Medical Care

# Screening, Brief Intervention, and Referral to Treatment in the Emergency Department: An Examination of Healthcare Utilization and Costs

--Manuscript Draft--

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| **Abstract:** | Background: There is increasing interest in deploying screening, brief intervention, and referral to treatment (SBIRT) practices in emergency departments (ED) to intervene with patients at risk for substance use disorders (SUD). However, the current literature is inconclusive on whether SBIRT practices are effective in reducing costs and utilization.<br><br>Objective: This study sought to evaluate the healthcare costs and healthcare utilization associated with SBIRT services in the ED.<br><br>Research Design: This study analyzed downstream healthcare utilization and costs for patients who were exposed to SBIRT services within an Allegheny County, Pennsylvania, ED through a program titled Safe Landing compared to 3 control groups of ED patients (intervention hospital pre-intervention, and pre- and post-intervention time period at a comparable, non-intervention hospital).<br><br>Subjects: The subjects were patients who received ED SBIRT services from January 1 to December 31 in 2012 as part of the Safe Landing program. One control group received ED services at the same hospital during a previous year. Two other control groups were patients who received ED services at another comparable hospital.<br><br>Measures: Measures include total healthcare costs, 30-day ED visits, 1-year ED visits, inpatient claims, and behavioral health claims. |

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| | Results: Results found that patients who received SBIRT services experienced a 21% reduction in healthcare costs and a significant reduction in 1-year ED visits (decrease of 3.3 percentage points).<br><br>Conclusions: This study provides further support that SBIRT programs are cost-effective and cost-beneficial approaches to SUD management, important factors as policy advocates continue to disseminate SBIRT practices throughout the healthcare system.<br><br>Keywords: screening, brief intervention, and referral to treatment; overdose; emergency department; healthcare costs; and utilization. |

Cover Letter


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October 31, 2017

Dear Editor-in-Chief,

I am pleased to resubmit the following manuscript, *"Screening, Brief Intervention, and Referral to Treatment in the Emergency Department: An Examination of Healthcare Utilization and Costs"* for a second review by the editors at Medical Care. The authors thank the editors and reviewers for their thoughtful and thorough comments. The authors believe they have adequately addressed each of these comments and have provided a point-by-point response in the table that was submitted with the revised manuscript documents. Additionally, per the directions of the decision letter, the authors have bolded revisions within the revised manuscript.

As the principal investigator, I verify that all authors identified in the manuscript fulfill all authorship guidelines as stated in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals. I would also like to disclose that funding for this study was provided by the Substance Abuse and Mental Health Services Administration (SAMHSA) via grant number 5U79T1020263, the Jewish Healthcare Foundation, and the Staunton Farm Foundation. The authors would like to disclose one conflict of interest: I, Janice Pringle, the corresponding author, have an ongoing relationship with SAMHSA and have completed consulting work for them. SAMHSA has awarded grants to the University of Pittsburgh, School of Pharmacy where I and Shannon M. Kearney are employed. The authors report no other conflicts of interest.

We thank the editors for this opportunity and for taking the time to consider our manuscript. Please feel free to reach out to the corresponding author for any questions or concerns regarding the manuscript.

Sincerely,

Janice L. Pringle, PhD
Principal Investigator
Director, Program Evaluation and Research Unit
University of Pittsburgh
School of Pharmacy

**Medical Care – Editor and Reviewer Comments – Point-by-Point Response from Authors**
HCPCS Manuscript: MDC-D-17-00357

| Reviewer | Comment | Revision/Response |
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| Editor | Please find the comments of the reviewers below. We would be willing to reconsider this manuscript pending a satisfactory revision and response to the reviewers' comments and critiques. | Thank you for the comment. The authors believe they have sufficiently responded to the reviewers' comments and critiques. Please see below our point-by-point response. |
| | This is a request for a major revision. At this point, clearly, we cannot promise eventual publication. | Thank you for the comment. The authors understand that this is a major revision. The authors believe they have sufficiently responded to the reviewers' comments and critiques. Please see below our point-by-point response. |
| Reviewer 1 | This manuscript makes an important addition to the literature on the relationship between SBIRT intervention and utilization and cost. The paper is well written and the statistical analysis is generally appropriate. A few clarifications would enhance the paper. | Thank you for the comments. No revision needed. |
| | The author(s) mention the use of two different control hospitals which are similar. Were they similar programmatically (e.g. size, case mix)? Or were the comparison metrics those mentioned in Table 1? | Thank you for the comment. Yes, the comparison metrics were those mentioned in Table 1. They include: demographics (age, gender, and race), number of claims, and total costs. The authors have added additional details about the hospitals in the methods section, paragraph 1. |
| | P-values for Table 1 need to be added. | Thank you for the comment. P-values have been added to Table 1. |
| | It is still unclear why the same control hospital could not be used to assess time-trend as well as intervention/control effect. | Thank you for the comment. There is only one control hospital within our study. There are two subgroups within the single control hospital: patients who received ED services at the hospital during 2010 and patients who received ED services during 2012. This study design controls for the time-trend effect as well as the intervention-control effect. |

