OBSERVING THE EFFECTS OF AN EDUCATIONAL INTERVENTION ON MRSA SCREENING COMPLIANCE IN AN ACUTE HEALTHCARE FACILITY

by

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ABSTRACT

BACKGROUND: Healthcare-associated infections, particularly methicillin-resistant *Staphylococcus aureus* (MRSA), have been an on-going public health problem for several years. Cases of MRSA are often missed due to non-compliance with MRSA screening procedures, which has been attributed to many factors. However, one of the most influential factors is a lack of knowledge regarding screening. Therefore, it is important to consider the benefits of providing education to physicians regarding MRSA screening. **METHODS**: A total of 34 primary care physicians (PCPs) at Western Psychiatric Institute and Clinic in Pittsburgh, PA were identified as the PCPs mainly responsible for swabbing incoming patients for MRSA. An intervention was developed that highlighted the appropriate swabbing procedure and MRSA surveillance measures, as well as a form of acknowledgement that the PCPs were required to sign and return to confirm that they participated. Baseline data of patients' swab status was collected for one month before the intervention. Following the intervention, swab status data was collected for one and a half months. **RESULTS**: Of the 34 PCPs that were contacted for the study, 18 returned the form of acknowledgement. In order to determine if the intervention was effective, compliance rates were calculated for each month. The baseline compliance rate was 66.67%. After the intervention, the first month's data yielded a compliance rate of 74.07%, and the remaining half month of data yielded a compliance rate of 80%. **CONCLUSION**: An educational intervention regarding MRSA screening had a significant impact on screening compliance. This suggests that with regular interventions, compliance could continue to improve and in the future, regular educational

interventions should be considered in healthcare settings in order to promote screening compliance.

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1.0 INTRODUCTION

Healthcare-associated infections (HAIs) have been an on-going problem in healthcare facilities across the United States and only in recent years have incidences of HAIs begun to decrease (Mera et al., 2011). Despite this decline, there are still problems maintaining compliance with appropriate infection prevention measures which results in issues with fully controlling HAIs. While numbers of HAIs are declining, the fact that HAIs still occur in these facilities is concerning due to the fact that many of them admit high-risk patients, such as the elderly or immunocompromised. Some facilities have measures in place for controlling these infections but do not adequately follow them, which can have life-threatening consequences.

Despite Pennsylvania Act 52 being enacted, a law which requires MRSA screening, low compliance with performing the methicillin-resistant *Staphylococcus aureus* (MRSA) swabbing procedure has been an on-going issue at Western Psychiatric Institute and Clinic (WPIC) in Pittsburgh, PA. Consistent failure to comply with hospital and state standards could result in life-threatening MRSA outbreaks due to cases being missed and admitted without isolation. Despite knowing there is non-compliance, the staff at Western Psychiatric Institute and Clinic (WPIC) have had difficulty identifying a solution that consistently improves the rates each data collection cycle. WPIC's physicians' MRSA swabbing compliance suffers because there are no on-going educational interventions provided to the primary care physicians. The goals of this project were to (1) address this issue by creating and providing a functional educational intervention that focuses on the necessary MRSA swabbing protocols, (2) monitor MRSA swabbing compliance before and after the intervention over several months, and (3) determine the effectiveness of the intervention.

2.0 BACKGROUND

2.1 THE EPIDEMIOLOGY OF HEALTHCARE-ASSOCIATED INFECTIONS

Healthcare-associated infections (HAI), defined as any new infection that a patient acquires from a healthcare facility, have been increasing in incidence and prevalence over the past decade across the United States (Mera et al., 2011). According to the Department of Health and Human Services, one in 25 patients in acute healthcare facilities has at least one HAI at any point in time, resulting in over one million HAIs in the United States annually ("Health Care-Associated Infections", n.d.). In 2007, the Centers for Disease Control and Prevention (CDC) released a report stating that there were an estimated 1.7 million cases of HAIs that year, a similar statistic to the present day's HAI prevalence, which highlights that healthcare professionals have still not been able to come up with a perfect solution to addressing HAIs. This could be due to the fact that HAIs can be caused by different organisms and result from different healthcare circumstances (e.g. surgery, extended admission).

In order to determine if there were distinct trends in the causes of these infections, a study conducted by Magill et al. (2014) examined CDC data regarding HAIs from 2009 to 2011. Of all the patients gathered from the data, 4.0% had at least one HAI. The most commonly reported HAIs were pneumonia and surgical site infections. Infections that did not occur at a surgical site developed within 48 hours of staying in a critical care unit. Upon admission, 98 HAIs were reported. The most commonly reported pathogen was *Clostridium difficile*, followed closely by *Staphylococcus aureus*. The authors noted that device-associated infections, such as those seen with ventilators, are the focus for most infection prevention, but the results found that about half of HAIs are non-surgical. Performing this study highlights areas of infection prevention that are in need of attention, such as non-surgical HAIs. Despite having to expand the focus to encompass these infections, it is becoming increasingly more difficult to do so because the organisms that cause HAIs are constantly developing antibiotic resistance (Magill et al., 2014).

