

REPORT

FINAL REPORT

Massachusetts Homeless Triage Assessment

August 10, 2017

James Mabli

Hande Inanc

Submitted to:

Massachusetts Housing and Shelter Alliance

P.O. Box 8638

Boston, MA 02114

Project Officer: Singumbe Muyeba, PhD, Research and Evaluation Specialist

Contract Number: 50420

Submitted by:

Mathematica Policy Research

955 Massachusetts Avenue

Suite 801

Cambridge, MA 02139

Telephone: (617) 491-7900

Facsimile: (617) 491-8044

Project Director: James Mabli

Reference Number: 50420.400

This page has been left blank for double-sided copying.

ACKNOWLEDGMENTS

This report was prepared for the Massachusetts Housing and Shelter Alliance by James Mabli and Hande Inanc of Mathematica Policy Research. Many individuals made important contributions to this study. The authors thank Huihua Lu for expert programming in generating study findings; Gretchen Rowe for reviewing the report; Dale Anderson and John Kennedy for editing assistance; and Colleen Fitts for preparing the manuscript. The authors also thank Joe Finn and Singumbe Muyeba of MHSA for their guidance and support throughout the study. On behalf of MHSA, the authors also extend their gratitude to the Kresge Foundation whose grant towards improvement of MHSA's research capacity made this study possible. Finally, the authors gratefully acknowledge Dr. Monica Bharel, Dr. Jessie Gaeta, and Tom Brigham for their role in constructing the triage assessment tool.

This page has been left blank for double-sided copying.

CONTENTS

EXECUTIVE SUMMARY IX

I. INTRODUCTION..... 1

 A. Background..... 1

 B. Research questions 2

 C. Organization of the report..... 2

II. DATA AND METHODOLOGY 3

 A. Data 3

 B. Methodology 3

III. TRIAGE ASSESSMENT SCORES AND SUBSEQUENT SERVICE USE..... 5

 A. Service use and triage total scores 5

 1. Description of triage total scores..... 5

 2. Description of service use in the six months before entering housing..... 5

 3. Associations between service use and triage total scores 6

 B. Service use and triage component scores 7

 1. Description of triage component scores..... 7

 2. Associations between service use in the six months before entering housing and homelessness history component score..... 8

 3. Associations between service use in the six months before entering housing and emergency service use component score 10

 4. Associations between service use in the six months before entering housing and physical health component score..... 11

 5. Associations between service use in the six months before entering housing and combined scores of mental health, substance use and dual diagnosis components..... 13

IV. CONCLUSION 17

APPENDIX A DATA AND METHODOLOGYA.1

APPENDIX B SUPPLEMENTAL TABLES.....B.1

This page has been left blank for double-sided copying.

TABLES AND FIGURES

Table III.1. Distribution of triage total scores, by geography and age 5

Figure III.1. Percentage of participants who used services in the six months before entering housing..... 6

Figure III.2. Percentages of participants who used services in the six months before entering housing, by triage total score 7

Table III.2. Average triage component scores, by geography and age 8

Figure III.3. Percentages of participants who used services in the six months before entering housing, by homelessness history component score 9

Table III.3. Triage questions within the homelessness history domain that were most predictive of service use 9

Figure III.4. Percentages of participants who used services in the six months before entering housing, by emergency service use component score 10

Table III.4. Triage questions within the emergency services domain that were most predictive of service use 11

Figure III.5. Percentages of participants who used services in the six months before entering housing, by physical health component score 12

Table III.5. Triage questions within the physical health domain that were most predictive of service use 13

Figure III.6. Percentages of participants who used services in the six months before entering housing, by combined component score for mental health, substance use, and dual diagnosis 14

Table III.6. Triage questions within the mental health domain, substance abuse domain, or dual diagnosis that were most predictive of service use 15

This page has been left blank for double-sided copying.

EXECUTIVE SUMMARY

Homelessness is a housing crisis that affects people nationwide. More than half a million people experienced homelessness in the United States on a single night in 2016.¹ In Massachusetts, nearly 20,000 people were homeless on a single night in 2016. Of that total, 1,272 were chronically homeless. Although the number of chronically homeless decreased both nationally and in Massachusetts from 2015 to 2016, continued community- and state-level efforts are needed to end chronic homelessness.

To help reduce chronic homelessness in Massachusetts, the Commonwealth launched a Pay for Success (PFS) initiative which provides permanent supportive housing for 500 to 800 homeless people who represent the costliest segment of the homeless population. The goal is to reduce the health care costs associated with remaining homeless. The Massachusetts Housing and Shelter Alliance (MHSA), a nonprofit, public policy organization dedicated to ending homelessness in Massachusetts, formed a coalition with other agency partners to serve as an intermediary between the initiative's investors, its providers, and the Commonwealth. The coalition's primary responsibility is to operate the program.

Participants are eligible for PFS if they are chronically homeless or are long-term homeless adults who frequently use emergency health services. Staff at emergency shelters and health services providers collect information about homeless people they serve, including demographic characteristics and five types (referred to as *domains*) of housing and health status: homelessness history, use of emergency services, physical health, mental health, and substance use. The triage assessment assigns a component score to each domain, a dual diagnosis score for the presence of both mental illness and substance use, and a total score that is the sum of the component and dual diagnosis scores. MHSA uses the total score to rank people based on their likelihood of being frequent users of emergency health services and returns the ranked list to providers. As housing units become available, providers use the list to determine to whom to provide housing.

Research objectives

The main objective of this study was to evaluate the effectiveness of the triage assessment in identifying people who frequently use health services. To address this objective, we used individuals' self-reported data from the triage assessment and data on their subsequent service use before entering housing to answer three research questions:

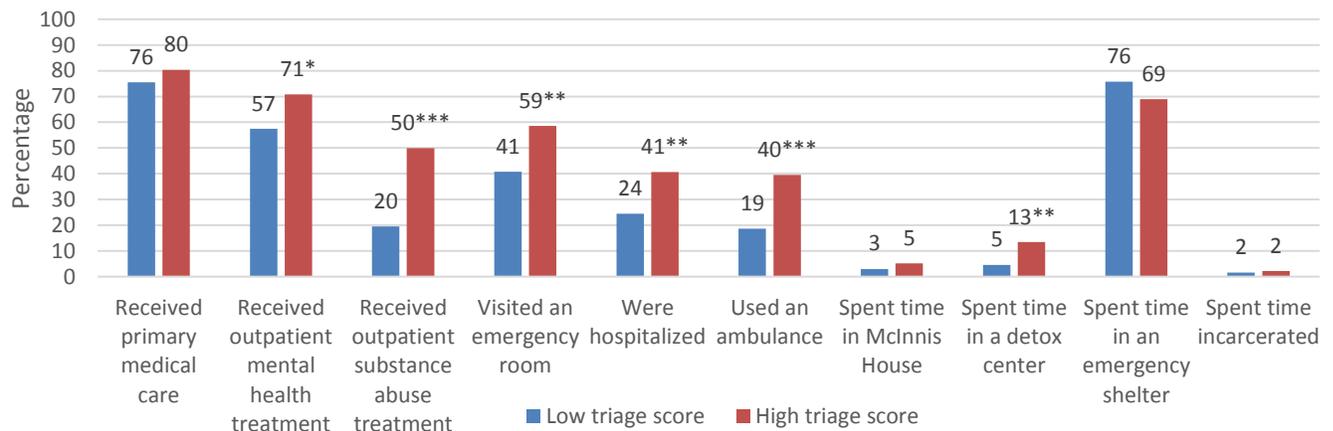
1. How are service use outcomes associated with triage assessment total scores? Do people with higher scores use emergency health services to a greater extent?
2. How are service use outcomes associated with each of the five triage component scores? Are some domains better at predicting subsequent service use than others?
3. Which individual questions used to create the domain scores are best at predicting subsequent service use?

¹ The statistics in this paragraph are taken from U.S. Department of Housing and Urban Development. "2016 Annual Homeless Assessment Report (AHAR) to Congress: Part 1: Point-in-Time Estimates of Homelessness." Available at <https://www.hudexchange.info/resources/documents/2016-AHAR-Part-1.pdf>.

Findings

Having a higher triage total score was associated with receiving outpatient mental health treatment, receiving outpatient substance abuse treatment, visiting an emergency room, being hospitalized, using an ambulance, and spending time in a detoxification center (Figure 1). About 71 percent of participants with a higher triage score received outpatient mental health treatment, compared to 57 percent of participants with a lower score. There also was a large difference in the percentage of participants who received outpatient substance use treatment (50 versus 20 percent). Participants with a higher triage total score were more likely than those with a lower score to visit an emergency room (59 versus 41 percent), become hospitalized (41 versus 24 percent), or use an ambulance (40 versus 19 percent). There was a smaller, but significant, difference in the percentage that spent time in a detox center (13 versus 5 percent).

Figure 1. Percentages of participants who used services in the six months before entering housing, by triage total score



Source: MHSa triage assessment and housing entry interview data, 2015–2017.

Notes: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage total score distribution, respectively. All outcomes measured in the six months before the housing entry interview.

Percentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

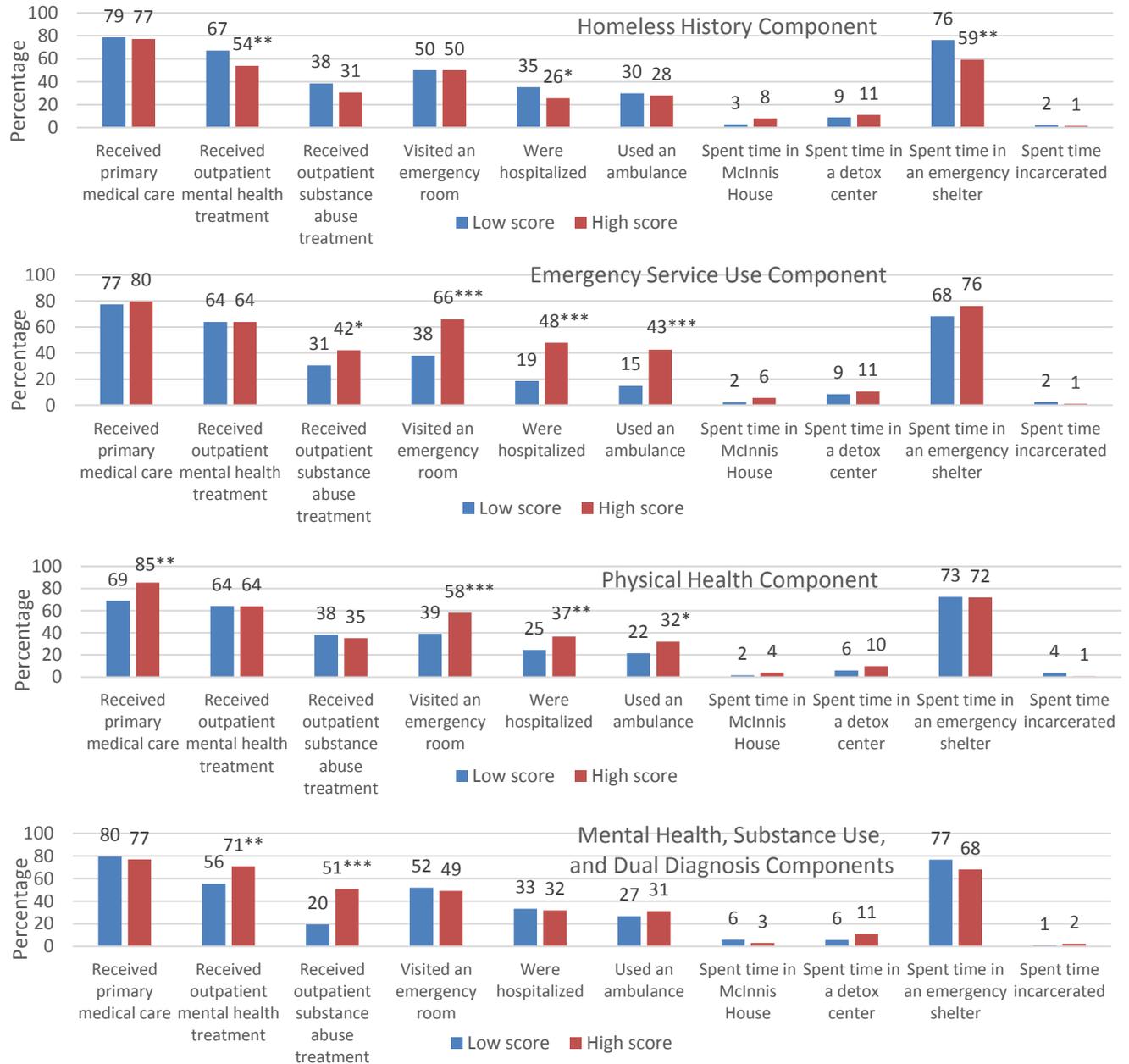
*Significantly different from zero at the .10 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Compared with the total score, triage component scores were less predictive of service use across the full range of outcomes, but were strong predictors for specific outcomes. For example, the emergency service use score strongly predicted visiting an emergency room, being hospitalized, and using an ambulance (Figure 2), and the physical health component score strongly predicted use of services related to physical well-being, such as receiving primary medical care, visiting an emergency room, being hospitalized, and using an ambulance. Similarly, the combined score from the mental health, substance abuse, and dual diagnosis components strongly predicted receiving outpatient mental health treatment and outpatient substance abuse treatment.

Figure 2. Percentages of participants who used services in the six months before entering housing, by triage component scores



Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Notes: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage component score distributions, respectively. All outcomes measured in the six months before the housing entry interview. Percentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

*Significantly different from zero at the .10 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

We also analyzed which individual questions used to create the domain scores were most predictive of subsequent service use. The findings revealed that the associations between the homelessness history score and service use outcomes were almost exclusively attributed to how often participants slept outside or on the street, rather than in a shelter. In contrast, the significant outcomes for the emergency service use score were associated with most of the questions in the domain. For the physical health domain, the outcomes with the largest associations with physical health score, such as emergency room visits and ambulance use were associated with almost all of the questions identifying whether the participant had ever been diagnosed with the need for dialysis, heart disease, HIV/AIDS, asthma or chronic obstructive pulmonary disease, or hepatitis C.

Conclusion

The findings provide evidence that the triage scoring metric is a strong predictor of subsequent service use. Of the 10 outcomes examined, the associations with the triage total score were in the expected directions for all outcomes and were statistically significant for the majority (6 of 10) of outcomes. Although the research findings suggest that the triage and assessment tool effectively identifies chronically homeless participants who will frequently use health services, more research is needed to provide definitive evidence of the tool's predictive power. Using administrative data on service receipt in place of the data self-reported by PFS participants when they enter housing could strengthen the methodology of this study. This would allow measurement of service receipt in each month following the triage assessment, rather than relying on self-reported service use recalled over a six-month period. Thus, it would be possible to estimate monthly rates of service use for *all* PFS participants, rather than only for those who entered housing and were interviewed at least six months after the triage assessment. This would maximize the representativeness of the findings to the program's population and would increase the precision of the estimates of the associations between triage scores and service use.

I. INTRODUCTION

Homelessness is a housing crisis that affects people nationwide. More than half a million people (549,928) experienced homelessness in the United States on a single night in 2016. More than two-thirds of these people stayed in emergency shelters, transitional housing programs, or safe havens, but the rest were unsheltered, meaning they resided on the street, in a vehicle, in a park, or in some other place not designated for a regular sleeping accommodation. The number of homeless nationwide decreased by 3 percent from 2015 to 2016.²

In Massachusetts, nearly 20,000 people were homeless on a single night in 2016. Of that total, 1,272 were chronically homeless, which is defined as an individual with a disabling condition who has been continuously homeless for a year or more or has had at least four episodes of homelessness in the past three years. Although the number of chronically homeless decreased both nationally and in Massachusetts from 2015 to 2016, continued community- and state-level efforts are needed to end chronic homelessness.

To combat homelessness in Massachusetts, the Massachusetts Housing and Shelter Alliance (MHSA), a nonprofit, public policy organization, coordinates about 100 community-based agencies operating programs that serve homeless people across the state. MHSA works with local, state, and federal agencies to design and implement policies and practices to end homelessness through strategies that help homeless people meet their health care, income, and housing needs. MHSA contracted with Mathematica Policy Research to perform a rapid-cycle evaluation of the effectiveness of an operational component of one specific strategy focused on permanent supportive housing. The evaluation used data reported from chronically homeless people in Massachusetts to assess whether a component of the current program intake model which assesses people's use of emergency health services functions as intended.

A. Background

To help reduce chronic homelessness in Massachusetts, the Commonwealth has launched a Pay for Success (PFS) initiative which provides permanent supportive housing for 500 to 800 homeless people. PFS seeks to provide housing to the costliest segment of the homeless population to reduce the health care costs associated with remaining homeless. MHSA formed a coalition with other agency partners to serve as an intermediary between the initiative's investors, its providers, and the Commonwealth. The coalition's primary responsibility is to operate the program.

Participants are eligible for PFS if they meet the definition of *chronic homelessness* used by the U.S. Department of Housing and Urban Development or if they are long-term homeless adults who frequently use emergency health services.³ MHSA and Boston Health Care for the

² These statistics are taken from U.S. Department of Housing and Urban Development. "2016 Annual Homeless Assessment Report (AHAR) to Congress: Part 1: Point-in-Time Estimates of Homelessness."

³ The Department defines a *chronically homeless* individual to mean "a homeless individual with a disability who lives either in a place not meant for human habitation, a safe haven, or in an emergency shelter, or in an institutional care facility if the individual has been living in the facility for fewer than 90 days and had been living in a place not meant for human habitation, a safe haven, or in an emergency shelter immediately before entering the institutional care facility. In order to meet the "chronically homeless" definition, the individual also must have been living as

Homeless created a triage and assessment tool to assess participants' health issues and current use of emergency services. Staff at emergency shelters and health services providers collect information about homeless people they serve, including demographic characteristics and five types of housing and health status (referred to as *domains*): homelessness history, use of emergency services, physical health, mental health, and substance use. The triage assessment assigns a score to each domain (referred to as a *component* score), a dual diagnosis score for the presence of both mental illness and substance use, and a total score that is the sum of the component scores and dual diagnosis score.⁴ MHSA uses the total score to rank people based on their likelihood of being frequent users of emergency health services and returns the ranked list to providers. As housing units become available, providers use the list to determine to whom to provide housing. Although providers prioritize those with higher ranks on the list, they have the discretion to house a small percentage of lower-ranked people whom they believe to be at high need of services. This has not yet occurred in the program, however.

B. Research questions

The main objective of this study was to evaluate the effectiveness of the triage assessment tool in identifying people who frequently use health services. To address this objective, we used individuals' self-reported data from the triage assessment and data on their subsequent service use before entering housing to answer three research questions:

1. How are service use outcomes associated with triage assessment total scores? Do people with higher scores use emergency health services to a greater extent?
2. How are service use outcomes associated with each of the five triage component scores? Are some domains better at predicting subsequent service use than others?
3. Which individual questions used to create the domain scores are best at predicting subsequent service use?

C. Organization of the report

In the remaining chapters of this report, we discuss the data and methodology used in the analysis and present our findings. In Chapter II, we provide an overview of the data and methodology used in the analysis. Chapter III includes detailed tables and figures describing the association between triage assessment scores and service use outcomes. In Chapter IV, we present conclusions based on the findings. The appendices of the report provide supporting material and additional tables. Appendix A is a supplement to Chapter II with a more detailed discussion of the data and methodology, and Appendix B has supplementary analytic tables.

described above continuously for at least 12 months, or on at least four separate occasions in the last 3 years, where the combined occasions total a length of time of at least 12 months. Each period separating the occasions must include at least 7 nights of living in a situation other than a place not meant for human habitation, in an emergency shelter, or in a safe haven.

⁴ For example, a participant who affirms he or she has been diagnosed with depression and who reports he or she has been treated for drug or alcohol problems would receive a score of 2.5 for depression, a score of 2 for drug or alcohol treatment, and an additional score of 3 for the presence of both conditions.

