A TWO-LEVEL APPROACH TO INCREASE HAND HYGIENE COMPLIANCE AMONG HEALTHCARE WORKERS IN A COMMUNITY HOSPITAL

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Epidemiology—Master of Science

2017

ABSTRACT

A TWO-LEVEL APPROACH TO INCREASE HAND HYGIENE COMPLIANCE AMONG HEALTHCARE WORKERS IN A COMMUNITY HOSPITAL

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Hand hygiene is a vital tool in the prevention of nosocomial infections such as central line associated bloodstream infections (CLABSIs) and catheter associated urinary tract infections (CAUTIs). This study implemented a two-level intervention centered on feedback and reminders of the importance of hand hygiene. The objective of this study was to increase hand hygiene compliance of healthcare workers to 70%, and to decrease CLABSI and CAUTI rates among in-patient units within a community hospital. Baseline data was collected from June 2016 to March 2017 and consisted of 1,991 hand hygiene observations. The two-level intervention was implemented over six weeks when 3,438 hand hygiene observations were recorded. After the first five weeks of the original intervention, and additional feedback component added to the sixth week, there was a significant increase in hand hygiene compliance, from an average rate of 53% (November 2016 to March 2017) to 65% after six weeks (p-value < 0.0001). Based on the results of this study, the odds of compliance are 1.17 (95% CI: 1.10-1.25) times higher for every two weeks of additional the intervention time, controlling for healthcare worker type and for hospital unit. There were ultimately too few CLABSI and CAUTI infection cases to analyze. However, the significant increase in hand hygiene compliance in just over a month's time, concomitant with weekly feedback and daily reminders for healthcare workers who are in regular and frequent contact with patients could potentially provide infection prevention units with knowledge to help them reach their infection prevention targets.

ACKNOWLEDGMENTS

This thesis could not have been completed without the guidance from the great minds that are a part of my committee: Drs. Lixin Zhang, David Todem, and Dorothy R. Pathak. Thank you for offering your wisdom through the study design and analysis stages of this thesis. A special thank you to Dr. Todem for providing assistance with the SAS coding. I would also like to thank the professors who taught me in my undergraduate studies and caused my interest in epidemiology to grow into what it is today: Drs. Elizabeth Wasilevich, Julie Wirth, David Barondess, and Dorothy R. Pathak. I am also thankful to the infection prevention team at the hospital that agreed to collaborate with me for this study. Everyone was extremely helpful and I learned life and career lessons that I will never forget. Lastly, I want to thank my family and loved ones for being there for me through this entire journey.

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KEY TO ABBREVIATIONS

CLABSI	Central Line Associated Bloodstream Infection
CAUTI	Catheter Associated Urinary Tract Infection
MRSA	Methicillin-Resistant *Staphylococcus aureus*
SSI	Surgical Site Infection
CDC	Centers for Disease Control and Prevention
NHSN	National Healthcare Safety Network
UTI	Urinary Tract Infection
MDRO	Multi-Drug Resistant Organism
VAP	Ventilator associate Pneumonia
Joint Commission	Joint Commission on Accreditation of Healthcare Organizations
HH Compliance	Hand Hygiene
Medsurg Unit	Medical Surgical Unit

CHAPTER 1: Aims and Objectives

This thesis is an intervention study with an overall goal to increase hand hygiene compliance. Hand hygiene is defined as the act of washing one's hands with soap and water, antiseptic hand wash or using antiseptic hand rub (14). The intervention that is being conducted is defined as weekly feedback of hand hygiene compliance rates on a unit's quality board, and daily reminders of the importance of hand hygiene. This intervention is being conducted to see if a two-level approach, feedback of hand hygiene compliance rates and reminders of its importance, is able to increase hand hygiene compliance. This intervention consists of two aims accompanied by two hypotheses.

Aim 1: To determine the impact on hand hygiene compliance using a two-level intervention focused on hand hygiene feedback and reminders of the importance of hand hygiene.

Hypothesis 1: A two-level intervention focused on hand hygiene compliance feedback and reminders of the importance of hand hygiene, will increase hand hygiene compliance from the 53% average rate of the five months prior to the intervention to 70%.

Aim 2: To see if hand hygiene compliance has an effect on Cather Associated Urinary Tract Infection (CAUTI) and Central Line Associated Bloodstream Infection (CLABSI) rates.

Hypothesis 2: As hand hygiene compliance increases to 70%, a reduction in CAUTI and CLABSI rates will be seen.

CHAPTER 2: Background and Significance

When a patient is admitted to a hospital, it is to receive treatment for a disease, infection or condition, not to become infected. Infections acquired during a patient's hospital stay are called, "nosocomial infections." According to the Center for Disease Control (CDC), "on any given day, 1 in 25 hospital patients have at least one nosocomial infection," (10). Nosocomial infections can be acquired through cross contamination between patients or through invasive procedures that might be used to treat patients. Some nosocomial infections include, but are not limited to, *Clostridium difficile* (*C. difficile*), Methicillin-Resistant *Staphylococcus Aureus* (MRSA), central line associated bloodstream infections (CLABSIs), catheter associated urinary tract infections (CAUTIs), and Surgical Site Infections (SSIs). This study focuses on CLABSIs and CAUTIs due to the cost of a single CLABSI infection and the rate at which CAUTIs occur, being the highest among nosocomial infections. This chapter will go into detail on the infections focused on in this study, and how hand hygiene can affect the nosocomial infection rate.

2.1 Central Line Associated Blood Stream Infections

Central Line Associated Bloodstream Infections (CLABSIs) are the result of bacteria entering the body through a central line placement. A central line is a type of intravascular device used in hospitals. Central lines are inserted into the body through one of the major blood vessels and usually end at, or close to, a patient's heart. Central lines are used for the withdrawal of blood, hemodynamic monitoring, and the infusion of medicine into a patient's body (10). Illustration of a Central Line can be seen in Figure 3 (Appendix B).

In order for a CLABSI to occur, bacteria must be able to attach to the extraluminal or intraluminal surface of a central line. After bacteria attaches to the central line, the bacteria then begin to colonize, and could lead to an infection and potentially hematogenous dissemination (6).

There are multiple opportunities for bacteria to enter the body through a central line system. These opportunities for bacterial contamination present themselves through a varying number of causes: device defects, contamination from outsides sources (i.e. healthcare workers or visitors) or it could be due to the severity of the disease that the patient is being treated for (6). Risks associated with CLABSIs include factors such as the central line insertion point, number of times the central line is drawn from, and central line insertion attempts. There is a common factor among most, if not all, CLABSIs: "Alteration of the patient's skin flora, either as a result of antimicrobial therapy or by colonization with an epidemic strain carried on the hands of hospital personnel," (6). *Staphylococcus aureus* and coagulase-negative staphylococci are bacteria that are mostly associated with CLABSIs (6).

2.1.1 What makes a CLABSI Case a Case?

According to the CDC, a CLABSI becomes a case when there is "a laboratory-confirmed bloodstream infection where the central line was in place for greater than two calendar days on the date of the event." The 'date of event' is the date that a criterion for meeting a laboratory-confirmed bloodstream infection first occurs. The criteria that need to be met consist of two levels 1) patient must have either a fever above 38℃, chills, or hypotension and 2) a blood specimen drawn that is not related to an infection at another site in the patient. The blood specimen must be drawn twice on separate occasions. All criteria must be met within the seven-day infection window period as defined by the National Healthcare Safety Network (NHSN). The infection window period begins on the date of either the first positive blood culture or the first observed sign or symptom of disease and consists of the three days before and the three days after. The central line also still needs to be inserted in the patient the day of the laboratory confirmation, or the day before. The only exception to this rule is if the laboratory confirmation

comes on the same day, or the day after, the central, line was removed (11). In cases where a patient is moved to another facility, and they have an implanted central line, the day that central line is first accessed is considered the first day for CLABSI surveillance. According to the CDC "Access is defined as line placement, insertion of needle into the port, infusion or withdrawal through the line," (11).

In the United States, the NHSN has been keeping track of CLABSI rates in hospitals. Hospitals across the nation have been reporting their CLABSI rates to the CDC since 1970 (6). According to the most recent report from the CDC, 3,655 acute care hospitals were able to report CLABSI data and reported that there were 17,758 infections in 2014 (11). CLABSI rates are sent to the NHSN, by month, as the number of infections over the number of days that a central line has been inserted in a patient; the resulting fraction is then multiplied by 1000 (11).

$$CLABSI\ Rate = \frac{\#\ of\ CLABSI\ infections}{\#\ of\ line\ days}\ x\ 1000$$

2.1.2 CLABSI Prevention

There are guidelines in place to help prevent CLABSI cases. For healthcare workers certain steps are needed to maximize patient safety before and during central line placement 1) perform hand hygiene before central line insertion, 2) use aseptic technique (e.g. wear a mask, cap, gown, sterile gloves, and a sterile full body drape), 3) place the line where it minimizes the risk of infection, and 4) prepare the insertion site with >0.5% chlorhexidine with alcohol, and place a sterile dressing over the line placement site (12).

