A novel engagement of suicidality in the emergency department: Virtual Collaborative Assessment and Management of Suicidality

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ABSTRACT

Objective: A novel avatar system (Virtual Collaborative Assessment and Management of Suicidality System; V-CAMS) for suicidal patients and medical personnel in emergency departments (EDs) was developed and evaluated. V-CAMS facilitates the delivery of CAMS and other evidence-based interventions to reduce unnecessary hospitalization, readmissions, and suicide following an ED visit.

Method: Using iterative user-centered design with 24 suicidal patients, an avatar prototype, “Dr. Dave” (based on Dr. Jobes) was created, along with other patient-facing tools; provider-facing tools, including a clinical decision support tool were also designed and tested to aid discharge disposition.

Results: Feasibility tests supported proof of concept. Suicidal patients affirmed the system’s overall merit, positive Perception of Care, and acceptability; medical providers (n = 21) viewed the system as an efficient, effective, and safe method of improving care for suicidal ED patients and reducing unnecessary hospitalization.

Conclusions: Technology tools including a patient-facing avatar and e-caring contacts, along with provider-facing tools may offer a powerful method of facilitating best-practice suicide prevention interventions and point-of-care tools for suicidal patients seeking ED services and their medical providers. Future directions include full development of V-CAMS and integration into a health electronic medical record and a rigorous randomized controlled trial to study its effectiveness.

1. Introduction

In 2016, 44,965 people died by suicide in the United States [1], making suicide the tenth leading cause of death overall [2] and the second leading cause of death among those aged 10–44 [3]. In addition, 9.8 million adults contemplate suicide annually. Of these, over one million will make a suicide attempt [4]. Suicide rates in the U.S. increased 24% from 1999 through 2014 for males and females and for all ages 10–44, from 10.5 to 13.0 per 100,000. In 2013, 1.3 million U.S. adults reported making a suicide attempt in the past year; 9.3 million adults reported serious thoughts about suicide [5–7]. The U.S. cost of suicides and suicide attempts in 2013 was $58.4 billion—of this 97% was due to lost productivity [8]. When adjusted for underreporting, the figure rises to $94.5 billion or $298 per capita [8].

Emergency department (ED) visits for suicidal ideation and costs associated with these visits has also soared in recent years [8]. Between 2006 and 2013, the rate of ED visits due to suicidal ideation increased by 12% on average annually; by 2013, 1% of all ED visits involved suicidal ideation. In 2012, 483,596 people were treated in EDs for suicide attempts and non-suicidal self-injury, and 332,833 were hospitalized [8]. By 2013, 72% of all ED visits for suicidal ideation resulted in hospital admission. Further, the average length of stay per hospital admission due to suicidal ideation increased from 5.1 days to 5.6 days. During this same period, the percent average annual increase in ED plus inpatient costs for those admitted due to suicidal ideation rose by $1000, from $5000 to $6000 per admission [8]. While it might be hoped that hospitalization may resolve suicide risk, studies show that suicide risk may actually increase (up to as much as 200 times) for individuals recently discharged [9–12].

Patients with behavioral health crises pose special challenges for hospital EDs [13]. In the face of increasing utilization, ED “boarding” has unfortunately prolonged the ED waiting experience as inpatient
hospital beds may be unavailable and/or transfer to another facility's inpatient unit can often take time [14]. Studies have shown that boarding leads to crowding, poor patient experience and lower quality care [15], delays in treatment, morbidity and mortality [16], and lost revenue [14]. On average, behavioral health patients wait more than three times longer for a bed compared to those with medical emergencies [13,14]. Behavioral health emergencies further deplete ED resources and contribute to crowding as beds that might otherwise be used to treat patients with life-threatening medical conditions [17] are used for those with behavioral health crises. One study found that every behavioral health admission prevented 2.2 beds from turning over and used for those with behavioral health crises. One study found that every behavioral health patient scored below the midpoint on a scale of therapeutic alliance. In the superior RCT in Denmark [31], comparing Dialectical Behavior Therapy (DBT) to CAMS, there were no differences in self-harm and suicide attempts with respect to suicide mitigation [42]. While numerous factors may account for this fact, expert opinion leads to two clear solutions: First, we have to find ways to “bake (evidence-based practices; EBPs) into healthcare systems so they are used more automatically” [42]. While “bits and pieces” [42] exist, we have yet to put them together in a way that facilitates ease of delivery. Second, smart innovative technologies, including mobile apps and behavioral health platforms, may help “bend the curve” by facilitating the delivery of EBPs, improving access to EBPs, and enabling care coordination [6].