II. DATA AND METHODOLOGY

In this chapter, we present an overview of the triage assessment data and housing entry interview data used to conduct the study. We also describe the statistical methods used to measure associations between triage assessment scores and service use outcomes. Appendix A provides a more detailed description of the data and methods.

A. Data

We used two administrative data files provided by MHSA to conduct the analysis: the triage assessment data and service use data collected by case managers when an individual enters housing through PFS. The triage assessment data contained information on participants' demographic characteristics and responses to questions in each of the five domains: homelessness history, use of emergency services, physical health, mental health, and substance use. The service use data obtained when participants entered housing contained information on participants' demographic characteristics, homelessness history, income sources, health insurance coverage, quality of life, disability and health history, and service use in the past six months. The contents of both files are described in Appendix A, Tables A.1 and A.2. The analysis was based on 147 PFS participants.

B. Methodology

The analysis consisted of a combination of descriptive statistics, multivariate regression methods, and machine-learning techniques.⁵ Before conducting the analyses that directly address the research objectives, we described the distributions of the triage scores using the mean score and the scores corresponding to the 10th, 25th, 50th, 75th, and 90th percentiles. We described the score distributions for all participants and by geography and age.

The primary analyses used multivariate regression methods and machine-learning techniques to address the three research questions. We estimated a set of regressions that empirically modeled the associations between the outcome measures in the service use data, the triage assessment total score, and the triage assessment component scores. The dependent variables consisted of the following outcome measures in the service use data, each measured over the six months before the housing entry interview:

1. Whether the participant received primary medical care
2. Whether the participant received outpatient mental health treatment
3. Whether the participant received outpatient substance abuse treatment
4. Whether the participant visited an emergency room

⁵ Machine-learning techniques are procedures that attempt to maximize prediction accuracy (in this case, the accuracy of predicting service use outcomes using information from the triage assessment), but to identify a more parsimonious set of independent variables than is typically found in more traditional model selection methods. The techniques focus on optimizing data for making predictions.

5. Whether the participant was hospitalized
6. Whether the participant used an ambulance
7. Whether the participant spent time in McInnis House⁶
8. Whether the participant spent time in a detox center
9. Whether the participant spent time in an emergency shelter
10. Whether the participant spent time incarcerated

The triage assessment total score was the main independent variable in the first set of regressions. Other independent variables included those that are not part of the scoring metric: geographic location, age, race, ethnicity, gender identity, prison, jail, and foster care. We estimated each of the ten regressions separately. We presented the results of these analyses using regression-adjusted figures of estimates of the association between triage scores and outcomes. These compare the percentages of participants with high triage assessment scores who used services before entering housing to the percentages of participants with low triage assessment scores who used services, accounting for differences across participants in geographic location and demographic characteristics.

We estimated a similar set of regressions to answer the second research question—how are service use outcomes associated with each of the five triage component scores? The regressions were identical to those for the triage total score, except we replaced the total score with the five triage component scores and the dual diagnosis score in each regression. Because the dual diagnosis score is based on the mental health and substance use component scores, we created a new variable equal to the sum of the mental health and substance use component scores and the dual diagnosis score and included this variable in the regression in place of the separate component and dual diagnosis scores. Thus, the total score was decomposed into four scores: the first three component scores (homelessness history, use of emergency services, and physical health) and a fourth score representing the sum of the mental health, substance use, and dual diagnosis scores.

The third research question identified which questions or fields in the triage assessment were strongly predictive of service use. We estimated associations between the set of outcome measures in the service use data and the set of individual variables on which the total and component scores are based using a set of machine-learning variable selection procedures. For each model, we used the set of 10 binary outcomes used in the previous regressions. The independent variables consisted of the 26 variables used to define the triage score; interaction variables we created using individual questions in the mental health domain and individual questions in the substance use domain, most of which were part of the scoring metric for dual diagnosis; and participant characteristics such as age, gender, race, and ethnicity used in the previous regressions.

⁶ The Barbara McInnis House is a medical respite facility located in Boston Medical Center that is part of Boston Healthcare for the Homeless Program. It provides round-the-clock, short-term medical and recuperative services for the homeless.

III. TRIAGE ASSESSMENT SCORES AND SUBSEQUENT SERVICE USE

In this chapter, we describe the distributions of triage total scores and present information on whether participants who receive higher scores have greater use of emergency health services after the triage assessment and before they enter housing, compared to those that have lower scores. We also conduct this analysis using triage component scores measuring homelessness history; emergency service use; physical health; and a combination of mental health, substance use, and dual diagnosis components of the triage assessment.

A. Service use and triage total scores

1. Description of triage total scores

Table III.1 presents the distribution of triage total scores for all participants and for participants by geographic location and age. The mean total triage score was 26.2, and the median was 25.5. Twenty-five percent of participants had a score at or below 12.5, while the score of the top 25 percent was at least 38.0.

Table III.1. Distribution of triage total scores, by geography and age

	All participants	Geographic location		Age	
		Participants living in Greater Boston	Participants living outside of Greater Boston	Participants younger than 50 years old	Participants at least 50 years old
Mean	26.2	21.1	30.3	26.9	25.6
10th percentile	7.0	6.0	12.0	7.5	6.5
25th percentile	12.5	8.5	18.5	13.5	11.0
50th percentile	25.5	15.6	32.0	26.5	23.8
75th percentile	38.0	33.0	40.5	38.0	38.3
90th percentile	45.5	41.0	46.5	45.5	45.0

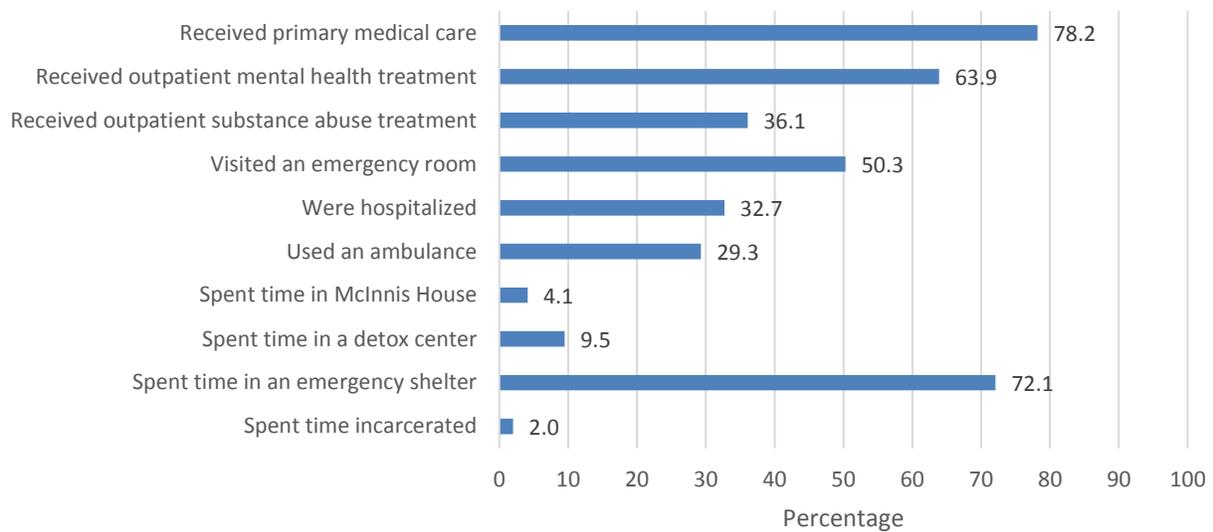
Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Scores varied by geography, but generally not by age. Scores were lower, on average, for participants living in Greater Boston than for those outside Greater Boston (21.1 versus 30.3). Scores were generally similar for participants younger than 50 years old and those at least 50 years old (26.9 versus 25.6).

2. Description of service use in the six months before entering housing

Most participants used services in the six months before entering housing (Figure III.1). Receipt of primary medical care was the most common service (78.2 percent of participants), followed by spending time in an emergency shelter (72.1 percent), receiving outpatient mental health treatment (63.9 percent), and visiting an emergency room (50.3 percent). Spending time in a detox center in McInnis House, or incarcerated were less common, with services received by at most 10 percent of participants. About 99 percent of participants used at least one service (not shown in figure).

Figure III.1. Percentage of participants who used services in the six months before entering housing



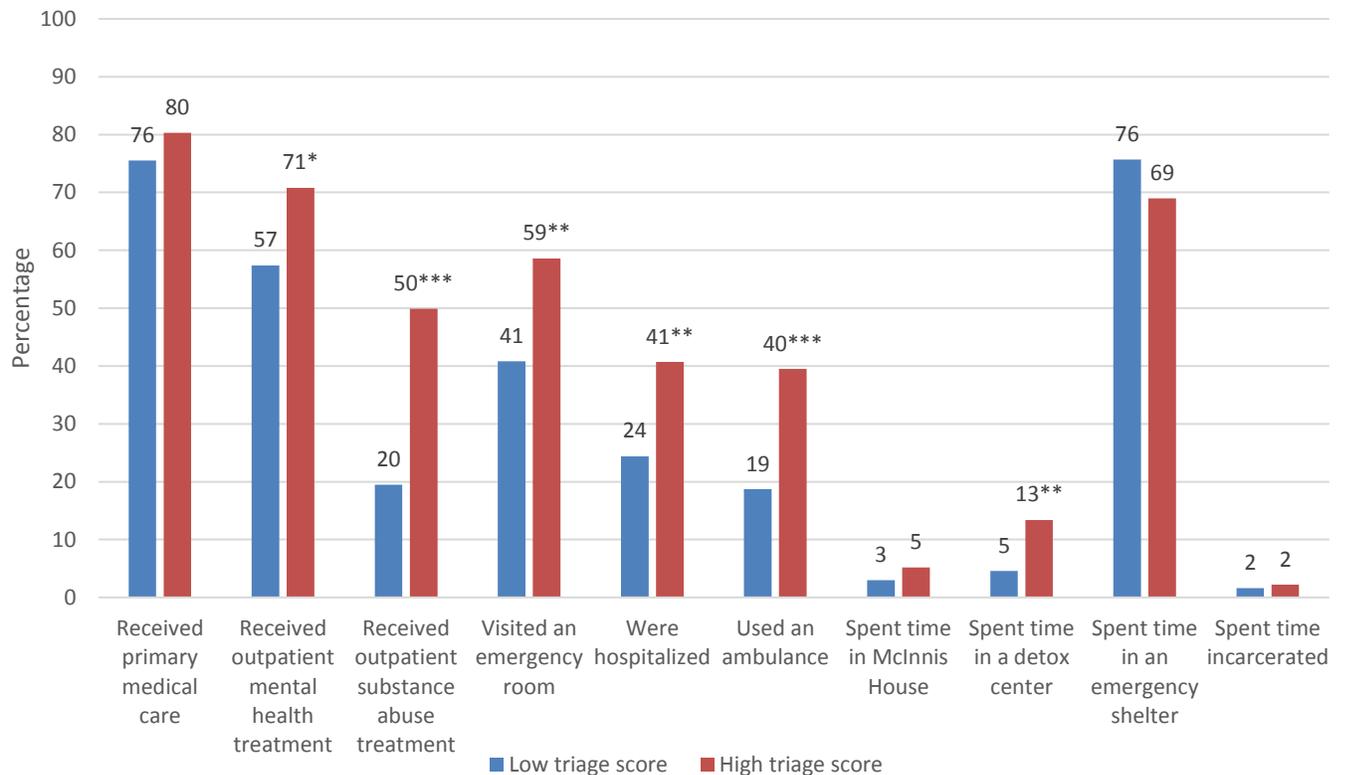
Source: MSHA triage assessment and housing entry interview data, 2015–2017.