Maintaining a central line is just as important as the insertion of a central line. The CDC has come up with CLABSI prevention strategies during the maintenance of a central line as well: be sure to perform hand hygiene, bathe ICU patients over two months of age with chlorhexidine on a daily basis, scrub the access port with antiseptic prior to use, use only sterile devices while

accessing lines, immediately replace dirty, wet, or out of normal position dressing, and be sure to routinely change the dressings around the central line using aseptic technique (12). An important step in CLABSI prevention is to remove unnecessary central lines (12).

2.2 Catheter Associated Urinary Tract Infections

Catheter Associated Urinary Tract Infections (CAUTIs) are Urinary Tract Infections (UTIs) that are associated with urinary catheter placement. Urinary catheters (Foley catheters) are devices that are used to watch urine levels during an ill patient's hospital stay or after a patient's surgery. Illustration of a Foley catheter system can be seen in Figure 4 (Appendix B).

The most prevalent risk factor for a CAUTI is the length of time that a catheter is inserted in a patient. The longer a catheter is inserted, the greater the chance for infection (21). CAUTIs make up for 40% of nosocomial infections in hospitals in the United States, and approximately 15-25% of patients have a urinary catheter inserted during their hospital stay (21). According to the CDC, "of all the UTIs acquired in the hospital, approximately 75% are associated with a urinary catheter," (13). Unlike normal UTIs, there are a wide range of pathogens that are associated with CAUTIs and many of them are multi-drug resistant organisms (MDROs). Pathogens that have been commonly associated with CAUTIs are enterococci, gram-negative bacilli, and funguria (21).

2.2.1 What Makes a CAUTI Case a Case?

What makes CAUTIs different from normal UTIs is the placement of the urinary catheter. This urinary catheter disrupts the normal environment of the patient and allows easy access of pathogens into the bladder. Pathogens that gain access to the bladder can come from the patient's own flora, healthcare workers, or other outside objects (20).

UTIs are diagnosed using Symptomatic Urinary Tract Infection criteria, Asymptomatic Bacteremic UTI or Urinary System Infection criteria. The diagnosis of a CAUTI is given to a UTI when three criteria are met during the seven day infection window period: 1) A patient must have either a fever greater than 38℃, suprapubic tenderness with no cause, costovertebral angle pain/tenderness with no cause, or issues with urinary urgency, frequency, or dysuria. Urinary urgency, frequency or dysuria cannot be counted as symptoms when catheter is in place. 2) A urinary catheter must be inserted for more than two calendar days on the date of UTI diagnosis. The catheter also needs to be in place the day of UTI diagnosis or the day before. If the catheter was removed, then the date of UTI diagnosis must be the day of removal, or the day after catheter removal. 3) A patient must also have a urine culture with no more than two species, one of which is a bacterium of $\geq 10^5$ CFU/ml (colony forming units per milliliter) (13).

Hospitals are also required to report monthly CAUTI rates to the NHSN similar to CLABSI rate reporting. CAUTIs are calculated by the number of infections over the number of days that a patient has a Foley catheter inserted; the resulting fraction is then multiplied by 1000 (13).

$$CAUTI\ Rate = \frac{\#\ of\ cauti\ infections}{\#\ of\ foley\ \ days}\ x\ 1000$$

2.2.2 CAUTI Prevention

CAUTI prevention is similar to CLABSI prevention. Guidelines have been implemented, by the CDC, to help minimize the risk of infection during Foley catheter use, insertion, and maintenance. In regards to catheter use, guidelines state that catheters should only be used in the appropriate situations and in place for the necessary amount of time. Foley catheter use should be minimized in all patients as much as possible as to lower the risk for CAUTI. Foley catheters should be avoided in nursing home settings, and used only as necessary in operative patients.

The guidelines also state that if operative patients need a Foley catheter, that it should be removed as soon as possible after their operation. Removal of a urinary catheter within 24 hours is preferred, unless there is a need for the catheter to remain inserted for a longer duration of time (15).

If a Foley catheter needs to be inserted, as with central lines, there are steps that can be taken to help minimize a patient's risk for a CAUTI during insertion. Guidelines for catheter insertion state the following: hand hygiene should be performed before and after the Foley catheter is inserted or handled, only properly trained healthcare workers who are aware of aseptic technique and the use of sterile equipment (i.e. gloves, drapes, sponges, sterile solution for cleaning, and single-packet use of lubricant jelly for insertion) for catheter insertion and maintenance should be handling Foley catheters (15). Healthcare workers should also properly secure Foley catheters to prevent them from moving around, and use the smallest catheter possible to minimize damage to the urethra (15).

Maintenance of Foley catheters is equally as important as the insertion of the Foley catheter. CDC guidelines for maintenance of Foley catheters help to minimize the risk for a CAUTI while maintaining a Foley catheter: follow aseptic technique and keep a closed drainage system, replace the catheter using sterile equipment and aseptic technique if the catheter disconnects or begins to leak, consider using urinary catheters that are already connected and have sealed junctions, be sure to have unobstructed urine flow (no kinks in the tubing), keep the urine collection bag below the bladder and not on the floor, be sure to empty the urine collection bag regularly and use a separate container for each patient, be sure to wear gloves and gowns appropriately during urinary catheter maintenance, only change indwelling urinary catheters if there is an infection, obstruction or if there is an issue with the closed system, do not use routine

antibiotic treatments in patients to prevent a CAUTI unless clinically appropriate, and do not use antiseptics to clean periurethral area to prevent a CAUTI while the catheter is inserted (15).

2.3 Cost of CAUTIs and CLABSIs

CAUTIs and CLABSIs are not just negative outcomes for the patient's health; they are also negative outcomes in terms of cost for the hospital. A meta-analysis looked at the cost, and the increased length of stay due to nosocomial infections (50).

In terms of cost, a CLABSI is the most expensive, per case, nosocomial infection ($45,814) when compared to other common nosocomial infections such as ventilator-associated pneumonia ($40,144), SSIs ($20,785), *C. difficile* infections ($11,285), and CAUTIs ($896) (50). MRSA was added as an additional category under the nosocomial infections, if studies included in the meta-analysis recorded presence of MRSA (50). MRSA was only added as an additional category under CLABSIs and SSIs. When MRSA was present in CLABSIs and SSIs the cost attributed to that infection increased from $45,814 to $58,614 and from $20,785 to $42,300 respectively (50).

According to the most recent report filed by the CDC on the health status of the United States, the average number of days spent in the hospital utilizing inpatient services is 6.1 days (34). According to the meta-analysis, SSIs, ventilator-associated pneumonia, and CLABSIs increase the length of a patient's stay beyond the average number of hospital days: 11.2 days (95% CI: 10.5-11.9), 13.1 days (95% CI: 11.9-14.3), and 10.4 days (95% CI: 6.9-15.2) respectively (50). *C. difficile* infections did not increase the length of stay past the 6.1-day average length of stay. According to the meta-analysis the length of stay recorded for patients with *C. difficile* infections was 3.3 days (95% CI: 2.7-3.8) (50). As for length of stay, in regards

to CAUTIs, there was not enough data recorded in the studies gathered by the meta-analysis to provide length of stay information (50).

2.4 Hand Hygiene

Even with the aforementioned guidelines on prevention of CLABSIs and CAUTIs, during line/Foley placement and management, hospitals continue to look for more interventions in order to cut down on CAUTI and CLABSI rates. An intervention that has been continually worked on is the increase of hand hygiene compliance among healthcare workers. Hand hygiene is a vital tool in stopping the spread of disease, and is the first step in the insertion and management of both central lines and urinary catheters (6, 21). According to the CDC, hand hygiene is defined as the washing of hands using soap and water, antiseptic hand wash, or the use of antiseptic hand rub (14).

An intervention study published in the year 2000, found that increasing the hand hygiene compliance from 47.6% to 66.2% showed a significant decrease in nosocomial infection rates (38). Despite the importance of hand hygiene compliance and display of effect moving from just a low to medium compliance level (38), hand hygiene compliance among healthcare workers continues to be low. According to the Joint Commission, hand hygiene compliance among healthcare workers is below 50% in most hospitals (25).

2.4.1 How Hand Hygiene Compliance is Captured

In most studies, in order to capture hand hygiene compliance, hospitals use covert observers to monitor healthcare workers' hand hygiene compliance. A study done in 2016 reported a 40.7% difference in hand hygiene observations of nurses who were directly observed (85.8% compliance) versus hand hygiene observations of nurses who were covertly observed (45.1% compliance) (27). The differences in covert and direct observations brought to light an

issue that makes hand hygiene observation difficult: the Hawthorne effect. The Hawthorne effect is an idea that a person will behave differently if they are aware that they are being watched.

