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Major Article

A demonstration project on the impact of safety culture on infection control practices in hemodialysis

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Background: Infections among hemodialysis patients continues to be major causes of morbidity and mortality despite advances in the science of infection prevention. Many infections are potentially preventable, yet research suggests that evidence-based interventions are not uniformly practiced in dialysis settings. The purpose of the project was to reduce the risk of infection among hemodialysis patients in an outpatient dialysis clinic in upstate New York through the development of an enhanced patient safety culture.

Methods: A survey was used to assess the safety culture of a large outpatient dialysis program. A Comprehensive Unit-based Safety Program was instituted to enhance infection prevention practices. Evidence-based checklists and audit tools were used to track staff adherence to protocols.

Results: Scores on the survey were strongly correlated with bloodstream infection rates. Adherence to infection control standards improved when the End Stage Renal Disease Safety Program was implemented, with audits improving from 27%-82% of procedures performed correctly. Bloodstream infection rates decreased from 2.33-1.07 events per 100 patient months, and the standardized infection ratios decreased from 1.960-0.985 in the 12-months after implementation.

Conclusions: The Comprehensive Unit-based Safety Program model and implementation of the safety program may be effective in improving the culture of safety and adherence to evidence-based practices in hemodialysis. Enhanced patient safety culture is correlated with improved patient outcomes.

End stage renal disease (ESRD) affects over 700,000 people in the United States, and it is estimated that the prevalence is rising by about 20,000 patients per year.[1] Patients with ESRD in the United States have higher mortality rates and fewer expected remaining life years when compared with those with other serious diseases such as cancer, diabetes, and cardiovascular disease.[1] Most patients with ESRD are treated with hemodialysis. Significant improvements in the hemodialysis process over the last decade has resulted in increased survivability for patients with ESRD. However, despite these improvements in treatment, hemodialysis patients in the United States have poorer outcomes than their cohorts in other industrialized nations.[2]

In the United States, infection is the leading cause of hospitalization, and the second leading cause of death, among patients with ESRD.[3] One of the most serious infections associated with hemodialysis is bloodstream infection (BSI), which is often associated with the type of device used for vascular access. Patients on hemodialysis normally have 3 options for long-term bloodstream access: an arteriovenous fistula (AVF or fistula), an arteriovenous graft (graft), or a central venous catheter (referred to as a catheter). An AVF is the preferred bloodstream access device when compared to a catheter because patients with a permanently inserted catheter are 8 times more likely to get a BSI,[4] and twice as likely to die[5] than patients with a fistula. Despite the compelling evidence to support use of AVF to decrease BSI risk, prevalence of AVF at the time of initiation of hemodialysis remains low.

In 2009, the Centers for Disease Control and Prevention (CDC) launched a Dialysis BSI Prevention Collaborative to determine if BSIs are preventable in the dialysis population.[6] This resulted in the identification and compilation of best practices into an evidence-based bundle entitled Core Interventions,[7] which includes 9 interventions that have been proven to reduce the risk of BSI. Evidence suggests that adherence to the Core Interventions can reduce BSI in patients on hemodialysis by up to 50%.[8]

The Agency for Healthcare Research and Quality (AHRQ) recently initiated a project entitled the National Opportunity to Improve

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Infection Control in ESRD. Researchers identified 73 distinct infection control opportunities during the care of a patient on hemodialysis[3] and created and validated a series of checklists and audit tools to standardize practice in accordance with the Core Interventions. Evaluation of the National Opportunity to Improve Infection Control in ESRD project demonstrated a significant reduction in access-related BSI of 44%, and improved clinician adherence to infection control standards.[3] Building on this research, the AHRQ released a toolkit in 2014 entitled the ESRD Safety Program.[9] This toolkit is intended to serve as an adjunct to the Comprehensive Unit-based Safety Program (CUSP) model that was also developed by the AHRQ, and has been shown to dramatically decrease the incidence of central line-associated BSI in the acute care setting.[10] The CUSP model provides the core elements to improve patient care by combining principles of teamwork and the science of safety with clinical best practices.[10] Once these core CUSP principles are in place, clinical care teams can use additional toolkits such as the ESRD Safety Program to address key safety issues such as risk of infection in patients on hemodialysis.