3. Associations between service use and triage total scores

The triage scoring metric was a strong predictor of subsequent service use. Having a higher triage total score was associated with receiving outpatient mental health treatment, receiving outpatient substance abuse treatment, visiting an emergency room, being hospitalized, using an ambulance, and spending time in a detox center (Figure III.2). About 71 percent of participants with a higher triage score received outpatient mental health treatment, compared to 57 percent of participants with a lower score. There also was a large difference in the percentage of participants who received outpatient substance use treatment (50 versus 20 percent). Participants with a higher triage total score were more likely than those with a lower score to receive medical services. There were large differences in the percentage of participants who visited an emergency room (59 versus 41 percent), who were hospitalized (41 versus 24 percent) or who used an ambulance (40 versus 19 percent). There was a smaller, but significant, difference in the percentage that spent time in a detox center (13 versus 5 percent).⁷

⁷ Triage total scores were not statistically associated with use of other services. The associations were positive, however, for all except one of these services, indicating that participants with greater service use also had higher scores. The association was negative for the percentage of participants that spent time in a shelter, which reflects the triage scoring metric assigning a lower triage score to participants that most often slept in shelters, as opposed to outside or on the street.

Figure III.2. Percentages of participants who used services in the six months before entering housing, by triage total score



Source: MHSa triage assessment and housing entry interview data, 2015–2017.

Note: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage total score distribution, respectively. All outcomes measured in the six months before the housing entry interview. Percentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

*Significantly different from zero at the .10 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

B. Service use and triage component scores

In this section, we describe the distributions of triage component scores and present information on whether participants who receive higher component scores have greater use of emergency health services after the triage assessment and before they enter housing, compared to those that have lower scores.

1. Description of triage component scores

Table III.2 presents the distributions of triage component scores and the dual diagnosis score for all participants and for participants by geographic location and age. The dual diagnosis score contributed the most to the total score—the mean score was 10.9 out of a total score of 26.2. The next highest contributions came from the domain measuring mental health, which had a mean of

5.1, and the domain measuring use of emergency services, which had a mean 4.4. The smallest contributions to the total score were from the domains measuring physical health, substance use, and homelessness history.

Table III.2. Average triage component scores, by geography and age

	All participants	Geographic location		Age	
		Participants living in Greater Boston	Participants living outside of Greater Boston	Participants younger than 50 years old	Participants at least 50 years old
Domain 1 score (homelessness history)	1.2	1.1	1.4	1.4	1.1
Domain 2 score (use of emergency services)	4.4	3.8	4.9	4.5	4.3
Domain 3 score (physical health)	2.9	2.7	3.1	2.6	3.2
Domain 4 score (mental health)	5.1	4.1	5.9	5.6	4.7
Domain 5 score (substance use)	1.6	1.3	1.8	1.6	1.6
Dual diagnosis	10.9	8.1	13.3	11.4	10.6

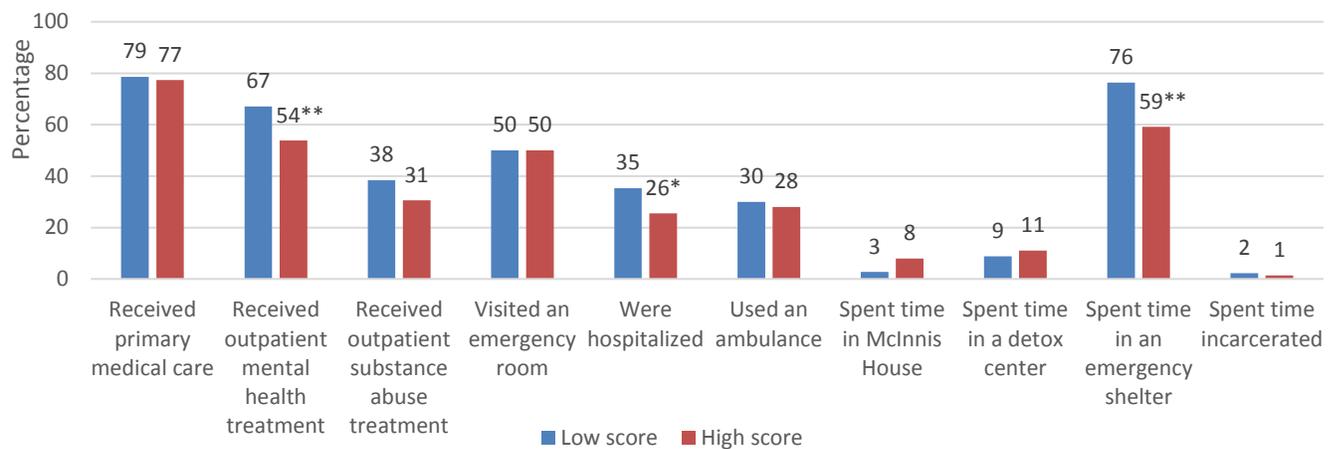
Source: MHSA triage assessment and housing entry interview data, 2015–2017.

The triage component scores varied by geography and age. Participants living outside Greater Boston had higher mean scores for all components than those living in Greater Boston. The largest differences were for mental health (5.9 versus 4.1) and dual diagnosis (13.3 versus 8.1). Scores were generally higher for younger participants as well. Compared to participants at least 50 years old, participants younger than 50 years old had higher component scores for homelessness history (1.4 versus 1.1), use of emergency services (4.5 versus 4.3), mental health (5.6 versus 4.7), and dual diagnosis (11.4 versus 10.6). In contrast, participants younger than 50 years old had a lower component score than the older group for physical health (2.6 versus 3.2) and the same score for substance use (equal to 1.6).

2. Associations between service use in the six months before entering housing and homelessness history component score

Having a higher homelessness history component score was associated with a lower likelihood of using three types of services: receiving outpatient mental health treatment, being hospitalized, and spending time in an emergency shelter (Figure III.3). The percentage of participants who received outpatient mental health treatment was 54 percent for participants with a higher homelessness history score compared to 67 percent for those with a lower score. The percentages of participants who were hospitalized were 26 and 35 percent, respectively, and the percentages of participants who spent time in an emergency shelter were 59 and 76 percent, respectively. The smaller rate of shelter use among participants with higher homelessness history scores is consistent with the triage scoring metric, which assigns higher scores to participants who have most often slept outside or on the street rather than in other places such as a shelter. However, the reason that participants with higher homelessness history scores were less likely to receive outpatient mental health treatment or be hospitalized is less clear.

Figure III.3. Percentages of participants who used services in the six months before entering housing, by homelessness history component score



Source: MHSA-linked triage assessment and housing entry interview data, 2015–2017.

Note: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage component score distribution, respectively. All outcomes measured in the six months before the housing entry interview.

Percentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

*Significantly different from zero at the .10 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

Based on the machine-learning analyses conducted to address the third research objective, we identified that the significant associations between homelessness history score and service use outcomes were almost exclusively due to how often participants slept outside or on the street, rather than in a shelter (Table III.3).⁸ For the outpatient mental health treatment outcome, the length of time since the participant has had his or her own place to stay, either with roommates or alone, was positively associated with receiving outpatient mental health treatment.

Table III.3. Triage questions within the homelessness history domain that were most predictive of service use

	Received outpatient mental health treatment	Was hospitalized	Spent time in an emergency shelter
D1: Q1. Been longer than a year since had own place to stay			
D1: Q2. Length of time since had own place	X		
D1: Q3. Location where most often slept	X	X	

Source: MHSA triage assessment and housing entry interview data.

