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Multifaceted Interventions to Improve Hand Hygiene Compliance Among Nurses

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Abstract

The WHO has identified hand hygiene as the single "most important measure to avoid the transmission of harmful germs and prevent healthcare-associated infections" (World Health Organization [WHO], 2009) and subsequently created guidelines specifically focused on hand hygiene and prevention of hospital-acquired infections (HAIs). Nurses know and understand the importance of performing hand hygiene before and after patient contact, but often compliance is subpar. An extensive literature review was conducted for methods and interventions to improve hand hygiene compliance. The review of literature found seven systematic reviews which helped shape this study. The purpose of this study is to examine the effects of multifaceted interventions on nurse hand hygiene compliance rates in a 12-bed adult trauma-surgical ICU as well as its effects on hospital acquired infections such as catheter associated urinary tract infections (CAUTI) and central line associated bloodstream infections (CLABSI).

Acknowledgements

Thank you, to my advisor, Melanie Hardin-Pierce, who pushed me through these five years and helped me finish this final year of the DNP program and project. Thank you, to my committee member, Cassie Degener, who helped fine tune my project. Thank you, to my clinical mentor, Kim Blanton, who, in the midst of the COVID-19 chaos was still able to provide feedback and support on my project. Thank you, to Amanda Wiggins who helped with the data analysis of this project. Thank you, to Becca Charles and the Trauma-Surgical ICU, without their help this project would not have been possible.

Dedication

I would like to dedicate this project to my pregnant wife and unborn child, my family, and friends. Without the love, support, and sacrifice from these individual I would not have been able to complete this journey through the DNP program and with this project.

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Background and Problem Statement

The World Health Organization (WHO) has created guidelines specifically focused on hand hygiene (HH) and prevention of hospital-acquired infections (HAIs), but it is far too often these guidelines are not adhered too. The WHO has identified hand hygiene as the single "most important measure to avoid the transmission of harmful germs and prevent healthcare-associated infections" (WHO, 2009).

HAIs which include ventilator associated events (VAE), catheter associated urinary tract infections (CAUTIs), central line associated blood stream infections (CLABSIs), and clostridium difficile (CD) are preventable infections and a primary source of increased mortality. In fact, the CDC estimated that in 2011 there were 722,000 and roughly 75,000 of those patients died as a direct result of the infection. These infections have also created a financial burden on the healthcare system as well, by adding an additional $1 Billion to healthcare costs from central line blood stream infections alone (The Joint Commission, 2016). In an article by Zimlichman et al., (2013), researchers calculated the cost of each HAI and found the cost of a CAUTI to be $896, CD: $11,285, VAE: $40, 144, and a CLABSI to be $45, 814. These are additional healthcare costs that are not reimbursed by insurance; therefore, hospitals are losing money on each HAI occurrence.

As the need for preventing HAIs continues to grow, and HH is identified as the best preventative measure, why are HH practices not strictly adhered too? According to Sopjani, Jahn, and Behrens, (2017) and Al- Dorzi et. al, (2014), the major barrier to hand hygiene compliance is lack of hand hygiene education. But according to Gould et al, (2017), additional education may only slightly improve hand hygiene compliance, whereas a multimodal strategy consisting of education, visual cues, and direct feedback has the largest impact on hand hygiene compliance.

Theoretical Framework

For this study, the use of the Iowa Model of Evidence-Based Practice to Promote Quality of Care guided the implementation of this Quality Improvement (QI) project. The Iowa Model is designed to help administrators make decisions that affect patient outcomes (Melnyk & Fineout-Overholt, 2015). The Iowa Model consists of seven steps which include the following: Identify "triggers"; Clinical applications; Organizational Priorities; Forming a team; Piloting a Practice Change; Evaluating the Pilot; and Evaluating Practice Changes; and Dissemination of Results (Melnyk & Fineout-Overholt, 2015).

Knowing that HH is the best intervention in the prevention of HAIs, low HH compliance rates was the "trigger" for this project. Providers continuously strive to improve patient outcomes and do no harm, therefore under the guidance of the Division of Infection Prevention and Control (IPAC) and the hand hygiene steering committee this QI project was piloted. The implementation of this QI project built upon the current practice in place for staff education and direct feedback from hand hygiene auditors, with additional education and visual cues that are currently in place. In the conclusion of the pilot study, the results were analyzed and results were disseminated to the staff of the study area.