2.2 ANTIBIOTIC RESISTANCE

Because the problem posed by HAIs is very widespread, the fact that the organisms that cause the infections are becoming increasingly antibiotic-resistant is very concerning for healthcare professionals. Antibiotic resistance exists in all organisms that cause HAIs and varies between organism and phenotype, whether by a specific antibiotic or antibiotic family, or by the extent of resistance amongst different strains of an organism. Treatment of HAIs is made difficult by this variance in resistance, especially if a patient has multiple HAIs at once (CDC, n.d.).

Resistance not only varies by the make-up of the organisms themselves but also by the distribution of different populations in the United States. A species of bacterium or an entire family of bacteria may be prevalent primarily in specific regions of the country (e.g. Northwestern United States) and only slightly noteworthy in other areas. A difference in prevalence may exist within a single family of bacteria as well. One species within a family may be more prevalent in one region of the country while another species is prevalent in a different region.

In addition to differences in regional prevalence, the amount of resistance can greatly differ between species of the same family. A resistant form of one species may be less prevalent than the resistant form of another. These variations in resistance can make it much more difficult for healthcare professionals to discover effective treatments for HAIs, which can be especially devastating when faced with infections caused by organisms such as MRSA (CDC, n.d.).

2.3 THE PATHOGENESIS OF MRSA AND TRENDS IN INFECTION

MRSA is a variation of *S. aureus* that is difficult to treat due to antibiotic resistance to the penicillin and cephalosporin families of antibiotics. The most common region of colonization in the human body is the nostrils, although the bacteria will also colonize mucosal membranes such as the respiratory and gastrointestinal tracts, as well as open wounds. *S. aureus* is particularly good at combatting the host's immune system and avoiding being destroyed by secreting endotoxins which instead destroy the host's immune cells and can result in tissue damage (Liu, 2009).

The first of two forms of MRSA is community-acquired MRSA (CA-MRSA). CA-MRSA is noted as being more virulent than healthcare-acquired MRSA (HA-MRSA), which is likely due to a higher number of virulence genes as well as several other defining factors. In the environment, strains of CA-MRSA could have developed through a higher likelihood of survival through a vast array of surfaces to adhere to and grow. As a result, there is a higher chance that a person will come in contact with an object or another person that is harboring the bacteria. There is also a higher likelihood that resistant strains will arise through competition with other strains. CA-MRSA can cause very severe illness in both immunocompromised and healthy people with symptoms such as necrotizing pneumonia and necrotizing fasciitis, both of which can have quick onsets and result in death (Liu, 2009).

The second form, HA-MRSA mostly affects patients in healthcare settings, and those who are immunocompromised. It rarely affects healthy individuals, although it does occasionally happen. Regardless of it being less virulent than CA-MRSA, HA-MRSA can still have devastating effects within healthcare facilities. Because MRSA is easily spread, this can result in outbreaks of HA-MRSA within these facilities that can kill immunocompromised patients rapidly. In addition to this, recent studies have found that CA-MRSA has been migrating into hospitals and other healthcare facilities, which poses a serious public health problem (Liu, 2009).

MRSA can be transmitted directly or indirectly. Healthy patients could potentially get MRSA if they come into direct contact with an infected patient, either by touching the infected area or by touching an infected patient's skin on or near the infected area. Indirectly, MRSA could be transmitted to a healthy patient through contact with a surface or object that has been touched by an infected patient. Many surfaces and objects in hospitals have the potential to become sites of MRSA transmission, including medical equipment, towels, counter tops, and used bandages (CDC, 2015).

Many studies have been focused on MRSA, its incidence and how it has changed over time (Dukic et al., 2013; Jarvis et al., 2012; Klein et al., 2013; Magill et al., 2014; Mera et al., 2011). It has been of particular interest to observe changes in MRSA incidence over the course of several years. A study conducted by Mera et al. (2011) observed MRSA incidence over a 10 year period on a national level using the Surveillance Network surveillance database, as well as the National Hospitalization Discharge Survey. By using these data collection tools, it was possible for the authors to collect information about MRSA prevalence from 1998 to 2007. Over the course of the 10 year period, annual prevalence rose continuously, starting at 32.7% in 1998 and reaching 53.8% in 2007. This increase was also noticeable in the number of hospitalizations related to MRSA, which rose from 3.5 per 1,000 in 1998 to 7.6 per 1,000 in 2007. The authors determined that strains of MRSA isolated during this time totally replaced analogous strains that were susceptible to methicillin (Mera et al., 2011).

