# Variation in patterns of health care before suicide: A population case-control study

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## ARTICLE INFO

## ABSTRACT

*Background:* The United States has experienced a significant rise in suicide. As decision makers identify how to address this national concern, healthcare systems have been identified as an optimal location for prevention.
*Objective:* To compare variation in patterns of healthcare use, by health setting, between individuals who died by suicide and the general population.
*Design:* Case-Control Study.
*Setting:* Eight healthcare systems across the United States.
*Participants:* 2674 individuals who died by suicide between 2000 and 2013 along with 267,400 individuals matched on time-period of health plan membership and health system affiliation.
*Measurements:* Healthcare use in the emergency room, inpatient hospital, primary care, and outpatient specialty setting measured using electronic health record data during the 7-, 30-, 60-, 90-, 180-, and 365-day time periods before suicide and matched index date for controls.
*Results:* Healthcare use was more common across all healthcare settings for individuals who died by suicide. Nearly 30% of individuals had a healthcare visit in the 7-days before suicide (6.5% emergency, 16.3% outpatient specialty, and 9.5% primary care), over half within 30 days, and > 90% within 365 days. Those who died by suicide averaged 16.7 healthcare visits during the year. The relative risk of suicide was greatest for individuals who received care in the inpatient setting (aOR = 6.23). There was both a large relative risk (aOR = 3.08) and absolute utilization rate (43.8%) in the emergency room before suicide.
*Limitations:* Participant race/ethnicity was not available. The sample did not include uninsured individuals.
*Conclusions:* This study provides important data about how care utilization differs for those who die by suicide compared to the general population and can inform decision makers on targeting of suicide prevention activities within health systems.

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## 1. Introduction

Data from the Centers for Disease Control and Prevention (CDC) coupled with recent celebrity deaths have shed light on the troubling epidemic of suicide in the United States (US) (Stone et al., 2018). Information is needed urgently to help inform policy decisions as leaders determine how to mitigate suicide. The 2012 National Strategy on Suicide Prevention highlighted the importance of healthcare systems in suicide prevention (US Department of Health and Human Services, 2012). This message has been supported by recent allocation of federal funding, policy position papers, and health services data, which have collectively called for implementation and testing of safer suicide care models throughout healthcare systems (Hogan and Grumet, 2016; Labouliere et al., 2018; Ahmedani and Vannoy, 2014; Hogan, 2016; Pringle et al., 2013; Stone et al., 2017; Power and McKeon, 2012). In addition, the Joint Commission released Sentinel Event Alert #56 recommending identification and treatment of suicide risk in all healthcare settings (Commission TJ, 2016). To enhance healthcare focused efforts to prevent suicide, it is important to understand how health service patterns differ for those at risk in order to better target prevention.

In 2018, the CDC released a report documenting the sustained rise in suicide rates across America (Stone et al., 2018). The report indicated that approximately half of people have a known mental health condition before suicide, and fewer than 40% have received behavioral health treatment prior to suicide (Stone et al., 2018). These data are consistent with other studies, which have found that > 80% of individuals make a healthcare visit in the year before suicide or suicide attempt, though most visits occur in general medical settings and do not include a recorded mental health or substance use disorder diagnosis (Ahmedani et al., 2014; Renaud et al., 2009; Luoma et al., 2002; Ahmedani et al., 2015). These patterns remain consistent for individuals with varying types of insurance, including commercial insurance and Medicaid (Ahmedani et al., 2014; Fontanella et al., 2017).

While many studies on health service use before suicide have analyzed data on visit types, there is less data from the US on how patterns of visits before suicide compare to the general population. This information is important for differentiating patients who are at risk. One US study found no difference in whether or not suicide decedents or general population controls made a healthcare visit, but did find that suicide decedents made more visits overall (Chock et al., 2015). Evidence from outside the US has shown that emergency room visits may occur twice as often for individuals who die by suicide, and that an increasing number of emergency room visits is an independent risk factor (Kvaran et al., 2015). Studies have found that a greater number of overall visits were associated with suicide (Morrison and Laing, 2011; Windfuhr et al., 2016). These studies provide conflicting information on whether those who die by suicide are more likely to have various types of health service use as compared to the general population. To date, most studies have been conducted outside of the US within different health system models, and studies from the US have been restricted by smaller sample sizes in singular geographic regions. It is hypothesized that individuals who die by suicide use more health services.