Literature Review Protocol

The data bases of CINAHL and PubMed were examined using key words that included hand hygiene, hand washing, compliance, and adhere*. Inclusion criteria included peer-reviewed, published in English, published within the last 5 years, and systematic reviews. The search resulted in 57 articles which were then examined for articles focused on improving hand hygiene compliance rates in the hospital setting. Articles focused on primarily technology-based

interventions, using patient encouragement, nursing home based, pediatric based studies, and integrative reviews were excluded, resulting in seven Level I, systematic reviews.

Review of Literature

In 2005, the WHO started a campaign for improving hand hygiene using multimodal interventions, which consists of system change, training and education, observation and feedback, reminders in the hospital and a hospital safety climate, known as the WHO-5 (WHO, 2005). The seven systematic reviews examine the effectiveness of single interventions and multimodal interventions consisting of the WHO-5, as well as other interventions and the effects on hand hygiene compliance (Table 1). The most common single interventions identified within the reviews was education. Multimodal interventions consist of more than one intervention and as many as eight, which were identified in Luangasanatip et al. (2015).

Three of the systematic reviews, Price et al. (2018), Lydon et al. (2017), and Gould et al. (2017) all concluded that the evidence is inconclusive, therefore the researchers are unable to rule that either single intervention or multimodal intervention has a greater impact on hand hygiene compliance than the other. Lydon et al (2017), states that "direct comparison of interventions with a single component and bundled interventions has sometimes revealed a similar or greater efficacy of single-component interventions". Even though all three studies were inconclusive for best practice, they identify that both single and multifaceted interventions are effective in increasing hand hygiene compliance. In fact, Price et al (2018), states "the evidence is sufficient to recommend the implementation of interventions to improve HCW [healthcare worker] HHC [hand hygiene compliance]… but is insufficient to make specific recommendations about the content and how the content should be delivered".

All seven reviews state that both single intervention studies and multimodal studies increase hand hygiene compliance, but of the seven, 4 of the 7 studies, identified multimodal interventions as having a greater impact on hand hygiene compliance than a single intervention. These four studies, Luanagasanatip et al. (2015), Kingston, O'Connell, and Dunne (2015), and Doronina et al. (2017), all conclude that any combination of the WHO-5 and interventions outside the WHO-5, particularly goal setting, reward incentives, and accountability, are all effective to increase hand hygiene compliance.

Agency Description

This study was conducted at a Level 1 academic medical center, in a 12-bed intensive care unit (ICU), consisting of Trauma and Surgical intensive care unit patients. The target population for this study is all registered nurses that worked within the Trauma-Surgical ICU. The purpose and aim of this study directly aligns with the mission and goals of the Level 1 academic medical center, to improve patient outcomes and provide advanced patient care.

Evidence Based Interventions

The interventions for this study were based on the findings of the seven systematic reviews discussed previously, all of which compared single intervention to multimodal intervention methods. All of the reviews acknowledge that both single intervention studies and multimodal studies increase hand hygiene compliance, but only 4 of the 7 articles identified multimodal interventions to have a greater impact on hand hygiene compliance than a single intervention. Of those articles supporting multimodal interventions, Luanagasanatip et al. (2015), Kingston, O'Connell, and Dunne (2015), and Doronina et al. (2017), all conclude that any combination of the WHO-5 and interventions outside the WHO-5, particularly goal setting, reward incentives,

and accountability, are all effective to increase hand hygiene compliance. These findings and results of the systematic reviews helped guide this project.

Purpose

The purpose of this project was to evaluate the effect of multifaceted interventions in a trauma-surgical intensive care unit in a level one trauma center. The specific aims of this project were to:

1. Increase average monthly hand hygiene compliance rate to greater than 92% during the intervention period.
2. Reduce all HAI rates (CAUTI, CLABSIs, CD, MRSA, and VAE) by 25% from pre-intervention period to intervention period.

