

Examination of the Effectiveness of the Mental Health Environment of Care Checklist in Reducing Suicide on Inpatient Mental Health Units

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Context: Suicide is one of the leading causes of death in the United States. While suicides occurring during psychiatric hospitalization represent a very small proportion of the total number of suicides, these events are highly preventable owing to the controlled nature of the environment. Many methods have been proposed, but no interventions have been tested.

Objective: To evaluate the effect of identification and abatement of hazards on inpatient suicides in the Veterans Health Administration (VHA).

Design, Setting, and Patients: The effect of implementation of a checklist (the Mental Health Environment of Care Checklist) and abatement process designed to remove suicide hazards from inpatient mental health units in all VHA hospitals was examined by measuring change in the rate of suicides before and after the intervention.

Intervention: Implementation of the Mental Health Environment of Care Checklist.

Main Outcome Measure: The number of completed suicides on inpatient mental health units in VHA hospitals.

Results: Implementation of the Mental Health Environment of Care Checklist was associated with a reduction in the rate of completed inpatient suicide in VHA hospitals nationally. This reduction remained present when controlling for number of admissions (2.64 per 100 000 admissions before to 0.87 per 100 000 admissions after implementation; $P < .001$) and bed days of care (2.08 per 1 million bed days before to 0.79 per 1 million bed days after implementation; $P < .001$).

Conclusions: Use of the Mental Health Environment of Care Checklist was associated with a substantial reduction in the inpatient suicide rate occurring on VHA mental health units. Use of the checklist in non-VHA hospitals may be warranted.

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SUICIDE IS THE ELEVENTH LEADING cause of death in the United States, taking the lives of more than 33 289 Americans in 2006.¹ While much attention has been focused on outpatient suicides,² which result in the overwhelming majority of deaths (>90% of all suicides), suicide among hospitalized patients remains a significant problem. A 2003 report by the American Psychiatric Association estimated that 1500 suicides take place on inpatient mental health units in the United States each year.³ In 2008, inpatient suicide was the second most common sentinel event reported to The Joint Commission.⁴ A recent review of published literature on inpatient suicides found common characteristics of patients who completed suicide while hospitalized, including young age, being male, admissions prompted by suicide at-

tempts, a family history of suicide, and a personal history of severe mental illness requiring prior hospitalization.⁵ Because these risk factors may be both nonmodifiable and ubiquitous (such as being male), they provide limited guidance to health care providers.⁶ One multisite study examining 76 completed inpatient suicides showed standard risk assessment and precautions to be ineffective; 77% of the inpatients denied suicidal ideation in their last communication, 42% were on 15-minute precautions at the time of their suicide, and 28% had no-suicide contracts.⁷ The authors concluded that severe agitation and anxiety (present in 79% of the patients) were a better predictor of completed suicide. A recent article that reviewed reports of inpatient suicides reached a similar conclusion, suggesting greater supervision early in the hospital stay as well as more cautious use of off-

unit privileges and leave as more effective means to prevent suicide.⁸

One hospital instituted a treatment policy whereby patients with moderate to severe symptoms of depression were “temporarily relieved of virtually all responsibility for themselves and others.”⁹ Patients in this study were ward restricted and treated with supportive psychotherapy and antidepressants. Patients were excused from potentially stress-inducing situations such as dealing with family and work conflicts or leaving the ward unsupervised until their symptoms had abated. While length of stay was long by American standards (approximately 25 days), the inpatient suicide rate decreased from 319 per 100 000 admissions to 97 per 100 000 admissions. Interestingly, all the suicides that did occur during the intervention period were associated with a failure to carry out the treatment program. Importantly, there was no increase in the rate of suicide outside the hospital in the year following discharge.

Other programs to prevent inpatient suicides have focused more directly on environmental modifications to decrease the presence of potential suicide hazards on psychiatric units. These efforts have used practical recommendations based on shared clinical experience,¹⁰ analysis of potential hazards using industrial engineering techniques,¹¹ and review of prior inpatient suicides using root cause analysis (RCA) methods.¹² Implementation of these recommendations has not been formally tested. The Mental Health Environment of Care Checklist (MHEOCC) was designed to assist with prevention of inpatient suicide. In 2007, the Veterans Health Administration (VHA) mandated the implementation of the MHEOCC.¹² This checklist led to the abatement of 8298 hazards on VHA mental health units in its first 2 years of use. Our objective is to evaluate the effect of identification and abatement of hazards on inpatient suicides in the VHA.