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| | The use of DnDnD is relatively new in this field. It would be helpful to the readers to walk through the model equation and the parameter interpretation in a little more detail. | Thank you for the comment. The model equation has been added to the text, along with descriptions of the model parameters. |
| | The use of linear probability model instead of the usual logistic regression needs to be justified. There are reasons to use either in given situations but it is not obvious why the author(s) would choose the linear probability model for utilization in this case. | Thank you for the comment. A mixed effects linear model was used so that it was easier to interpret interactions within the model. Justification has been added within the text. |
| | It seems from Table 2 that the pre-index costs were lower in year 2012 even in the intervention hospital compared to 2010. Any reason why? How does that affect the interpretation of decreased cost post-index? | Thank you for the comment. The authors have though about this comment and believe the affect could be due to the passing of the Affordable Care Act – signed into law in 2010.<br><br>Regardless, the lower pre-index costs doesn't affect the interpretation; the authors explicitly controlled for time within the model, so the main effect picks up that difference within the model. |
| | As mentioned earlier, it is unclear whether the DnDnD model controls for this trend. It would be helpful to see the model equation written out. | As addressed in the comment above, there is only one control hospital within the study, and the model does control for the time trend. The model equation and a further description of the variables within the model has been added to the text. |
| | In the discussion section, the authors need to soften the language re: causality. | Thank you for the comment. The authors have hedged the language a bit in the discussion. |
| | Table 2, lines between average costs and standard error can be removed as it is too busy to read. | Thank you for the comment. This has been completed. This change was also made to Table 1 and 3, where appropriate. |
| | "The results of analyses conducted with Allegheny County service data indicated an average of 6 to 14 ED visits were related to overdose and persons…."Should these be percentages? | Thank you for the comment. No, these are not percentages; they are the average number of ED visits related to overdose per day. This has been revised to be clarified.<br><br>This statistic was acquired from the following reference: |

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| | | Hulsey E, Brink L, Dalton E, et al. *Opiate-Related Overdose Deaths in Allegheny County: Risks and Opportunities for Intervention.* 2016. |
| | If the above clarifications require additional space, the SBIRT training and fidelity section could be tightened a little. | Thank you for the comment. The authors have removed a lot of the content on SBIRT training and fidelity. The authors also removed additional results on SBIRT numbers. |
| Reviewer 2 | This was an excellent study design describing the cost effectiveness of healthcare utilization and health care costs, as measured by Medicaid claims data, associated with care after SBIRT was implemented in one Pennsylvania Hospital with three sets of controls: a historical control, and two contemporaneous controls (other hospitals). | Thank you for the comment. |
| | A recent review suggests efforts to reduce emergency department visits are sparse - I wonder if the authors feel comfortable extending their findings to this line of inquiry. See: Raven MC, Kushel M, Ko MJ, et al. The effectiveness of emergency department visit reduction programs: a systematic review. Annals of Emergency Medicine. 2016;68(4):467-483 e415. | Thank you for the comment. The authors added a sentence and this citation to a paragraph in the discussion about studies implementing interventions in the real world. |
| | More details could be provided about the weighted propensity score and associated diagnostics. I assume an ATT model was used. | Thank you for the comment. Clarification has been added. |
| | What variables were included in the modeling? | Thank you for the comment. The model equation has been added to the text, which shows the variables utilized in the modeling. Additional descriptions of the variables were also added within the text following the model equation. |
| | Did all [variables] achieve reasonable balance post-weighting? | Thank you for the comment. Yes, all variables achieved a reasonable post-weighting balance. These are unadjusted means, demonstrates the need for the PS match. Added to footnote to clarify. |
| | By what threshold? If not, were doubly-robust statistical models used? | Thank you for the comment. Standardized differences between the pre-weighted and post-weighted variables were calculated, and the average difference was added to the text. They achieved a reasonable standardized difference |

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| | | based on the threshold in the study cited within the text (Austin PC). |
| | The paragraph on page 15 beginning with "Additionally, Safe Landing…" seems to present results from a separate paper, but it is not clear to me how that other paper justifies the statement that it follows. | Thank you for the comment. The authors removed the paragraph as we removed the content in the methods broaching this topic. |
| | Furthermore, that paragraph provides new results regarding the implementation of the intervention in the hospital, but those results are not presented in the paper. I recommend either providing specific citations for this intervention, or to consider dropping this paragraph and including summaries specific to the results presented here. | Thank you for the comment. The authors removed the paragraph as we removed the content in the methods broaching this topic. |
| | I appreciate that the results for Tables 2 and 3 distinguish between the different control groups, but Table 1 does not. I do not understand why all control hospitals are lumped together - they should be separated. Also, differences between the groups should be easier to see (i.e., indicators of $p<0.05$, as done in Tables 2 and 3). | Thank you for the comment. As was clarified before, there is only one control hospital within our study. Table 1 distinguishes between the two subgroups within the control hospital (years 2010 and 2012). P-values have been added to the table. |
| | I would like to see Tables that provide the full set of results from the weighted regression models. It's not intuitively apparent to me how the regression results are used to calculate the values produced in Tables 2 and 3. These tables just show that costs decreased/increased within hospitals, but the regression results should show that such changes (i.e., the 21% reduction in the intervention hospital) are greater than the 6.2% reduction in intervention hospital, 2012. This isn't really apparent from the tables. Further, such results should be described more fully in the paper. | Thank you for the comment. The results have been restructured; Table 2 now shows the full regression results, and Table 3 shows the model estimates from the regression results. |
| Reviewer 3 | The study design remains somehow unclear. The focus of the study clearly is set on costs and healthcare utilization. The study design is a sort of cost-minimization analysis, comparing the costs without taking the patient-relevant outcome gains into consideration. Especially in this case in remains unclear how intense and frequent the healthcare of these special patients would be adequate. | Thank you for the comment. Please see how we addressed the comments below. |
| | There is no randomization at all and it remains unclear how the study populations where selected. | Thank you for the comment. Our study was an observational study, so therefore we did not use |