This case-control study examines the relative risk of suicide for various healthcare encounters across a network of healthcare systems within the US. We investigate variation in visits made to different settings (emergency room, inpatient, outpatient specialty, primary care), number of visits and diagnosed mental health or substance use conditions between those who died by suicide and a matched control population. In addition, this study uniquely assesses variation in the timing of health service use, including in 7-, 30-, 60-, 90-, 180-, and 365-day time periods to provide important information on whether a contact was made, and about the proximity of visits, to inform opportunities for prevention and targeting of care delivery.

## 2. Methods

### 2.1. Study setting, population, and sample

This case-control study was conducted within the Mental Health Research Network (MHRN), a consortium of 13 learning healthcare systems, which serve 12.5 million individuals across 15 states each year (Rossom et al., 2016; Mental Health Research Network, 2019). These systems provide a comprehensive array of primary and specialty care, and have affiliated research centers. Data are from eight MHRN-affiliated systems, including: Harvard Pilgrim Healthcare (Massachusetts), HealthPartners (Minnesota), Henry Ford Health System (Michigan), and the Colorado, Georgia, Hawaii, Northwest, and Washington state regions of Kaiser Permanente. Institutional Review Boards at each site approved this study.

A total of 2674 individuals who died by suicide (cases) from 2000 to 2013, were members of the participating systems and were continuously enrolled in the health plan for at least 10 months during the year prior to their death, were included. The 10-month enrollment criterion was used to capture all utilization, but to allow for a short gap given that individuals are often disenrolled from health plans for the month of their death. For each case, we identified all health system individuals using the same enrollment criterion matched by the same time-period and health system. Then, we randomly selected a sample of 100 control individuals per case for a total of 267,400 general population control individuals. The date of suicide for cases was considered the index date and all matched controls were assigned the same corresponding index date. The index date was used to measure 7-, 30-, 60-, 90-, 180-, and 365-day time periods of healthcare utilization. All visits recorded on the index date were excluded.

### 2.2. Data sources

A Virtual Data Warehouse (VDW) is maintained by all MHRN-affiliated health systems, which consists of electronic health record (EHR) and insurance claims data for their members (Ahmedani et al., 2014; Ahmedani et al., 2015; Hornbrook et al., 2005; Go et al., 2008). This combination allows the capture of data on nearly all healthcare utilization both within and outside of each system. The VDW includes data on encounters, medication fills, diagnoses, medical tests, procedures, treatments, and patient demographics (Coleman et al., 2016). The VDW is a federated data model in which the same variables and data definitions are created locally from each unique data system to allow uniformity across sites. These data are regularly subject to quality control verification. Electronic records were matched to official state government mortality records, including date and cause of death, using Social Security numbers or a combination of patient names, birthdates, and demographic profiles consistent with the CDC scheme (Boggs et al., 2017; CDC, 2010a). For this study, eligible individuals who died by suicide from 2000 to 2013 were identified from VDW mortality records using International Classification of Diseases, 10th revision (ICD-10) codes ranging from X60-X84 and Y87.0 (WHO, 2012).

Healthcare encounters were captured for all cases and controls during the year prior to the index date, including the number of days prior to the index date. These data were categorized into subtypes of utilization, including outpatient medical specialty, outpatient primary care, and emergency room visits as well as inpatient hospitalizations. International Classification of Diseases, 9th revision (ICD-9) codes were captured from encounters, permitting the identification of diagnoses recorded at each visit (CDC, 2010b). Diagnoses for all mental health conditions (ICD-9-CM codes 293–302.9; 306.0–316) and substance use disorders (ICD-9-CM codes 291–292.9; 303.0–305.9) were captured (Ahmedani et al., 2014).

Demographic information on age, sex, and insurance status were available. Insurance status was defined by the type of health plan of the enrolled member (commercial, Medicaid/Medicare, other). Estimated

neighborhood income and education were calculated using geocoded addresses and census block data. Race and ethnicity data were not available prior to 2008, thus these data were not included.