Project Sample, Measures, and Methods

This study was conducted in a 12-bed Trauma-Surgical intensive care unit, consisting of 36 registered nurses. The staffing model for this ICU calls for 5 to 6 registered nurses to be working at one time. Hand hygiene opportunities are and were recorded under direct observation by the IPAC hand hygiene auditors. These auditors randomly record HHC opportunities throughout the enterprise via the IPAC hand hygiene application on the IPAC tablet.

The primary measure of this study was to examine HHC rates while also examining the impact on secondary measures, HAI rates (CAUTIs, CLABSIs, CD, MRSA, and VAE). Another secondary measure of this study was to evaluate nurse knowledge of proper hand hygiene which was assessed using pre and post intervention survey. The five-question survey was created by the primary investigator, with each question relating to proper hand hygiene technique and the "5 Moments" of patient contact. Also, in the post-intervention survey, nurses were asked to identify barriers to hand hygiene compliance. This ICU was selected based on the fiscal year 2019 HHC

results. Prior to IRB approval, this study was approved by the Division of Infection Prevention and Control.

Project Design and Implementation

By utilizing the evidence from the systematic reviews and the Iowa Model for Implementation, this study was created. During this quasi-experimental retrospective with pre and post survey study, an educational PowerPoint with goal setting was distributed to the nurses, visual cues installed, and performance feedback emailed to the staff.

The pre-intervention survey was distributed to staff during the last week in August 2019. On August 30th, additional signage was placed throughout the ICU and the text message reminder script was distributed. On September 1st, the educational PowerPoint based on the "5 Moments" of patient contact, proper hand hygiene technique, and goal setting for hand hygiene was distributed to ICU staff.

The visual cues cards were placed inside the hand sanitizer window, which served as a reminder to staff to perform hand hygiene. The hand hygiene auditors continued their normal duty of data collection through direct hand hygiene observation and provide direct feedback of hand hygiene to staff. The nurse manager was asked to include HHC results in a monthly email to staff as an additional way of providing direct feedback to staff as well as a way of holding staff accountable. Lastly, once a week messages were sent to the nurses via text message to remind them of the "5 Moments" of hand hygiene.

Statistical Analysis

Descriptive statistics were used to summarize hand hygiene compliance as well as pre-intervention and post-intervention nurse survey items. The two-sample t-test was utilized to examine differences in the pre-intervention and post-intervention survey knowledge scores as

well as the monthly HAI rates. All data analysis was conducted using SPSS, version 25, with an alpha of 0.05.

Results

During the pre-intervention period, the total number of hand hygiene opportunities for the ICU was 78, which decreased during the intervention period to 46 (Table 2). Overall, the average monthly HHC rates for nurses within the ICU decreased from the pre-intervention period of 90% to 88% during the intervention period (Figure 1). Similarly, the average hospital HHC rates also decreased during these times, from 93% to 86%, respectively (Figure 2). The decrease in the average monthly HHC rates for both the hospital and T/S ICU during the intervention period were not statistically significant (Table 3A). Also, the difference between the ICU and hospital average monthly HHC rates during the intervention period were not statistically significant (Table 3B). The HAI rates during the intervention period specifically, CAUTI, CD, MRSA, and CLABSI rates did not improve. There were zero (0) CAUTIs and CD during both pre-intervention and intervention periods. As Table 4 shows, the CLABSI and MRSA rates increased during the intervention period, but both were not statistically significant. Lastly, the rate of VAE decreased from 7.0 in the pre-intervention period to 3.2 during the intervention period, but it too was not statistically significant.

As for the survey results, the pre-intervention survey reached 22% of the staff nurses (8 of 36), whereas the post-intervention survey reached about 31% of the nurses (11 of 36). The surveys consisted of five questions, and average scores for the surveys were 4.8 and 4.7, respectively.

Limitations

There are several limitations of this study that have been identified. One limitation that has been identified of this study is use of text message reminders that were sent to staff during the week.

These reminders were sent at a select time during the weekday and missed the nurses that only work weekends. Text message reminders were limited to one day a week due to concern for alarm fatigue. A second limitation of the study is the survey responses because the surveys were anonymous, we were unable to link the pre and post survey. Similarly, it is unclear who or if any of the nurses reviewed the educational PowerPoint during the study period.