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| | | randomization. Clarification has been added to the text regarding the study design. |
| | Please clearly describe the study design and methods in health economic wording | Thank you for the comment. Language has been adjusted. |
| | The costing process remains completely unclear. What is the perspective? | Thank you for the comment. The cost of the intervention was not the focus of this study; the focus was on the healthcare cost and utilization impact of SBIRT. A future study could focus on costing the intervention and examine how cost effective an SBIRT program actually is; a paragraph about this has been added to the discussion section. |
| | What data is used and where do the information come from? | Thank you for the comment. The data extraction process and the specific data that was obtained have been clarified within the text. |
| | Are all costs taken into consideration covered by Medicaid? | Thank you for the comment. Yes. A sentence has been added for clarification in the *Healthcare Costs* subsection. |
| | What about out-of-pocket costs? | Thank you for the comment. Out-of-pocket costs and payment by other payers are not included. Clarified in the *Healthcare Costs* subsection. |
| | What are the costs of the special program itself? | Thank you for the comment. The cost of the intervention was not the focus of this study; the focus was on the healthcare cost and utilization impact of SBIRT. A future study could focus on costing the intervention and examine how cost effective an SBIRT program actually is; a paragraph about this has been added to the discussion section. |
| | It would be great to see details of resource utilization such as inpatient, outpatient, pharmaceuticals, psychological treatment etc. if available. | Thank you for the comment. Additional detail regarding resource utilization has been added to Table 1. |
| | From my point of view there are too many methodological issues unsolved (or at least unclear) to be able to assess the validity of the results. In comparison to the method descriptions the description of | Thank you for the comment. The authors have removed a lot of the description of the intervention and added more to the methods. We |

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| | the intervention is too long. Therefore I recommend full revision and resubmission. | hope this clarifies and details the mentioned methodological issues. |

**Title:** Screening, Brief Intervention, and Referral to Treatment in the Emergency Department: An Examination of Healthcare Utilization and Costs

**Short Title:** Screening, Brief Intervention, and Referral to Treatment in the Emergency Department.

**Keywords:** screening, brief intervention, and referral to treatment; overdose; emergency department; healthcare costs and utilization.

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**Number of Figures/Tables:** 3

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**Disclosures/Conflicts of Interest:** The author Janice Pringle is a consultant for the Substance Abuse and Mental Health Services Administration (SAMHSA), which funded this study.

SAMHSA has awarded grants to the University of Pittsburgh, School of Pharmacy where Janice Pringle and Shannon M. Kearney are employed. No other conflicts of interest exist.

**Meeting Presentation:**

The contents of this manuscript, or portions of its content, have been presented at the following public meetings and conferences:

INEBRIA, Lausanne, Switzerland, September 2016;

Office of National Drug Control Policy Meeting, Webinar, August 2016;

Overdose Task Force 2016, Coordinating Care for Individuals with Substance Use Disorders, Pittsburgh, PA, June 2016; and

Healthcare Common Procedure Coding System Meeting, Pittsburgh, PA, March 2016

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Sherry Rickard-Aasen, MBA, assisted with implementing the *Safe Landing* program.

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John Radack, MS, assisted with data analysis.

**Title:** Screening, Brief Intervention**,** and Referral to Treatment in the Emergency Department: An Examination of Healthcare Utilization and Costs

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## Abstract

**Background:** There is increasing interest in deploying screening, brief intervention, and referral to treatment (SBIRT) practices in emergency departments (ED) to intervene with patients at risk for substance use disorders (SUD). However, the current literature is inconclusive on whether SBIRT practices are **effective in reducing costs and utilization.**

**Objective:** This study sought to evaluate the healthcare costs and healthcare utilization associated with SBIRT services in the ED.

**Research Design:** This study analyzed downstream healthcare utilization and costs for patients who were exposed to SBIRT services within an Allegheny County, Pennsylvania, ED through a program titled *Safe Landing* compared to 3 control groups of ED patients (intervention hospital pre-intervention, and pre- and post-intervention time period at a comparable, non-intervention hospital).

**Subjects:** The subjects were patients who received ED SBIRT services from January 1 to December 31 in 2012 as part of the *Safe Landing* program. One control group received ED services at the same hospital during a previous year. Two other control groups were patients who received ED services at another comparable hospital.

**Measures:** Measures include total healthcare costs, 30-day **ED visits**, 1-year **ED visits**, inpatient claims, and behavioral health claims.

**Results:** Results found that patients who received SBIRT services experienced a 21% reduction in healthcare costs and a significant reduction in **1-year ED visits (decrease of 3.3 percentage points).**

**Conclusions:** This study provides further support that SBIRT programs are cost-effective and cost-beneficial approaches to SUD management, important factors as policy advocates continue to disseminate SBIRT practices throughout the healthcare system.

**Keywords:** screening, brief intervention, and referral to treatment; overdose; emergency department; healthcare costs; and utilization.

## Introduction

Substance use disorders (SUD) and harmful drug and alcohol use are increasing problems in the United States.[1] Opioid overdoses have been declared a nationwide epidemic, with more than 28,000 opioid-related deaths in 2014.[2] In addition to the individual and population health risks, patients with SUDs and those who engage in harmful drug and alcohol use also pose a significant toll on healthcare utilization for the healthcare system.[3]

Screening, brief intervention, and referral to treatment (SBIRT) is an evidence-based approach for identifying and intervening with individuals who misuse alcohol or other drugs.[4] SBIRT uses a validated screening procedure to classify at-risk patients into risk categories.[5] Those at moderate risk of harm from their substance misuse receive a brief intervention (BI), a short conversation using motivational interviewing principles to encourage behavior change, while those at higher risk are referred to appropriate care.[5,6]

Policy advocates contend that SBIRT is cost-effective and cost-beneficial.[7,8] However, the evidence supporting these conclusions is limited and primarily focused on alcohol screening and brief intervention (SBI) within primary care settings.[7-10] In a 2009 review, Latimer et al. concluded that cost-effectiveness evidence for alcohol SBI is scarce, and it is unclear whether SBI for alcohol misuse results in net cost savings.[9] Bray et al. found little evidence that alcohol SBI would reduce downstream healthcare use and costs after reviewing the literature from 1962 to 2010.[11]

However, some studies suggest that SBIRT may be cost-effective and cost-beneficial, specifically in emergency department (ED) settings. A quasi-experimental study by Estee et al. resulted in significant Medicaid savings associated with SBIRT when it was implemented in EDs in Washington state.[12] Additionally, Barbosa et al. found that SBIRT services cost $8.63 less in