CULTURE OF SAFETY IN DIALYSIS SETTINGS

Multiple factors contribute to patients on hemodialysis and the high risk of acquiring a health care–associated infection (HAI). Although some of these risk factors for infection are nonmodifiable, many infections are potentially preventable through clinician adherence to infection control standards. Evidence indicates that infection control standards are not uniformly implemented nor followed in dialysis facilities.[3] Clinician behavior, such as adherence to infection control standards, has been shown in the literature to be impacted by the culture of safety in the institutions in which they practice. The landmark report *To Err is Human: Building a Safer Health System*[11] was the first major publication to describe the gravity of the safety problem. Since the Institute of Medicine report, there have been numerous safety initiatives and studies in various health care settings, but few have examined the impact of the culture of safety in outpatient hemodialysis centers. In 2014, Ulrich and Kear[12] conducted one of the first studies investigating the culture of safety in dialysis settings. The authors modified the AHRQ staff survey assessment tools used in acute care and medical offices to be appropriate for use in acute and outpatient dialysis settings. One of the major concerns identified by the respondents was poor adherence to infection control standards in their units, which was often attributed to lack of time, lack of knowledge, or failure to adhere to established protocols.[12]

METHODS

Description of demonstration project

To explore the relationship between patient safety culture and outcomes in hemodialysis patients, a demonstration project was launched in late 2017. The goal was to assess hemodialysis staff perceptions of safety culture and determine if the development of CUSP teams and the implementation of the AHRQ ESRD Safety Program toolkit could improve safety culture, enhance staff adherence to infection prevention standards, and impact patient outcomes.

The demonstration project took place in a large outpatient dialysis program in upstate New York. The organization has 6 outpatient clinics sites that together perform 70,000 procedures annually. The project had 6 main components. These included a baseline survey of dialysis program staff to determine perceptions of the patient safety culture in each site; baseline practice audits at each of the 6 clinic sites; selection of the intervention unit and development of a CUSP team; implementation of checklists and audit tools; data collection; and analysis of outcomes. The project was reviewed by the institutional review board of Loyola University Chicago and was assigned a status of exempt.

Survey of staff perception of safety culture

A survey tool (Appendix A) was adapted from the 2016 AHRQ Hospital Survey on Patient Safety Culture (HSOPS).[13] The HSOPS has been validated and used extensively as a reliable measure of patient safety culture in the acute care setting.[13] Although there have been several surveys of patient safety culture adapted and validated for use in nonhospital health care areas,[14] a survey specific to the dialysis setting has not yet been developed. Four dimensions from the HSOPS that were thought to be most applicable to the dialysis setting were selected for use in the survey for this project: teamwork within unit, continuous improvement, communication openness, and management support for patient safety. The AHRQ definitions for these dimensions, database of percent positive response from the 2016 survey, and standard deviation (Appendix B) were used for comparison with the results of this project survey. Additional items were added to assess how often dialysis staff believed their coworkers performed hand hygiene, and staff were asked to give their unit an overall grade on safety. Demographic information was collected on job role and length of time working in each of the 6 hemodialysis units and within the current program. Inclusion criteria for participation was to be a staff member who provided direct patient care in the outpatient dialysis setting, and included charge nurses, staff nurses, and patient care technicians. All responses were confidential and no identifying information was collected.

The paper survey tool was distributed to the 6 outpatient dialysis clinics in December 2017. Promotional posters were created and hung in the staff lounge of each unit, and an incentive was offered for participation. Quantitative items were scored based on positive responses on a 5-point Likert scale. Negatively worded items were designed to be reversed during scoring to obtain an overall safety score with a high score indicating a more positive perception of patient safety at each particular dialysis site. The mean for each of the 4 domains on the tool were calculated for each unit and compared with the percent positive responses from the 2016 HSOPS national database in the 4 included dimensions. Unit scores were also compared with scores on the Ulrich and Kear[12] nephrology nurse patient safety (NNPS) culture survey. An overall safety score was determined for each unit by averaging the percent positive responses from each dimension.

Qualitative data were collected during a brief staff meeting in each of the dialysis clinics when the results of the survey and BSI comparison was shared. Dialysis staff were asked 2 questions: “What about these results surprise you?” and “What do you think this means for patient safety?” Responses were recorded by clinic setting and common themes were identified.

Baseline audit

An extensive baseline audit of infection prevention practices was conducted in each of the clinic sites in December 2017 at the start of the project. The audit included observations of procedures considered most critical to prevention of BSI in the dialysis setting. Critical procedure categories observed included AVF/graft connection and disconnection, catheter connection and disconnection, exit site care, and station cleaning. An infection preventionist (IP) was trained in the use of the checklists and audit tools for each procedure by the project lead. The checklists and audit tools were downloaded from the CDC dialysis safety website.[15] These tools list all of the recommended steps for each procedure. All steps had to be performed in the correct order for the procedure to be counted as “successful.”