A third limitation of this study was the small sample sizes, whether HHC opportunities, HAI rates, or nurse survey responses. Factors limiting sample size for this study include nurse shortage, patient room closure, auditor shortage, and low pre-intervention and post-intervention survey responses. One issue that unexpectedly created this limitation was a nursing shortage, resulting in patient room closures and nurses from other ICUs to staff the selected unit during the study period. This created an additional limitation of those nurses not being exposed to the educational PowerPoint. In addition to the nursing shortage, in October the number of compliance auditors was reduced from 4 to 1, but in November, a second auditor was hired.

The last limitation identified in this study is information bias due to the data collection of HH compliance using direct observation. Direct observation potentially limits data collection related to HH opportunities of patient contact, possibly missing out due to obstructive views from curtains and equipment. Also, direct observation can create the Hawthorne effect, which may falsely increase compliance. The Hawthorne effect is a behavior change when individuals know they are being observed (Hagel et al., 2015). In summary, healthcare workers know they are being observed so they make sure to perform HH.

Discussion

One intervention to improve HHC that was identified in the four systematic reviews but was not included in this study, was the use of reward incentives. The types of reward incentives used in

previous studies were not easily identifiable and varied greatly, from candy to pizza parties, therefore were not included in this study due to feasibility.

It was expected that HAI rates would improve during the intervention period, with the goal of improving all HAIs by 25%. Both CAUTI and CD rates remained zero during the entire study period. MRSA and CLABSI rates increased during the study period but were not found to be statistically significant. The only HAI rate to improve during the intervention period was VAE rate, which met the goal of improving by 25%, although it was not found to be statistically significant. The reporting and inclusion criteria for HAIs did not change during the study period, therefore did not impact the HAI rates.

The pre-intervention and post-intervention surveys, based on hand hygiene knowledge and the "5 Moments" of hand hygiene, revealed nearly identical results. The average pre-intervention survey result was 4.8 out of 5, whereas the average post-intervention score was 4.7 out of 5. These findings suggest that knowledge or education is not a barrier to HHC, which are similar findings of the systematic review by Gould et. al (2017).

In the post-intervention survey, nurses were asked to identify barriers to HHC, which can be seen in Table 5. As identified in the previous section, the common barriers to HHC that were identified were classified into 3 categories, the two most common being, emergencies and time. Emergencies, especially in the ICU, are the reason the idealistic HHC rate of 100% is not possible or truly expected. Time will continuously be a barrier to HHC due to the urgency and acuity of illness in the ICU. Despite citing time as a barrier to HHC, alcohol-based hand rubs (ABHR) require 20-30 seconds for proper use when entering and exiting a patient room.

Based on the findings of the four systematic reviews and the Iowa Model which guided this project, it was expected that the HHC rates would increase during the study period, but that was

not the case. The average monthly HHC rate decreased from 90% in the pre-intervention period to 88% in the intervention period, which was not statistically significant. Due to the decrease in HHC during the intervention period, the goal of HHC greater than 92% was not met. This decrease in the average monthly HHC rate was largely impacted by the low number of HH observations during the study period, which consisted of 46 observations compared to 78 observations in the pre-intervention period.

The low number of HH observations during the intervention period created skewed data. For example, for the ICU during the intervention period, 3 of the 4 months, the average monthly HHC rate was 100%, but for the month of November the HHC rate was 53%. This outlier month of November decreased the average monthly HHC rate to 88% during the intervention period. Although the HHC during November appears to be a statistical outlier, it may be true representation of HHC. As stated previously, in November, a new HH auditor was hired, which may have removed or decreased the Hawthorne effect from the data collection bias.

Direct HH observation is considered the "Gold Standard" of practice (Kingston, O'Connell, & Dunne, 2015), but due to the Hawthorne effect, should direct observation be considered best practice? In an observational study by Hagel et al., (2015), comparing HHC rates between direct observation and electronic counting system, researchers found that healthcare workers performed 8 HH events when not under observation compared to 21 HHEs per hour when under observation. This illustrates the drastic overestimation and unreliability of HHC when recorded via direct observation as well as the need for further research in interventions to improve HHC.