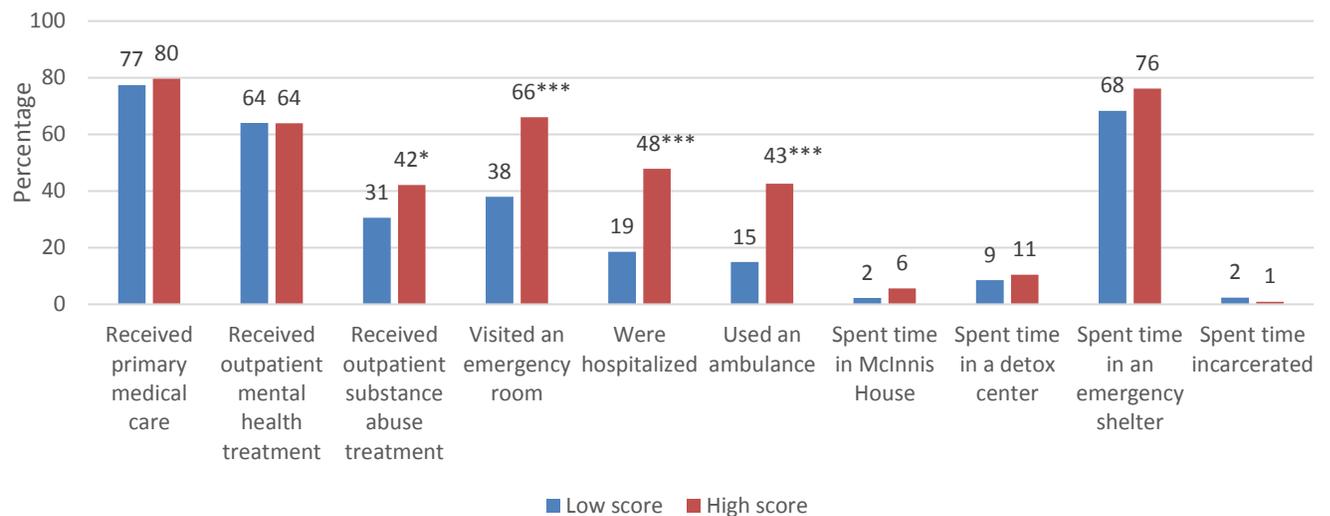
Note: X indicates questions that were predictive of service use based on the least-angle regression (LARS) machine-learning technique.

⁸ For these findings, see Appendix Table B.1.

3. Associations between service use in the six months before entering housing and emergency service use component score

Having a higher emergency service use component score was positively associated with four service use outcomes: receiving outpatient substance abuse treatment, visiting an emergency room, being hospitalized, and using an ambulance (Figure III.4). The percentage of participants who were hospitalized was 48 percent for participants with a higher emergency service use score compared to 19 percent for those with a lower score—a 29-point difference. There also were large differences in use of emergency rooms (66 and 38 percent, respectively) and ambulances (43 and 15 percent, respectively). The difference in receipt of outpatient substance abuse treatment was smaller but still significant, with 42 percent of participants with higher scores receiving treatment, compared to 31 percent of participants with lower scores.

Figure III.4. Percentages of participants who used services in the six months before entering housing, by emergency service use component score



Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Note: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage component score distribution, respectively. All outcomes measured in the six months before the housing entry interview.

Percentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

*Significantly different from zero at the .10 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

The associations between service use outcomes and the emergency service use component score were attributed to the associations between the service use outcomes and most of the questions in the domain (Table III.4). Ambulance use was attributed to the full set of questions, whereas being hospitalized was due to all of the questions except the number of stays in a detox or treatment facility, and visiting an emergency room was due to all of the questions except for the number of nights spent in an emergency shelter. The association between emergency service use score and receiving outpatient substance abuse treatment was solely due to the number of stays in a detox or treatment facility.

Table III.4. Triage questions within the emergency services domain that were most predictive of service use

	Received outpatient substance abuse treatment	Visited an emergency room	Was hospitalized	Used an ambulance
D2: Q1. Number of times been in an emergency room		X	X	X
D2: Q2. Number of nights have been hospitalized		X	X	X
D2: Q3. Number of stays had in a detox or treatment facility	X	X		X
D2: Q4. Number of nights spent in an emergency shelter			X	X

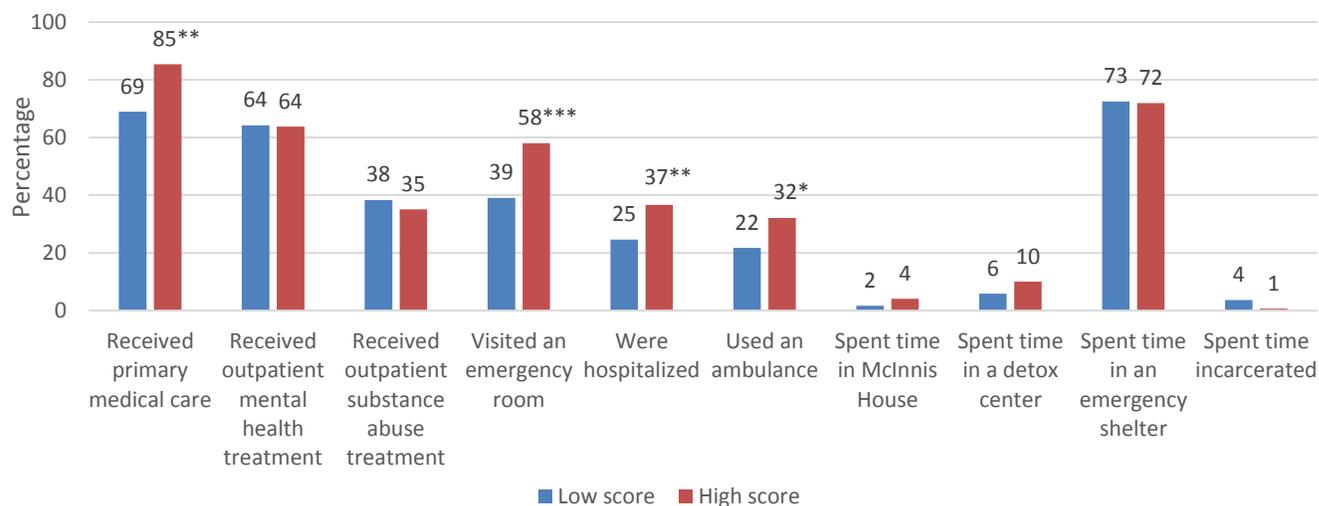
Source: MHSA triage assessment and housing entry interview data.

Note: X indicates questions that were predictive of service use based on the least-angle regression (LARS) machine-learning technique.

4. Associations between service use in the six months before entering housing and physical health component score

Having a higher physical health component score (in other words, experiencing physical health problems), was associated with greater use of services related to physical well-being, namely receiving primary medical care, visiting an emergency room, being hospitalized, and using an ambulance (Figure III.5). The percentage of participants who visited an emergency room was 58 percent for participants with a higher physical health score, compared to 39 percent for those with a lower score—a 19-point difference. The percentage of participants who received primary medical care was 85 percent for participants with a higher physical health score and 69 percent for those with a lower score—a 16-point difference. There were smaller but still significant differences in hospitalizations (37 and 25 percent, respectively) and ambulance use (32 and 22 percent, respectively).

Figure III.5. Percentages of participants who used services in the six months before entering housing, by physical health component score



Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Note: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage component score distribution, respectively. All outcomes measured in the six months before the housing entry interview.

Percentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

*Significantly different from zero at the .10 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Only 2 out of 11 of the physical health questions in the triage tool—whether the participant had experienced head trauma and if they had ever been treated for an illness related to the cold such as hypothermia or frostbite—did not predict the association between physical health scores and use of services (Table III.5). Emergency room visits and ambulance use were associated with almost all of the remaining nine questions. The association between the physical health score and visiting an emergency room was attributed to having been diagnosed with the need for dialysis or with heart disease, HIV/AIDS, diabetes, asthma/chronic obstructive pulmonary disease (COPD), hepatitis C, or cancer. These were all positive associations, meaning that participants who reported these diagnoses in the triage interview were more likely to subsequently visit an emergency room. The association between the physical health score and using an ambulance, however, was the net effect of a set of positive associations and a set of negative associations. Ambulance use was positively associated with having been diagnosed with the need for dialysis or with heart disease, HIV/AIDS, asthma/COPD, or hepatitis C, and was negatively associated with having been diagnosed with cirrhosis or cancer. The remaining two outcomes, receipt of primary medical care and being hospitalized, were associated with much fewer questions. The association between the physical health score and receiving primary medical care was attributed to having been diagnosed with high blood pressure or diabetes, whereas the association between the physical health score and being hospitalized was attributed to having been diagnosed with the need for dialysis or with diabetes or hepatitis C.

Table III.5. Triage questions within the physical health domain that were most predictive of service use

	Received primary medical care	Visited an emergency room	Was hospitalized	Used an ambulance
D3: Q1. Diagnosed with the need for dialysis		X	X	X
D3: Q2. Diagnosed with heart disease		X		X
D3: Q3. Diagnosed with cirrhosis				X
D3: Q4. Diagnosed with high blood pressure	X			
D3: Q5. Diagnosed with HIV/AIDS		X		X
D3: Q6. Diagnosed with diabetes	X	X	X	
D3: Q7. Diagnosed with asthma/COPD		X		X
D3: Q8. Diagnosed with hepatitis C		X	X	X
D3: Q9. Diagnosed with cancer		X		X
D3: Q10. Ever been knocked unconscious by head trauma				
D3: Q11. Ever been treated for hypothermia or frostbite				

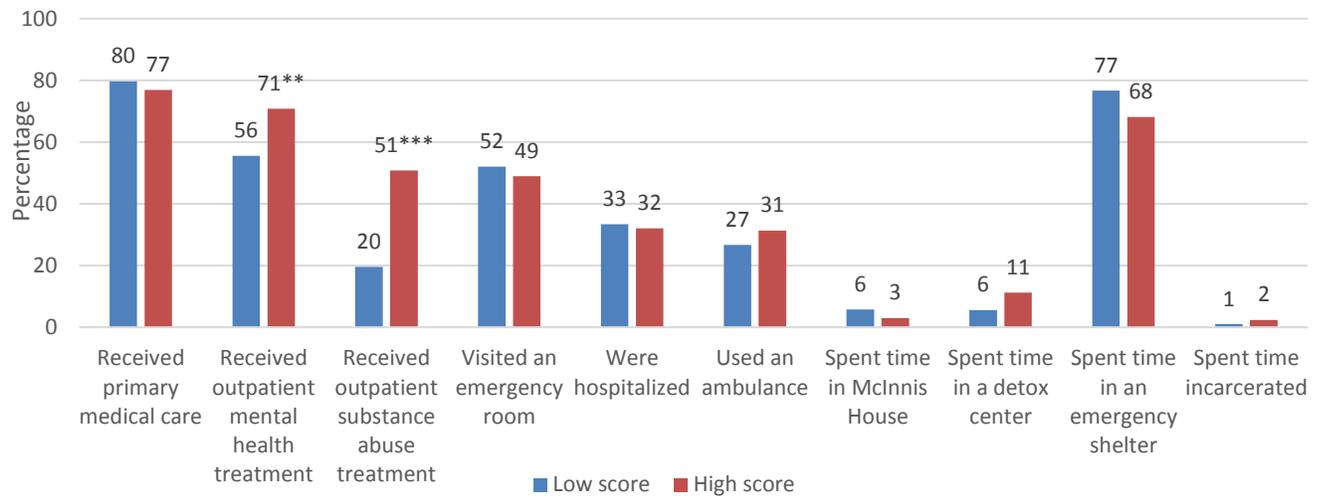
Source: MHSA triage assessment and housing entry interview data.