Aligned with the U.S. Surgeon General and the National Action Alliance for Suicide Prevention’s “Zero Suicide” (ZS) other policy initiatives [43,44,46–48], we sought to develop a highly innovative, scalable, and effective suicide assessment and intervention for use in EDs. Our goal was to bake suicide prevention EBPs into EDs, to reduce suicides, unnecessary hospitalization, and improve clinical care within large systems of care.

Influenced by “Nurse Louise,” a discharge nurse avatar developed by Brian Jack, MD and colleagues at Boston University to reduce hospitalization readmission rates, we wondered whether an avatar [49–51] could be used in EDs to perform a CAMS suicide risk assessment with suicidal ED patients, to teach behavioral skills for reducing imminent distress, and to generate hope by hearing personal stories from persons with lived experience. Studies of “Nurse Louise” had demonstrated its efficacy in reducing ED visits and hospital re-admissions by about 10–30% [52,53]. “Nurse Louise,” delivered on a touchscreen attached to a desktop computer and wheeled into the patient’s hospital room, “engaged” the patient with patient education and safety information to facilitate a successful discharge from the hospital [54]. Patients “talked” to “Nurse Louise” by answering a series of simple questions about their problems; “Nurse Louise” responded by offering information based on a simple pre-programmed menu of options. The clear majority of patient users were “very satisfied” with “Nurse Louise” (78%) and found “her” “very easy to use” (78%) [54]. Only 11% of patients scored below the midpoint on a scale of therapeutic alliance. In addition, 74% of patients preferred receiving discharge instructions from “Nurse Louise” than from a live doctor or nurse: “She kept asking if I was tired, if I wanted to take a break. She cared about me, you know,” “Sometimes doctors just talk and assume you understand what they're saying. With a computer you can go slow, go over things again and she checks that you understand.”; or “I've had problems with, not this hospital, but other hospitals. I wasn't given the quality time that this lady gave me.” [56,57]. Engagement with “Nurse Louise” was estimated to save $145 per patient by reducing personnel requirements. Importantly, “Nurse Louise” cut hospital readmissions by half, saving the hospital $412 per patient [55].

Several studies have been conducted to date involving use of virtual agents to address mental health problems. Rizzo and colleagues have developed virtual simulation environments to facilitate training among mental health providers [58–62]. More recently, SimCoach was developed as a virtual healthcare agent to provide veterans and military service members with information about behavioral health problems, assistance in exploring options for care, and to help them connect with live service providers when needed [63]. Lisetti and her colleagues recently developed and tested an avatar to administer a brief motivational intervention for reducing problem drinking; the avatar was deemed both helpful and well-liked by its users [64]. These findings are consistent with other positive findings from avatar studies [65,66].

The current study sought to design, develop, and evaluate the feasibility of “Dr. Dave” and the Virtual CAMS system, including electronic “Caring Contacts,” for suicidal patients in EDs, as well as a provider-facing clinical decision support tool to aid in discharge disposition to reduce unnecessary hospitalization.

2. Method

2.1. Process of prototype development and formative evaluation

We applied user-centered design (UCD) principles and methods throughout the formative evaluation as we designed and built the software and content [67–71]. This agile development approach began with understanding the workflow and needs of target end-users, creating and refining preliminary ideas using paper prototypes, progressing to low-fidelity prototypes, and finally building the digitized
software. UCD methods included: contextual inquiry, concurrent think aloud, retrospective think aloud, concurrent probing, and retrospective probing. Semi-structured interviews followed individually administered usability tests to gain further insights into the end-user's experience. We conducted tests in small “batches” (often 4 to 5 users) to understand and verify usability problems. Testing continued until achieving saturation (i.e., no new information was identified by subsequent testers). Changes to address an identified problem were then made, followed by more testing and refinements until no further usability or user-experience problems were identified. Striving for more than ratings of usability, acceptability, and satisfaction, we endeavored for each user to experience a deep sense of feeling cared about and understood.

Virtual CAMS included the following elements: (1) a computer tablet-based avatar (“Dr. Dave”) performing a 15-minute segment of the CAMS Suicide Status Interview (SSI); (2) the discharge disposition clinical decision support tool that distills SSI content into an easy-to-review provider report; (3) “Caring Contacts” post-discharge messages; and (4) videos of peer-specialists with lived experience telling their stories for purpose of generating hope. In addition, we developed videos of Dr. Jobes introducing patients to the SSI for later testing of whether suicidal ED patients preferred digital recordings to an avatar.

Throughout the formative evaluation, feedback was solicited from suicidal outpatients at three private outpatient specialty clinics serving suicidal patients (n = 13), psychiatric inpatients (n = 2), and peer advocates with lived experience (n = 5). In addition, feedback was also solicited from medical providers serving these patients (n = 21).

