the conviction had to occur between April 1, 2005 and July 31, 2007) and when the arrest for the later offense resulted in a conviction. Similar to the comparison

group, time-to-recidivism was the number of days between the two arrest dates.

THE SCRAM INTERVENTION

The way in which the alcohol-monitoring intervention is implemented can affect the conclusions that may be drawn; therefore, a brief description of the SCRAM implementation approach is necessary before the analysis is discussed.

We hypothesized that SCRAM use should reduce the probability of recidivism for offenders who were required to use the device because it promotes sobriety on the part of the user—a necessary, if not sufficient, condition for effective substance abuse treatment. Additionally, the treatment literature suggests that SCRAM should be used for at least 90 days in order to keep users sober long enough to impact their behavior (e.g., Marlowe, DeMatteo, and Festinger, 2003).

What happened in practice? The average amount of time that the SCRAM anklet was worn was 70 days, with a median time of 61.5 days. The minimum and maximum number of days the anklet was worn was eight days and 212 days, respectively. Only 25% of the sample wore the anklet for 90 days or more. It was surprising to see that the SCRAM intervention for the majority of sentences resulted in such a short duration of usage; too short, perhaps, to realistically expect it to impact alcohol use over the long term.

Moreover, the average amount of time between arrest and the SCRAM intervention was 283 days. In short, it was nearly nine and 1/3 months after arrest before the SCRAM intervention was initiated. Although very late in the game, this is not unexpected because the SCRAM users were selected for the study based on the SCRAM intervention occurring after conviction. It is not unusual for a DWI or

related case to take this amount of time to be processed from arrest to conviction, especially considering that a jury trial may have been involved in some cases. We know however, that early identification and rapid processing of addicted offenders improves the likelihood of positive outcomes (e.g., Anspach, Ferguson, and Collum, 2005).

SCRAM AND RECIDIVISM: PRECURSOR TO THE MULTIVARIATE ANALYSIS

Before examining the impact of SCRAM use on recidivism, holding other potential effects constant with multivariate analysis, we investigated a couple of additional questions. First, to what extent did SCRAM users engage in re-offenses while wearing the ankle bracelet? The answer to that question was very infrequently. Only four out of the 114 SCRAM wearers committed a new offense while wearing the anklet. This 3.5% re-offense rate for offenders while wearing SCRAM is relatively low and suggests that the SCRAM device could be an effective or useful monitoring tool.

The research literature also suggests that the number of prior DWI convictions is likely to influence the probability of recidivism, since repeat offenders are at greater risk for additional DWIs (Gould and Gould, 1992). To investigate whether these factors jointly influenced the probability of recidivism, a preliminary contingency-analysis was conducted. Table 2 shows the results of this analysis.

Table 2. Percent Recidivating for Any Offense by Number of Prior DWIs and Group

# Prior DWIs	SCRAM >=90 days	N	SCRAM <90 days	N	Comparison Group	N
			% Recidivating			
0 or more	9.4%	32	20.7%	82	20.3%	261
1 or more	6.9%	29	20.3%	69	21.2%	241
2 or more	0.0%	18	21.2%	52	28.6%	91
3 or more	0.0%	10	20.7%	29	36.7%	30

In Table 2, as the range becomes more restricted to offenders with larger numbers of prior DWIs, the recidivism rate increases consistently for the comparison group. For SCRAM users that wore the anklet for less than 90 days, the recidivism rates reflected a small variation (between 20% and 21%) with the number of prior DWIs. These rates, however, were generally lower than for the comparison group. For SCRAM users who wore the anklet for 90 days or more, recidivism rates decreased as the range became more restricted to offenders with larger numbers of prior DWIs. The recidivism rate became zero for offenders with two or more prior DWIs. From these results, it may be argued that the SCRAM device appears to be most effective for offenders who have two or more prior DWIs (i.e., third-time offenders) and who wear the anklet for at least 90 days.

These results also suggest that the duration of the SCRAM intervention may influence outcomes. In particular, it appears that the intervention must last at least 90 days to reduce the probability of future re-offenses. This is consistent with research that suggests that 90 days of drug treatment may be the minimum threshold for the detection of dose-response effects. Six to twelve months, however, may be the threshold for meaningful reductions in drug use from a clinical perspective. Twelve months of drug treatment appears to be the "median point" on the dose-response curve; i.e., the point at which approximately 50% of clients who complete 12 months or more of drug abuse treatment remain abstinent for an additional year following completion of treatment (Marlowe, DeMatteo, and Festinger, 2003).