Note: X indicates questions that were predictive of service use based on the least-angle regression (LARS) machine-learning technique.

5. Associations between service use in the six months before entering housing and combined scores of mental health, substance use and dual diagnosis components

The remaining two triage score components, mental health and substance use, and the dual diagnosis score that uses information from both of these components, are closely related. Thus, we constructed a combined score that is equal to the sum of these three scores. Having a higher score on these components was associated with receiving outpatient mental health treatment and outpatient substance abuse treatment (Figure III.6). The percentage of participants that received outpatient substance abuse treatment was 51 percent for participants with a higher combined score compared to 20 percent for those with a lower score—a 31-point difference. While smaller, the difference in the percentages of participants who received outpatient mental health treatment was still sizable (71 versus 56 percent).

Figure III.6. Percentages of participants who used services in the six months before entering housing, by combined component score for mental health, substance use, and dual diagnosis



Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Note: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage component score distribution, respectively. All outcomes measured in the six months before the housing entry interview.

Percentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

The association between the combined scores of mental health, substance use, and dual diagnosis and receiving outpatient mental health treatment was attributed to having been diagnosed with psychosis/schizophrenia or bipolar disorder, or having been hospitalized for emotional problems (Table III.6). It also was attributed to (1) the interaction between being diagnosed with anxiety and having been treated for drug or alcohol problems in the past year and (2) the interaction between currently using a nonprescribed substance and being diagnosed with depression. However, it was not attributed to either of the substance use questions on their own.

The machine-learning analysis also showed that the association between the combined scores of mental health, substance use, and dual diagnosis and receiving outpatient substance abuse treatment was attributed to having been treated for drug or alcohol problems in the past year in the substance use domain but was not attributed to any mental health condition in the mental health domain. The interaction between mental health and substance use questions was important, however. The association was attributed to being diagnosed with bipolar disorder or anxiety and using a nonprescribed substance. It also was attributed to having been treated for drug or alcohol problems and being diagnosed with depression, anxiety, or another mental health condition.

Table III.6. Triage questions within the mental health domain, substance abuse domain, or dual diagnosis that were most predictive of service use

	Received outpatient mental health treatment	Received outpatient substance abuse treatment
D4: Q1. Ever diagnosed with psychosis or schizophrenia	X	
D4: Q2. Ever diagnosed with bipolar disorder	X	
D4: Q3. Ever diagnosed with depression		
D4: Q4. Ever diagnosed with anxiety		
D4: Q5. Ever diagnosed with other mental health condition	X	
D4: Q6. Ever hospitalized for emotional problems	X	
D5: Q1. Currently using any substance that is not prescribed		
D5: Q2. Ever treated for drug or alcohol problems		X
D4Q1 * D5Q1. Ever diagnosed with psychosis or schizophrenia and currently using nonprescribed substance		
D4Q2 * D5Q1. Ever diagnosed with bipolar disorder and currently using nonprescribed substance		X
D4Q3 * D5Q1. Ever diagnosed with depression and currently using nonprescribed substance	X	
D4Q4 * D5Q1. Ever diagnosed with anxiety and currently using nonprescribed substance		X
D4Q5 * D5Q1. Ever diagnosed with other mental health condition and currently using nonprescribed substance		
D4Q6 * D5Q1. Ever hospitalized for emotional problems and currently using nonprescribed substance		
D4Q1 * D5Q2. Ever diagnosed with psychosis or schizophrenia and treated for drug or alcohol problems		
D4Q2 * D5Q2. Ever diagnosed with bipolar disorder and treated for drug or alcohol problems		
D4Q3 * D5Q2. Ever diagnosed with depression and treated for drug or alcohol problems		X
D4Q4 * D5Q2. Ever diagnosed with anxiety and treated for drug or alcohol problems	X	X
D4Q5 * D5Q2. Ever diagnosed with other mental health condition and treated for drug or alcohol problems		X
D4Q6 * D5Q2. Ever hospitalized for emotional problems and treated for drug or alcohol problems		X

Source: MHSA triage assessment and housing entry interview data.

Note: X indicates questions that were predictive of service use based on the least-angle regression (LARS) machine-learning technique.

This page has been left blank for double-sided copying.

IV. CONCLUSION

This study evaluated the effectiveness of the triage assessment tool in identifying chronically homeless individuals who frequently use health services. The analyses used self-reported data on participants' service use in the six months before entering housing and self-reported triage assessment data to address the research questions.

The findings provide evidence that the triage scoring metric is a strong predictor of subsequent service use. Of the 10 outcomes examined, the associations with the triage total score were in the expected directions for all outcomes and were statistically significant for the majority (6 of 10) of outcomes. Having a higher triage total score was associated with receiving outpatient mental health treatment, receiving outpatient substance abuse treatment, visiting an emergency room, being hospitalized, using an ambulance, and spending time in a detox center. The differences in the rates of service use between participants with higher and lower triage total scores ranged from 8 to 30 percentage points.

Compared with the total score, triage component scores were less predictive of service use across the full range of outcomes but were strong predictors for specific outcomes. For example, the emergency service use score strongly predicted visiting an emergency room, being hospitalized, and using an ambulance, and the physical health component score strongly predicted use of services related to physical well-being such as receiving primary medical care, visiting an emergency room, being hospitalized, and using an ambulance. Similarly, the combined score from the mental health, substance abuse, and dual diagnosis components strongly predicted receiving outpatient mental health treatment and outpatient substance abuse treatment.

We also analyzed which individual questions used to create the domain scores were most predictive of subsequent service use. The findings revealed that the associations between the homelessness history score and service use outcomes were almost exclusively attributed to how often participants slept outside or on the street, rather than in a shelter. In contrast, the significant outcomes for the emergency service use score were associated with most of the questions in the domain. For the physical health domain, 9 of the 11 questions were associated with a service use outcome. The outcomes with the largest associations with physical health score, such as emergency room visits and ambulance use, were associated with almost all of these nine questions, including having been diagnosed with the need for dialysis, heart disease, HIV/AIDS, asthma/COPD, or hepatitis C. Finally, the association between the combined scores of mental health, substance use, and dual diagnosis and receiving outpatient substance abuse treatment was attributed to having been treated for drug or alcohol problems in the past year in the substance use domain but was not attributed to any mental health condition in the mental health domain. The interaction between mental health and substance use questions was important, despite the mental health questions not being strongly associated with subsequent receipt of substance abuse treatment.

Although the research findings suggest that the triage and assessment tool effectively identifies chronically homeless participants who will frequently use health services, more research is needed to provide definitive evidence of the tool's predictive power. Using

administrative data on service receipt in place of the data self-reported by PFS participants when they enter housing could strengthen the methodology of this study. This would allow measurement of service receipt in each month following the triage assessment, rather than relying on self-reported service use recalled over a six-month period. Thus, it would be possible to estimate monthly rates of service use for *all* PFS participants, rather than only for those who entered housing and were interviewed at least six months after the triage assessment. This would maximize the representativeness of the findings to the program's population and would increase the precision of the estimates of the associations between triage scores and service use.

APPENDIX A

DATA AND METHODOLOGY

This page has been left blank for double-sided copying.

In this appendix, we describe the triage assessment data and housing entry interview data used to conduct the study. We also describe how the data were processed to construct the analysis file. Finally, we present an overview of the statistical methods used to measure associations between triage assessment scores and service use outcomes.

Data

We used two administrative data files provided by MHSA to conduct the analysis: the triage assessment data and the service use data obtained in the housing entry interview. The triage assessment data file contained 1,775 observations, one for each individual that had been assessed from January 2015 to April 2017. As described in Table A.1, the data contained information on participants’ demographic characteristics and responses to questions in each of the five domains: homelessness history, use of emergency services, physical health, mental health, and substance use.

Table A.1. Contents of triage assessment data

Background information and demographics		
Name	Q1. Ever diagnosed with need for dialysis	
Client identification number	Q2. Ever diagnosed with heart disease	
Gender identity	Q3. Ever diagnosed with cirrhosis	
Ethnicity	Q4. Ever diagnosed with high blood pressure	
Race	Q5. Ever diagnosed with HIV/AIDS	
Veteran status	Q6. Ever diagnosed with diabetes	
Ever been in foster care	Q7. Ever diagnosed with asthma/COPD	
Ever been in jail	Q8. Ever diagnosed with hepatitis C	
Ever been in prison	Q9. Diagnosed with cancer that required chemotherapy or surgery in the past year (excluding skin cancer)	
Permanent physical disability status	Q10. Ever been knocked unconscious by head trauma	
Health insurance	Q11. Ever been treated for illness related to cold (hypothermia or frostbite)	
Domain 1: Homelessness history		
Q1. Been longer than a year since had own place to stay	Q1. Ever been diagnosed with psychosis or schizophrenia	
Q2. In past 3 years, how many times been homeless then housed again	Q2. Ever been diagnosed with bipolar disorder	
Q3. In past 6 months, location where most often slept	Q3. Ever been diagnosed with depression	
Domain 2: Utilization of emergency services in past six months		
Q1. Number of times visited emergency room	Q4. Ever been diagnosed with anxiety	
Q2. Number of nights spent hospitalized	Q5. Ever been diagnosed with other mental health conditions	
Q3. Number of stays in a detox or treatment facility	Q6. Ever been hospitalized for emotional problems	
Q4. Number of nights spent in emergency shelter	Domain 5: Substance use	
	Q1. Currently using any substance that is not prescribed	
	Q2. In past year, have been treated for drug or alcohol problems	

Source: MHSA triage assessment data.