### 2.3. Statistical analyses

Descriptive statistics were used to characterize the sample. Demographic characteristics included age in years, sex (male/female), insurance status (commercial, Medicaid/Medicare, other), education (proportion of individuals living in census blocks where ≥25% are college graduates), and income (proportion of individuals living in census blocks where ≥20% have incomes below the US poverty level). The proportion of individuals who made any healthcare visit was calculated for the 7-, 30-, 60-, 90-, 180-, and 365-day time periods before the index date. These analyses were stratified by diagnosis (mental health, substance use, or other) and health service setting. Data were then stratified by insurance status, due to the importance of insurance in health service access. Conditional logistic regression models were used to calculate the odds of suicide associated with each visit type. All models were conditional on site, and adjusted models also controlled for age and sex, consistent with other studies. Study procedures did not include matching for age or gender, because this analysis is part of a larger study which seeks to conduct sub-group analyses. Education and income levels were not significantly different between study groups and were not used for adjustment. Finally, conditional logistic regression models were used to estimate the odds of suicide based on the total number of visits by subtype. All analyses were conducted using SAS software (Anon, 2008). Statistical significance was assessed via two-tailed tests using Hochberg's method for multiple comparison adjustments with an adjusted threshold of $p = 0.05$.

### 3. Results

The sample included 2674 individuals who died by suicide (cases) and 267,400 general population health plan members (controls). As described in prior research, cases were more likely to be men (77.5% male versus 47.5% for controls) and older aged (mean 49.9 years old versus 39.4 years old for controls). There were no differences in neighborhood income, such that 10.2% of cases as compared to 9.8% of controls ($p = 0.504$) lived in neighborhood census blocks where ≥20% of residents have incomes below the US poverty level. Similarly, there were no statistically significant differences between the proportion of individuals living in census blocks where ≥25% are college graduates (38.3% of cases versus 36.8% of controls; $p = 0.113$) (Ahmedani et al., 2017). Among cases, approximately 70% had commercial insurance and one-quarter had Medicare or Medicaid whereas nearly 80% of controls had commercial insurance.

The proportion of individuals who made healthcare visits during the 7-, 30-, 60-, 90-, 180-, and 365-day periods prior to the index date are shown in Tables 1 and 2. There were observed differences supporting greater healthcare use among cases across all visit types during every time-period ($p < 0.05$). Nearly one-third of cases made any type of visit during the 7-day period prior to suicide as compared with approximately 11% of controls. During the 365-day period, most study individuals had a healthcare encounter, including > 91% of cases and > 85% of controls.

Primary care and outpatient medical specialty visits were the most common visit types during the 365-day period for all individuals; however, individuals who died by suicide (~79% for each subtype) made each of those visit types more than controls (73% in primary care and 63% in medical specialty settings). In the emergency room, nearly 7% of cases made a visit within 7-days, > 14% within 30 days, and nearly half (43.8%) within 365 days before suicide. This is in contrast with approximately 21% of controls with emergency room visits within the year before the index date and only 0.6% with 7-days. This wide variation also extended to the inpatient setting where 5.9% of cases