Another aspect to consider when gathering hand hygiene observations and implementing interventions, is the burden of compliance. The uneven burden of hand hygiene compliance addresses the issue that not all healthcare worker types have equal opportunities for patient interaction that require hand hygiene. A recent study, found a statistically significant difference in hand hygiene opportunities at a patient's bedside, recorded in a seven-day period, for nurses and physicians (4). During the seven-day period of hand hygiene observation, it was found that there were 13,989 hand hygiene observations for nurses compared to the 2,516 observations for physicians (4). This is important information so that hand hygiene interventions can be aimed at healthcare workers that have more patient interaction, and thus have a greater impact on hand hygiene compliance

2.4.2 The Current State of Hand Hygiene Compliance Interventions

Multiple intervention studies have been done trying to increase and sustain hand hygiene compliance. Hand hygiene compliance interventions range from a single intervention to a multi-intervention approach. According to a meta-analysis performed in 2013, 78% of the 45 studies gathered consisted of a multi-level intervention approach (42). Despite the large number of studies that consist of multi-level interventions it seems that interventions that consist of one to two levels are the most effective. It was reported that studies that had between one to two levels of intervention showed the largest increase in hand hygiene compliance with a statistically significant, pooled odds ratio of 3.44 (95% CI: 1.11-10.68) (42). The discovery of a hand hygiene intervention with as few levels as possible is key as to not add too much of a burden to infection prevention teams.

2.5 Significance of this Intervention Study

This intervention falls under the two-level intervention approach that is seen to have the greatest effect on increasing hand hygiene compliance (42). The first level of this study's intervention is the implementation of weekly reporting of hand hygiene compliance for each unit, and the second level of this study's intervention is the reminders of the importance of hand hygiene.

Among the hand hygiene intervention studies from current literature, included in the studies done by Schweizer et al. and Kingston et al., feedback of hand hygiene compliance is included as part of the intervention in 33 of the combined 57 studies (26, 42). In the 33 studies, none of them have weekly feedback, and only a few studies have immediate or continuous feedback as displayed in Table 6 (Appendix A). The observations for the studies with immediate or continuous feedback are not covert observations. The intervention of this current study is significant because the hand hygiene observations are done covertly and are accompanied with weekly feedback.

This study is also significant because the intervention is targeting nurses. According to current literature, nurses hold the majority of hand hygiene observations (4). The intervention in this study is rolled out to all healthcare workers, but nurses get the most reminders of the importance of hand hygiene and of their unit's hand hygiene compliance rate.

CHAPTER 3: Methods

3.1 Study Area

Collaborating with an Infection Prevention team in a community hospital, an intervention was implemented that took aim to increase hand hygiene compliance among healthcare workers. This intervention targeted 12 inpatient medical surgical units and excluded emergency units, intensive care units, critical care units, and maternity wards.

3.2 The Two-Level Hand Hygiene Intervention

The hand hygiene intervention implemented in this study was composed of two parts: weekly posting of hand hygiene compliance and the daily reminder of the importance of hand hygiene.

3.2.1 Weekly Posting of Hand Hygiene Compliance

Healthcare workers in the hospital were notified by the Infection Prevention team that the Infection Prevention team will be monitoring hand hygiene compliance rates, and that the hand hygiene compliance rates will be posted on the unit's quality board. The unit's quality board can be seen by all healthcare workers, but is mainly seen and utilized by the unit's nurses and nurse assistants. The quality board is where all of the unit's goals and statistics are placed, so it is frequently visited by the unit staff. The nursing managers of each unit were also notified that they were responsible for posting the hand hygiene compliance rates on their unit's quality board. The hand hygiene compliance rates for each unit were displayed in graph format that showed two graphs: a graph with their unit's compliance alone (unit graph) and a graph that showed all of the observed units' hand hygiene compliance rates next to each other (unit-wide graph). Each week both graphs would change between two different versions. For weeks one, three, and five, the unit graph would be of the unit's hand hygiene compliance for the previous

week and the unit-wide graph would show all of the observed units' hand hygiene compliance for the previous week (see Figure 5 in Appendix B). For weeks two, four and six, the graphs would be a bi-weekly assessment: the unit graph would show the unit's hand hygiene compliance rate for the past two weeks and the unit-wide graphs would show the observed units' average hand hygiene compliance rate individually for the past two weeks (see Figures 6 and 7 in Appendix B for examples).

The graphs that displayed the unit's hand hygiene compliance were a part of a group of documents that helped nursing managers talk about important topics during daily morning and night shift meetings with their unit's staff. The daily morning and night shift meetings were called 'daily huddles' and the documents that help the nursing mangers were known as huddle helpers; a huddle helper was created to talk about hand hygiene (see Figures 5, 6, and 7 in Appendix B for examples of the huddle helpers).

3.2.2 Daily Reminder of the Importance of Hand Hygiene

The second part of this intervention involves the daily reminders of the hand hygiene compliance rates and the importance of hand hygiene by the nurse managers in the daily huddles. On the hand hygiene huddle helper, they were given talking points to help stress the importance of hand hygiene in stopping the spread of disease. These documents also had talking points for the bi-weekly assessment. If a unit's hand hygiene compliance rate for the previous two weeks was on a decline, the hand hygiene huddle helper continued to stress the importance of hand hygiene compliance, in accordance with current methods at the partnered hospital. The huddle helper reporting a declining hand hygiene compliance rate also stressed that the healthcare workers talk amongst themselves on what the potential barriers are to performing hand hygiene, Figure 8 (Appendix B). If a unit's compliance rate for the previous two weeks was on an

increasing trend, the hand hygiene huddle helper was altered to tell the unit to keep up the good work with the increasing hand hygiene compliance rates. The huddle helper also continued to stress the importance of high hand hygiene compliance, Figure 7 (Appendix B).

3.3 Recording Hand Hygiene Observations

Hand hygiene observations were recorded via stealth observation, the current hand hygiene observation method of the partnered hospital. The partnered hospital used the hand hygiene data collection and observer validation technique that is given out by the Joint Commission on Accreditation of Healthcare Organizations (the Joint Commission). The partnered hospital used volunteer data collectors from different departments in the hospital. Each potential data collector must go through an hour-long hand hygiene observation education seminar. The education seminar taught the volunteers how to be data collectors and taught them what constituted as proper documentation of a hand hygiene observation. After the seminar, the potential data collectors took a sixteen-question test that consisted of different scenarios they might see while out collecting data (Appendix C). The potential data collectors are only allowed to get one question wrong on this test. If the potential data collector passes the test, then he/she is considered an official stealth, hand hygiene data collector and may start collecting hand hygiene observations.

While out collecting data, the data collectors are looking for observations that fall under the partnered hospital's hand hygiene policy. Healthcare workers at the partnered hospital are taught, at new employee orientation, that any time they enter or exit a patient's room they are to follow proper hand hygiene. According to the partnered hospital's policy, proper hand hygiene includes the action of hand washing, antiseptic hand washing, or antiseptic product washing. Entry and exit to a patient's room are counted as two separate hand hygiene opportunities. Hand

hygiene observations were not documented if the data collector was witnessing an emergent or urgent situation, where the patient needed immediate medical attention. The data collectors were also told that if they were uncertain if the healthcare worker did or did not wash their hands, then do not record the observation. Hand hygiene observations were gathered at random times over a 24-hour time period each day of the week during the six-week intervention period.

3.4 Joint Intervention

During the sixth week of the intervention, May 8th to May 12th The partnered hospital instituted "coaches." The coaches were instructed to talk with healthcare workers who were not compliant with hand hygiene, and to remind them to wash their hands upon entry or exit of a patient's room. The coaches were also required to document any reason given by the non-compliant healthcare worker as to why that healthcare worker did not wash their hands.

3.5 Testing Intervention Effect/Statistical Analysis

In order to evaluate the effect of the intervention, a segmented logistic regression model with random effects was used. The cutoff points for the segmented regression were obtained using the results from preliminary analyses that suggested that the rates of hand hygiene compliance over the entire sampling period 1) remained constant between June 2016 and July 2016 (Period 1), between August 2016 to October 2016 (Period 2) and between November 2016 to March 2017 (Period 3); and 2) increased linearly between April 2017 to the second week of May 2017 (Intervention Period). A continuity condition was imposed on the regression parameters to constrain the fitted proportions to be the same on both sides of the month of March (regarded as a knot). Because the rate between November 2016 and March 2017 was constant, the test of the slope of the regression line for the intervention period serves as a test of the intervention effect. Specifically, this was assessed by looking at the interaction term in the

segmented regression model between the constant line fitted for November 2016-March 2017 and April 2017 to the second week of May 2017. The parameter estimate for this interaction term provides an estimate of the linear slope for the intervention. These analyses were adjusted for the effect of the type of healthcare worker, and the unit random effects term. The random effects were imposed to account for the within-unit association, resulting from the same healthcare workers contributing multiple hand hygiene observations pre and during intervention period. All statistical analyses were conducted using SAS 9.4, and statistical significance was established for p-values less than 0.05.