The baseline practice audit took place over 4 hours and allowed for 2-4 observations of each critical procedure. The auditors wore gowns, gloves, and face shields and stood in close proximity to the patient/station to better observe the steps each clinician was taking. At the end of the observation period, a total number of observed procedures and total performed correctly was documented giving a percent total of correct procedures for each category. To assure reliability, audit scores of the trained IP and the project lead were calculated with percent agreement being 96%.

Unit selection for intervention & development of CUSP team

An overall percent positive score from the responses of the baseline survey was calculated for each of the dialysis sites to compare staff perceptions of safety culture at each dialysis clinic. One of the 6 dialysis sites was selected to be the demonstration site. The criteria for selection was a site with the median number of staff and patient visits, and scores on pretest measures that indicated a need of improvement but were not the lowest or highest extremes. The site that was selected, Location 5, was the most representative of dialysis units in this program.

Implementation of ESRD Safety Program

Existing AHRQ and CDC materials were used to guide the project. Checklists and audit tools were downloaded from the CDC website,[15] as these tools align with the Core Interventions and allow for more observations to be performed than the AHRQ version of audit tools. The procedural checklists were used to teach and guide the practice of the staff. With the exception of the checklists and audit tools, all other educational material used in the project, including PowerPoint (Microsoft Corp, Redmond, WA) presentations, informational sheets, videos, and posters, were downloaded from the ESRD Safety Toolkit found on the AHRQ website.[9]

Weekly CUSP team meetings were held at the demonstration site during the month of January 2018, led by the project lead. Each week, a different module and material from the AHRQ toolkit was discussed (Fig 1). The CUSP team disseminated the information to the rest of the staff throughout the week. Procedural checklists and information sheets from the toolkit were posted in the staff lounge and at the nurses' stations to stimulate discussion and be available for curious staff. The charge nurse agreed to have a safety brief during morning huddle with staff to allow for any anticipated safety issues to be identified and discussed before patient arrival.

After the baseline practice audit was well established, the trained IP continued to audit each location monthly for the first 2 quarters of 2018 following the same methodology and tools. CUSP team meetings were held monthly and practice audit findings from the IP were discussed, along with any reported BSIs or staff-identified safety issues. Quarterly standardized infection ratios (SIRs) and line lists of BSI pathogens were collected and compared to baseline to assess for change. Safety issues and ongoing results were disseminated back to dialysis leadership during monthly quality assurance and performance improvement meetings.

Data collection and analysis

Baseline BSI rates and SIRs for each site were calculated using data reported to the National Health Safety Network (NHSN) in all 4 quarters of 2017 to establish the preimplementation period for comparison. BSIs were identified and reported into the NHSN of the CDC according to the Dialysis Event Surveillance Protocol.[16] BSI rates were calculated by number of BSI events per dialysis patient months in each unit, and are expressed in terms of number of BSI events per 100 dialysis patient months. The benchmark rate was 1.27 BSI events per 100 dialysis patient months and represents the mean of aggregated data in the NHSN.

The SIR is a summary measure used by the NHSN to track HAIs. The SIR adjusts for facility and/or patient-level factors that may contribute to HAI risk. The SIR compares the number of infections observed to the number that would be predicted given a standard population. An SIR >1.0 indicates more infections were observed than predicted, whereas an SIR <1.0 indicates fewer were observed.[17]

The organisms that were cultured from the BSIs were documented using corresponding laboratory data from 2017. BSI organisms were stratified into 1 of 3 categories: common skin commensals as defined by the NHSN,[18] methicillin-resistant *Staphylococcus aureus* (MRSA), or other pathogen. BSI rates, SIRs, and documentation of organisms cultured continued throughout the project period.

RESULTS

Results of baseline survey

Ninety-nine direct care staff from the 6 outpatient locations were eligible to complete the safety survey. Each location had a >80% response rate, except Location 1 with a 61% response rate, for a final sample of 80. Results of this adapted survey suggested that overall, the dialysis program staff rated their worksites lower in teamwork and management support for safety than the AHRQ database and the NNPS culture survey, and higher in continuous improvement and communication openness (Table 1). For ease of comparing survey