**Table 1**
Variation in health service use within the 7-, 30-, and 60-day time periods before suicide.[*], [**], [***]

| Visit type | 7- days prior to index date | | | 30- days prior to index date | | | 60- days prior to index date | | |
|---|---|---|---|---|---|---|---|---|---|
| | Controls, % (n = 267,400) | Cases, % (n = 2674) | AOR (95% CI) | Controls, % (n = 267,400) | Cases, % (n = 2674) | AOR (95% CI) | Controls, % (n = 267,400) | Cases, % (n = 2674) | AOR (95% CI) |
| Any encounter | 10.7 | 29.6 | 3.31 (3.04, 3.61) | 29.9 | 54.3 | 2.67 (2.47, 2.89) | 44.1 | 66.2 | 2.42 (2.23, 2.62) |
| Inpatient stay | 0.2 | 5.9 | 32.03 (26.24, 39.11) | 0.7 | 11.7 | 16.86 (14.73, 18.29) | 1.2 | 15.0 | 12.18 (10.53, 13.71) |
| Emergency room or urgent care visit | 0.6 | 6.5 | 11.26 (9.53, 13.31) | 2.5 | 14.1 | 6.82 (6.08, 7.64) | 4.8 | 19.6 | 5.08 (4.56, 5.57) |
| Outpatient specialty visit | 6.2 | 16.3 | 2.73 (2.45, 3.04) | 17.9 | 36.7 | 2.52 (2.32, 2.73) | 27.1 | 48.8 | 2.45 (2.26, 2.65) |
| Primary care visit | 4.3 | 9.5 | 2.16 (1.99, 2.46) | 15.4 | 27.0 | 1.90 (1.74, 2.07) | 26.4 | 39.2 | 1.70 (1.57, 1.84) |
| Any visit with MH diagnosis | 1.2 | 13.5 | 15.50 (13.72, 17.52) | 3.4 | 27.7 | 12.19 (11.12, 13.35) | 5.3 | 34.4 | 10.39 (9.55, 11.31) |
| Inpatient with MH diagnosis | 0.04 | 3.1 | 70.42 (54.15, 102.27) | 0.2 | 7.2 | 44.28 (36.57, 53.63) | 0.3 | 9.7 | 33.13 (28.29, 38.79) |
| Emergency room or urgent care visit with MH diagnosis | 0.03 | 2.1 | 70.89 (49.31, 101.92) | 0.1 | 5.9 | 54.65 (44.26, 67.19) | 0.2 | 8.0 | 38.10 (32.06, 45.27) |
| Outpatient specialty visit with MH diagnosis | 0.8 | 7.6 | 13.31 (11.37, 15.58) | 2.1 | 17.3 | 11.94 (10.70, 13.31) | 3.1 | 22.2 | 10.94 (9.92, 12.07) |
| Primary care visit with MH diagnosis | 0.3 | 3.3 | 11.14 (8.85, 14.03) | 1.2 | 9.7 | 8.65 (7.54, 9.93) | 2.2 | 14.4 | 7.41 (6.61, 8.31) |
| Any visit with SU diagnosis | 0.3 | 4.2 | 16.62 (13.46, 20.53) | 0.8 | 10.1 | 12.27 (10.69, 14.08) | 1.4 | 13.2 | 9.39 (8.33, 10.59) |
| Inpatient with SU diagnosis | 0.02 | 1.8 | 103.68 (66.38, 161.92) | 0.08 | 4.1 | 52.29 (40.56, 67.40) | 0.2 | 5.5 | 33.17 (27.03, 40.71) |
| Emergency room or urgent care visit with SU diagnosis | 0.03 | 1.4 | 61.53 (39.79, 95.15) | 0.1 | 2.9 | 30.61 (23.34, 40.13) | 0.2 | 3.9 | 22.66 (18.09, 28.37) |
| Outpatient specialty visit with SU diagnosis | 0.1 | 1.2 | 10.24 (7.03, 14.91) | 0.3 | 4.0 | 12.33 (9.97, 15.25) | 0.5 | 5.8 | 11.10 (9.32, 13.23) |
| Primary care visit with SU diagnosis | 0.1 | 0.5 | 4.38 (2.58, 7.58) | 0.4 | 2.4 | 5.12 (3.95, 6.64) | 0.8 | 3.9 | 4.49 (3.66, 5.50) |

* Odds ratios are adjusted for age and sex.

** MH denotes mental health.

*** SU denotes substance use.

**Table 2**

Variation in health service use within the 90-, 180-, and 365-day time periods before suicide.[*],[**],[***]