We were unable to evaluate the effect of hand hygiene compliance on CLABSI and CAUTI rates because the number of observed infections during the intervention period (6 weeks) was insufficient to perform a meaningful statistical analysis.

The data collection and intervention methods were approved and determined exempt via the institutional review board at Michigan State University and the partnered hospital.

CHAPTER 4: Results

4.1 Descriptive Characteristics of Baseline and Intervention Data

This section contains hand hygiene compliance distribution information during baseline and intervention time periods.

4.1.1 Baseline Data Characteristics

Pre-intervention data consisted of hand hygiene observations gathered by the partnered hospital between the months of June 2016 and March 2017. Table 1 (Appendix A) and Figure 1 (Appendix B) display the hand hygiene compliance rates, based on 1991 observations, from June 2016 to March 2017. Table 1 (Appendix A) shows, that during the baseline time period, nurses had the majority of hand hygiene observations with 900 observations, followed by nurse assistants with 368 observations, doctors with 356 observations, and finally the 'other' category with 367 observations.

4.1.2 Intervention Data Characteristics

Intervention data consisted of hand hygiene observations that were gathered during April 2017 and the first two weeks of May 2017. Figure 2 (Appendix B) displays the hand hygiene compliance rates of both the baseline and intervention time periods. In Figure 2 (Appendix B) the baseline period is marked with blue diamonds, the original study intervention period is marked with red squares, and the joint intervention is marked with a green triangle.

According to Table 2 (Appendix A), there were 3,438 hand hygiene observations during the intervention time period. During the intervention time period, nurses had the most observations with 1,200 observations, followed by nurse assistants with 614 observations, doctors with 424 observations and finally the 'other' category with 1200 observations.

4.2 Intervention Effect

This section contains the results of the segmented regression model used to test the effect of the intervention.

4.2.1 Trends in Baseline Data

Before a segmented regression could be fitted to the data, preliminary analyses were conducted. An unstructured logistic regression model was fit to the data with the month of march as the reference category adjusting for healthcare worker type, and the hospital units serving as random effects (Table 2, Appendix A). SAS contrast statements were used to test whether there was a temporal (month) effect on the hand hygiene compliance rates, and whether any temporal structural effect could be imposed on these pre-intervention rates. These analyses suggested that three segments could be used to describe the rates of hand hygiene compliance before the intervention. The first segment represents the period June 2016-July 2016, the second segment represents August 2016-October 2016, and the third segment represents November 2016-March 2017. The results of this analysis can be seen in Table 4 (Appendix A). The temporal trend (month effect), tested by contrast of June 2016 - March 2017, was statistically significant at a 5% level (p-value = 0.0181) for the pre-intervention period. The months within the three plateaus, in the baseline data, were not statistically significant from one another: June 2016 - July 2016 (p-value = 0.7388), August 2016 - October 2016 (p-value = 0.7458), and November 2016 - March 2017 (p-value = 0.9782).

4.2.2 Intervention Effect on Hand Hygiene Compliance

The full logistic regression model and SAS contrast statements suggested that the hand hygiene compliance rates were found to be linearly related to the time lag following the initiation of the intervention. The results of the segmented regression model can be seen in Table 5

(Appendix A). Under the segmented regression model the intervention effect is captured through the slope of the regression line for the six week period (Apr 2017 – 2nd week of May 2017) compared to the five months preceding the intervention (Nov 2016 – Mar 2017). The estimate of that slope and the associated standard error are 0.3181 and 0.0657, and a simple t-test showed that the slope was statistically different from zero with a p-value below 0.0001. The odds of hand hygiene compliance will be exp(0.5*0.3181) = 1.17 (95% CI: 1.10-1.25) times higher for every two additional weeks during the intervention, controlling for healthcare worker type and unit as random effects. The estimate of the slope was multiplied by 0.5 since the unit of time in the model for estimating the hand hygiene compliance was one month. The variance measuring the heterogeneity of units on the hand hygiene compliance was estimated to be 0.0956 with a standard error 0.0481 (data not shown in Table 5) (p-value = 0.0117, based on mixture distribution).

CHAPTER 5: Discussion/Conclusion

Based on the results of this study, the hand hygiene compliance was significantly increased over the full six weeks of intervention but did not reach the 70% goal. The two-level intervention did increase hand hygiene compliance from 53% to 59% during the five weeks it was implemented. Once the intervention was combined with the coaches from the paired hospital, hand hygiene compliance significantly increased to 65%. There were ultimately too few CLABSI and CAUTI infection cases to analyze.

Previous literature has stated that observed hand hygiene opportunities are unevenly distributed among healthcare workers (4). This study's observed hand hygiene opportunities were also unevenly distributed among healthcare workers. As presented in Table 1 (Appendix A), in the baseline and intervention data, nurses had the most hand hygiene observations. In the intervention data, the 'other' category had the second highest number of observations, which is different from the baseline data. The difference between the number of observations in the baseline and intervention data (Tables 1 and 2, Appendix A) could be due to the fact that the partnered hospital cast a wider net for healthcare worker types during the intervention time period. The 'other' category, during the intervention time period, contained more healthcare worker types in the intervention data than it did in the baseline data.

When observing the baseline data, there was a dip in hand hygiene compliance percentage between the months of August 2016 and October 2016. After further investigation, it was made known that the partnered hospital had changed observation techniques during the aforementioned time period. Specifically, in the months of June 2016 and July 2016, the Infection Prevention team collected hand hygiene observations themselves. During the August 2016 to October 2016 time frame, the partnered hospital enlisted college volunteers to collect

hand hygiene observations; this action was to alleviate the burden on the Infection Prevention team . The Infection Prevention team believed the observations during this time period (August 2016 to October 2016) to be of low quality, and returned to collecting observations themselves during the months of November 2016 to March 2017. That is why the rate of hand hygiene compliance for this time period was used as a reference for testing the effect of the intervention.

The use of a segmented regression model is one of the strengths of this study. While adjusting for healthcare worker type and for heterogeneity across units, this model demonstrates a statistically significant increasing slope during the intervention period when compared to the five months prior to the intervention. Even though the goal of 70% hand hygiene compliance was not met, the increasing slope shows that it could have been met given a longer time period of intervention and assuming that the rate of hand hygiene compliance increase remained the same for the additional time of intervention.

The data collection process implemented by the partnered hospital is a key to this study's successful gathering of hand hygiene observations, and a perceived strength of this study. The partnered hospital was able to gather over 50 validated hand hygiene observers, who were able to maintain their covert status, and gather observations 24 hours a day. With the amount of hand hygiene observers, this study was able to have a large sample size for the intervention period (N = 3438).

The posting of the units' compliance rate graphs are also a possible key to the increase in hand hygiene compliance. A case could be made that the units seeing compliance rates as a weekly or bi-weekly goal, instead of a monthly goal, could be a reason for the significant increase in the compliance rates. It could be argued that narrowing the window of focus could have made healthcare workers feel like the goal was more attainable. It is also worth noting that

the compliance rate graphs allowed units to see how they compared to other units. The aforementioned comparison could add an element of competition among units to have better hand hygiene compliance rates than other units in the study.

Despite the strengths of this study, there are several limitations. Some of the units that were excluded from this study (i.e. intensive and critical care units) are units that usually hold the bulk of the CAUTI and CLABSI infection numbers for any hospital (4). The intensive care, critical care, emergency department, and maternity ward were excluded during study design due to lack of hand hygiene observers at the partnered hospital. It was not until a several weeks before the study began that the partnered hospital recruited over 50 hand hygiene observers. The exclusion of the intensive and critical care units is a limitation that could be the reason for the lack of CAUTI and CLABSI data. The difficulty of the units to comply with the intervention at the beginning of the study is another limitation. The lack of intervention compliance during the first week of the study could have held back the initial rise in hand hygiene compliance.

Another limitation has to do with the intervention time frame. A five-week time frame, plus the week 6th week of additional feedback added to the original intervention via 'coaching', was insufficient to reach the 70% compliance goal. A short time frame, paired with difficulty of intervention compliance during the first week did not help in reaching the 70% compliance goal. Given the observable trend that can be seen before and after the joint intervention, it is possible that the goal of a 70% compliance rate can be reached given a longer intervention period, and assuming that the estimated increase in hand hygiene compliance per every two additional weeks of intervention will continue. While this study did demonstrate a significant increase in hand hygiene compliance, the question of sustainability deserves further exploration.

The lack of control group is also a potential limitation as it may render uncertain whether a true effect is being seen. However, despite the lack of a control group, it is highly likely that the observed increase in hand hygiene compliance is due to the intervention for two reasons. First, there were no other interventions running concurrently until the second week of May 2017. Second, based on the segmented regression model, the increase in compliance during the intervention period was statistically significant compared to the five months prior to the intervention.