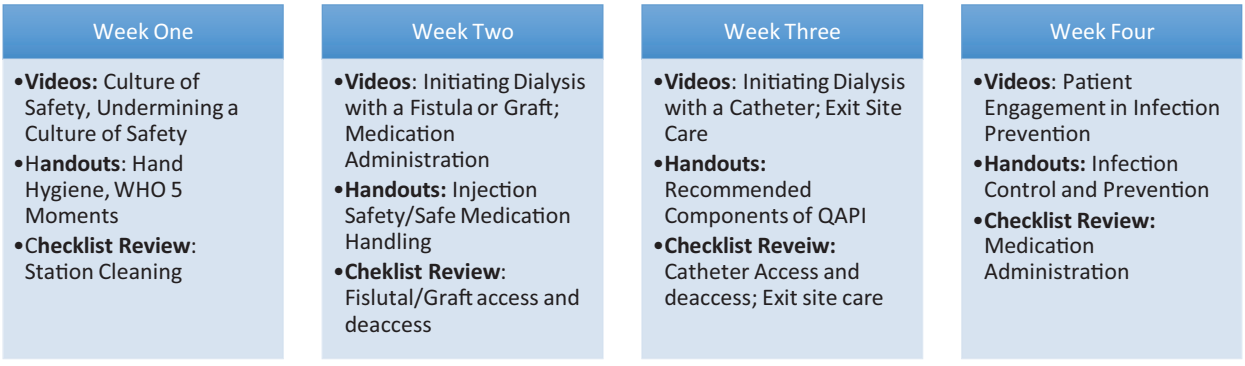

Fig 1. Education timeline of weekly topics covered in videos, handouts, and review of checklists during the Comprehensive Unit-based Safety Program meeting. *QAPI*, quality assurance and performance improvement; *WHO*, World Health Organization.

Table 1
Results of the baseline safety survey. Percent of positive response in each dimension is shown by unit and as an average across the 6 units (program); an overall safety score was calculated for each unit by averaging the percent of positive response from each dimension. Database averages for each dimension from the AHRQ surveys and scores for each dimension from the NNPS culture surveys are listed for comparison

Dimension	Percent positive response								
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Program average	AHRQ database average	NNPS culture survey average
Teamwork	51	56	33	82	26	92	57	72	64
Continuous improvement	77	78	60	96	85	84	80	73	70
Communication openness	80	61	67	82	74	96	77	68	69
Management support safety	75	67	33	89	56	63	63	80	72
Unit average	71	66	48	88	60	84			

AHRQ, Agency for Healthcare Research and Quality; *NNPS*, nephrology nurse patient safety.

results, the AHRQ recommends that a survey score that is 5 percentage points higher than the AHRQ database average be considered "better," and a score that is 5 percentage points less than the database average be considered "lower."[13] An overall safety culture score for each unit was calculated by averaging the positive response rate of each of the measured dimensions for each unit. These overall scores ranged from a high of 88 in Location 4, to a low of 48 in Location 3.

As illustrated in Table 1, Unit 5, the chosen demonstration site, had an overall positive staff perception of patient safety culture of 60%, making this site the second lowest scoring unit in the program overall. However, staff rated teamwork and management support of safety lower than the AHRQ and the Ulrich and Kear (NNPS culture survey) mean, but rated continuous improvement and openness to communication higher, similar to the averages of the program overall and reinforcing this unit selection as representative of the program overall.

Prior to the intervention, a staff meeting was held at the demonstration site to further explore staff perceptions and willingness to participate. The comments elicited from dialysis staff during the open-ended questioning were quite frank. Staff stated that they felt tremendous stress during periods when patients are transitioning on and off the dialysis machines, because they believed they did not have enough time to perform all of the tasks required. Dialysis staff indicated that they knew the steps that they should be following, but they sometimes "had to make a choice" between tasks because of time constraints. They reported choosing to eliminate steps that they feel were "unnecessary" or "did not endanger patients." They admitted to taking shortcuts, such as not performing hand hygiene or changing gloves each time protocols required a glove change, putting a patient on a machine prior to registered nurse assessment of the patient, or skipping station cleaning until the end of the day. Staff also described feelings of burnout. The most telling statement was "we know we don't always do the right thing, but we feel that we are forced to make decisions due to time constraints." These insights were very helpful in understanding the day-to-day concerns of the dialysis staff and reinforced the importance of changing the culture to a safety culture if real change in practice was to occur.

BSI rates and survey results

The safety culture score was compared to the BSI rate at each location (Fig 2), and a correlation statistic was calculated using Kendall's tau-b (−0.867). These data indicated a strong negative relationship between staff perception of safety and BSI rates ($P = .017$). The lower the staff perceived the safety culture, the higher the BSI rate tended to be at each of the locations at the beginning of the project. Location 5, the intervention unit, had the second highest BSI rate in the dialysis program, and the second lowest safety score. The unit with the highest safety score, Location 4, was the only location with BSI rates from 2017 that were below the NHSN benchmark.

Results of baseline audit

The baseline practice audit program-wide revealed an average of 53% compliance with required steps in the 4 measured critical procedures. In many of the failed procedures, the missed steps were similar across facilities. One common finding was staff using 2% chlorhexidine gluconate (CHG) or 70% alcohol pads interchangeably for skin antisepsis, or not allowing the disinfectant to dry. Another common finding was staff would palpate and clean a fistula or graft, but then fail to change gloves and perform hand hygiene before disinfecting and cannulating the site.