2.1.1. “Dr. Dave” avatar

The avatar was built by Benjamin Lok, PhD and Mohan Zalake at the University of Florida. The 15-minute “Dr. Dave” prototype administered the CAMS SSI. “Dr. Dave” asked the patient questions, and patients typed their responses using a keyboard. “Dr. Dave” then verified “his” understanding (e.g., “This is what I understood is causing you the most emotional pain. Is that right?”) before moving to the next question. To ensure accurate numeric ratings, graphic images of scale anchors increase in size (see Fig. 1). For ease of use with acutely distressed users, communication segments were brief and used simple language.

2.1.2. Peer-specialist videos

We created two peer-specialist videos, each approximately 7 min in length (see Fig. 2). Each conveyed a message similar to those provided during in-person meetings with suicidal ED patients: “You are not alone. I have walked in your shoes. It’s important to let people know what’s troubling you so they can help. There is hope.”

2.1.3. Virtual CAMS clinical decision support

A goal of V-CAMS is to provide ED doctors with a report that summarizes various assessment results obtained from “Dr. Dave.” This feedback report provides a series of results based on 25 years of “Suicide Status Form” research conducted by Dr. Jobes and his colleagues. These results are intended to supplement a professional clinical interview and decision-making to optimize clinical outcomes for the patient. [49,50]. We conducted two major iterations of the tool with medical providers (see Fig. 3).

2.1.4. Caring contacts

Two waves of testing with suicidal inpatients and outpatients were conducted. Participants were asked to imagine: “You have been discharged from the ED after a suicide attempt. After a month, you receive a message from your providers.” Querying their preferred form of communication (e.g., letter, email, text), the content of the message, the “sender” of the contact (e.g., their ED providers, “Dr. Dave,” the V-CAMS team), as well as the frequency and duration of contact.

2.2. Formative evaluation procedures

During the first phase of development, input was solicited from a variety of end-users, beginning with hospital administrators, medical providers, and peer specialists, and progressing to suicidal patients. The
intent was to better understand provider workflow in EDs and use case scenarios for suicidal ED patients to ensure that the eventual avatar would be well-tolerated, and add significant value for healthcare systems, patients, and providers. A total of 12 meetings with administrators and medical providers were completed across several hospital services, including two inpatient psychiatry units, one psychiatric liaison service in a hospital, and three EDs to collect critical feedback and input.

Next, testing was conducted with 15 suicidal outpatients and two inpatients. These convenience samples were used as proxies for ED patients, as our early testing required easy access to suicidal patients and an ability to advance-schedule testing sessions. Potential participants were told about the research by their provider based on the study inclusion criteria: English-speaking, 18 years and older, currently suicidal and/or had made a suicide attempt in the past six months and deemed sufficiently stable to participate in the research. No exclusion criteria were set. Those interested directly contacted the research team who then conducted screening and informed consent procedures—either online, via the telephone, or in person. Test sessions were conducted in person in the ED or virtually using a combination of an online screen sharing tool and telephone for suicidal outpatients. Two researchers conducted each interview: one facilitated the user-test session; the other took notes. A semi-structured interview was conducted after each test session to better understand users’ comments and preferences. Measures included: a demographics questionnaire, and the Usability, Satisfaction and Acceptability Questionnaire (USAQ), a brief face-valid self-report measure using a five-point Likert scale (1 = poor; 3 = good; 5 = excellent) adapted from the System Usability Scale (SUS) [71,72]. When testing occurred remotely, participants were interviewed while at their clinics and in the presence of staff for safety. New ideas generated by participants were treated as hypotheses to verify through further testing. Interviews ranged in length from 60 to 90 min.

Providers were told about the study by the research site contact at each organization. Procedures were identical to those used with patients with one exception: testing focused primarily on provider tools and workflow integration. All participants were compensated $50 for their time. All procedures used in this effort were approved by EBPI’s and The Catholic University of America’s Institutional Review Boards (IRB).

2.3. Summative evaluation procedures

Our final test of feasibility involved evaluating the completed Virtual CAMS prototype with suicidal ED patients. Participants were 18 years or older, English-speaking, currently admitted to the ED due to an acute suicidal crisis and deemed by staff as sufficiently stable to provide consent and participate. Patients were approached about the study by their medical provider. Those interested were screened and provided a brief study overview by EBPI staff. All ten patients approached wished to participate; three, however, declined because of the perceived arduous nature of the informed consent process. Following consent, participants (n = 7) completed a demographics questionnaire, were provided a tablet containing V-CAMS, and used it as they wished. All patients completed the SSI. Once done (typically 20–25 min), participants completed the USAQ and a brief semi-structured interview. Participants were paid $50 for their effort. Demographic data are described in Table 1.