When an individual is housed through PFS, case managers collect follow-up information on demographic characteristics, homelessness history, income sources, health insurance coverage, quality of life, disability and health history, and health care service use in the past six months. We refer to this as *service use* data. Case managers collect this information each month thereafter for one year, and then switch to collecting it once per quarter. Each participant receives a unique identification number used in both the triage assessment and the follow-up interviews, facilitating the linkage between the two sets of data files.

The service use data obtained when participants entered housing contained 4,774 observations for 464 individuals. The data contain multiple observations per person—one for the entry interview and additional observations for subsequent monthly interviews. As described in Table A.2, the data contain information on participants’ demographic characteristics, homelessness history, income sources, health insurance coverage, quality of life, disability and health history, and service usage in the past six months.

Table A.2. Contents of the service use data obtained when participants entered housing

Background information and demographics	Health insurance
Name	Health insurance coverage
Secure client number	
Client identification number	Quality of life
Interview date	Satisfaction with life in general before program entry
Provider agency	Satisfaction with health before program entry
Housing entry date	Satisfaction with living environment before program entry
Length of stay	Disability / health history
Created by organization	Mental health disability status
Assessment type and date	Type of mental health disability
Type of housing	Physical health disability status
Completed verification of homelessness form	Type of physical health disability
Age	Substance abuse status
Gender	Type of substances
Ethnicity	Service usage within past six months
Race	Receipt of primary medical care
Veteran status	Receipt of outpatient mental health treatment
Marital status	Receipt of outpatient substance abuse treatment
City	Number of times visited emergency room
County	Number of times hospitalized
	Number of days hospitalized
	Number of times used an ambulance
Homelessness history	Number of days spent in McInnis House
Indicator of chronically homeless	Number of days in detox center
Duration of homelessness	Number of nights spent in emergency shelter
Residence before program entry	Number of days spent incarcerated
Income sources	
Monthly income	

Source: MHSA housing entry interview data.

We created a matched triage and service use data file by merging the two data files using the unique client identification number that is common in both datasets. Next, we dropped observations that were available in one of the data files but not in the other. We identified triage assessments and service use interviews conducted in months subsequent to the housing entry interview and dropped these cases from the matched data file. Among the remaining matched records, we kept those that corresponded to valid and complete triage assessment records and valid and complete service use records. This resulted in 443 matched records with both triage and service use data.

The service use outcomes measured in the housing entry interview were based on a six-month look-back period. For example, one question asks “how many times have you been hospitalized in the six months prior to entry into housing?” For participants who entered housing within six months of the triage assessment, the service use look-back period partially overlaps with the look-back period for the triage assessment interview. A participant who was housed five months after the triage assessment, for instance, will have a one-month overlap with the look-back period for the triage assessment. In this case, a participant hospitalized one month before the triage assessment would receive a higher triage assessment score and have a service use outcome that indicates he or she was hospitalized. The service use outcome would appear to be associated with the triage score simply due to the event occurring within the overlapping period. To assess the extent to which this may occur, we measured the number of months between the triage assessment date and the housing entry interview date (Table A.3).

Table A.3. Length of time between triage assessment and housing entry interview

	Number of people	Percentage of people
0 to less than 1 month	119	26.9
1 to less than 2 months	72	16.3
2 to less than 3 months	54	12.6
3 to less than 4 months	46	10.4
4 to less than 5 months	37	8.4
5 to less than 6 months	15	3.4
6 to less than 12 months	66	14.9
12 to less than 24 months	24	5.4
At least 24 months	8	1.8
Total	443	100.0

Source: MHSA triage assessment and housing entry interview data.

Although including in the analysis only those participants who entered housing at least six months after the triage assessment would ensure that the service use look-back period measures events that occurred after the triage assessment, the analysis would be based on 22.1 percent of participants (98 individuals) (Table A.3). To obtain a larger sample size and thus increase the reliability of the study findings, we used at least four months as the threshold for our main analyses (33.9 percent of participants, or 150 individuals), but used the sample of participants

that were housed at least six months after the triage assessment to conduct several auxiliary analyses described in the following section.

To prepare the analysis file, we ran data checks to identify any out-of-range values or data inconsistencies. With the exception of the number of days between the triage assessment and the housing entry interview, all of the outcome measures, triage assessment variables, and individual characteristic variables had values that were to be expected. Thus, we concluded there were no out-of-range values.

We examined the extent of missing data using the analysis file that included only those people who were housed at least four months after the triage assessment. There were no missing data in the triage assessment variables. For the service use data, the outcome measures had relatively low missing rates, with no missing data for 147 out of 150 cases (98 percent). The three observations with missing data had missing information for all outcomes and were excluded from the analysis. Among the 147 participants with complete outcome information, the missing rates for demographic characteristics and background variables were low, ranging from 0 to 1 percent. There were no missing data for age and gender, whereas 0.7 percent of people had missing values for the variables indicating time in foster care, jail, or prison, and 1.4 percent of people had missing values for race. The city and county variables had larger missing rates of 8.2 percent. We performed simple random imputation for the remaining missing values for jail, prison, foster care (1 case each), and race (2 cases) based on their gender and age.

Methodology

The analysis consisted of a combination of descriptive statistics, multivariate regression methods, and machine-learning techniques. Before conducting the analyses that directly address the research objectives, we performed a preliminary assessment of the triage scores and outcome measures. First, we estimated descriptive statistics characterizing the distribution of triage assessment scores, consisting of the mean score and the scores corresponding to the 10th, 25th, 50th, 75th, and 90th percentiles. We described the score distributions for all participants and for participants grouped by geography and age. For geography, 9 of the 13 counties in Massachusetts were represented in the data; the exceptions are Bristol, Dukes, Franklin, and Hampshire Counties. We grouped participants according to whether they lived in counties typically considered “Greater Boston” (Norfolk and Suffolk) or in the other counties (Barnstable, Berkshire, Essex, Hampden, Middlesex, Plymouth, and Worcester), which roughly divided the sample into two halves. For age, we grouped participants into those younger than 50 years old and those who were at least 50 years old, which also yielded roughly equal sized groups.

The primary analyses used multivariate regression methods and machine-learning techniques to address the three research questions. We estimated a set of regressions that empirically modeled the associations between the outcome measures in the service use data, the triage assessment total score, and the triage assessment component scores. The dependent variables consisted of the following outcome measures in the service use data, each measured over the six months before the housing entry interview:

1. Whether the participant received primary medical care
2. Whether the participant received outpatient mental health treatment
3. Whether the participant received outpatient substance abuse treatment
4. Whether the participant visited an emergency room
5. Whether the participant was hospitalized
6. Whether the participant used an ambulance
7. Whether the participant spent time in McInnis House
8. Whether the participant spent time in a detox center
9. Whether the participant spent time in an emergency shelter
10. Whether the participant spent time incarcerated

The triage assessment total score was the main independent variable in the first set of regressions. Other independent variables included those that are not part of the scoring metric: geographic location, age, race, ethnicity, gender identity, prison, jail, and foster care. We estimated each of the ten regressions separately. Because all of the outcomes were binary, we estimated logistic regression models that associated the triage score with the probability that the event occurred in the past six months.

We presented the results of the regression analyses using regression-adjusted figures and tables of estimates of the association between triage scores and outcomes. For example, a regression-adjusted figure compared the percentage of people with a higher triage score that visited an emergency room in the past six months with the percentage of people with a lower triage score that visited an emergency room. We defined the lower triage score as the 25th percentile score and the higher triage score as the 75th percentile score. We obtained the regression-adjusted estimates by estimating the regression, using the regression coefficients and variable values for each person in the sample to obtain a predicted probability of the event occurring (for example, visiting an emergency room in the past six months), and averaging the predicted probabilities to obtain the adjusted (predicted) percentage of people in the data. By performing these steps assuming all participants have the higher triage score value, then repeating the procedure assuming all participants have the lower triage score value, we obtained two averaged values. The difference between these values is the regression-adjusted estimate of the association of service use with the triage score.

We estimated a similar set of regressions to answer the second research question—how are service use outcomes associated with each of the five triage component scores? The regressions were identical to those for the triage total score, except we replaced the total score with the five triage component scores and the dual diagnosis score in each regression. Because the dual diagnosis score is based on the mental health and substance use component scores, we created a new variable equal to the sum of the mental health and substance use component scores and the dual diagnosis score and included this variable in the regression in place of the separate

component and dual diagnosis scores.⁹ Thus, the total score was decomposed into four scores: the first three component scores (homelessness history, use of emergency services, and physical health) and a fourth score representing the sum of the mental health, substance use, and dual diagnosis scores. The regression-adjustment procedure evaluated the predicted outcome measure at the 25th and 75th percentile of each component score separately, meaning that we estimated a single regression for each outcome, but used the regression output to calculate four separate predictions.

For both sets of regressions—those using the triage total score and those using the component scores—we performed auxiliary analyses that restricted the data to participants who had their housing entry interview at least six months after the triage assessment. This reduced the sample size from 147 to 95 people, but provided evidence that our findings were robust to whether we included participants interviewed 4 or 5 months after the triage assessment.

The third research question identified which questions or fields in the triage assessment are strongly predictive of service use. We estimate associations between the set of outcome measures in the service use data and the set of individual variables on which the total and component scores are based using a set of variable selection procedures. We used two machine-learning techniques—least-angle regression (LARS) and the Lasso—that build on recent advances in data science to optimize the fit of a predictive model to the data. These procedures attempt to maximize prediction accuracy but to identify a more parsimonious set of independent variables than is typically found in more traditional “stepwise” model selection methods. This approach makes it easier to intuit the connection between the service use outcome measures and predictors such as depression and substance abuse. We treated LARS as our primary approach and assessed the sensitivity of our findings by also using Lasso. Because the findings were generally robust using either method, we present findings from LARS only.