ED settings compared to outpatient settings and resulted in 13.7% more patients drinking below threshold levels.[13] A study conducted by Gentilello et al. also suggested that SBIRT applications within an ED result in a subsequent reduction in ED readmissions up to 36 months after the interventions.[14]

The Pennsylvania Department of Human Services (DHS) studied the costs of care in different healthcare settings for Medicaid patients. ED visits and repeated admissions to hospitals were identified as some of the highest cost drivers.[15] Moreover, a significant proportion of the patients receiving Medicaid who were high ED and hospital utilizers also had diagnoses of SUD. Thus, the Pennsylvania Department of Human Services' Medicaid Office sought to apply ED-based interventions that could reduce downstream costs (largely mediated via reduced ED visits and hospital readmissions). Given the ED-associated SBIRT research and DHS' need to find a way to reduce ED and hospital admissions among its Medicaid patients, the program titled *Safe Landing* was developed, which implemented SBIRT services within 1 ED in Allegheny County, Pennsylvania.

The aims of the *Safe Landing* program **and this study** were two-fold: (1) determine whether the implementation of the ED SBIRT services resulted in significantly reduced downstream healthcare costs; and (2) determine whether the implementation of the ED SBIRT services resulted in significantly reduced patient ED visits.

## Methods

### Study Setting and Intervention

This study was a retrospective analysis of a quality assurance intervention, in which the project team compared a group of adult patients who received ED SBIRT services from January 1 to December 31 in 2012 from the intervention hospital where *Safe Landing* was implemented

against 3 groups of ED patients who did not receive SBIRT services. One control group consisted of patients who received ED services at the intervention hospital in 2010 (prior to implementation of *Safe Landing).* The other 2 control groups included patients who received ED services at a different, but comparable, hospital in 2010 and 2012, respectively. This design controlled for time trend effects (e.g., state-wide policy changes) and hospital effects (i.e., intervention hospital vs. control hospital). **The 2 hospitals were programmatically similar and compared based on patient demographics (age, race, and gender), number of claims, and total healthcare costs (see Table 1). Both hospitals are located in Pittsburgh's metropolitan area, and each of the hospitals is a part of 1 of the 2 largest health systems. The study team received Institutional Review Board exemption to conduct this study.**

The *Safe Landing* intervention involved several systematic steps for each patient. First, the patient was asked validated questions concerning their substance use ("triage-screen" or "pre-screen") by the triage nurse.[16] The "triage screen" was embedded into the intervention hospital's electronic health record (EHR). If the patient's answers indicated the patient was at risk for overdose, then additional screening questions were asked by the treatment nurse using the evidence-based Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) screening instrument ("screen").[17] Next, numerical values tallied from the patient's ASSIST responses were used to calculate a "risk score" in an automated fashion in the EHR system of the intervention hospital (with levels being: no risk, low risk, moderate, high, and significant). Based on the patient's ASSIST score, the patient received brief feedback (no-/low-risk) or a BI (moderate risk) from the treatment nurse.

Patients scoring with high or significant ASSIST risk levels were identified for referral to SUD treatment and received a BI intended to boost patients' commitment to accept a referral and

immediately pursue rehabilitation and recovery services upon discharge. When these high-risk patients expressed a willingness to seek specialty treatment, the intervention site ED staff (nurses and social workers) facilitated access to specialty treatment and services via a "warm hand-off" - the process of introducing the patient to the behavioral health provider in real time. The BIs and referrals to SUD treatment were noted in a designated part of the EHR using the Healthcare Common Procedure Coding System (HCPCS) associated with SBIRT services.[18]

Trained ED staff conducted the interventions. Training consisted of 3 hour-long didactic lecture modules held at various time points beginning in May 2010 and concluding in June 2011. Four sessions were held for each module to capture the entire ED staff. The first module trained ED staff on addiction and overdose, specifically the scope of the problem in the intervention ED's catchment area, and an introduction to SBIRT. The second module trained ED staff on how to conduct screenings, assess patient risk level, and conduct BIs using motivational interviewing techniques.[19,20,21] The third module trained ED staff on referral to treatment and proper protocols for completing "warm hand-offs" of patients to recovery supports and treatment. Several booster sessions were provided upon the health system's request to reinforce concepts covered in the curriculum and ensure continued program fidelity. New staff received training on all modules as they were hired.

**Subjects, Data, and Measures**

Eligible patients included those who had visited 1 of the hospitals' EDs during either 2010 or 2012 and had Medicaid coverage; they were identified by an honest broker (HB). The experimental group from the intervention hospital in 2012 consisted of 2,546 patients, and the control group from the intervention hospital in 2010 consisted of 2,817 patients. The control group from the control hospital in 2012 consisted of 3,678 patients, and the control group from

the control hospital in 2010 consisted of 3,112 patients. **The study was designed as observational, where patients who had claims within the specified timeframes comprised the groups of the study. Random assignment to different treatments was not used. All patients who required brief feedback or a brief intervention received this step of the intervention at the intervention hospital, if desired.**

The data comprised Medicaid healthcare claims from 2010 and 2012 for all study subjects. The HB extracted the claims data for all patients who visited 1 of the hospitals during the years of interest. Each patient was assigned an index ED date, which signifies the first ED visit date of the year for each year. All claims data for these patients for the 12 months preceding and 12 months following the index ED visit were extracted and analyzed.

*Healthcare Costs.* Total healthcare costs were estimated by summing all allowable charges within general and behavioral health data, excluding the index ED event. **Out-of-pocket costs and payment by other payers were not included within the total healthcare cost calculations, and all costs taken into consideration were covered by Medicaid.**

***Healthcare Utilization.*** Binary measures were generated for ED visits within 30 days and 1 year of the index event, inpatient claims, and outpatient behavioral health claims where 0 indicated no claim and 1 indicated at least 1 claim in the associated time period before or after the index ED event. Control variables also provided by the HB included patient demographics (age, gender, and race/ethnicity) and the number of months the patient was covered by Medicaid.