The results in Table 2 suggest that the number of prior DWIs and the length of time the SCRAM was used may influence the probability of recidivism, which is about as far as bivariate analysis will permit. These findings, however, prompted us to include interdependency terms in the Cox multivariate regression that reflect the joint influence of SCRAM use and prior DWIs.

**RESULTS OF THE MULTIVARIATE
SURVIVAL ANALYSIS**

Table 3 presents the results of the Cox regression on the probability of recidivism. The last row in the table shows the findings for SCRAM users who wore the device for at least 90 days and who had at least one prior DWI. The associated temporal influences on the probability of recidivism are explained below.

Table 3. Cox Regression of Probability of Recidivating Over Time

			Number of obs	=	375		
No. of subjects	=	375					
No. of failures	=	73					
Time at risk	=	233914					
			LR chi2(10)	=	45.42		
Log likelihood	=	−382.289	Prob > chi2	=	0		
	Coef.	Std. Err.	z	P > z		[95% Conf. Interval]	
Comparison Group, no prior DWIs	−0.502	0.754	−0.670	0.505	−1.980		0.975
SCRAM used less than 90 days, no prior DWIs	−0.024	0.631	−0.040	0.970	−1.261		1.214
SCRAM used less than 90 days, at least one prior DWI	−10.714	4.173	−2.570	0.010	−18.892		−2.535
SCRAM used more than 90 days, no prior DWIs	0.171	1.052	0.160	0.871	−1.890		2.233

Table 3 continues

SCRAM used more than 90 days, at least one prior DWI	−1.482	0.734	−2.020	0.044	−2.921	−0.043
Age	−0.032	0.014	−2.250	0.025	−0.059	−0.004
Number of Prior DWIs	−0.106	0.105	−1.010	0.311	−0.312	0.100
Number of Prior Offenses	0.104	0.022	4.730	0.000	0.061	0.147
Gender	0.017	0.433	0.040	0.969	−0.832	0.865
Number of Charges	−0.008	0.093	−0.090	0.929	−0.190	0.173
Race	−0.416	0.260	−1.600	0.110	−0.926	0.094
Gaston County	−0.131	0.554	−0.240	0.813	−1.217	0.955
Mecklenburg County	−0.121	0.438	−0.280	0.782	−0.979	0.737
t						
SCRAM used less than 90 days, at least one prior DWI	1.769	0.686	2.580	0.010	0.425	3.114

In examining all of the variables that simultaneously affected recidivism in the single survival analysis, the following findings were produced:

1. Age was a significant predictor of recidivism. For every annual increase in age, there was an approximate 3% reduction in the probability of recidivism.

2. The number of prior offenses was a reliable predictor of recidivism. For every incremental increase in the number of prior offenses, there was an approximate 11% increase in the probability of recidivism.

3. Offenders with no prior DWI offenses (in either the SCRAM or comparison groups) were not significantly different in terms of their propensity to recidivate from comparison group members who had at least one prior DWI offense. That is, SCRAM did not significantly influence the probability of recidivism for offenders with no prior DWIs.

4. Overall recidivism rates for offenders with at least one prior DWI offense were essentially the same for SCRAM users and comparison group members (21.7% and 21.2%, respectively) when the SCRAM device was worn for *less than 90 days*. The pattern of recidivism, however, varied over time. Offenders with at least one prior DWI offense who wore the ankle bracelet less than 90 days were significantly less likely to recidivate than comparison group members with at least one prior DWI offense. This indicates that SCRAM exerted a "short-term" effect on the probability of recidivism for offenders with at least one prior DWI. For example, considering recidivism within a 324-day period, the recidivism rate for SCRAM users who wore the device less than 90 days was 33%, compared to 57% for the

comparison group. Longer term, the probability of recidivism changed and the SCRAM advantage deteriorated. For example, considering recidivism over a 648-day period, we find the rate for SCRAM users who wore the device less than 90 days was 30% compared to 32% for the comparison group. Figure 1 illustrates how the probability of recidivism changed differently over time for SCRAM users who wore the device for less than 90 days, and their comparison group. SCRAM users had a lower probability of recidivism than their comparison group until well after 1,000 days from date of arrest. Beyond a 1,000-day period, the trends reversed.