Future Research for Practice

To improve future research for practice in similar studies, it would be advised to closely monitor access of the educational PowerPoint as well as the pre-intervention and post-intervention

survey. By monitoring access to the PowerPoint and Surveys, one can better estimate the number of staff members that have been reached with the interventions. This study did not have a tracker or counter associated with the PowerPoint therefore it is unknown who, or if anyone reviewed the PowerPoint. Another implication for future practice would be utilizing personalized access for the staff nurses for the pre-intervention and post-intervention surveys. The personalized access allows researchers to track individual results and would allow for pairing of the pre and post survey results.

There are numerous areas of research investigating interventions to improve HHC due to the high risk for infection and ever-growing number of multidrug resistant organisms. One area of research that is growing in popularity is the use of patient or family empowerment to improve provider HHC. For instance, if patient sees a missed opportunity to perform HH, they speak up to remind the provider. In a study by Stewardson et al., (2016), which compared multifaceted interventions and multifaceted interventions in combination with patient participation to remind HCW to perform HH, both intervention groups found an increase in HHC rates, but only by 3% and 4%, respectively. Studies involving patient empowerment are revealing that patients and families are reluctant to speak up and ask providers to perform HH. In fact, in a study by Sande-Meijide et al., (2019), found that of patients surveyed, 76% of patients and families are not willing to ask providers to perform HH for fear of annoying or receiving worse treatment from their providers. Evidence utilizing patient empowerment to increase HHC is poor and has its limitations. For example, one limitation of patient empowerment would be in the ICU setting due to acuity of illness, sedation, and mechanical ventilation ultimately making patient empowerment a poor intervention strategy.

Another area of research that is being investigated is the use of technology and electronic monitoring systems (EMS). The use of technology and EMS of HHC is rapidly growing due to the major flaw of direct observation of HHC. One example of technology to monitor HHC is the use of video monitoring (VM), which allows auditors to observe staff HHC in and out of patient rooms from a distance. By utilizing cameras, auditors are able to watch multiple locations at one time, rather than observing discreetly staff enter and exit patient rooms. In a systematic review by Srigley et al., (2015), researchers found that use of VM resulted in a "sharp and sustained increase" in HHC. Although use of VM increases HHC rates, Srigley et al (2015) state that cost and privacy of staff and patient are major concerns of this technology.

A second form of technology and EMS is the use of staff trackers and sensors to monitor HHC. Many commercial systems exist which utilize sensors near the patient's doorway, patients' bed, and sanitizer dispenser (Boyce et al., (2019), Doll et al., (2019), and Iversen et al, (2019)). Based on sensors and trackers these systems use algorithms to determine if a HH opportunity should take place. In these studies, Boyce et al., (2019) found the average HHC rates to be 28%, Doll et al., (2019), 30%, and Iversen et al., (2019), 44% (Table 6). These various EMS provide the ability to track and monitor HH beyond entering and exiting a patient room, increasing the number of possible HH opportunities and observations.

One feature of some EMS is the ability to provide immediate feedback to staff for opportunities to perform HH. For instance, in the study by Doll et al., (2019), the researchers found that with the EMS that provided immediate feedback (type B), HHC rates were 93%. One limitation and concern that was not addressed in the studies utilizing EMS with immediate feedback systems was the possibility of notification or alarm fatigue.

Technology and EMS have great potential in the ability to increase HHC rates because of the ability to provide immediate feedback and assess HHC where direct observation is limited (Alshehari, Park, & Rashid, 2018). Unfortunately, EMS have many limitations such as the low levels of evidence and research supporting the sustained improvement of HHC rates (Alshehari et al., 2018). Another limitation of EMS, as discussed in an article by McKay, Shaban, and Ferguson (2019), is the feasibility due to cost, citing one study utilizing video monitoring, costing $50,000 for a 17 bed ICU. This expense only covered installation of the cameras and did not cover maintenance or daily monitoring of the system. Due to the limitations discussed, it led Srigley et al., (2019) to conclude that the researchers were unable to recommend adoption of any HH monitoring technology.