The baseline practice audit at Location 5 revealed a 27% compliance rate with established standards. The most notable finding was that not a single catheter connection, disconnection, or exit site care was performed correctly. The observers consistently found inappropriate use of alcohol instead of CHG as a skin disinfectant, and several instances of neglecting to perform hand hygiene between dirty and clean procedures. Therefore, Location 5 appeared to be an ideal site to implement practices designed to enhance adherence to evidenced-based guidelines.

Results of intervention

The objectives for the CUSP team were to improve understanding of safety culture on the unit and align clinician practice with the CDC Core Interventions as evidenced by the results of a monthly IP practice audit. The CUSP team and the unit staff were engaged in the project, and actively participated in the education sessions and safety briefings that occurred weekly in January 2018. Staff verbalized understanding the importance of following all of the steps on the checklists and brainstormed with leadership possible changes to the

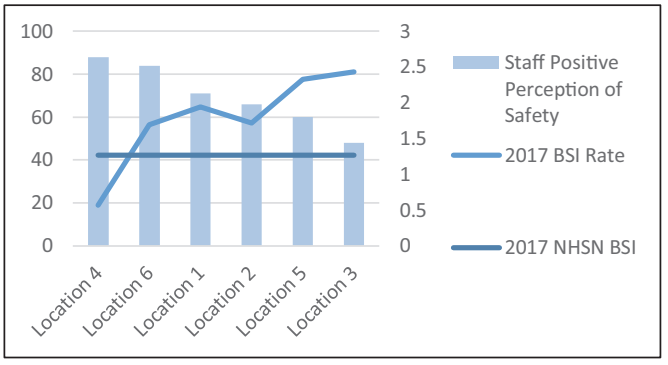

Fig 2. Comparison of overall safety culture survey score to the 2017 BSI rate and NHSN mean for each location. *BSI*, bloodstream infection; *NHSN*, National Healthcare Safety Network.

patient scheduling that would allow more time to complete required tasks and possibly reduce the feeling of being rushed. BSIs that were identified during the intervention period were discussed with staff to determine if there may have been lapses in practice that led to the infection. Staff reported increased adherence to using the appropriate skin antiseptic agents and better technique collecting cultures to reduce the potential for a contaminated specimen.

Practice audit results for the first 6 months during and after implementation of the safety program showed an upward trend in compliance at the demonstration site. Audit scores improved from 27% at baseline in Location 5 to 79% of procedures performed successfully by June 2018. Monthly audits continued to be performed monthly using the same methodology and tools after the intervention period was complete. There were modest improvements over the initial 6-month intervention period. By December 2018, procedures were performed correctly 82% of the time. However, the auditor continued to note that some of the previously identified issues, such as the antiseptic agent not being fully dry before the bloodstream was accessed or before the dressing was applied to the access site, were still occurring intermittently. This finding was noted in the nonintervention units as well.

Postimplementation infections

Although the intervention period was the first 2 quarters of 2018, data were collected for the entire year to better gauge sustainability of the change. Table 2 displays BSI events and SIR data for each quarter in 2017, and for each quarter of 2018.

In Table 2, the number of BSIs (events) per quarter are listed, along with the corresponding SIR and 95% confidence interval. BSI events entered into the NHSN are compared with pooled mean rates from aggregate dialysis event data. A *P* value was calculated by the NHSN to determine if the facility rate was statistically significantly different than the pooled mean rate. For this metric, the demonstration site had BSI rates statistically significantly higher than the NHSN mean in all 4 quarters of 2017, indicating excess BSI incidence. For 2017, the BSI rate was 2.33 per 100 dialysis patient months. After the project was implemented, the first 2 quarters of 2018 experienced BSI rates that were not statistically significantly different than the pooled mean (Table 2), a marked improvement. This trend continued during the final 2 quarters of 2018, when the BSI rate remained below the NHSN benchmark (Fig 3). For 2018, the combined BSI rate was 1.07 per 100 dialysis patient months, compared to the NHSN benchmark of 1.27.

Each quarter (Q1-Q4) in Table 2 displays an SIR >1 with the exception of 2018 Q1, when the SIR had a significant decrease because there were fewer than one-half of the predicted BSIs for that quarter. For each SIR, except 2017 Q2, the value is not statistically significantly different than 1, indicating that the number of observed infections is not significantly different than the number of predicted infections.