Figure 1. Adjusted Survival Functions for SCRAM Users (less than 90 Days) and Similar Comparison Group Members
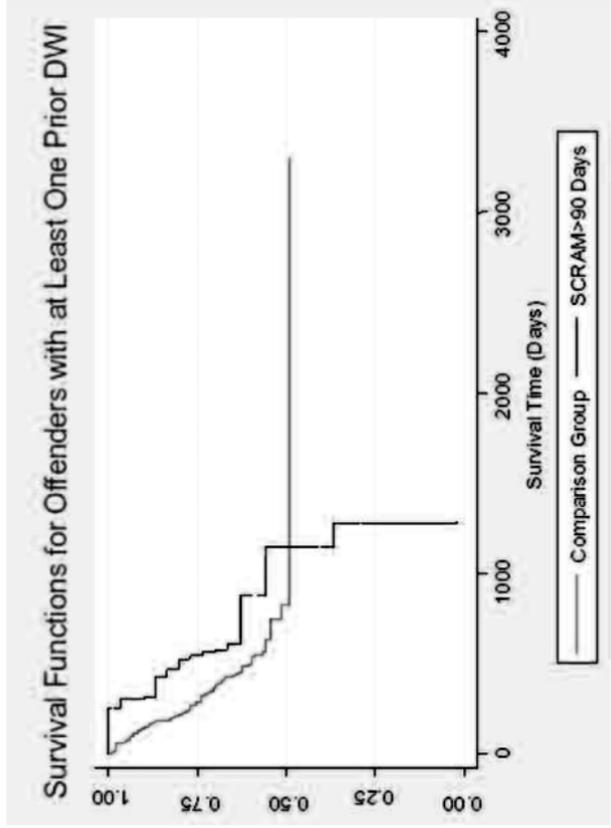
5. The overall recidivism rate for offenders with at least one prior DWI who wore the SCRAM ankle bracelet for at least 90 days (N = 29) was about one half the rate for the comparison group (N = 241); i.e., 10.3% versus 21.2%, respectively. The Cox regression indicated that this difference was statistically significant and was not time dependent. The use of SCRAM was associated with a reduced probability of recidivism at all times during the tracking period for offenders who had at least one prior DWI and who used the device for at least 90 days.

CONCLUSIONS

The 3.5% re-offense rate while offenders were wearing the SCRAM ankle bracelet is relatively low and suggests that SCRAM may be useful as a monitoring tool. Because half of the SCRAM users re-offended at some other point in time, these results further suggest that offender behavior while wearing the SCRAM device may have the potential to predict future recidivism. The small sample size, however, precludes us from reaching definitive conclusions about this use of the SCRAM device.

[12] The results of the multivariate survival analysis suggest that the use of SCRAM may influence the long-term probability of recidivism if it is worn for at least 90 days or more by offenders with at least one prior DWI offense. Consistent with the substance abuse treatment literature, wearing the device for at least 90 days appears to reduce the probability of recidivism over what it would be if the device were worn for a shorter period of time. These findings suggest that SCRAM may be effective with repeat offenders; however, the results must be regarded as tentative until validated by replication or a stronger experimental design.

Research regarding the effectiveness of monitoring devices is limited. There is little in the literature about monitoring devices to suggest that monitoring alone, without being used in conjunction with treatment, will have a long-term influence on offender behavior (Gable and Gable, 2007). The data from this study were not extensive enough to address the question of how the SCRAM produces the observed effects.

A plausible hypothesis is that SCRAM must be used in conjunction with substance abuse treatment to produce long-term impacts on offender behavior. SCRAM promotes sobriety on the part of the user, a necessary first step for substance abuse treatment to have an impact on offender behavior. Because no data were available on whether the SCRAM users received substance abuse treatment while wearing the SCRAM device, this hypothesis could not be tested in this study.

In lieu of data about attendance in substance abuse treatment, conclusions reached must be considered preliminary as the data were insufficient to explore all of the complexities of the use of the SCRAM bracelet. Key among them was the lack of information on treatment received while the ankle bracelet was worn. However, data clearly indicate that offenders whose SCRAM intervention lasted at least 90 days and who had at least two prior DWIs had a lower probability of recidivating than other offenders. Consequently, if SCRAM is used as a component of a comprehensive treatment program, the data support the SCRAM intervention for at least 90 days, targeting offenders with at least one prior DWI. In addition to determining the effectiveness of the SCRAM bracelet, this study developed hypotheses with regards to the types of offenders for whom the SCRAM bracelet is most likely to be effective. The results of this study and future studies may serve as a guide for judges and other criminal justice partners in determining which offenders would most benefit from use of monitoring and the use of the SCRAM bracelet.

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