One possible area of future research for this Level 1 trauma center is use of video cameras to monitor HH related to the 5-moments of patient contact. This institution in in the process of installing an eICU, which allows for providers to remotely monitor and assess patients. These cameras could also be utilized to monitor bedside HHC. As discussed, previous studies have utilized video cameras for monitoring of HHC, but it was not recommended due to costs. Once the cameras are in place, the monitoring of HHC would not create an increased cost as in previous studies, but it would remove or reduce the Hawthorne effect to accurately depict HHC surrounding patient care.

Conclusion

In conclusion, the purpose of this study was to utilize multifaceted interventions to improve hand hygiene compliance rates within a trauma-surgical ICU at a level 1 trauma center. The interventions consisted of an educational PowerPoint with goal setting, visual cues, text message reminders, and performance feedback. The objectives, to increase HHC to greater than 92% and

decrease all HAI rates by 25%, were both not met during this study. It is recommended that further research be conducted in order to improve hand hygiene compliance. One major area of research that is being investigated in the use of various technologies and EMS to monitor and improve HHC. These systems reduce the incidence of the Hawthorne effect, possibly giving a true representation of HHC rates when not under direct observation. Unfortunately, these systems and technologies are expensive and evidence supporting a cost-benefit analysis of these systems is lacking (Lydon et al., 2017). As Neo et al. (2016) stated, "there is no 1-size-fits-all solution to improve HH", therefore, it is recommended that further research is conducted and tailored to fit the culture of each individual healthcare institution.

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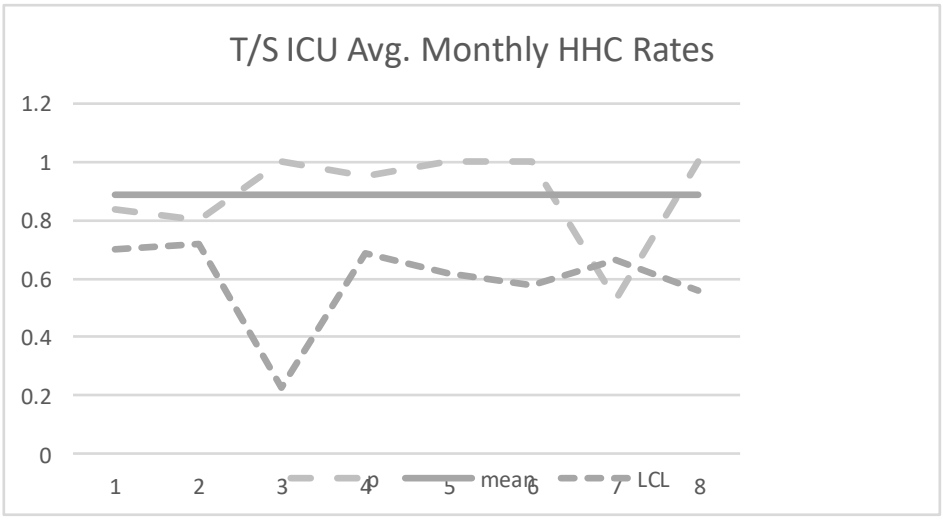
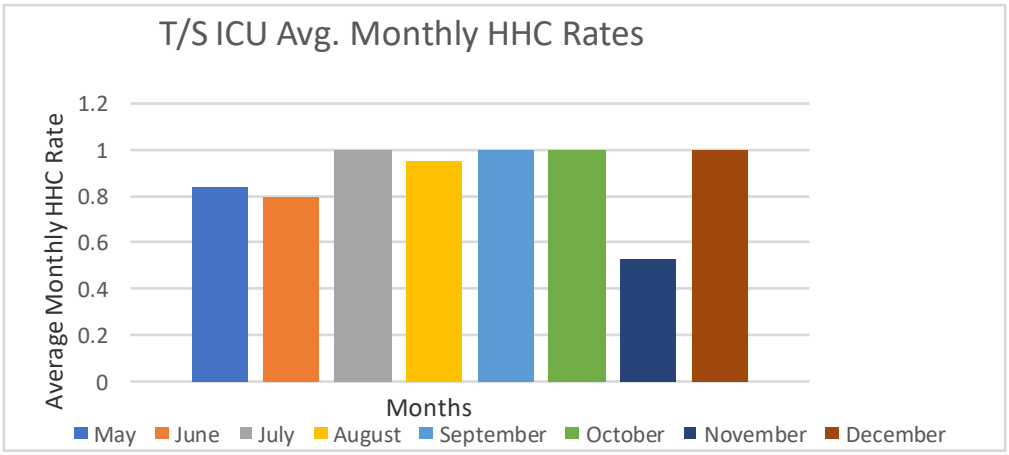
Figure 1: T/S ICU Avg. Monthly HHC Rates

A).



