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Brief Report

Reducing central line-associated bloodstream infection (CLABSI) rates with cognitive science-based training

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There have been many tactics throughout the years aimed at reducing central line-associated bloodstream infections (CLABSI) in the healthcare setting. To reduce CLABSI rates at this facility, we employed cognitive science-based online training directed at nursing departments. Following implementation, we found significant reductions in CLABSI rates that were sustained for a minimum of 9 months. These results demonstrate that this learning methodology can be used to help decrease CLABSI and potentially other health care-associated infections.

The average healthcare-associated central line-associated bloodstream infection (CLABSI) costs $48,108.[1] A central line-associated bloodstream infections (CLABSI) increases patient mortality by 12%-25%.[2] Additionally, with the COVID-19 pandemic beginning in 2020, there was shown to be a significant increase in many hospital-associated infections, including CLABSIs.[3]

One strategy to reduce CLABSI is to increase staff, but this can be financially and operationally burdensome. While there are multiple other strategies for reducing CLABSI,[4] one alternative is to strategically place smart cards and standards-based signage near patient beds. The goal of these external memory aids is to reduce the burden on the caregivers' brains.

The present intervention, using training to introduce or reinforce concepts and procedures that support safe and effective central line placement and maintenance, was designed to strengthen those caregiver's brains. The training was delivered by an online e-learning platform designed to accommodate how people learn, remember, and forget.[5] The system presents questions and collects responses, then algorithmically determines whether and when to provide corrective feedback. Other algorithms in the training determine whether, when, and how to revisit material; learning is not complete until the platform has determined that all content has been mastered.

The purpose of this investigation was to determine the extent to which cognitive science-based online training can affect CLABSI rates.

METHODS

The participants were 541 registered nurses (RNs) at one hospital in the mountain west region of the United States of America. The participants included RNs that worked in various units, including the Emergency Department, Critical Care, Medical-Surgical, and Behavioral Health.

On July 5, 2020, the participants were assigned one CLABSI prevention training module containing 27 learning objectives. The assignment was delivered via the hospital's learner management system (LMS), which is the source of all online training that the participants receive. The training included important CLABSI prevention tactics with a focus on optimal maintenance of the central line.

The training module was announced via message in the LMS system, which was accompanied by a direct email from the Chief Nursing Officer that conveyed the importance of the training. The study participation window closed on September 3, 2020. A total of 536

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Conflict of Interest: Matthew Jensen Hays, PhD, is an employee of Amplifire, the software platform used to deliver the training. He is salaried; there is no direct monetary benefit to him from the work described or the publication thereof.

This quality improvement project was determined exempt from human subjects review by the systems' Institutional Review Board.

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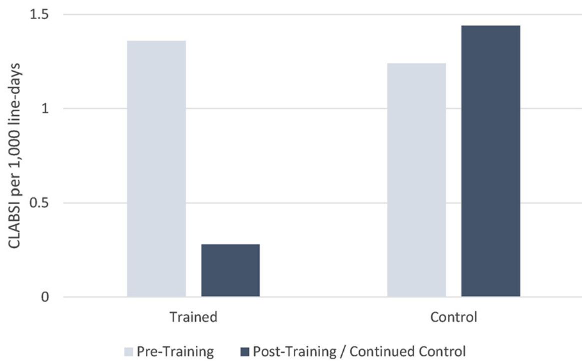

Fig 1. CLABSI per 1,000 line-days at the trained and control locations in the pre-training and post-training periods.

participants (99%) completed the training. The median training duration was 22.82 minutes (IQR: 16.56-33.85).

CLABSI incidences and line-days were evaluated using a pre-test post-test design with the seven other hospitals in the same health care system, where no training had been conducted, serving as a control group. The pre-training period was defined as November 2019 through June 2020. The training was conducted from July 2020 through September 2020, with the post-training period as of October 2020 through July 2021.

RESULTS

At the trained location, the pre-training period comprised 6,642 line-days. During that period, there were 9 CLABSI, yielding a rate of 1.36 CLABSI per 1,000 line-days. The post-training period comprised 7,180 line-days. During that period, there were 2 CLABSI, yielding a rate of 0.28 CLABSI per 1,000 line-days. Fig 1 depicts this 79% reduction in the CLABSI rate. A chi-squared test (with Yates's continuity correction) indicated that the pre-versus-post-training difference in CLABSI rates was statistically significant: $\chi^2 = 3.76$, $P = .05$.

At the control locations, the pre-training period comprised 23,306 line-days. During that period, there were 29 CLABSI, yielding a rate of 1.24 CLABSI per 1,000 line-days. The post-training period comprised 29,906 line-days. During that period, there were 43 CLABSI, yielding a rate of 1.44 CLABSI per 1,000 line-days. As expected, a chi-squared test indicated that there was no effect of training at the untrained control locations: $\chi^2 = 0.36$, $P = .55$.

Finally, a chi-squared test (with Yates's continuity correction) indicated that CLABSI rates in the trained and control groups were statistically significantly different in the post-training period: $\chi^2 = 5.49$, $P = .02$.

DISCUSSION

These data indicate that cognitive-science-based training can measurably impact CLABSI rates. The adaptive learning platform we used was able to modify and improve caregiver behavior in a way that substantially reduced the CLABSI rate.

The influence of training was durable, with a sustained absence of CLABSI for the first eight months post-training; the first CLABSI did not occur until June 2021. In contrast, in the pre-training period, the trained location never experienced a 3-month period without at least one CLABSI.

This finding is yet more notable given the dates during which these data were collected. Throughout this health system, several post-training months had proportional and substantial spikes in COVID hospitalizations. The increase in CLABSIs can be seen in the control group in Fig 1, and mirrors a nationwide trend, specifically a 46%-47% increase in CLABSI during Q3 and Q4 of 2020.[3]

More generally, the pandemic and the significant increase in COVID patients resulted in a greater proportion of high-acuity patients, with concomitantly higher risks of infection and other negative outcomes, including increased mortality risk in some cases. This COVID hospitalization increase was seen in all hospitals in this healthcare system, both the trained locations and the control groups. This change in patient population also increased the burden on the health care system's staff; compared to typical patients, COVID patients require significantly more attention over a longer period of time.[6] Multiple staff members faced burn-out and the changes in staffing related to increased patient load and new nurses that were unfamiliar with hospital protocols may have also led to these increases in CLABSI rates around the country.[6]

Nevertheless, the beneficial effects of the present intervention continued to manifest. Despite the burden felt by the health care workers, there was a high completion rate of the program. This can be attributed to the continued support and promotion of the training from Senior Leadership, indicating that the nursing staff understood and supported this initiative towards patient safety.

Without the training, we would have expected approximately ten CLABSI during the post-training period at the trained location − eight more than were observed. With a CLABSI mortality rate of 12%- 25%,[2] the training in this pilot program is estimated to have saved one to two lives. This illustrates the benefits of this cognitive-science-based training program on patient safety and infection prevention.

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