METHODS

MENTAL HEALTH ENVIRONMENT OF CARE CHECKLIST

The VHA leadership wanted to decrease inpatient suicide through a standardized improvement process. Previous work suggested that architectural changes result in more robust safety improvements than interventions such as staff training or changes in processes of care.¹³ Therefore, a committee was formed to develop a process to address architectural and other environmental hazards associated with completed inpatient suicide. The MHEOCC was developed during an 8-month period by a multidisciplinary group that included engineers, architects, and mental health care providers. The group conducted a comprehensive review of the literature in this area, reviewed many previous inpatient suicides in the VHA, and incorporated engineering and architectural specifications to guide the development of the checklist. The checklist was designed for mental health staff, and its applicability was determined with usability testing. The final checklist included 114 items to be reviewed (and abated if found). Thirty-nine items were general and meant to be applied to all parts of a mental health unit. For example, to eliminate a possible anchor point for hanging, all heating ventilation and air conditioning duct covers should

be flush with the wall and be secured with tamper-resistant screws. The checklist included specific items examining potential hazards in the sleeping rooms, bathrooms, seclusion rooms, unit entrance, dining room, staff offices, and nurses' station. The checklist included specific recommendations for use and suggested abatements for potential hazards that were identified. Following the release of the MHEOCC in November 2007, each VHA hospital with a mental health unit treating actively suicidal patients was requested to use the checklist and report the hazards found and abated every 3 months. Implementation of the MHEOCC was comprehensive: all mental health units used it, all identified hazards, and all abated hazards. Specific environmental hazards and abatements are described extensively elsewhere.¹² The MHEOCC is regularly updated and is available at <http://www.patientsafety.gov/SafetyTopics.html>.

REVIEW OF RCA REPORTS OF INPATIENT SUICIDE AMONG VETERANS

The VHA established the National Center for Patient Safety in 1999 to encourage the development of patient safety within the VHA.¹⁴ The National Center for Patient Safety instituted an RCA program to individually and collectively analyze adverse events.¹⁵ Each VHA facility supports a full-time patient safety manager responsible for investigating all adverse events at the facility. The National Center for Patient Safety requires that an RCA be done in all cases of inpatient suicide (as well as for many other adverse event categories).

To identify all completed inpatient suicides in the database, we searched all RCAs conducted between January 1, 1999 (known date of the first RCA) and March 31, 2011, and collected all RCAs with suicide or suicide attempt listed as the event in the incident field. We also used PolyAnalyst natural language software (Megaputer Intelligence, Inc) to search the entire text of each RCA for the terms *suicide*, *suicide attempt*, and *self-harm*. We then manually reviewed each RCA that alluded to suicide to find cases of completed suicides on inpatient mental health units. Only suicides occurring on mental health units were included in our analysis.

EXAMINATION OF VOLUME OF CARE TO DEVELOP RATE OF SUICIDE ON INPATIENT MENTAL HEALTH UNITS

We accessed data regarding the number of admissions per quarter and the bed days of care per quarter provided on VHA inpatient mental health units from January 1, 1999, to March 31, 2011, from VHA administrative data sets. These numbers were used as the denominator to determine inpatient suicide rates per admission and per bed days of care.

AGENCY FOR HEALTHCARE RESEARCH AND QUALITY HOSPITAL DISCHARGE DATA

Generation of a non-VHA mental health inpatient suicide rate was sought to examine whether there was a secular trend in the number of mental health inpatient suicides. The Nationwide Inpatient Sample (NIS), sponsored by the Agency for Healthcare Research and Quality, obtains data for approximately 20% of all US hospital admissions. The data include information regarding both clinical discharge diagnoses and inpatient service utilization. The sampling design includes community hospitals as primary sampling units, and all discharges from the sampled hospitals are included. The sample includes 5 to 8 million discharges per year. In 2000, the NIS sampled 994 hospitals in 28 states with a total of 7 450 992 admissions. By 2008, the sampling framework had increased to 42 participating states, 1056 hospitals, and 8 158 381

Table. Proportion of Quarters in Which Suicides Occurred Before and After MHEOCC Implementation^a

Quarters	Before MHEOCC	After MHEOCC	Total
No.			
With suicides	22	3	25
Without suicides	10	11	21
Total	32	14	46
% With suicides	69	21	54

Abbreviation: MHEOCC, Mental Health Environment of Care Checklist.

^aTwo-sided Fisher exact, $P = .004$.

admissions. Stratification and weighting variables are provided by the Agency for Healthcare Research and Quality to allow generation of national estimates while taking into account the complex sampling design and expansion of the sampling framework over time. The NIS does not have a coding for suicide; thus, we developed a proxy coding scheme for inpatient suicide.