| Visit type | 90- days prior to index date | | | 180- days prior to index date | | | 365- days prior to index date | | |
|---|---|---|---|---|---|---|---|---|---|
| | Controls, % (n = 267,400) | Cases, % (n = 2674) | AOR (95% CI) | Controls, % (n = 267,400) | Cases, % (n = 2674) | AOR (95% CI) | Controls, % (n = 267,400) | Cases, % (n = 2674) | AOR (95% CI) |
| Any encounter | 54.1 | 73.6 | 2.33 (2.13, 2.54) | 71.2 | 83.7 | 2.05 (1.85, 2.29) | 85.5 | 91.7 | 1.91 (1.66, 2.19) |
| Inpatient stay | 1.7 | 17.3 | 10.13 (9.07, 11.30) | 3.1 | 21.8 | 7.46 (6.75, 8.23) | 5.6 | 28.9 | 6.23 (5.70, 6.82) |
| Emergency room or urgent care visit | 6.9 | 24.0 | 4.53 (4.13, 4.97) | 12.3 | 33.1 | 3.75 (3.45, 4.08) | 21.2 | 43.8 | 3.08 (2.85, 3.30) |
| Outpatient specialty visit | 33.9 | 55.4 | 2.31 (2.14, 2.51) | 47.8 | 67.1 | 2.14 (1.97, 2.33) | 63.4 | 78.7 | 2.03 (1.85, 2.24) |
| Primary care visit | 35.3 | 47.6 | 1.58 (1.46, 1.71) | 53.7 | 63.4 | 1.43 (1.32, 1.55) | 72.8 | 79.1 | 1.37 (1.25, 1.51) |
| Any visit with MH diagnosis | 6.7 | 39.0 | 9.76 (9.00, 10.59) | 10.1 | 45.6 | 8.14 (7.52, 8.81) | 14.8 | 53.2 | 7.15 (6.61, 7.74) |
| Inpatient with MH diagnosis | 0.4 | 11.1 | 26.32 (22.79, 30.40) | 0.7 | 14.3 | 20.47 (18.05, 23.21) | 1.2 | 19.1 | 17.04 (15.27, 19.01) |
| Emergency room or urgent care visit with MH diagnosis | 0.4 | 9.7 | 31.50 (27.01, 36.74) | 0.7 | 12.5 | 22.41 (18.64, 25.57) | 1.1 | 15.7 | 16.38 (14.59, 18.39) |
| Outpatient specialty visit with MH diagnosis | 3.8 | 25.1 | 10.33 (9.81, 11.35) | 5.4 | 29.6 | 8.86 (8.12, 9.68) | 7.8 | 35.2 | 7.70 (7.08, 8.36) |
| Primary care visit with MH diagnosis | 3.1 | 17.8 | 6.86 (6.18, 7.61) | 5.5 | 24.4 | 5.73 (5.23, 6.29) | 9.1 | 32.7 | 5.06 (4.65, 5.51) |
| Any visit with SU diagnosis | 2.0 | 15.7 | 8.44 (7.56, 9.43) | 3.3 | 20.5 | 6.71 (6.08, 7.40) | 5.4 | 27.8 | 6.02 (5.51, 6.57) |
| Inpatient with SU diagnosis | 0.2 | 6.2 | 24.59 (20.44, 29.59) | 0.4 | 8.3 | 17.15 (14.68, 20.04) | 0.8 | 11.7 | 13.59 (11.93, 15.47) |
| Emergency room or urgent care visit with SU diagnosis | 0.3 | 5.0 | 19.64 (16.12, 23.93) | 0.5 | 6.7 | 14.64 (12.38, 17.31) | 0.9 | 9.6 | 11.95 (10.39, 13.75) |
| Outpatient specialty visit with SU diagnosis | 0.7 | 7.1 | 10.49 (8.94, 12.29) | 1.2 | 10.0 | 9.15 (7.99, 10.48) | 1.9 | 13.5 | 7.59 (6.75, 8.54) |
| Primary care visit with SU diagnosis | 1.1 | 5.4 | 4.45 (3.74, 5.30) | 2.0 | 8.2 | 3.76 (3.26, 4.34) | 3.5 | 13.1 | 3.66 (3.26, 4.12) |

* Odds ratios are adjusted for age and sex.