Statistical Analyses

**Dependent variables were constructed comprising aggregate measures for a patient within the study time period for each of the outcome measures. Multilevel models with individual random effects were estimated using patient demographics and lengths of**

**coverage as controls. The independent variables of interest were an indicator of the index event provider (intervention or control hospital), year of the index event (2010 or 2012), and a pre- or post-index event indicator designating the 12 months before the index ED visit versus the 12 months after. Interacting these variables in the model produces a Differences in Differences in Differences (DnDnD) design.[20,21]**

**To assess the healthcare cost effects of the *Safe Landing* intervention, healthcare costs were modeled using a multilevel generalized linear model (GLM) assuming a gamma-distributed dependent variable and a log link function. Gamma GLM is often used to model cost data because of the common positive skew in the data.[22,23] Healthcare events (i.e., 30-day ED use, 1-year ED use, inpatient claims, and outpatient behavioral health claims) were modeled using multilevel linear probability models. A linear probability model was estimated not only due to ease of interpretation, but also because equivalently specified propensity score weighted nonlinear models were unable to converge. In addition, it has been shown that the use of the linear probability model is suitable in the case where the means of the dependent variables are not close to 0 or 1, as it is in this case.[24]**

**The DnDnD models are specified as follows:**

$$Y_{it} = f(\beta_0 + \beta_1 HOSP_i + \beta_2 POST_{it} + \beta_3 YEAR_i + \beta_4 HOSP_i*POST_{it} + \beta_5 HOSP_i*YEAR_i + \beta_6 POST_{it}*YEAR_i + \beta_7 HOSP_i*POST_{it}*YEAR_i + \beta_8 X_{it} + \gamma G_i) + \varepsilon_{it}$$

**$Y_{it}$ is the outcome for person i at time t, f(·) is a link function (log for the cost models and identity link for the utilization outcomes), and $\varepsilon_{it}$ is an independent and identically distributed (IID) error or residual. Specifying both f(·) and the distribution of $\varepsilon_{it}$ yielded various models appropriate for a variety of outcomes. The βs are fixed-effect parameters to be estimated, and γ is a vector of random-effect parameters (i.e., variance components) to**

**be estimated. HOSP is a dichotomous variable set to 1 when the individual had his/her index ED event at the intervention hospital and 0 otherwise. POST is a dichotomous variable set to 1 for observations corresponding to the year following the index visit and 0 otherwise. YEAR is a dichotomous variable set to 1 if the individual's index event occurred in 2012, and 0 otherwise. The next 4 items are interaction terms of the preceding 3, and $X_{it}$ is a vector of demographic characteristics (i.e., age, gender, and race/ethnicity) and adjustments for partial year follow-up (due to lack of Medicaid coverage through the year). $G_i$ is a vector of indicator variables for each included patient. $\beta_7$ captures the change in the outcome for those receiving the index ED event at the intervention hospital when SBIRT was intended to have been delivered relative to the comparison group. Thus, this captured the association between an intention of SBIRT delivery and healthcare utilization and cost outcomes.**

**To minimize the impact of observable confounders, a propensity score was estimated and represented the likelihood that each included patient would be in the treatment group.[25] The propensity score was derived from a logit regression of treatment group membership on demographics and pre-index event costs and utilization. Kernel matching was used to weight all patients in the comparison groups such that the comparison groups resembled the treatment group in terms of the potential confounding variables. Weights applied to control group members are a function of the distance between their propensity score and those of treated subjects, thus providing for estimates representing the average treatment effect on the treated subjects. Following the application of propensity score weights, standardized differences indicated that the treatment and control groups were sufficiently balanced, as no covariate had a weighted standardized**

**difference exceeding 0.1.[20] The average standardized difference following the application of the weights was 0.016.**

## Results

Table 1 shows the patient characteristics for the intervention and control groups. Typical subjects were in their late 20s or early 30s. Subjects were predominantly White and African-American females. Subjects were covered by Medicaid between 8 and 11 months out of a possible 13 months on average. There are 13 months total because the month of the index event and the preceding 12 months were included. Patients had between 110 and 124 claims in the year before the index event and between 94 and 160 claims in the year after the index event on average.

**Table 1.** Characteristics of Study Sample by Index Event Year and Index Event Provider (Intervention vs. Control Hospital)

**Table 2 below shows the full specification of the regression models, with coefficient and interaction estimates. The first row of the table contains the triple interaction, which represents the effect of the interaction net of hospital, year, and time (pre/post) effects. Model output shows a significant negative association between the intervention group and total costs ($p<0.001$), ED claims after 1 year ($p<0.01$), inpatient claims after 1 year ($p<0.01$), and behavioral health claims after 1 year ($p<0.05$).**

**Table 2. Full Model Outputs of Healthcare Costs and Utilization**

**Table 3 below details the model predictions from the models shown in Table 2, along with significance tests between the intervention group and the other groups of the study. The model estimates show the magnitude of the changes for the various model effects. Overall, total healthcare costs declined by 21% for the intervention group (($9,954 -**

**$7,880)/$9,954) in the 12 months following the index event relative to the 12 months prior. The incidence of ED visits and inpatient claims also fell significantly in the intervention group (3.3 and 4.1 percentage points, respectively).**

**Table 3. Estimates of Impacts of SBIRT on Healthcare Costs and Utilization**

## Discussion

Potential Effects on Healthcare Costs and Public Policy

This project has several salient considerations regarding how to address SUDs. SUDs can lead to increased healthcare utilization and costs,[3] and this study suggests that SBIRT programs may have the potential to improve patient outcomes via reductions in healthcare utilization, and resultant decreased costs.