Primary diagnosis for the admission is coded in the data set according to the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*. Comorbid medical conditions were classified with a modified version of the Charlson Comorbidity Index on the basis of hospital discharge *ICD-9-CM* codes. The Charlson Comorbidity Index assigns a score between 1 and 6 points depending on the severity of the additional diagnosis (and hence the comorbidity). The modified Charlson Comorbidity Index was dichotomized into low comorbidity (scores of 0 or 1) or high comorbidity (scores of ≥ 2) for analysis.¹⁶ We excluded hospital stays for those aged 18 years and younger. For our purposes, only patients with a primary admitting diagnosis of a psychiatric condition were considered to be mental health patients. Diagnoses considered mental health diagnosis included adjustment disorders, impulse control disorders, mood disorders, personality disorders, schizophrenia, and other psychotic disorders. Patients were considered a likely inpatient suicide if they (1) had a primary mental health diagnosis (as described here), (2) had a Charleston Comorbidity Index score of 0 or 1, and (3) died during the hospitalization.

STATISTICAL ANALYSIS

Because inpatient mental health suicide is a very rare event, we adopted several approaches in our statistical analysis. We balanced the strongest statistical approaches such as the segmented Poisson regression with weaker but more easily interpreted approaches such as analysis of before vs after implementation of the MHEOCC. Because the data revealed either 1 or 0 suicides per quarter (no quarter had >1 suicide), we simply studied the proportion of quarters with any suicide using Fisher exact test owing to small sample size (only 14 quarters in the postintervention phase from 2008-2011). Second, we performed an exact logistic regression as it produces more accurate inference in small samples because it does not depend on asymptotic results.¹⁴ We used the Poisson distribution to study the number of occurrences because inpatient suicide happens rarely but has many opportunities to occur. We studied these events as a rate (eg, rate of inpatient mental health suicide per 100 000 inpatient mental health admissions, or rate of suicide per 1 million bed days of inpatient mental health care). We modeled the count data of the number of inpatient mental health suicides using the Poisson distribution. The link function was the logarithm, and either total inpatient mental health admissions or total inpatient mental health bed days were the

offset. Rate ratios (RRs) and accompanying 95% CIs were calculated to represent the strength of association between MHEOCC implementation and suicide rates. We first contrasted the average inpatient mental health suicide rates before and after use of the MHEOCC. We then included all the observed suicide rates from 46 quarters in a time-series Poisson regression. For our primary analysis, we performed a segmented Poisson regression analysis of interrupted time series.¹⁵ This analysis allows for graphical display and visual inspection of the trend and for verification through statistical comparison of the trend results.

To study secular trends among non-VHA hospitals during the same period, we used our estimates of inpatient mental health suicide rates (per 100 000 admissions) using data from the NIS. We used all available data from the NIS and imputed the rates for 2011 based on the trend from a time-series Poisson regression.

RESULTS

Our review of the RCA database revealed 25 completed suicides that occurred on VHA inpatient mental health units between January 1, 1999, and March 31, 2011. Twenty-two suicides occurred prior to implementation of the MHEOCC (1999-2007) and 3 occurred after (2008-2011).

The VHA nationally provided a mean (SD) of 1 316 582 (77 899) bed days of care per year on mental health units in the years prior to implementation of the checklist and 1 072 714 (37 810) bed days of care per year after implementation. There was a mean (SD) of 101 234 (1918) inpatient mental health admissions per year before implementation of the checklist and 100 524 (1555) admissions per year after implementation.

A total of 11.5 years (1999-2011) of data were analyzed. Overall during this 11.5-year span, more than half of the quarters (54%) had at least 1 suicide. There was a significant decrease in the proportion of quarters with at least 1 suicide, from 69% during the pre-MHEOCC period to 21% during the post-MHEOCC period (**Table**). The exact logistic regression resulted in an odds ratio of 0.13 (95% CI, -0.02 to 0.64; $P = .008$), showing that implementation of the MHEOCC was associated with an 87% reduction in the likelihood of having a suicide occur in a quarter.