** MH denotes mental health.

*** SU denotes substance use.

**Table 3**

Variation in health service use by insurance status within the year period before suicide.[*],[**],[***]

| Visit type | Commercial | | | Medicare/Medicaid | | | Other/self-pay | | |
|---|---|---|---|---|---|---|---|---|---|
| | Controls, % (n = 214,650) | Cases, % (n = 1855) | AOR (95% CI) | Controls, % (n = 41,127) | Cases, % (n = 685) | AOR (95% CI) | Controls, % (n = 10,276) | Cases, % (n = 123) | AOR (95% CI) |
| Any encounter | 84.5 | 90.0 | 1.84 (1.57, 2.15) | 91.9 | 97.1 | 2.77 (1.75, 4.37) | 82.6 | 90.2 | 1.86 (0.95, 3.62) |
| Inpatient stay | 4.4 | 25.7 | 7.72 (6.90, 8.63) | 11.9 | 37.7 | 4.16 (3.48, 4.97) | 4.5 | 30.9 | 6.55 (3.61, 11.87) |
| Emergency room or urgent care visit | 20.3 | 42.1 | 3.19 (2.90, 3.51) | 26.9 | 49.1 | 2.86 (2.42, 3.37) | 17.9 | 42.3 | 2.76 (1.73, 4.41) |
| Outpatient specialty visit | 61.4 | 76.0 | 2.03 (1.82, 2.27) | 76.2 | 87.6 | 2.08 (1.63, 2.66) | 57.3 | 72.4 | 2.06 (1.28, 3.33) |
| Primary care visit | 71.0 | 75.4 | 1.33 (1.19, 1.48) | 83.5 | 90.1 | 1.71 (1.31, 2.22) | 69.4 | 75.6 | 1.36 (0.84, 2.22) |
| Any visit with MH diagnosis | 14.2 | 52.8 | 7.62 (6.93, 8.38) | 18.4 | 54.3 | 5.79 (4.89, 6.85) | 13.2 | 55.3 | 7.14 (4.28, 11.93) |
| Any visit with SU diagnosis | 5.2 | 29.8 | 6.94 (6.25, 7.72) | 6.7 | 21.0 | 3.76 (3.04, 4.64) | 5.1 | 33.3 | 10.07 (5.24, 19.35) |

* Odds ratios are adjusted for age and sex.

** MH denotes mental health.

*** SU denotes substance use.

versus 0.2% of controls were hospitalized in the 7-day period and nearly 29% of cases compared with 6% of controls were hospitalized within the 365-day period.

Healthcare encounters with mental health or substance use diagnoses recorded during the visit were more common for individuals who died by suicide. Overall, approximately half of those who died by suicide had a visit with a mental health diagnosis whereas 28% of cases had a visit with a substance use diagnosis recorded within the 365-day period. Among controls, fewer than 15% had a mental health visit and approximately 5% had a substance use visit during the same time-period. While a smaller proportion of the sample had emergency room or inpatient hospitalization with a mental health or substance use disorder recorded, these visit types had the greatest risk of suicide with the adjusted odds ratio > 60.0 during the 7-day period and > 10.0 for each visit type during the 365-day period.

Table 3 depicts the proportion of the study sample who made various types of healthcare visits, by insurance type, within the 365-day period prior to the index date. For individuals with commercial insurance or Medicare/Medicaid, health service use was more common among those who died by suicide, as compared with controls, for each visit type. This remained consistent for individuals with 'other' types of health insurance, except for primary care visits where there were no observed differences between cases and controls. Over 90% of cases and 80% of controls made visits within the year prior to the index date for all insurance types. However, a greater proportion of cases and controls with Medicare/Medicaid made healthcare visits in each setting as compared with those who had commercial or 'other' health insurance products. Across all insurance types, between 53 and 55% of cases had a visit with a mental health diagnosis, while ~30% of those with commercial or other insurance versus 21% of those with Medicare/Medicaid had a visit with a substance use diagnosis.

In Table 4, the mean number of visits, in total and by sub-type, are presented for cases and controls during the 365-day time-period prior to the index date. Cases made an average of nearly 17 healthcare visits in the year before suicide as compared to 7.5 visits for controls. Both sample groups made most visits in outpatient medical specialty (9.9 visits for cases versus 4.1 visits for controls) and primary care settings (3.8 visits for cases versus 2.4 visits for controls). On average, cases had nearly 5 visits with a mental health diagnosis and 2 visits with a substance use diagnosis as compared to < 1 visit each for controls. The median number of visits was smaller, but cases still made a median of 9 overall visits before suicide compared to a median of 4 visits for controls.