Open-ended qualitative data from all suicidal patients (n = 24) gleaned from the semi-structured interviews that followed engagement with “Dr. Dave” were analyzed by two graduate students under the direction of Dr. Jobes using a modified version of Consensual Qualitative Research (CQR) methodology [73,74]. Verbatim responses to the primary interview question (“What are your overall impressions of “Dr. Dave?”) were categorized using a four-level CQR coding strategy (0 = not applicable, 1 = low, 2 = medium, 3 = high) for each coding domain. Coding domains included: 1) Overall Merit (i.e., is this process worth doing, would you want to use Dr. Dave or avatar/technology while waiting for medical attention in the future; would it be helpful to others?); 2)
Perception of Care (i.e., feeling or belief that one is being supported and cared for in time of need); and 3) “Acceptability of Technology” (i.e., like/dislike of technology for risk assessment, particularly in a medical setting). Taken together, the resulting interview responses were overwhelming supportive of the V-CAMS Dr. Dave experience.

3. Results

Overall, four important findings emerged through our initial 80+ hours of testing and interviews. First, administrators and providers universally viewed tablets as acceptable technology to deliver V-CAMS as patients are always under observation—either directly monitored in open-spaces or with cameras when in a closed room. They excluded only psychotic and/or severely agitated patients as inappropriate to use CAMS. Second, all participants liked the hope-instilling videos by peer-specialists and viewed them as a nice counterbalance to the “Dr. Dave” SSI. Finally, patient participants preferred a simple avatar (like “Nurse Louise”) using a computer-generated voice instead of recorded delivery of CAMS or use of Dr. Jobes’ actual voice for “Dr. Dave.” Stated plainly by one participant, “It’s clear that the avatar is a computer and not a person trying to get into my head.” While not all suicidal patients felt strongly in their preference, all found the simple avatar acceptable and valuable to use.

Three themes emerged for providers. First, about 30% of the sample wanted the clinical decision support tool to provide a definitive recommendation about whether to hospitalize or release a patient. Second, providers universally wanted the capacity to “drill deeper” into the clinical support content as needed and have ability to access as-needed and “Just-in-Time Training” materials about how to do specific CAMS and other EBP therapeutic tasks (e.g., how specifically to talk with a suicidal patient about removing lethal means and effectively tolerating their distress). Providers also wanted the ability to “prescribe” skills modules and see what skills patients learned while waiting in the ED. Finally, providers viewed Virtual CAMS integration into their electronic health records as essential requirement going forward.

Patients too responded favorably to Virtual CAMS. Suicidal ED patients experienced “Dr. Dave” as easy to use, helpful, and in some cases, even an entertaining therapeutic distraction while they waited in the ED. They described “Dr. Dave” in adjectives similar to those used to describe “Nurse Louise” on which our avatar was based: “He’s kind and asks me really practical, helpful questions;” “He speaks to me directly in a compassionate way—he is kind and invested.” While the peer specialist videos were also well-received, several consistent recommendations emerged: 1) shorten videos to a max of 5 min; 2) increase diversity of stories and peer specialists (both were Caucasian and similar in age); and 3) avoid language that could trigger patient distress (e.g., avoid talk about lethal means). With respect to the “Caring Contacts,” fewer than 10% of the total sample preferred to receive text messages from “Dr. Dave.” The majority preferred that they be delivered by their ED provider. Feasibility was also reflected in the quantitative ratings: USAQ ratings across all user categories were higher than our original 3.5 a priori cut-off score. Specifically, non-ED suicidal patients

![Fig. 3. V-CAMS SSI template.](image-url)
produced a mean score of 4.4 (SD = 0.30) during the formative evaluation phase; suicidal ED patients averaged a score of 4.5 (SD = 0.41) during the summative phase.