The current study found that the implementation of an ED-based SBIRT program was associated with 21% lower healthcare costs from pre-index event to post-index event. This translates to approximately $2,100 per patient per year. This reduction in healthcare costs could be linked mainly to decreased inpatient use, which accounted for approximately **72% of the change in costs in the SBIRT group.** Complementing this overall decrease in inpatient costs, there was also a statistically significant reduction in 1-year ED visit rates. Additionally, there was a moderate effect on the use of behavioral healthcare, which also contributed to a small portion of the decrease in costs. However, as a sensitivity analysis, models were estimated using only healthcare costs that were unrelated to behavioral healthcare; the reduction in behavioral healthcare costs in these models is virtually unchanged.

There are a number of possible explanations for the association with lower costs. First, *Safe Landing* may have prevented patient relapses requiring detoxification and associated acute treatment. A decrease in patient relapses means the costs necessary for these patients and visits

would be negated. Second, BIs may have prevented the need for more intensive treatment, reducing the number of referrals to more expensive treatment services, and thus reducing overall costs at this level. Third, through patient awareness, the triage screening may have had an impact upon patient alcohol and drug use by patients. Finally, it is possible that some reductions are because of improvements in general health and a reduction in accidents associated with decreased substance use. These are just a few interpretations, but future research on the types of inpatient and behavioral healthcare patients receive is needed to understand the types of patients and care possibly influenced by SBIRT.

The SBIRT *Safe Landing* program makes an important contribution to the literature on the impact of SBIRT implemented in real-world settings rather than traditional randomized clinical trials. Few studies have rigorously analyzed the potential reduction in healthcare costs associated with SBIRT. **Even fewer studies are set in the ED and focused on the potential to reduce ED visits.[26]** A challenge to estimating the impact of SBIRT on healthcare costs in a real-world setting is a lack of adequate control groups because it is often not feasible to generate such a sample by design. However, Estee et al. used a control group of patients drawn from Medicaid claims data and propensity scores matched to SBIRT patients and concluded that SBIRT did reduce healthcare costs.[12] Our project also used claims data and propensity score matching, but across 3 different control groups, allowing for time and setting factors to be accounted. **As Raven et al., note, it is essential that future studies remain rigorous when studying interventions in the ED so that more definitive results can be made about intervention effectiveness for improving patient care or reducing healthcare costs.[26]**

**A plausible next step of the *Safe Landing* program, and therefore a focus of a future study, would be to consider the cost of the intervention and determine its cost-effectiveness.**

**The focus of the current study was on the impact of SBIRT on healthcare costs and healthcare utilization. However, a future study could examine the cost savings of an SBIRT intervention in terms of healthcare utilization versus the cost of delivering SBIRT. A study of this nature would provide valuable insight into the true cost-effectiveness of SBIRT services, and in particular, ED-based SBIRT services.**

Finally, besides potentially attenuating downstream healthcare costs, the application of SBIRT within the ED could provide a significant strategy communities can use to reduce overdose risk.[27] The results of analyses conducted with Allegheny County service data indicated an average of 6 to 14 ED visits per day were related to overdose, and persons who died from overdose had touched an ED at least once in the year prior to their death.[28] The impact of providing SBIRT services within community EDs on subsequent overdose risk is worthy of future study and could provide further support for implementing SBIRT in this healthcare setting.

## Conclusion

**In this study, SBIRT implementation showed the potential to reduce healthcare costs and utilization as measured by Medicaid claims data.** As the United States healthcare system moves toward reducing healthcare costs while also improving patient health, it will be important to provide evidence that new and existing methods can achieve these goals.[29] **SBIRT use in the ED has the potential to achieve these objectives in a manner that can be readily incorporated into existing practice settings.**

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Table

**Table 1.** Characteristics of Study Sample by Index Event Year and Index Event Provider (Intervention vs. Control Hospital)

| | | 2010 (Pre-Intervention) | | 2012 (Post-Intervention) | | Significance | Statistical Test |
|---|---|---|---|---|---|---|---|
| | | Control Hospital (N=3,112) | Intervention Hospital (N=2,817) | Control Hospital (N=3,678) | Intervention Hospital (Experimental Group) (N=2,546) | | |
| **Age** | **Coefficient SD** | **37.0 (13.1)** | **34.5 (13.0)** | **37.3 (13.0)** | **35.5 (13.0)** | *** | **ANOVA** |
| **% Female** | **Coefficient SD** | **60.4 (0.49)** | **69.1 (0.46)** | **60.4 (0.49)** | **68.8 (0.46)** | *** | **Chi-Square** |
| **% White** | **Coefficient SD** | **50.7 (0.50)** | **47.5 (0.50)** | **49.8 (0.50)** | **42.7 (0.49)** | *** | **Chi-Square** |
| **% Black** | **Coefficient SD** | **46.4 (0.50)** | **49.9 (0.50)** | **45.5 (0.50)** | **54.8 (0.50)** | *** | **Chi-Square** |
| **% Other** | **Coefficient SD** | **2.9 (0.17)** | **2.6 (0.16)** | **4.7 (0.21)** | **2.6 (0.16)** | *** | **Chi-Square** |
| **Months covered before index event** | **Coefficient SD** | **8.4 (4.3)** | **10.9 (3.8)** | **10.7 (3.7)** | **11.1 (3.6)** | *** | **ANOVA** |
| **Months covered after index event** | **Coefficient SD** | **11.1 (3.4)** | **11.1 (3.5)** | **10.9 (3.5)** | **11.2 (3.4)** | *** | **ANOVA** |
| **# of claims in year before index event** | **Coefficient SD** | **124.3 (167.5)** | **110.2 (149.2)** | **118.6 (172.5)** | **118.1 (162.4)** | **p = 0.012** | **ANOVA** |
| **Proportion Inpatient** | **Coefficient SD** | **0.03 (0.07)** | **0.04 (0.09)** | **0.03 (0.07)** | **0.04 (0.10)** | *** | **ANOVA** |
| **Proportion Outpatient/ED** | **Coefficient SD** | **0.70 (0.22)** | **0.68 (0.24)** | **0.79 (0.20)** | **0.68 (0.23)** | *** | **ANOVA** |
| **Proportion Pharmacy** | **Coefficient SD** | **0.27 (0.22)** | **0.28 (0.23)** | **0.18 (0.19)** | **0.28 (0.23)** | *** | **ANOVA** |
| **# of claims in year after index event** | **Coefficient SD** | **160.2 (199.0)** | **109.0 (155.8)** | **145.1 (177.6)** | **94.1 (133.4)** | *** | **ANOVA** |
| **Proportion Inpatient** | **Coefficient SD** | **0.02 (0.06)** | **0.03 (0.09)** | **0.02 (0.06)** | **0.03 (0.09)** | *** | **ANOVA** |
| **Proportion Outpatient/ED** | **Coefficient SD** | **0.70 (0.21)** | **0.67 (0.26)** | **0.75 (0.20)** | **0.66 (0.26)** | *** | **ANOVA** |
| **Proportion Pharmacy** | **Coefficient SD** | **0.28 (0.21)** | **0.30 (0.26)** | **0.23 (0.20)** | **0.31 (0.26)** | *** | **ANOVA** |
| **Any medical claim in 30 days following index event** | **Coefficient SD** | **0.75 (0.43)** | **0.69 (0.46)** | **0.76 (0.43)** | **0.71 (0.46)** | *** | **Chi-Square** |
| **Any inpatient event in year prior to index event** | **Coefficient SD** | **0.19 (0.39)** | **0.19 (0.39)** | **0.17 (0.37)** | **0.18 (0.39)** | **p = 0.051** | **Chi-Square** |