Hand hygiene compliance is, and will continue to be, a pressing topic in hospital environments. The two-level intervention implemented in this study seems to be effective, but needs to be tested in all units over a longer period of time. This will allow the sustainability of the intervention to be tested.

APPENDICES

APPENDIX A

Tables

Hand Hygiene Compliance Rates		
Month	**Compliance**	
Jun 2016	57%	
Jul 2016	57%	
Aug 2016	44%	
Sep 2016	44%	
Oct 2016	45%	
Nov 2016	55%	
Dec 2016	57%	
Jan 2017	54%	
Feb 2017	53%	
Mar 2017	48%	
HCW Distribution		
HCW Type	**Compliant**	**Observations**
Doctor	201	356
Nurse	469	900
Nurse Asst.	150	368
Other	177	367
Total	997	1991

Table 1: Hand Hygiene Compliance and HCW Distribution for Baseline (June 2016 - March 2017). Monthly hand hygiene compliance and distribution of healthcare workers (HCW) during baseline period (June 2016 – March 2017).

Hand Hygiene Compliance Rates		
Month	**Compliance**	
Apr 2017	54%	
May 1-7, 2017	59%	
May 8 - 12, 2017	65%	
HCW Distribution		
HCW Type	**Compliant**	**Observations**
Doctor	260	424
Nurse	722	1200
Nurse Asst.	271	614
Other	722	1200
Total	1975	3438

Table 2: Hand Hygiene and HCW Distribution for Study Intervention (Apr 2017 - May 7, 2017) and Joint Intervention (May 8, 2017 - May 12, 2017). Monthly hand hygiene compliance and distribution of healthcare workers (HCW) during study intervention period (Apr 2017 – May 7, 2017) and joint intervention period (May 8, 2017 – May 12, 2017).

Effect	Month	HCW Type	Estimate	Standard Error	DF	t Value	p-value
Intercept			0.1151	0.1293	11	0.89	0.3924
Month	Jun2016		0.279	0.1918	724	1.46	0.1461
Month	Jul 2016		0.364	0.2047	724	1.78	0.0758
Month	Aug 2016		-0.2229	0.1815	724	-1.23	0.2198
Month	Sep 2016		-0.2871	0.1873	724	-1.53	0.1257
Month	Oct 2016		-0.1257	0.1594	724	-0.79	0.4306
Month	Nov 2016		0.2704	0.1931	724	1.4	0.1619
Month	Dec 216		0.2852	0.2103	724	1.36	0.1756
Month	Jan 2017		0.2234	0.1983	724	1.13	0.2603
Month	Feb 2017		0.1716	0.1729	724	0.99	0.3214
Month	Apr 2017		0.1913	0.09251	724	2.07	0.039
Month	May 2017a		0.4077	0.1176	724	3.47	0.0006
Month	May 2017b		0.6987	0.1358	724	5.14	<0.0001
Month	Mar 2017		0	.	.	.	.
HCW Type		Doctor	0.03257	0.08389	724	0.39	0.6979
HCW Type		Other	-0.2431	0.07248	724	-3.35	0.0008
HCW Type		PCT	-0.5788	0.07756	724	-7.46	<0.0001
HCW Type		Nurse	0	.	.	.	.

Table 3: Hand Hygiene Compliance and Unstructured Model Results. Hand hygiene compliance and full logistic regression model: hand hygiene compliance = month + HCW type + Unit (random effects). P-values are significant at a value <0.05. SAS contrast statements were used to see if there was a temporal (month) effect on the baseline data. HCW=healthcare worker

Month	DF	DF	F Value	p-value
Jun 2016-Jul 2016	1	724	0.11	0.7388
Aug 2016 - Oct 2016	2	724	0.29	0.7458
Nov 2016 - Mar 2017	4	724	0.11	0.9782
Jun 2016 - Mar 2017	9	724	2.24	0.0181

Table 4: SAS Contrasts. SAS Contrasts used to see if there was a temporal (month) effect on baseline data within full logistic regression model: hand hygiene compliance = month + HCW type + Unit (random effects). P-values are significant at a value <0.05.

Effect	HCW Type	Estimate	Standard Error	DF	t Value	p-value
Intercept		0.4007	0.1606	11	2.5	0.0298
Aug 2016 - Oct 2016		-0.5199	0.1541	61 7	-3.37	0.0008
Nov 2016 - May 2017b		-0.2302	0.1399	61 7	-1.65	0.1004
Nov 2016-Mar 2017*Apr 2017- May 2017b (Linear Time Effect)		0.3181	0.0657	61 7	4.84	<.0001
Jun 2016 – Jul 2016		0	.	.	.	.
HCW Type	Doctor	0.06093	0.1072	61 7	0.57	0.5699
HCW Type	Other	-0.1483	0.102	61 7	-1.45	0.1465
HCW Type	PCT	-0.4915	0.1035	61 7	-4.75	<0.0001
HCW Type	Nurse	0	.	.	.	.

Table 5: Hand Hygiene Compliance and Reduced Model. Results of segmented regression model adjusting for healthcare workers and unit with a continuity condition imposed on the regression parameters to constrain the fitted proportions to be the same on both sides of the month of March (regarded as a knot). P-values are significant at <0.05. Jun 2016- Jul 2016 is reference category. HCW= healthcare worker.

Publication	Feedback	Frequency of Feedback
Huis et al. 2013	bar charts of hand hygiene rates sent to ward manager	Twice over 6 months
van den Hoogen et al. 2011*	feedback after missed hand hygiene opportunity	Immediate
Martin-Madrazo et al. 2012	compliance rate for each health care worker	after 6 month study period
Henderson et al. 2012	compliance rate by job type	quarterly
Linam et al. 2011*	after missed hand hygiene opportunity. Bottle of alcohol based hand rub carried with them.	immediate
Marra et al. 2010	Health care workers had access to view and review observations recorded	Unknown how many times feedback was reviewed.
Ho et al. 2012	was not included in orginal design. Added due to dropping compliance rate	Unknown
Pittet et al. 2000	performance feedback in hospital newsletter	March and September every year for 4 years
Hugonnet et al. 2002	performance feedback in hospital newsletter	2 months after each of the 7 biannual surveys for 4 years
Aboumatar et al. 2012*	HH dashboard all HCWs could access; reports sent to institution leaders and mid-level managers. Reward for highest unit compliance	HCWs had unlimited access to dashboard (frequency of use not measured); reports sent to managers on biweekly basis
Helder et al. 2010	On completeness of hand washing technique not compliance rate. Used flourescent hand rub solution	N/A
Bedat et al. 2010	HH compliance rates given during education sessions	every two weeks for a month.
Bischoff et al. 2000	HH compliance feedback with education sessions	6 times over the span of 6 months
Brown et al. 2003	feedback not on HH compliance but on noscomial colonization in the unit.	reports sent out biweekly. HH compliance was shown once and then was decided against.
Grayson et al. 2011	created audit system	did not specify if HCWs had access or how often compliance rates were reported.
Trick et al. 2007	performance detailed in handout/discussed with HCWs	Annual education meeting for 3 years.
van de Mortel et al. 2000	bar charts displaying performance placed above sinks.	2 weeks after baseline prevalence gathered, 6 months and 12 months after start of study as well.
Mathai et al. 2011*	feedback after missed hand hygiene opportunity	immediate
Mertz et al. 2010*	HH compliance rates shown on whiteboard both graphically and numerically. Meetings with HCWs held biweekly for unit-specific feedback	every two weeks for a year?
Monistrol et al. 2012	performance feedback mailed to ward nurse managers	after each of the 2 observations periods
Pessoa-Silva et al. 2007	performance feed back during follow up period after interventions	months 28, 32 and 36 of 36 month study
Picheansathian et al. 2008	perfmance feedback	frequency not specifically reported
Rosenthal et al. 2003	bar charts of HH rates were displayed at meetings	Monthly from July 1998 to July 2002
Rosenthal et al. 2005	feedback on Hand hygiene compliance rates through graphic presentations at meetings and posted in ICUs	monthly posting
Scheithauer et al. 2012*	feedback on HH compliance after noncompliant	immediate
Sharek et al. 2002	compliance data displayed	frequency not specified
Swoboda et al. 2007*	voice prompt reminders if noncompliant	immediate
Allegranzi et al. 2010	HH performance feedback	frequency not specified
Tromp et al. 2012	Performance feedback	at baseline and at post intervention
Harbarth et al. 2002	graphs of HH compliance rates	8 week intervals
Zerr et al. 2005	HCWs received educational material including data on hospital-wide HH compliance	frequency not specified
Armellino et al. 2012*	feedback displayed on electronic boards mounted in hallways and sumary reports delivered to unit supervisors via email	immediate and continuous feedback (door chimed everytime HCW entered/exited)