For each model, we used the set of 10 binary outcomes used in the previous regressions. The independent variables consisted of the 26 variables used to define the triage score; interaction variables we created using individual questions in the mental health domain (diagnoses with any of psychosis or schizophrenia, bipolar disorder, depression, anxiety, or other mental health conditions) and individual questions in substance use domain (current use of any substances and receipt of treatment for drug or alcohol problems), most of which are part of the scoring metric for dual diagnosis; and participant characteristics such as age, gender, race, and ethnicity used in the previous regressions.

⁹ For example, a participant who affirms he or she has been diagnosed with depression and who reports he or she has been treated for drug or alcohol problems would receive a score of 2.5 for depression, a score of 2 for drug or alcohol treatment, and an additional score of 3 for the presence of both conditions.

APPENDIX B

SUPPLEMENTAL TABLES

This page has been left blank for double-sided copying.

Table B.1. Participants' service use in the six months before entering housing, by triage total score^a

	Outcome among participants with lower triage total scores		Outcome among participants with higher triage total scores		Difference	
	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error
Percentage of participants who received primary medical care	75.5	4.9	80.3	4.0	4.8	6.3
Percentage of participants who received outpatient mental health treatment	57.4	5.2	70.8	5.0	13.4*	7.2
Percentage of participants who received outpatient substance abuse treatment	19.5	4.5	49.9	5.5	30.4***	7.1
Percentage of participants who visited an emergency room	40.8	5.6	58.6	5.3	17.8**	7.7
Percentage of participants who were hospitalized	24.4	4.5	40.7	5.1	16.3**	6.8
Percentage of participants that used an ambulance	18.7	4.1	39.5	5.1	20.8***	6.5
Percentage of participants who spent time in McInnis House	3.0	1.8	5.2	2.4	2.2	3.0
Percentage of participants who spent time in a detox center	4.6	2.2	13.4	3.5	8.8**	4.1
Percentage of participants who spent time in an emergency shelter	75.7	4.8	69.0	4.8	-6.7	6.8
Percentage of participants who spent time incarcerated	1.6	1.5	2.2	1.2	0.6	1.9

Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Note: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage total score distribution, respectively. All outcomes measured in the six months before the housing entry interview.

^aPercentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

*Significantly different from zero at the .10 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Table B.2. Participants' service use in the six months before entering housing, by homelessness history component score^a

	Outcome among participants with lower triage total scores		Outcome among participants with higher triage total scores		Difference	
	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error
Percentage of participants who received primary medical care	78.6	3.4	77.3	5.0	-1.3	6.0
Percentage of participants who received outpatient mental health treatment	67.1	3.7	53.8	5.7	-13.3**	6.8
Percentage of participants who received outpatient substance abuse treatment	38.4	3.7	30.6	4.8	-7.8	6.1
Percentage of participants who visited an emergency room	50.4	3.9	50.1	5.6	-0.3	6.8
Percentage of participants who were hospitalized	35.3	3.6	25.5	4.7	-9.8*	5.9
Percentage of participants who used an ambulance	29.9	3.5	28.0	4.5	-1.9	5.7
Percentage of participants that spent time in McInnis House	2.7	1.4	7.9	3.4	5.2	3.7
Percentage of participants who spent time in a detox center	8.8	2.5	11.0	3.6	2.2	4.4
Percentage of participants who spent time in an emergency shelter	76.4	3.7	59.1	6.5	-17.3**	7.5
Percentage of participants who spent time incarcerated	2.2	1.2	1.4	1.9	-0.8	2.2

Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Note: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage total component distribution, respectively. All outcomes measured in the six months before the housing entry interview.

^aPercentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

*Significantly different from zero at the .10 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

Table B.3. Participants' service use in the six months before entering housing, by emergency service use component score^a

	Outcome among participants with lower triage total scores		Outcome among participants with higher triage total scores		Difference	
	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error
Percentage of participants who received primary medical care	77.4	3.9	79.6	4.7	2.2	6.1
Percentage of participants who received outpatient mental health treatment	64.0	4.5	63.9	4.9	-0.1	6.7
Percentage of participants who received outpatient substance abuse treatment	30.6	4.0	42.1	4.7	11.5*	6.2
Percentage of participants who visited an emergency room	37.7	5.0	65.8	5.6	28.1***	7.5
Percentage of participants who were hospitalized	18.5	4.2	47.9	5.6	29.4***	7.0
Percentage of participants who used an ambulance	14.9	3.8	42.6	5.3	27.7***	6.5
Percentage of participants who spent time in McInnis House	2.2	1.5	5.6	2.3	3.4	2.7
Percentage of participants who spent time in a detox center	8.5	2.8	10.5	3.0	2.0	4.1
Percentage of participants who spent time in an emergency shelter	68.3	4.6	76.2	4.3	7.9	6.3
Percentage of participants who spent time incarcerated	2.4	1.3	0.9	1.4	-1.5	1.9

Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Note: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage component score distribution, respectively. All outcomes measured in the six months before the housing entry interview.

^aPercentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

*Significantly different from zero at the .10 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Table B.4. Participants' service use in the six months before entering housing, by physical health component score^a

	Outcome among participants with lower triage total scores		Outcome among participants with higher triage total scores		Difference	
	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error
Percentage of participants who received primary medical care	68.9	5.3	85.4	3.8	16.5**	6.5
Percentage of participants who received outpatient mental health treatment	64.2	4.5	63.8	3.9	-0.4	6.0
Percentage of participants who received outpatient substance abuse treatment	38.3	4.6	35.1	3.6	-3.2	5.8
Percentage of participants who visited an emergency room	39.4	5.2	58.1	4.9	18.7***	7.1
Percentage of participants who were hospitalized	24.6	4.3	36.6	4.1	12.0**	5.9
Percentage of participants who used an ambulance	21.7	4.1	32.1	3.8	10.4*	5.6
Percentage of participants who spent time in McInnis House	1.7	1.2	4.1	1.6	2.4	2.0
Percentage of participants who spent time in a detox center	5.9	2.5	10.0	2.4	4.1	3.5
Percentage of participants who spent time in an emergency shelter	72.5	4.6	71.9	3.8	-0.6	6.0
Percentage of participants who spent time incarcerated	3.7	2.2	0.7	0.9	-3.0	2.4

Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Note: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage component score distribution, respectively. All outcomes measured in the six months before the housing entry interview.

^aPercentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

*Significantly different from zero at the .10 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Table B.5. Participants' service use in the six months before entering housing, by mental health, substance use, and dual diagnosis component score^a

	Outcome among participants with lower triage total scores		Outcome among participants with higher triage total scores		Difference	
	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error
Percentage of participants who received primary medical care	79.7	4.3	76.9	4.2	-2.8	6.0
Percentage of participants who received outpatient mental health treatment	55.6	5.3	70.8	4.6	15.2**	7.0
Percentage of participants who received outpatient substance abuse treatment	19.6	4.4	50.8	5.8	31.2***	7.3
Percentage of participants who visited an emergency room	52.1	5.2	49.2	4.3	-2.9	6.7
Percentage of participants who were hospitalized	33.4	4.9	32.0	4.5	-1.4	6.7
Percentage of participants who used an ambulance	26.7	4.6	31.3	4.3	4.6	6.3
Percentage of participants who spent time in McInnis House	5.8	3.1	3.0	1.8	-2.8	3.6
Percentage of participants who spent time in a detox center	5.6	2.5	11.2	2.7	5.6	3.7
Percentage of participants who spent time in an emergency shelter	76.7	4.6	68.1	4.8	-8.6	6.6
Percentage of participants who spent time incarcerated	1.0	1.0	2.4	1.3	1.4	1.6

Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Note: Lower and higher triage scores correspond to the 25th and 75th percentiles of the triage component score distribution, respectively. All outcomes measured in the six months before the housing entry interview.

^aPercentages were regression-adjusted for gender, race, ethnicity, age, residential location, incarceration history (jail or prison), and foster care history.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Table B.6. Triage questions that were most predictive of service use

	Received primary medical care	Received outpatient mental health treatment	Received outpatient substance abuse treatment	Visited an emergency room	Was hospitalized	Used an ambulance	Spent time in McInnis House	Spent time in a detox center	Spent time in an emergency shelter	Spent time incarcerated
D1: Q1										
D1: Q2		X								X
D1: Q4		X			X		X			
D2: Q1				X	X	X				
D2: Q2				X	X	X				X
D2: Q3		X	X	X		X				
D2: Q4					X	X				
D3: Q1		X		X	X	X	X			
D3: Q2			X	X		X				
D3: Q3						X				
D3: Q4	X									X
D3: Q5				X		X	X			
D3: Q6	X			X	X		X			
D3: Q7				X		X	X			
D3: Q8			X	X	X	X	X			X
D3: Q9				X		X				
D3: Q10							X			X
D3: Q11							X	X		
D4: Q1		X				X				X
D4: Q2		X			X	X				
D4: Q3										
D4: Q4										
D4: Q5		X								
D4: Q6		X					X			
D5: Q1					X					
D5: Q2			X							
D4Q1 * D5Q1	X			X	X	X				
D4Q2 * D5Q1			X			X				X
D4Q3 * D5Q1		X		X	X	X	X	X		
D4Q4 * D5Q1			X					X		X
D4Q5 * D5Q1							X			X
D4Q6 * D5Q1						X	X			X
D4Q1 * D5Q2										
D4Q2 * D5Q2										X
D4Q3 * D5Q2			X					X		
D4Q4 * D5Q2		X	X							
D4Q5 * D5Q2	X		X				X	X		
D4Q6 * D5Q2			X		X	X				

Source: MHSA triage assessment and housing entry interview data, 2015–2017.

Note: X indicates questions that were predictive of service use based on the least-angle regression (LARS) machine-learning technique.

This page has been left blank for double-sided copying.

www.mathematica-mpr.com

**Improving public well-being by conducting high quality,
objective research and data collection**

PRINCETON, NJ ■ ANN ARBOR, MI ■ CAMBRIDGE, MA ■ CHICAGO, IL ■ OAKLAND, CA ■
TUCSON, AZ ■ WASHINGTON, DC ■ WOODLAWN, MD

MATHEMATICA
Policy Research

Mathematica® is a registered trademark
of Mathematica Policy Research, Inc.