The rate of suicide was 2.64 per 100 000 inpatient mental health admissions before use of the MHEOCC, and it decreased to 0.87 per 100 000 admissions after MHEOCC implementation ($P < .001$). The pre-MHEOCC suicide rate (per 100 000 admissions) was about 3 times as large as the post-MHEOCC suicide rate (RR=3.03; 95% CI, 2.37 to 3.91; $P < .001$). The rate of suicide was 2.08 per 1 million bed days before implementation of the MHEOCC, and it decreased to 0.79 per 1 million bed days after implementation ($P < .001$). Again, the pre-MHEOCC inpatient mental health suicide rate (per 1 million bed days of care) was about 2.5 times as large as the post-MHEOCC suicide rate (RR=2.63; 95% CI, 2.02 to 3.46; $P < .001$). Using all 46 quarters of data, we studied the change in inpatient mental health suicide rates before and after MHEOCC implementation and found a decrease of 62% associated with MHEOCC implementation (RR=0.38; 95% CI, -0.17 to 0.84; $P = .02$).

During the same period from 2000 to 2011, we estimate that yearly psychiatric inpatient suicide rates among non-VHA hospitals fluctuated between 45 and 28 per 100 000 admissions. There was a nonsignificant declining trend for inpatient suicide rates in non-VHA hospitals. Compared with the significant 62% reduction in suicide rates in the VHA hospitals, the non-VHA hospitals experienced a 21% decrease (RR=0.79; 95% CI, 0.67 to 0.99; $P=.05$).

As seen in **Figure 1**, there was a reduction in inpatient mental health suicide rates after introduction of the MHEOCC (from an average of 2 suicides per 9 months to 1 every 14 months). However, Figure 1 also suggests that the suicide rate may have been decreasing before introduction of the MHEOCC. Using segmented Poisson regression, we estimated the slopes in both periods (before and after use of the MHEOCC). We found that the slope during the period before use of the MHEOCC was essentially flat (RR=1.00; 95% CI, -0.99 to 1.01; $P=.42$), while there was a significant decreasing trend in the period after introduction of the MHEOCC (RR=0.86; 95% CI, -0.76 to 0.98; $P=.03$). Thus, in the period after MHEOCC introduction, the inpatient mental health suicide rate decreased by 14% each quarter. We included the inpatient suicide trend line for non-VHA hospitals as well. A trend of decreasing suicide rates is clearly vis-

ible, albeit far less dramatic than in the VHA hospitals. The non-VHA rate seems to be continuous during the period in contrast to the sharp decline seen for VHA hospitals after introduction of the MHEOCC.

The most frequently identified hazards involved anchor points in either a bathroom or closet. In bathrooms, common anchor points included the bathroom door, shower head, and towel bar or hook. Suggested abatements included shower heads that do not provide anchor points and breakaway towel hooks. In closets, common anchor points were the closet door and clothing rod. Open closet arrangements and breakaway clothing hooks were suggested abatements. To further understand the findings, we examined details of the suicides and the specific hazards identified and abated using the checklist. The most frequent methods and locations of completed suicide were also the most frequent hazards found and addressed (**Figure 2**). As the checklist only addressed physical changes to the environment, some methods were not abated. However, as the most common means were related to environmental hazards, these were abated using the MHEOCC.

We also examined the 3 suicides occurring after implementation of the MHEOCC. In all 3 cases, the hazard could have been identified and abated through use of the MHEOCC.

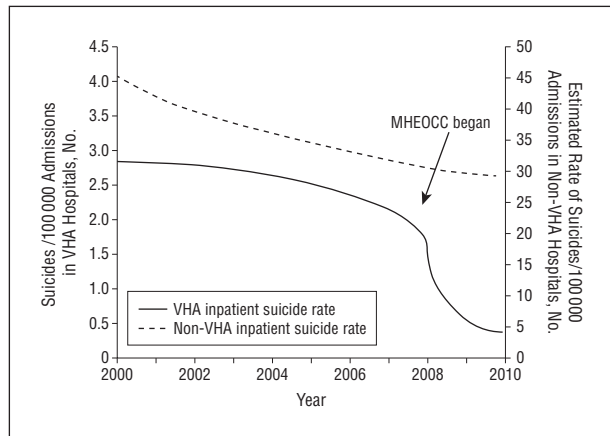


Figure 1. Trend in inpatient suicides before and after implementation of the Mental Health Environment of Care Checklist (MHEOCC). VHA indicates Veterans Health Administration.