Table 6: List of Studies that Include Feedback of HH Performance and Frequency of Feedback. List of Hand Hygiene studies from Schweizer et al. 2014 and Kingston et al 2016 that included feedback of hand hygiene performance. Studies with an '*' have an immediate or continuous feedback frequency with HCWs being directly observed

APPENDIX B

Figures

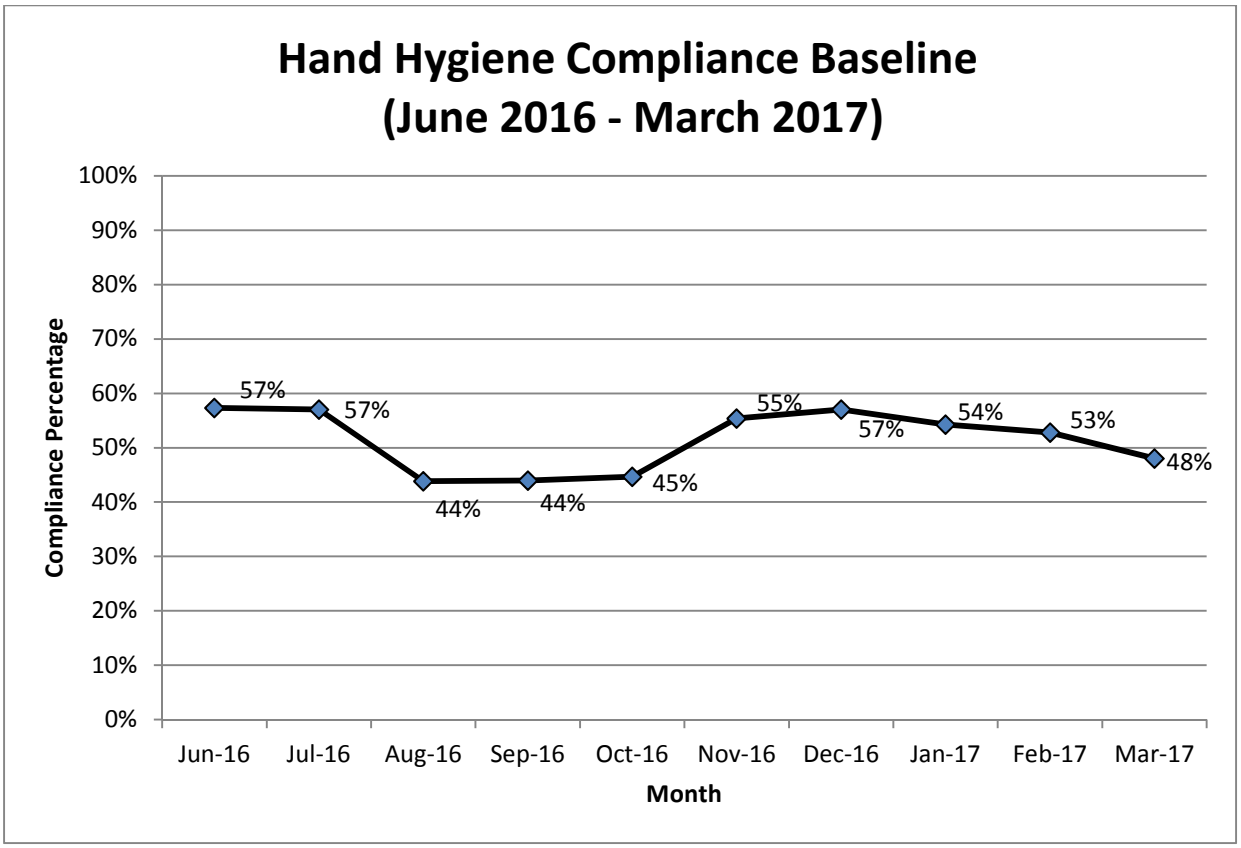


Figure 1: Hand Hygiene Compliance Baseline (June 2016 - March 2017). Hand hygiene compliance rates of 12 in-patient units during baseline period (June 2016 - March 2017)

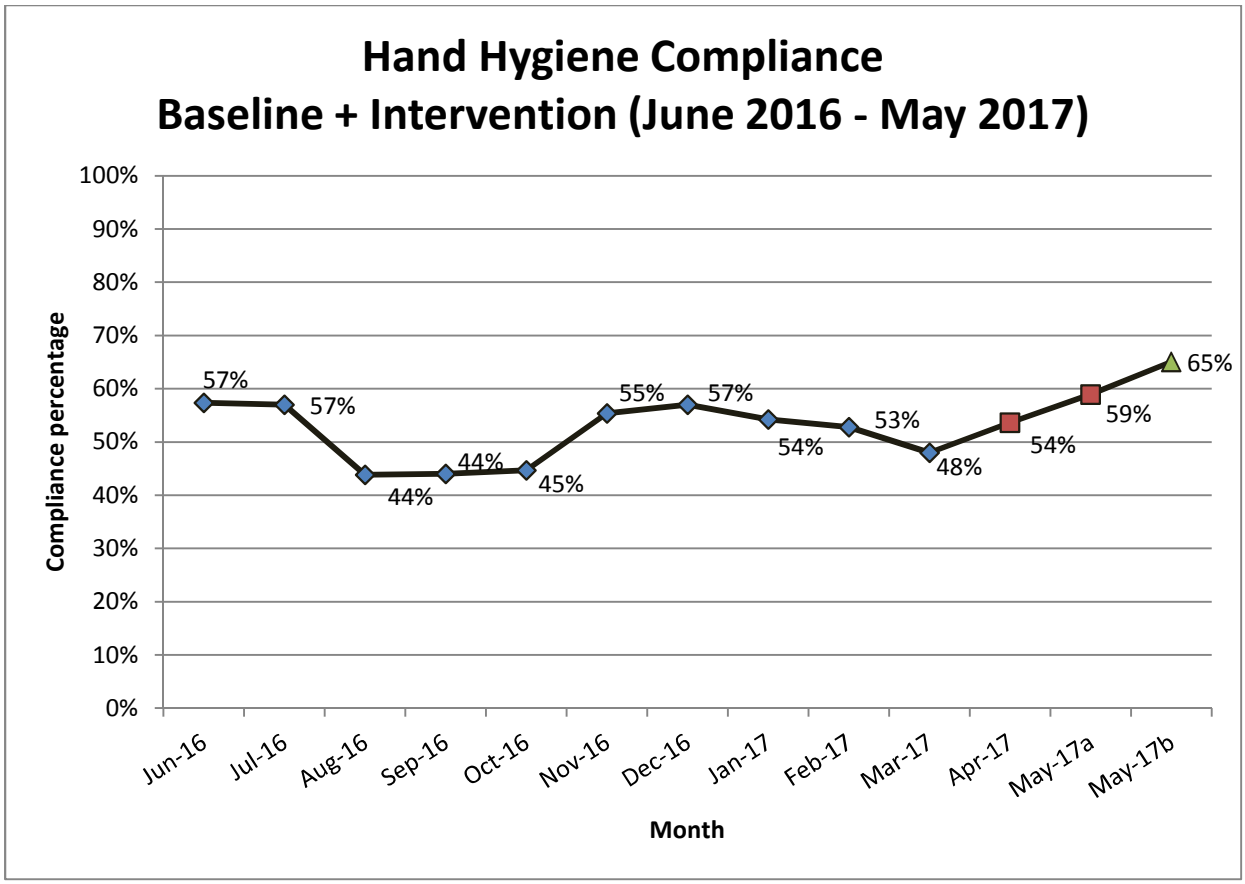


Figure 2: Hand Hygiene Compliance Baseline + Intervention (June 2016 - May 2017). Hand hygiene compliance for baseline and intervention time periods for full model. Blue diamonds = baseline period; red squares = two-level intervention; green triangle = joint intervention with partnered hospital. May 17a = May 1 – 7, 2017; May 17b = May 8- May 12, 2017.