| | | 2010 (Pre-Intervention) | | 2012 (Post-Intervention) | | Significance | Statistical Test |
|---|---|---|---|---|---|---|---|
| | | Control Hospital (N=3,112) | Intervention Hospital (N=2,817) | Control Hospital (N=3,678) | Intervention Hospital (Experimental Group) (N=2,546) | | |
| **Any inpatient event in year following index event** | **Coefficient SD** | **0.20 (0.40)** | **0.16 (0.37)** | **0.20 (0.40)** | **0.14 (0.35)** | *** | **Chi-Square** |
| **Any behavioral health claim in year prior to index event** | **Coefficient SD** | **0.48 (0.50)** | **0.37 (0.48)** | **0.48 (0.50)** | **0.38 (0.49)** | *** | **Chi-Square** |
| **Any behavioral health claim in year following index event** | **Coefficient SD** | **0.50 (0.50)** | **0.38 (0.49)** | **0.50 (0.50)** | **0.38 (0.48)** | *** | **Chi-Square** |
| **Total healthcare costs in year before index event** | **Coefficient SD** | **9579.6 (18251.0)** | **11011.3 (52866.4)** | **8810.4 (17149.5)** | **12371.3 (51178.8)** | **p = 0.0011** | **ANOVA** |
| **Inpatient Costs** | **Coefficient SD** | **1776.6 (7294.8)** | **5501.1 (49853.1)** | **1605.2 (6542.8)** | **6092.5 (47593.4)** | *** | **ANOVA** |
| **Outpatient/ED Costs** | **Coefficient SD** | **6212.5 (13607.6)** | **4053.9 (9163.2)** | **6161.1 (12969.1)** | **4474.5 (10228.9)** | *** | **ANOVA** |
| **Pharmacy Costs** | **Coefficient SD** | **1590.7 (3393.1)** | **1456.2 (4022.6)** | **1045.0 (3092.9)** | **1804.3 (4717.2)** | *** | **ANOVA** |
| **Total healthcare costs in year after index event** | **Coefficient SD** | **12096.4 (21376.0)** | **10214.6 (33373.6)** | **10699.4 (19411.9)** | **9679.4 (37440.9)** | **p = 0.008** | **ANOVA** |
| **Inpatient Costs** | **Coefficient SD** | **2279.9 (9031.6)** | **4488.9 (28298.6)** | **1931.4 (8257.0)** | **4148.4 (33562.4)** | *** | **ANOVA** |
| **Outpatient/ED Costs** | **Coefficient SD** | **7773.9 (15716.7)** | **4373.5 (11296.8)** | **7298.4 (14152.2)** | **4314.5 (11135.7)** | *** | **ANOVA** |
| **Pharmacy Costs** | **Coefficient SD** | **2042.7 (4078.9)** | **1352.2 (3917.6)** | **1470.6 (3909.6)** | **1216.4 (3690.1)** | *** | **ANOVA** |

*****p<0.001**
**Authors' analysis of data from the *Safe Landing* project. Statistics are unadjusted (i.e., propensity score weights are not applied)**
**Patient data ranges from 2009-2013.**
**SD = Standard deviations in parentheses.**
**Specialty alcohol/drug treatment claims and detox claims identified using procedure codes/modifiers.**
**Behavioral health events identified by source of claim.**
**Patients were drawn from 2 hospitals based on whether they had an ED visit in 2010 or 2012.**
**ED = emergency department**
**ED and outpatient claims combined.**