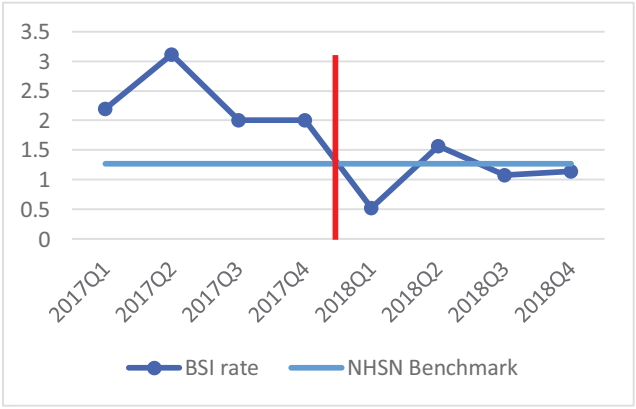

Fig 3. Preintervention and postintervention BSI rate as compared to the NHSN benchmark. The vertical line in the center of the graph indicates the implementation of the intervention. *BSI*, bloodstream infection; *NHSN*, National Healthcare Safety Network.

The 2017 SIR was 1.960, which indicates that in the year prior to the intervention there were nearly twice as many BSIs observed than were predicted. The 2018 SIR was 0.985, which indicates that in the year postintervention there were slightly fewer BSIs observed than were predicted.

Reduction in skin pathogens

In addition to a reduction in the total number of BSIs during the intervention period, there was also a decrease in organisms identified from blood cultures that are associated with poor aseptic technique. During the first 2 quarters of 2017, there were 9 BSIs in the intervention unit. The bacteria that were cultured included 5 MRSA and 3 common skin commensal organisms. In comparison, during the first 2 quarters of 2018, there were 3 BSIs in the demonstration site. The identified organisms included 1 MRSA, whereas there were no BSIs caused by common skin commensal organisms, representing a 100% decrease in the number of common skin commensal BSIs and an 80% reduction in MRSA BSIs.

DISCUSSION

One of the objectives of this project was to assess staff perception of patient safety culture in the outpatient dialysis setting and determine if patient safety culture may have a relationship to patient outcomes. Staff were eager to complete the survey, and many were open and honest when interviewed in person about the survey results. At the start of the project, positive staff perception of safety culture in their setting was strongly associated with decreased rates of BSIs

Table 2
Location 5 BSI events per quarter for 2017 and 2018 along with corresponding SIR. Data collected from the National Healthcare Safety Network

Summary year/quarter	In-plan patient months	Events	Predicted BSI	SIR	95% confidence interval	BSI rate	Benchmark	*P* value
2017Q1	182	4	1.9687	2.032	0.646, 4.901	2.20	1.27	.0243
2017Q2	193	6	2.2784	2.633	1.067, 5.477	3.11	1.27	.0010
2017Q3	200	4	2.4814	1.612	0.512, 3.888	2.00	1.27	.0333
2017Q4	196	4	2.4546	1.630	0.518, 3.931	2.00	1.27	.0312
2018Q1	192	1	2.2568	0.443	0.022, 2.185	0.52	1.27	1.0000
2018Q2	191	3	2.1847	1.373	0.349, 3.737	1.57	1.27	.1177
2018Q3	186	2	1.8742	1.067	0.179, 3.526	1.08	1.27	.5761
2018Q4	176	2	1.8063	1.107	0.186, 3.658	1.14	1.27	.8312

BSI, bloodstream infection; *SIR*, standardized infection ratio.

among the patients in their care. Conversely, the lower the staff rated the safety culture at their site, the higher the BSI rate tended to be.

Staff in the intervention site openly shared some of the reasons why they thought the culture of the dialysis unit and BSI rates were linked at the start of the project. Factors dialysis staff reported included skipping steps that they deemed "not important" or "not a risk to patient safety" and intense pressure to get patients on and off the machines in a short period of time. Staff pointed out that either more staff or more time and/or optimization of patient scheduling to allow more time in between patients would decrease the temptation to skip steps they knew were important.

Another interesting revelation, which should be of concern if this attitude exists in other dialysis settings, is that some professional staff admitted to encouraging their patients to refuse fistula placement, despite the increased risk of infection with long term catheter use. Staff stated that they preferred patients with catheters because they require much less time to care for and do not require patients to stay for an extended period after their treatment because homeostasis is quickly achieved with a catheter. In contrast, it often takes more staff time to achieve homeostasis among patients with a fistula. The quicker a patient is able to leave the unit, the more time the staff has to clean and prepare the station for the next patient. Not surprisingly, the dialysis site in which this belief was most prevalent had a long term catheter rate of almost 50%, compared to the national rate of 15% long term catheter use and the national goal of <10%.[1] As in other health care settings, the staff perception of safety culture and beliefs regarding what may be "acceptable" in daily practice may be a reliable indicator of actual clinician behavior.