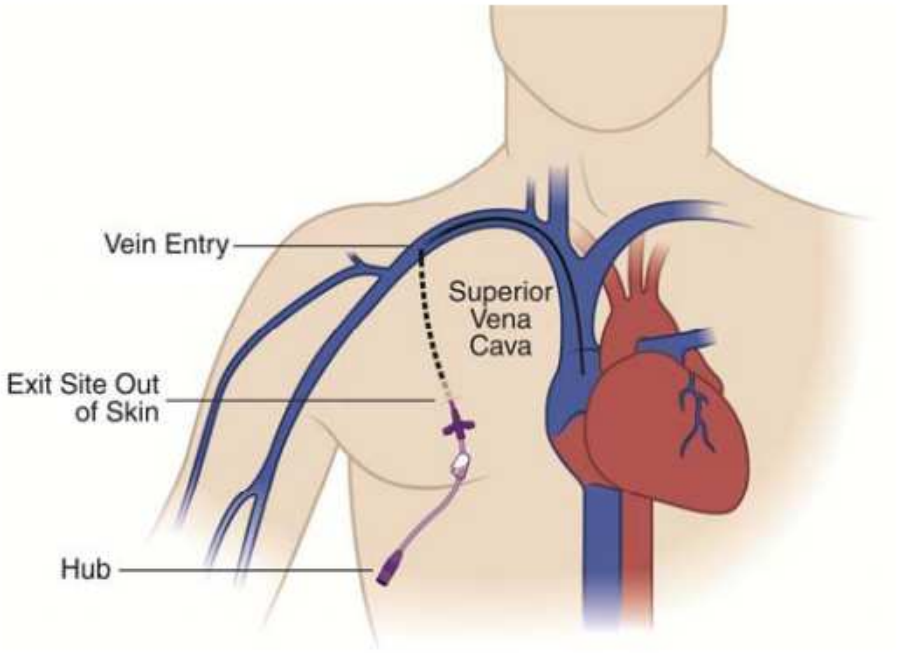


Figure 3: Central Line Insertion Site. Illustration of central line insertion site. Source: *Pictures of Central Venous Catheters*. Digital image. *The Joint Commission*. The Joint Commission. Web. <https://www.jointcommission.org/assets/1/6/CLABSI_Toolkit_Tool_13_Pictures_of_Central_Venous_Catheters_F.pdf>.

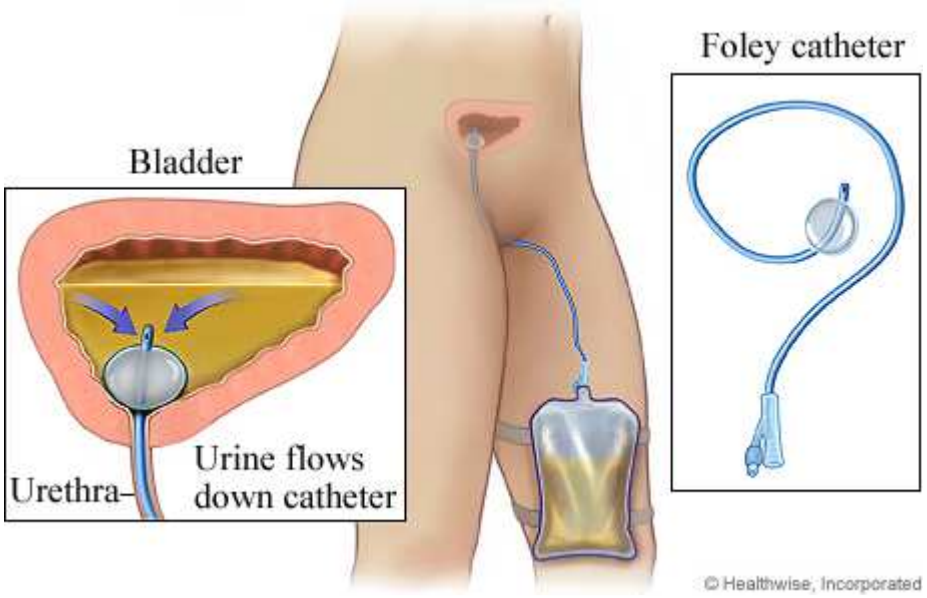


Figure 4: Indwelling Urinary Catheter System. Illustration of indwelling urinary catheter system. Source: *Indwelling Foley Catheter for Women*. Digital image. *Metro Health University of Michigan Health*. Metro Health University of Michigan Health, Web. <https://metrohealth.net/healthwise/indwelling-foley-catheter-for-women/>.

Wash In! Wash Out!
Hand Hygiene Compliance

Here is what you need to know:

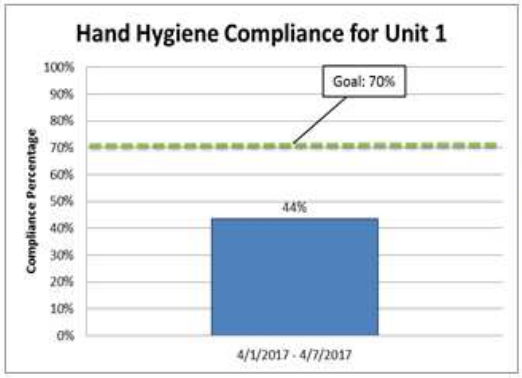
- Below is your unit's and the entire Hospital's Hand Hygiene compliance rate for the past week
- Your compliance for 4/1/2017 – 4/7/2017 is 44%

Why is it important?

- We are tracking each unit's hand hygiene compliance to reach our goal of 70% compliance or higher (target goal is green dotted line).
- High hand hygiene compliance and zero HAIs will help fulfill Hospital's mission to improve the health of the people in our communities.
- We want to provide a safe environment for Patients and Caregivers.

What do we need from you?

- Remind Caregivers to wash in and wash out every time!
- Discuss your weekly compliance with your Caregivers in daily huddle meetings.
- Post the compliance graph for your Caregivers so they can see their progress!



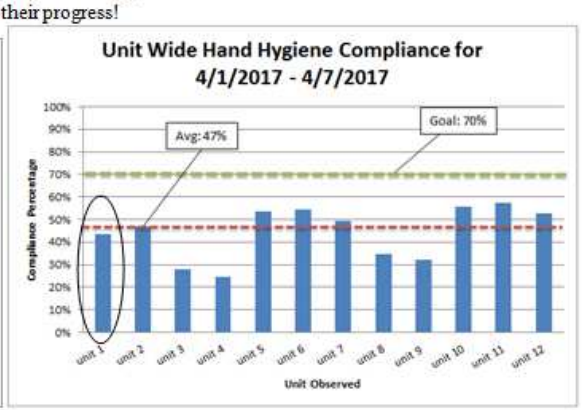


Figure 5: Weekly Hand Hygiene Huddle Helper. Example of weekly hand hygiene huddle helper that was distributed to units every other week.

Wash In! Wash Out!
Hand Hygiene Compliance

Here is what you need to know:

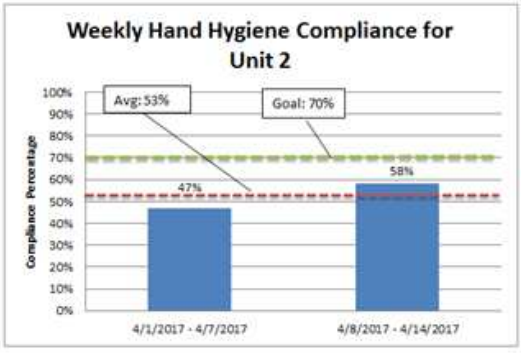
- Below is your unit's and the Hospitals Hand Hygiene compliance rate for the past 2 weeks
- Your unit's compliance is increasing!
- Your average unit compliance for 4/1/2017 – 4/14/2017 is 53%

Why is it important?

- We are tracking each unit's hand hygiene compliance to reach our goal of 70% compliance or higher (target goal is green dotted line).
- High hand hygiene compliance and zero HAIs will help fulfill the hospital's mission to improve the health of the people in our communities.
- We want to provide a safe environment for Patients and Caregivers.

What do we need from you?

- Keep up the good work!
- Discuss your weekly compliance with your Caregivers in daily huddle meetings.
- Post the compliance graph for your Caregivers to see.



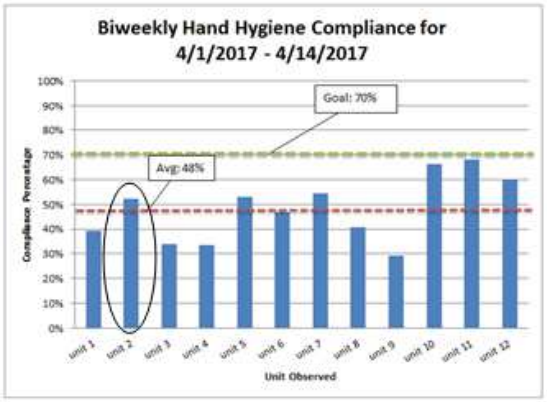


Figure 6: Positive Bi-weekly Huddle Helper. Example of positive biweekly assessment huddle helper that was distributed to units that had increased hand hygiene compliance after 2 weeks.

Wash In! Wash Out!
Hand Hygiene Compliance

Here is what you need to know:

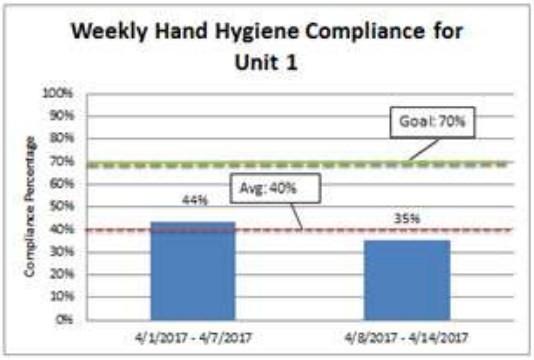
- Below is your unit's Hand Hygiene compliance rate for the past 2 weeks
- Your unit's compliance is **decreasing**
- Your average unit compliance for 4/8/2017 – 4/14/2017 is 40%

Why is it important?