Key: 1- May; 2- June, 3-July; 4- August; 5-September; 6- October; 7- November; 8- December;
*Intervention period began September 1st.

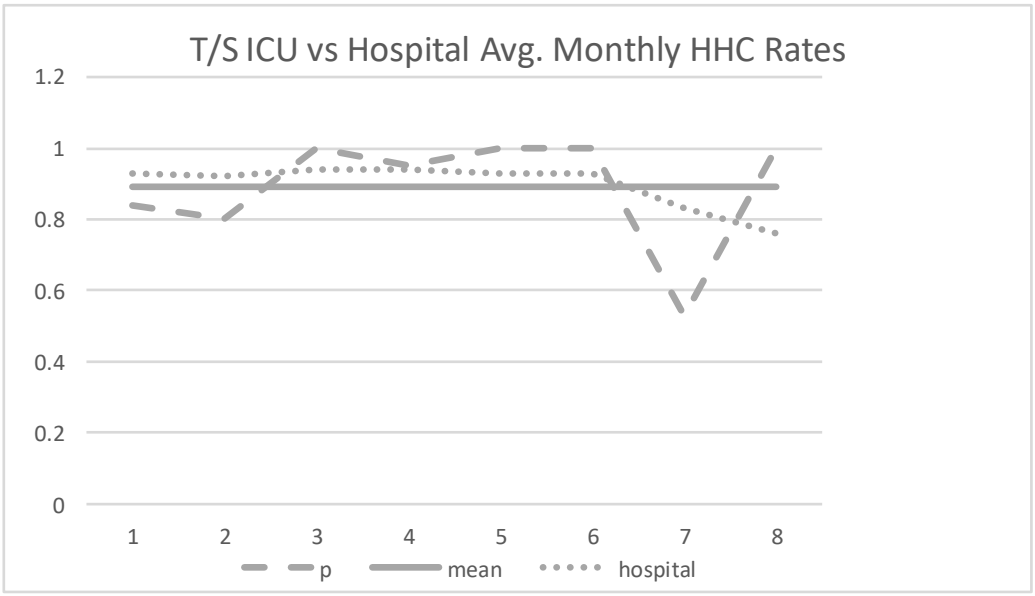
B).



*Intervention period began September 1st.

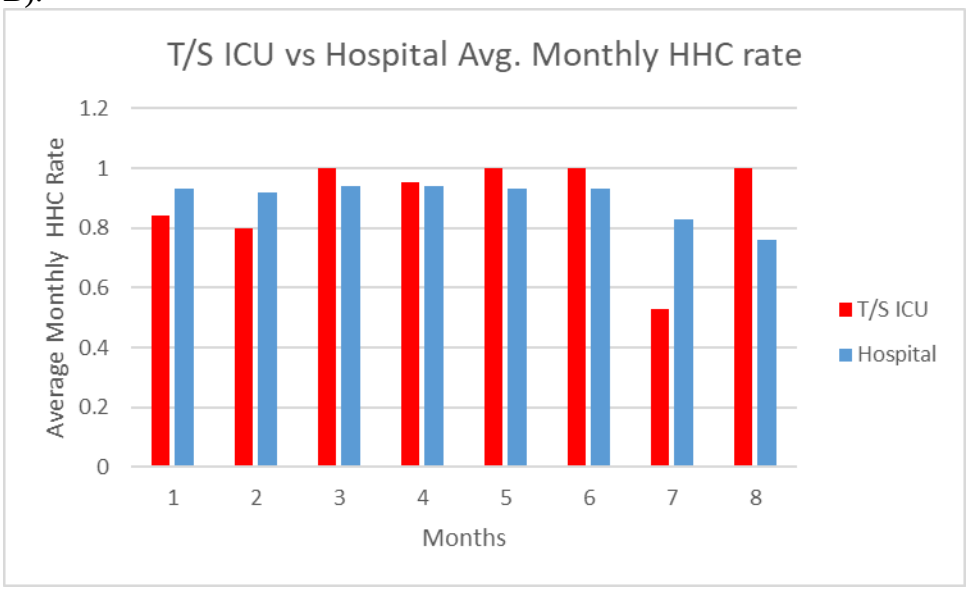
Figure 2: T/S ICU vs. Hospital Average Monthly HHC Rates

A).