The second objective of this project was to improve staff adherence to evidence-based methods to reduce BSI in the dialysis population. The use of checklists has been successfully implemented in other health care settings to improve staff performance of recommended practices. Procedural checklists have been brought to the chair/bed side by staff in similar initiatives to guide practice at the point of care. However, in this project, the CUSP team felt strongly that having another item to remember to bring to the dialysis station would be counterproductive. There was concern that it could lead to increased contamination of the hands or station, and that adding another task for staff to perform during patient care would not be welcome. Instead, the CUSP team felt that educational information and identifying missed steps in the procedures would best be taught during periods of low activity on the unit when staff would be more receptive. The checklists were reviewed with staff while patients were on the machines and posted at the nurses' station and in the break room for continued review and to keep them fresh in people's minds.

Practice audits were very poor at baseline in each of the dialysis sites. Many of the deficits, such as staff not knowing that CHG is the preferred skin antiseptic or not allowing the skin antiseptic to fully dry before accessing the site, were common in each of the dialysis clinic sites in the program. Prior to this project, audits were often done from afar, such as by standing at the nurses' station, and auditors were often watching 2 or more procedures at the same time. The audits for this project were performed with the IP in close proximity to the clinician and patient while each of the tasks were performed, likely resulting in identifying more lapses in procedures and more reliable scoring. Unreliable auditing processes prior to the project likely resulted in missed opportunities for the auditor to recognize and intervene before improper practices became entrenched in the culture. Having the auditor nearby increased the attention to safe practice and resulted in better observations of each step in the procedure. This procedural change was instituted for all future audits in all of the dialysis sites.

Throughout 2018, the results of practice audits at the demonstration site improved, most notably during the first 2 quarters. However, the improper choice of antiseptic and lack of allowing sufficient dry time continued to be problematic. It was observed that the alcohol pads and the CHG pads were the same size and stored in the same drawer. The CUSP team concluded that the look-alike packaging was a contributor to the lack of compliance. Administrative leaders are exploring changing the CHG product to a sponge that would allow for a more noticeable difference in size and provide more surface area to adequately clean and disinfect sites.

Improved staff adherence to the Core Interventions was evident in the changes in BSI rates, pathogen identification, and SIR at the intervention site. The BSI rate in 2017 was statistically significantly higher than the NHSN mean prior to the project at the demonstration site. After implementation of the safety program, all 4 quarters of 2018 had a lower rate that were not statistically significantly different than the NHSN mean, a very desirable outcome. The SIR also decreased dramatically in the first quarter of 2018, before rising slightly in quarters 2-4 to be more in line with the NHSN predicted number of BSIs. At the end of 2018, the annual SIR was 0.985, indicating that there were fewer infections than predicted in the postintervention time period, compared to 2017 when the annual SIR was 1.960, indicating that there were nearly twice as many infections as predicted in the preintervention period. Therefore, there were changes in the desired directions for adherence to infection control recommendations and BSI rates and SIR, but it is difficult to determine if these changes are statistically significant, probably due to very small sample size.

The recovered pathogens when infections did occur were very interesting as well. Prior to the project, almost all of the organisms cultured from blood were organisms commonly found on the skin, which may indicate that poor skin antisepsis, hand hygiene, and exit site care contributed to the infection. The first 2 quarters of 2018 had no instances of common skin commensals in the blood, and only 1 instance of MRSA. MRSA is commonly associated with invasive infections in the dialysis population and may or may not be related to a lapse in procedures. This organism is a frequent pathogen in hemodialysis patients in whom the incidence of invasive MRSA is 100x greater than the nondialysis population.[19] Common skin commensals and MRSA can easily be introduced directly into the patient's bloodstream during dialysis treatment or access site preparation and care by transfer of the bacteria from the skin to the access device. The reduction of BSIs with these organisms indicates that there was likely improved adherence to infection control recommendations such as the Core Interventions.

Although this was a demonstration project with a small sample size, most of the staff of this dialysis organization participated in the survey and a strong correlation was found between staff perception of safety culture and the BSI rate of the patients in their practice location. Staff perception of patient safety culture is known to impact clinician behavior and patient outcomes and has been extensively studied in various health care settings. Although not well studied in dialysis, it may be reasonable to expect that safety culture might impact dialysis clinicians in the same way that it influences the behavior of clinicians in other settings. The results of this study can be used to start conversations in other dialysis programs regarding patient safety and to develop educational programs that address the patient safety culture in the dialysis setting.