**Table 4**
Variation in the number of health service encounters within the year period before suicide.

| Visit type | Controls # of visits Mean, SD (Median) | Cases # of visits Mean, SD (Median) | AOR[***, ***] (95% Cl) |
|---|---|---|---|
| Any encounter | 7.5,11.4 (4) | 16.7, 22.3 (9) | 1.02 (1.02, 1.02) |
| Inpatient stay | 0.1, 0.8 (0) | 0.6, 1.5 (0) | 1.11 (1.09, 1.13) |
| Emergency room or urgent care visit | 0.4, 1.2 (0) | 1.1, 2.2 (0) | 1.20 (1.18, 1.22) |
| Outpatient specialty visit | 4.1, 8.2 (1) | 9.9, 16.1 (4) | 1.03 (1.03, 1.03) |
| Primary care visit | 2.4, 3.4 (2) | 3.8, 4.7 (2) | 1.04 (1.03, 1.05) |
| Any visit with MH diagnosis | 0.7, 3.4 (0) | 4.8, 10.5 (1) | 1.08 (1.08, 1.09) |
| Any visit with SU diagnosis | 0.2, 2.1 (0) | 1.7, 9.1 (0) | 1.06 (1.05, 1.07) |

[*] Odds ratios are based on mean # of visits and adjusted for age and sex.
[**] MH denotes mental health.
[***] SU denotes substance use.

## 4. Comment

Much national dialogue persists about whether patterns of healthcare use differ among those who die by suicide as compared to the general population. Answering this question can provide information on how to target suicide prevention activities; however, limited data has been available. The current study provides the first large-scale data on the types and timing of healthcare utilization before suicide as compared to general population controls across geographically diverse US regions. We detail important variation in the relative risk of making various types of healthcare visits. These data show that across all levels of healthcare, including outpatient medical specialty and primary care, inpatient hospitals, and emergency rooms, individuals who died by suicide were more likely to make a healthcare visit compared to matched controls. Importantly, this variation was generally consistent within insurance types. While there is some evidence that having insurance may reduce population-level risk of suicide, (Lang, 2013) over 90% of individuals in the US have health insurance (Cohen et al., n.d.). Collectively, these findings diverge from other smaller US-based research, which showed no difference in overall healthcare use (Chock et al., 2015). Our study suggests that there are unique opportunities to prevent suicide in all health system settings.

Importantly, this study found that healthcare settings with the greatest rate of utilization (outpatient specialty and primary care visits) also had the smallest relative odds of suicide. Alternatively, the setting with the greatest relative odds (inpatient), also had the smallest absolute utilization rate. Applied to the clinical setting, these findings highlight the tension between maximizing prevention opportunities (i.e., focusing on settings with the greatest absolute utilization) versus targeting interventions for those with the greatest risk (i.e., focusing on settings with the greatest risk signal). The emergency room may provide a unique opportunity to address this tension, given that this setting has both a large absolute utilization rate and a substantial relative risk.

Over one-fifth of individuals make an emergency room visit within two months prior to their death. Compared to matched general population controls, those who die by suicide are much more likely to make an emergency room visit (including a substantial difference right before suicide). While it is not unique that individuals seen in the emergency room with a mental health diagnosis are at risk, it is important to note that the risk signal for all emergency visits is also large. Given these factors, significant effort to prevent suicide for all patients in the emergency room appears warranted, particularly since emergency room visits are generally longer in duration than standard outpatient visits providing more time for low and moderate intensity identification and brief intervention before connection to specialized behavioral health care. An example of this approach was implemented in the ED-SAFE study (Miller et al., 2017).

Inpatient hospitalizations are also much more common for individuals who die by suicide as compared to the general population, but overall, a small number of people received this type of care. This dynamic provides an opportunity in which high intensity interventions may be possible. The longer visit duration may help facilitate the time needed to start high intensity intervention before subsequently connecting individuals to high intensity outpatient behavioral health care after discharge.