Key: 1- May; 2- June, 3-July; 4- August; 5-September; 6- October; 7- November; 8- December
*Intervention period began September 1st.

B).



Key: 1- May; 2- June, 3-July; 4- August; 5-September; 6- October; 7- November; 8- December;
*Intervention period began September 1st.

Table 1: Synthesis Table

Study Author	Year	Study Design	Interventions	Findings
Alshehari, Park, & Rashid,	2018	SR	S & MM	MM > S
Price et al.	2018	SR	S & MM	IC
Doronina, Jones, Martello, Biron, & Lavoie-Tremblay	2017	SR	S & MM	MM > S
Gould, Moralejo, Drey, Chudleigh, & Taljaard	2017	SR	S & MM	IC
Lydon et al.	2017	SR	S & MM	IC
Kingston, O'Connell, & Dunne	2015	SR	S & MM	MM > S
Luanagasanatip et al.	2015	SR	S & MM	MM > S

Legend: >: more effective; Ø: not significant; ↓: decrease; IC: inconclusive; MM: multimodal interventions; MX: mixed results; NR: Not reported; S: single intervention; SR: systematic review;

Table 2: Trauma/Surgical ICU Hand Hygiene Opportunity and Compliance Rate by Month

	Month	Hand Hygiene Opportunities	Hand Hygiene compliance	Percentage
Pre-Intervention Period	May	25	21	84%
	June	30	24	80%
	July	2	2	100%
	August	21	20	95%
		Average Monthly HHC Rate:		**90%**
Intervention Period	September	12	12	100%
	October	9	9	100%
	November	17	9	53%
	December	8	8	100%
		Average Monthly HHC Rate:		**88%**

Table 3: Hand Hygiene Compliance Descriptive Statistics:

A) Avg. Monthly HHC Rates: T/S ICU and Hospital

	Pre-Intervention Period: Mean ± (SD)	**Intervention Period: Mean ± (SD)**	**P value**
T/S ICU	.90 ± .09	.88 ± .24	.91
Hospital	.93 ± .01	.86 ± .04	.19

B) Intervention Period Avg. Monthly HHC Rates: Hospital vs. T/S ICU

	Hospital Avg. Monthly HHC: Mean ± (SD)	**T/S ICU Avg. Monthly HHC: Mean ± (SD)**	**P value**
Intervention Period	.86 ± .04	.88 ± .24	.88

Table 4: HAI rates Pre-Intervention vs. Intervention Period

HAI	Pre-Intervention Period: Mean ± (SD)	Intervention Period: Mean ± (SD)	P value
CLABSI	0	1.8 ± 3.65	.391
MRSA	0	.98 ± 1.95	.391
VAE	7 ± 4.97	3.2 ± 3.67	.266

Table 5: Post Intervention Survey: RN Identified Barriers to Hand Hygiene Compliance

Time	Emergencies	Miscellaneous
Time	Red alarms	N/A
Time	Emergency situations	Inadequate Supplies
Feeling Rushed		Short Staffing
Managing many things at 1 time, constantly having a time crunch.		Going into a patient's room and not expecting to touch the patient or any belongings

Table 6: Studies examining the Use of Electronic Monitoring Systems vs. Direct Observation

Study Author	Year	Study Design	Monitoring Type	HHC rate	
				EMS	D/O
Boyce et al.	2019	Obs	EMS	28%	83%
Doll et al.	2019	Obs	EMS	30%	90%
Iversen et al.	2019	Obs	EMS	44%	N/A

Key: D/O: direct observation; EMS: electronic monitoring system; HHC: hand hygiene compliance; N/A: information not available; obs: observational study.