COMMENT

Use of the MHEOCC on VHA inpatient mental health units was associated with a reduction in the inpatient psychiatric suicide rate. The reduction remained present even after volume of care (admissions or bed days of care) was considered. The reduction in inpatient psychiatric suicides in VHA hospitals after implementation of the MHEOCC was greater than the predicted improvement trend in VHA hospitals and the secular trend for inpatient psychiatric suicides in non-VHA hospitals. It is important to realize that the MHEOCC is limited to changes in the environment of care on psychiatric units. As such, it does not address or attempt to change or improve any processes of care on those units. This suggests that modification of the physical hospital environment alone can reduce the risk of inpatient suicide. This study builds on

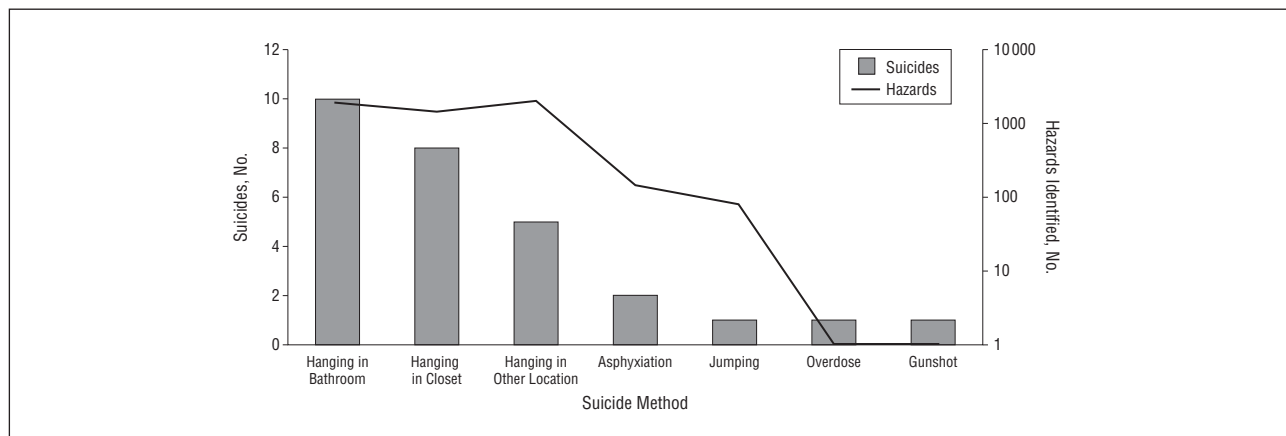


Figure 2. Inpatient suicide methods and related hazards found using the Mental Health Environment of Care Checklist.

the existing outpatient literature suggesting that environmental alterations alone can be associated with reduction in suicides.¹⁷⁻¹⁹ It does not preclude the possibility that similar improvements could be realized through improvements to the process of care.

There are several limitations to this work. Suicide on inpatient mental health units is a rare event. Therefore, although our statistical analysis suggests that these results are not due to chance, some caution is warranted. Second, it is possible that we have undercounted completed suicides that have occurred. However, even if there was a bias toward underreporting, there is no reason to believe that the underreporting would be limited to the time after implementation of the MHEOCC as the same counting methods were used in both periods. Furthermore, our previous work suggests that RCA reports of inpatient suicides represent all of the events that occur.¹² Without a group of control hospitals, we cannot say for certain that reduction in inpatient suicides was due to use of the MHEOCC and not some other unknown factor. Our estimation of inpatient psychiatric suicide at non-VHA hospitals using NIS data is flawed and only provides a limited assurance that there is no secular trend. This method likely overestimated the suicide rate on non-VHA mental health units because any sudden death in a healthy patient admitted with a primary admitting diagnosis of a psychiatric condition would be attributed as a suicide. However, we believe this method would still allow a trend for decreased suicides to be seen if one existed. While we know of no specific interventions to reduce inpatient suicide, our study period included a multitude of VHA efforts aimed to reduce outpatient suicide.²⁰ It is plausible that some of these interventions may have influenced inpatient care. Lastly, this study did not examine the overall rate of suicide among veterans. Therefore, it is possible that the checklist did not lead to a true reduction in suicide, but rather delayed suicide until after discharge.

Many non-VHA hospitals may be considering a number of actions and improvement strategies to decrease the risk of suicide on their mental health units. Despite the limitations outlined, we advocate that such non-VHA mental health units consider using the MHEOCC to identify and mitigate hazards. The use of the MHEOCC successfully detected and abated hazards, especially anchor points in bathrooms and closets. These abatements appear to have decreased the number of suicides across a large health care system. Thus, use of the MHEOCC appears to be an evidence-based intervention to prevent suicide. While this intervention was implemented by the VHA with minimal difficulty, it remains to be seen whether such recommendations could be implemented outside the VHA system. Clearly there are significant barriers (including cost) to its implementation.

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