This study also supports prior research demonstrating that nearly all individuals who die by suicide make a healthcare visit in the year before death and approximately half make contact with the health system within a month of suicide (Ahmedani et al., 2014; Luoma et al., 2002). The majority of healthcare visits occur within outpatient medical specialty and primary care settings. As a result, there are many opportunities for identification and early treatment, as on average, individuals who die by suicide have nearly 10 outpatient medical specialty and 4 primary care visits in the year before death –significantly more than controls. Recent research also indicates that most individual physical health conditions as well as multimorbidity of physical health

conditions, are associated with increased risk for suicide, even after adjustment for mental health conditions, which supports greater need for outreach to individuals receiving care in general medical settings (Ahmedani et al., 2017; Ilgen et al., 2013; Webb et al., 2012). Since most people receive care in general medical settings (but there is a small risk difference), lower intensity approaches are optimal to maximize reach within available resources.

Consistent with other research, this study demonstrates that those who die by suicide are more likely than the general population to have a mental health or substance use diagnosis (Ilgen et al., 2010). In this study, visits with recorded mental health and substance use diagnoses represented the largest variation in relative risk of suicide between cases and controls. These conditions have long been the focus of most suicide prevention interventions, particularly within behavioral health settings (Hampton, 2010). However, these data also support other recent studies indicating that only half of all individuals have a mental health diagnosis before suicide (Stone et al., 2018; Ahmedani et al., 2014). As such, patients with a mental health or substance use condition should be offered higher intensity interventions. Integrated or collaborative care models may be successful ways to provide a higher level care in non-behavioral health settings, and subsequently be best structured to connect individuals to the highest intensity interventions within behavioral health settings (Unutzer et al., 2002). Nonetheless, targeting suicide prevention activities to only individuals with one of these conditions limits the reach of those efforts to only half of individuals at risk.

The Joint Commission's Sentinel Event Alert #56 is supported by the findings from this study by recommending identification approaches and treatment for suicide risk in all healthcare settings (Commission TJ, 2016). The national Zero Suicide initiative offers a menu of evidence-based approaches to assist health systems with providing care for individuals at risk (Hogan and Grumet, 2016; Suicide Prevention Resource Center, 2018). The current study provides important data to help determine how to target those services. Pragmatic screening tools are low intensity and available for use in all settings, including the 9th item of the Patient Health Questionnaire and (Simon et al., 2013; Simon et al., 2016) the Columbia Suicide Severity Rating Scale (Posner et al., 2011). Recent data support the use of machine learning to identify people at risk for suicide using health care data (Simon et al., 2019; Kessler et al., 2017). Low- to moderate- intensity brief interventions include safety planning, crisis response planning, and caring contacts, while high intensity suicide-specific treatment approaches include Dialectical Behavioral Therapy and Cognitive Behavioral Therapy for Suicide Prevention (Linehan et al., 2006; Brown et al., 2005; Stanley and Brown, 2012; Motto and Bostrom, 2001; Luxton et al., 2014; Bryan et al., 2018; Stanley et al., 2018). Collaborative assessment and management of suicidality (CAMS) also represents a high intensity approach for individuals at risk in behavioral health (Jobes, 2012).

This study must be considered in the context of limitations. While the study provides important information on the relative risk of suicide for various healthcare visit types, future research is needed to prospectively examine the absolute risk associated with these visits. The current study included a large sample of individuals in geographically diverse US regions, but the participating health systems did not cover all US states. Due to limitations in historical data capture, this study also did not ascertain race/ethnicity records. We do not know the mortality status of controls, but most were likely living past the index date since they were enrolled. Also, these data do not provide information on the adequacy or patient satisfaction of services or the level of care satisfaction. Furthermore, these findings may not generalize to individuals who are uninsured, some of whom may be at high risk. Future research may shed light on this issue. Finally, we were not able to separate Medicaid versus Medicare insurance types. Future analyses should investigate these groups separately.

## 5. Conclusion

This study found that most individuals make healthcare visits before suicide and visit patterns for those who died by suicide differ from the general population. These differences include wide variation in use of many types of healthcare, particularly in emergency room settings. The emergency room provides a unique opportunity for prevention given that a large proportion of patients receive care in that setting before suicide, and the relative risk difference is substantial. There remain smaller differences between individuals at risk for suicide and the general population in use of primary care and outpatient medical specialty care, but these represent the most common visit types before suicide. This study supports recent policy and system-level initiatives suggesting that there are unique opportunities to prevent suicide in all healthcare settings.

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## Declaration of competing interest

The authors report no conflicts of interest for this project.

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