- We are tracking each unit's hand hygiene compliance to reach our goal of 70% compliance or higher (target goal is green dotted line).
- High hand hygiene compliance and zero HAIs will help fulfill the hospital's mission to improve the health of the people in our communities.
- We want to provide a safe environment for Patients and Caregivers.

What do we need from you?

- Remind your Caregivers of the importance of Hand Hygiene!
- Discuss your weekly compliance with your Caregivers in daily huddle meetings.
- Post the compliance graph for your Caregivers to see.
- Talk with your Caregivers about overcoming potential barriers to performing hand hygiene.



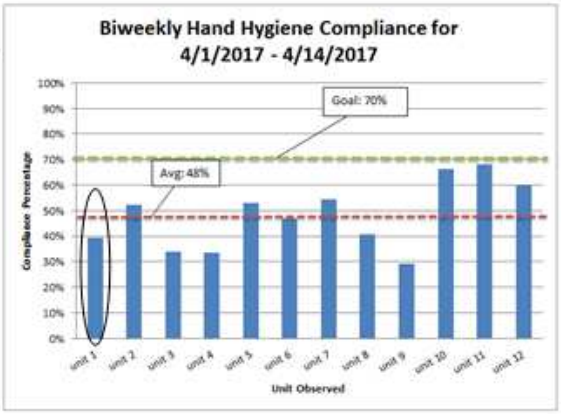


Figure 7: Negative Bi-weekly Huddle Helper. Example of negative biweekly assessment huddle helper that was distributed to units that had decreased hand hygiene compliance after 2 weeks.

APPENDIX C

Hand Hygiene Observer Test

Competency test for observers _____
Name _____ Date _____

Review the scenarios below and record them on a hand hygiene data collection form just as you would if you were watching the situation on a nursing unit. Do not read into the situation; what is written is all you are able to observe.

1. A physician cleans her hands with hand sanitizer and heads toward a patient room. Her cell phone rings and she answers, looks up something on the computer, and then enters the patient room 10 minutes later.
a. Wash on entry
b. Wash on exit
c. No wash on entry
d. No wash on exit
e. Unable to determine

2. A nurse enters a patient room and begins talking with a patient as she heads to the sink to wash her hands. After drying her hands, she takes the patient's blood pressure.
a. Wash on entry
b. Wash on exit
c. No wash on entry
d. No wash on exit
e. Unable to determine

3. A nursing assistant walks out of a patient room rubbing his hands together and shaking them dry.
a. Wash on entry
b. Wash on exit
c. No wash on entry
d. No wash on exit
e. Would not monitor in an emergency situation

4. A physician enters a patient room holding coffee and a chart, bypassing the hand sanitizer dispenser.
a. Wash on entry
b. Wash on exit
c. No wash on entry
d. No wash on exit
e. Unable to determine

5. A phlebotomist arrives at a patient's room. The phlebotomist puts on gloves and enters the patient's room to draw a blood sample.
a. Wash on entry
b. Wash on exit
c. No wash on entry
d. No wash on exit
e. Unable to determine

6. A staff member from Food and Nutrition applies hand sanitizer to his hands, enters the patient's room to deliver a tray, then applies hand sanitizer again on his way out of the room.
a. Wash on entry and exit
b. No wash on entry or exit
c. No wash on entry but wash on exit
d. Wash on entry but no wash on exit
e. Unable to determine

7. A nurse prepares to enter an isolation room by putting on a gown and gloves. She then enters the patient room.
a. Wash on entry
b. Wash on exit
c. No wash on entry
d. No wash on exit
e. Unable to determine

8. An nurse applies hand sanitizer before entering a patient room. She then enters the patient room and turn off the IV alarm. She realizes that she forgot a pair of gloves she will need to assess the patient's wound. She exits the patient room, grabs gloves, and re-enters the room to perform patient care.
a. Wash on entry, wash on entry (re-entry), and wash on exit
b. Wash on entry, no wash on exit, and no wash on entry
c. No wash on entry, no wash on exit, and no wash on entry
d. No wash on entry, no wash on exit, and wash on entry
e. Unable to determine

9. A code blue is called. Three health care workers run into the patient room without washing their hands to stabilize the patient.
a. Wash on entry
b. Wash on exit
c. No wash on entry
d. No wash on exit
e. Would not monitor in an emergency situation

10. A physical therapist enters a patient room without washing her hands. She asks the patient several questions while resting her hands on the bedrail. She exits the room without washing her hands.
a. Wash on entry and exit
b. No wash on entry or exit
c. No wash on entry but wash on exit
d. Wash on entry but no wash on exit
e. Unable to determine

11. A physician and a fellow use the hand sanitizer dispenser at the nurse's station. They both go directly into a patient's room.
a. Wash on entry
b. Wash on exit
c. No wash on entry

d. No wash on exit
e. Unable to determine

12. A housekeeper uses the hand sanitizer dispenser, puts on gloves, then enters a patient room to begin daily cleaning.
a. Wash on entry
b. Wash on exit
c. No wash on entry
d. No wash on exit
e. Unable to determine

13. A phlebotomist arrives on the unit already wearing gloves. She enters a patient room to draw a blood sample.
a. Wash on entry
b. Wash on exit
c. No wash on entry
d. No wash on exit
e. Unable to determine

14. During physician patient rounds, the attending physician applies hand sanitizer when leaving the patient room then immediately enters the next patient room while continuing to rub hand sanitizer into her skin.
a. Wash on entry and exit
b. No wash on entry or exit
c. No wash on entry but wash on exit
d. Wash on entry but no wash on exit
e. Unable to determine

15. A nurse runs into a patient room as the patient begins falling from his bed.
a. Wash on entry
b. Wash on exit
c. No wash on entry
d. No wash on exit
e. Would not monitor in an emergency situation

16. A dietary tech picks up a tray, enters a patient room, places the tray on the patient's table, leaves the room and picks up another tray. The dietary tech is not wearing gloves per the hospital's infection control policy.
a. Wash on entry but no wash on exit
b. Wash on exit
c. No wash on entry or exit
d. Would not monitor because dietary are not considered health care workers needing to wash
e. Would not monitor in an emergency situation

Courtesy of Cedars-Sinai Health System and The Johns Hopkins Hospital and Health System

APPENDIX D

IRB Approval Letter

MICHIGAN STATE
UNIVERSITY

Initial IRB Application Determination *Exempt*

July 7, 2017

To: Lixin Zhang
909 Fee Road, Rm637

Re: **IRB# x17-161e** Category: Exempt 1
Approval Date: March 6, 2017

Title: A TWO-LEVEL APPROACH TO INCREASE HAND HYGIENE COMPLIANCE AMONG HEALTHCARE WORKERS IN A COMMUNITY HOSPITAL

The Institutional Review Board has completed their review of your project. I am pleased to advise you that **your project has been deemed as exempt** in accordance with federal regulations.

This letter was reissued on 7/7/2017 to reflect the change in the project's title.

The IRB has found that your research project meets the criteria for exempt status and the criteria for the protection of human subjects in exempt research. **Under our exempt policy the Principal Investigator assumes the responsibilities for the protection of human subjects** in this project as outlined in the assurance letter and exempt educational material. The IRB office has received your signed assurance for exempt research. A copy of this signed agreement is appended for your information and records.

Renewals: Exempt protocols do not need to be renewed. If the project is completed, please submit an *Application for Permanent Closure*.

Revisions: Exempt protocols do not require revisions. However, if changes are made to a protocol that may no longer meet the exempt criteria, a new initial application will be required. If the project is modified to add additional sites for the research, please note that you may not begin your research at those sites until you receive the appropriate approvals/permissions from the sites.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects and change the category of review, notify the IRB office promptly. Any complaints from participants regarding the risk and benefits of the project must be reported to the IRB.

Follow-up: If your exempt project is not completed and closed after three years, the IRB office will contact you regarding the status of the project and to verify that no changes have occurred that may affect exempt status.

Please use the IRB number listed above on any forms submitted which relate to this project, or on any correspondence with the IRB office.

If we can be of further assistance, please contact us at 517-355-2180 or via email at IRB@msu.edu. Thank you for your cooperation.

c: Jay Liggins, David Todem, Dorothy Pathak

Office of Regulatory Affairs
Human Research Protection Programs

Biomedical & Health Institutional Review Board (BIRB)

Community Research Institutional Review Board (CRIRB)

Social Science Behavioral/Education Institutional Review Board (SIRB)

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