To gain greater insights into the preferences and opinions of suicidal patients, a thorough analysis of qualitative data from the semi-structured interviews further supported feasibility. For the Overall Merit domain, 13 of 18 endorsed the experience at a medium to high level (with four not applicable responses; inter-rater reliability Kappa = 0.906; p < .0001). One participant noted: “It’s great! You can learn a lot from it... It hit everything as far as emotions, I can’t stress that enough. It explained everything right down to a tee: What you’re going through; what you’re going to go through. It made me feel like I wasn’t alone - that there are people going through the same thing that I am.” Another patient observed: “Something to do in the emergency room...there is certainly going to be a lot waiting. Something to focus on instead of all the sights and sounds of the ER. “Dr. Dave” is paying attention specifically to you.” Similarly, Perception of Care domain responses were also positive, with 12 of 18 endorsing this domain at a medium to high level (with six “not applicable responses; inter-rater reliability Kappa = 0.832; p < .0001). One patient described: “I think the interaction...it’s this avatar, which is hilarious because he blinks, I like the videos, it’s engaging and it serves its purpose - it provides a connection, and using healing language to get you to stop thinking about whatever angle you are looking at, and focus on a road to recovery.”

4. Discussion

Death by suicide and other suicidal behaviors (suicide attempts, suicidal ideation, and non-suicidal self-injury) remain a significant public health problem. Despite considerable suicide prevention initiatives and numerous efficacious suicide prevention interventions like CAMS, suicide rates in the United States have continued to rise [1,2,5] and efforts to date have failed to “bend the (statistical) curve” away from suicide [6]. This project, with its innovative platform-based avatar system, seeks to help bend the curve by “baking” EBPs directly into large healthcare organizations and leveraging innovative technologies both at and beyond the point of care to reduce suicide, avert unnecessary hospitalization, and decrease hospital readmissions. Virtual CAMS, with its avatar, “Dr. Dave,” was inspired by another efficacious hospital-based avatar (“Nurse Louise”) that successfully sought to reduce medical-surgical hospital readmissions by facilitating discharge planning. We thus sought to determine its feasibility for use with suicidal ED patients in acute distress and with their treatment providers.

Several findings are particularly noteworthy. First, medical personnel and administrators were overwhelmingly positive in their view that such a tool could have a positive impact in the ED. There was consistent consensus across sites about the benefits of such a system (namely, the ease and efficiency of delivering a suicide prevention EBP while suicidal patients waited in the ED, and one that standardizes care). Use of clinical decision support tools and “Just-in-Time Training” to aid in the discharge disposition efforts was well received. We also found consensus with respect to patients who would be excluded from its use (i.e., psychotic and/or highly agitated, aggressive patients). Second, when provided a choice between use of traditional online video methods and an avatar to perform the SSI, suicidal patients preferred a hybrid approach that included a brief introduction by Dr. Jobs, with the bulk of the modified CAMS assessment performed by a simple avatar. This was particularly important for patients with paranoid cognitions who were better able to tolerate the avatar. Finally, use of an avatar to perform a suicide risk assessment was broadly acceptable to suicidal ED patients that we interviewed. Indeed, suicidal ED patients described “Dr. Dave” similarly to how medical-surgical patients described “Nurse Louise.”

Several study limitations are important to note. First, while Virtual CAMS was developed with extensive target end-user feedback during the formative evaluation, the sample size of suicidal ED patients who interacted with the completed prototype was small (n = 7) and limited to a single teaching hospital in an urban environment. The complexity of conducting this type research with a vulnerable population in fast-moving EDs as well as the intended scope of the project limited our ability to test our hypotheses and findings in other geographic regions and with more suicidal ED patients – thus compromising the ability to generalize from our findings presented here. Future research is required with more participants and in more varied hospital settings to determine whether the findings indeed generalize. Second, because not all components of Virtual CAMS were programmed into the platform due to the project scope, it is impossible to know for certain how the components (beyond “Dr. Dave”) will be used once seamlessly integrated into a delivery platform and deployed. Finally, by virtue of the feasibility focus, we do not know whether such a system will actually produce the intended outcomes we seek: namely, decreases in suicides, unnecessary hospital admissions, and readmissions. Give the promising nature of Virtual CAMS, more research is needed to fully develop Virtual CAMS with additional input from more suicidal ED patients from a range of hospital EDs and providers, to integrate its various components, and ultimately submit the intervention to a rigorous clinical test to determine its efficacy.

Given the magnitude of the suicide public health problem and the universal acknowledgment of challenges for suicidal patients—and their providers—in hospital emergency departments, the need for innovation for more effective ED-based assessment and intervention is
clear. The promise of Virtual-CAMS described in the present investigation is encouraging but more research and development is needed to fully realize the potential of the Virtual-CAMS intervention. As we pursue more input from suicidal ED patients (and their providers) from a range of hospital EDs, we will endeavor to further integrate its varied components and ultimately test the impact of V-CAMS within well-powered rigorous randomized controlled trial research. Within this pursuit, we aim to provide compassionate patient-centered care, while meaningfully assisting busy ED providers, through an innovative, cost-effective, and clinically-efﬁcacious approach to help avert the tragedy of suicide.

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