Limitations of the Demonstration Project

A limitation of the project is that the project took place in only 1 health care organization's outpatient dialysis program. Although almost all of the entire dialysis program staff (N = 80) contributed to the initial survey, qualitative discussions of perceptions of safety culture and audits in their settings, results may not be generalizable beyond the organization studied. Another limiting factor is that the intervention was implemented at only 1 of 6 outpatient dialysis sites

that was administratively chosen because of limited time and resources for this demonstration project. There was no random assignment of sites and a small sample at each in which to make comparisons. With a small sample size, it is more difficult to interpret statistical findings because a large standard error and confidence interval yield less precise results that may over- or under-estimate the true effect of the intervention. A larger number of dialysis staff participants, increased audit opportunities, and a greater number of implementation sites would provide a better understanding of the human and organizational factors that impact the development and acceptance of effective strategies to improve safety culture and patient outcomes.

CONCLUSIONS

The number of patients on dialysis is growing; they are living longer, and they are often sicker as a group than previous cohorts. Preventing infections and promoting optimal patient safety is a priority. Further study is needed to assess the impact of patient safety culture and implementation of AHRQ and CDC guidelines in the hemodialysis settings. In addition, more study is warranted into the optimal staffing and the patient scheduling model in use by many dialysis facilities. Perception of being rushed was a major factor for poor performance reported by staff in this project, and in the Ulrich and Kear[12] project as well. Staff distress and risk for burnout is a concern. Staff not only need to be properly trained and supported in an organizational culture that values safety, they must also have enough time to perform all of the recommended steps to prevent infection. It is imperative to rethink standard scheduling models and expectations for rapid turnover of patients to ensure that dialysis patients are free of preventable harms and staff feel good about their practice. This will not only benefit patients but will also ensure that qualified staff are able to be recruited and retained to take care of the growing population of persons with ESRD in need of dialysis.

APPENDIX A

Assessment of patient safety culture

INSTRUCTIONS: Think about the way things are done in your facility and provide your opinions on issues that affect the overall safety of care provided to patients. Please place an X in the box which most closely corresponds with your opinion. ALL RESULTS ARE CONFIDENTIAL.

Think about your facility…
How much do you agree or disagree with the following statements?

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
My supervisor or manager seriously considers staff suggestions for improving patient safety.					
Mistakes have led to positive change here.					
After we make changes to improve patient safety, we evaluate their effectiveness.					
Management provides a work climate that promotes patient safety.					
Patient safety is never sacrificed to get more work done.					
Problems often occur in the exchange of information between patients and staff, or between staff members in this unit.					

(*continued*)

(*Continued*)

Think about your facility…
How much do you agree or disagree with the following statements?

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Patient safety is never sacrificed to get more work done.					
Problems often occur in the exchange of information between patients and staff, or between staff members in this unit.					

How often do the following things happen in your facility?

	Never	Rarely	Sometimes	Most of the time	All of the time
We do not have enough staff to handle the workload.					
Staff freely speak up if they see something that may negatively affect patient care.					
When a lot of work needs to be done quickly, we work together as a team to get the work done.					
In this facility, people treat each other with respect.					
My manager gives positive feedback when they see a job done according to established safe principles.					
In this unit, staff washes their hands immediately after removing gloves.					

	Poor	Fair	Good	Very Good	Excellent
Overall, how would you rate the systems and processes your work unit has in place to prevent, catch, and correct problems that have the potential to affect patients?					

	Failing "F"	Poor "D"	Acceptable "C"	Good "B"	Excellent "A"
Please give your unit an overall grade on patient safety.					

Demographics

What is your primary role at this dialysis center?
Nurse_____Technician_____Other role_____

How long have you been providing dialysis treatment services at <u>any</u> dialysis facility?
Less than 1 year_____1-3 years_____3-5 years_____
5-10 years_____10-15 years____>15 years_____

How long have you been providing dialysis treatment services at your current facility?
Less than 1 year_____1-3 years_____3-5 years_____
5-10 years_____10-15 years____>15 years_____

In your current position, do you frequently have direct contact or interaction with patients?
_____YES, I do have frequent direct contact or interaction with patients.
_____NO, I do not have frequent direct contact or interaction with patients.

Thank you for your response to this very important survey!

APPENDIX B

Dimension	Definition: The extent to which...	Positive response (%)	Standard deviation (%)
Teamwork within units	Staff support each other, treat each other with respect, and work together as a team.	82	5.91
Organizational learning/ Continuous improvement	Mistakes have led to positive changes and changes are evaluated for effectiveness.	73	7.44
Management support for safety	Management provides a work climate that promotes patient safety and shows that patient safety is a top priority.	72	9.14
Communication openness	Staff freely speak up if they see something that may negatively affect a patient and feel free to question those with more authority.	64	6.70

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