## Table 2. Full Model Outputs of Healthcare Costs and Utilization

| | | Total healthcare costs in 1 year | Any ED Claim in 30 days | Any ED Claim in 1 year | Any inpatient claim in 1 year | Any outpatient behavioral health claim in 1 year |
|---|---|---|---|---|---|---|
| Intervention Hospital x Post-Index Event x Index Year 2012 | Coefficient | -0.405 | -0.020 | -0.071 | -0.047 | -0.037 |
| | SE | (0.090) | (0.019) | (0.022) | (0.018) | (0.016) |
| | P-Value | *** | 0.282 | 0.001 | 0.010 | 0.019 |
| Intervention Hospital x Index Year 2012 | Coefficient | 0.141 | 0.015 | 0.041 | 0.025 | 0.051 |
| | SE | (0.088) | (0.013) | (0.019) | (0.015) | (0.018) |
| | P-Value | 0.111 | 0.243 | 0.027 | 0.092 | 0.005 |
| Post-Index Event x Index Year 2012 | Coefficient | 0.236 | 0.019 | 0.039 | 0.041 | 0.018 |
| | SE | (0.051) | (0.013) | (0.015) | (0.013) | (0.011) |
| | P-Value | *** | 0.153 | 0.009 | 0.001 | 0.097 |
| Index Year 2012 | Coefficient | -0.337 | 0.007 | -0.032 | -0.036 | -0.007 |
| | SE | (0.052) | (0.009) | (0.013) | (0.010) | (0.012) |
| | P-Value | *** | 0.482 | 0.013 | *** | 0.578 |
| Intervention Hospital x Post-Index Event | Coefficient | -0.009 | 0.009 | -0.085 | -0.024 | 0.003 |
| | SE | (0.071) | (0.013) | (0.016) | (0.013) | (0.012) |
| | P-Value | 0.894 | 0.505 | *** | 0.066 | 0.777 |
| Post-Index Event | Coefficient | -0.055 | 0.108 | 0.085 | -0.011 | 0.011 |
| | SE | (0.039) | (0.010) | (0.011) | (0.009) | (0.008) |
| | P-Value | 0.159 | *** | *** | 0.237 | 0.160 |
| Intervention Hospital | Coefficient | -0.142 | -0.038 | -0.051 | -0.006 | -0.076 |
| | SE | (0.069) | (0.009) | (0.014) | (0.011) | (0.013) |
| | P-Value | 0.040 | *** | *** | 0.594 | *** |
| Age in Years | Coefficient | 0.060 | 0.008 | 0.008 | -0.002 | 0.026 |
| | SE | (0.010) | (0.002) | (0.002) | (0.002) | (0.002) |
| | P-Value | *** | *** | *** | 0.325 | *** |
| Age Squared | Coefficient | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | SE | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| | P-Value | 0.035 | *** | *** | 0.004 | *** |
| Female | Coefficient | -0.208 | -0.011 | 0.037 | 0.034 | -0.067 |
| | SE | (0.044) | (0.008) | (0.010) | (0.007) | (0.010) |
| | P-Value | *** | 0.146 | *** | *** | *** |
| Race: black | Coefficient | -0.522 | -0.041 | -0.007 | -0.028 | -0.175 |
| | SE | (0.039) | (0.007) | (0.009) | (0.007) | (0.010) |
| | P-Value | *** | *** | 0.451 | *** | *** |
| Race: non-white, non-black | Coefficient | -0.577 | -0.075 | -0.133 | -0.046 | -0.223 |
| | SE | (0.138) | (0.020) | (0.026) | (0.016) | (0.029) |
| | P-Value | *** | *** | 0.004 | 0.005 | *** |
| Months covered by Medicaid | Coefficient | 0.100 | -0.001 | 0.024 | 0.008 | 0.010 |
| | SE | (0.006) | (0.001) | (0.001) | (0.001) | (0.001) |
| | P-Value | *** | 0.223 | *** | *** | *** |
| Constant | Coefficient | 6.753 | 0.036 | 0.203 | 0.071 | -0.089 |
| | SE | (0.199) | (0.031) | (0.042) | (0.029) | (0.042) |
| | P-Value | *** | 0.241 | *** | 0.017 | 0.035 |
| Observations | | 24300 | 24,300 | 24,300 | 24,300 | 24,300 |

Robust standard errors in parentheses.
***p<0.001

| | | Total healthcare costs in 1 year | Any ED Claim in 30 days | Any ED Claim in 1 year | Any inpatient claim in 1 year | Any outpatient behavioral health claim in 1 year |
|---|---|---|---|---|---|---|
| **SE = Standard errors in parentheses.**<br>**Cost modeled as mixed effect gamma GLM; binary outcomes modeled as mixed effects linear models.**<br>**Data from patients who visited either intervention hospital or control hospital in 2010 and/or 2012. Patients with index events in both years are considered to be separate for the purpose of these models.**<br>**Constants were not reported.** | | | | | | |

**Table 3. Estimates of Impacts of SBIRT on Healthcare Costs and Utilization**

| Patient Group | Time Period | | Healthcare Costs | 30-day ED Visits | 1-year ED Visits | Inpatient Claims | Outpatient Behavioral Health Claims |
|---|---|---|---|---|---|---|---|
| Control Hospital 2010 | Pre-Index | Coefficient | $13,961 | 15.5% | 64.7% | 20.0% | 41.3% |
| | | P-Value | *** | *** | *** | *** | 0.046 |
| | Post-Index | Coefficient | $13,215 | 26.3% | 73.1% | 18.9% | 42.5% |
| | | P-Value | *** | 0.473 | *** | *** | *** |
| Intervention Hospital 2010 | Pre-Index | Coefficient | $12,119 | 11.7% | 59.6% | 19.4% | 33.7% |
| | | P-Value | *** | *** | 0.089 | *** | 0.002 |
| | Post-Index | Coefficient | $11,364 | 23.4% | 59.6% | 15.9% | 35.2% |
| | | P-Value | *** | 0.089 | 0.099 | 0.088 | 0.054 |
| Control Hospital 2012 | Pre-Index | Coefficient | $9,963 | 16.2% | 61.5% | 16.4% | 40.7% |
| | | P-Value | *** | *** | 0.0011 | 0.022 | 0.016 |
| | Post-Index | Coefficient | $11,944 | 28.9% | 73.9% | 19.4% | 43.6% |
| | | P-Value | *** | 0.003 | *** | *** | *** |
| Intervention Hospital 2012 (experimental group) | Pre-Index | Coefficient | $9,954 | 13.9% | 60.6% | 18.3% | 38.1% |
| | | P-Value | *** | *** | 0.004 | *** | 0.595 |
| | Post-Index | - | $7,880 | 25.4% | 57.3% | 14.2% | 37.7% |

**Authors' analysis of data from the *Safe Landing* project.**
**Data ranges from 2009-2013.**
**ED = emergency department**
***p<0.001, relative to experimental group, post-index.**