These trends were mirrored in a study conducted by Jarvis et al. (2012), which examined the prevalence of MRSA in 2010 as compared to statistics acquired in previous studies conducted in 2006. In order to determine national prevalence during 2010, the authors distributed a survey to members of the Association for Professionals in Infection Control and Epidemiology, or the APIC (Jarvis et al., 2012). This nationwide association includes members of various backgrounds, including nursing, medicine, microbiology, and epidemiology. Each member plays a role in infection control, ranging from identifying and preventing HAIs in healthcare settings to collecting and analyzing data in order to better understand infection prevention measures ("About APIC", n.d.). By including the members of the APIC, the authors could collect national point-prevalence data, specified for one day between August 1st and December 30th of 2010. The authors received 590 responses to the survey and concluded that out of 67,412 inpatients during this time period, there were 4,476 MRSA cases. Nationwide MRSA prevalence was 66.4 per 1,000 in-patients. Active surveillance testing, such as culture tests, was performed at 75.7% of the facilities, and for most patients, MRSA was detected within 48 hours of their admission (Jarvis et al., 2012).

Increasing MRSA prevalence could be related to many factors, such as competing resistant strains or increasing population density. Age has been considered a factor in increasing incidence, due to decreasing immunity with age. Seasonality, although not widely considered, has been suggested as having an effect on MRSA incidence. Despite these considerations, it is unclear whether or not age and seasonality play a role in MRSA incidence. To examine this, a study was conducted by Dukic et al. (2013) by performing a meta-analysis on several geographically unique studies that focused on MRSA incidence over time. Each study's regional focal point was a different area of the United States and it was not feasible to extrapolate the results from a single study to other areas of the country due to differing regional attributes (e.g. population density). As such, the authors compared 17 studies on the basis of several criteria. The studies had to count CA-MRSA infection and had to have at least one “reference denominator.” These denominators were classified as 1) studies of the incidence of CA-MRSA in a population, 2) studies of proportion of all *S. aureus* infections that were categorized as CA-MRSA, and 3) studies of the proportion of all MRSA infections that were CA-MRSA. The 17 studies spanned a time frame from 1988 to 2009, and during this time, the authors noted a significant increase in CA-MRSA infections. Based on their findings, they conclude that CA-MRSA has become endemic in many regions and at a high rate, and children are especially affected. The authors also mentioned that urban populations involved in the study likely had an impact on the rate at which CA-MRSA spread (Dukic et al., 2013).

2.4 WHAT IS MRSA SCREENING AND WHY IS IT NECESSARY?

In order to determine which patients newly admitted into healthcare facilities are positive for MRSA, a screening test must be performed that looks for only MRSA and no other organisms. To complete MRSA screening tests, swabs from the nostrils, groin, and/or underarms are obtained with a specialized transport swab. Once the swab is collected, it is placed back into its transport tube, which contains a bulb (ampule) that houses a transport medium, and sent to a laboratory for testing (Borer et al., 2002). These tests provide information regarding the antibiotic susceptibility of the isolate obtained from the swab, which is necessary for determining whether or not there are resistant strains of the isolate as well as potentially identifying which specific antibiotic or antibiotics to which the isolate is resistant.

There are several commonly used methods for determining the antibiotic susceptibility of an organism ("Antibiotic Resistance/Susceptibility", n.d.). The first method is the dilution method. An isolate is placed in increasing concentrations of antimicrobial agent, an antibiotic, within a broth solution or on agar to determine the lowest concentration necessary to completely inhibit the organism's growth. This minimum concentration will be an indication of the concentration at which specific antibiotic needs to be administered. However, this test is not always successful, as a positive result can only be considered valid if the positive control shows growth and the negative control shows no growth ("Examples of…", n.d.).

The second method is the disk diffusion method. The isolate is plated evenly on a growth medium, such as Mueller-Hinton agar. Antibiotic susceptibility is determined through the placement of commercially-prepared disks containing a specific antibiotic and observation of growth patterns. If no growth occurs surrounding a disk, the isolate is considered susceptible. The width of the areas of no growth surrounding the disks is measured and compared against a chart of standardized measurements to qualitatively determine if the level of susceptibility is "completely susceptible" (no growth), "intermediate" (some growth), or "resistant" ("Examples of…", n.d.).

The third method is the E-Test, which involves commercially-made strips that contain decreasing concentrations of an antibiotic. To determine the concentration at which the isolate is susceptible, a numerical scale is marked on the strip. This provides a more quantitative measurement. Unfortunately, each antibiotic must have its own form of the test strip and this can become very costly, unlike the disk diffusion method, which is more economical (“Examples of…”, n.d.).

Ultimately, performing these tests is more cost efficient than treating a patient with MRSA. According to the 2014 national laboratory fee guidelines associated with performing a MRSA screening test, on average, a laboratory would be required to pay $9.05 per new admission (“2014 Clinical…”, 2014). In 2000, it was reported that the average cost of treatment per MRSA case was about $35,367. However, due to inflation and rising costs, this number is likely closer to an average of over $50,000 at the present time with even higher costs for higher risk individuals, such as transplant patients.

Annually, total MRSA cases cost around $4.5 billion (Aureden et al., 2010). Within a healthcare setting, one uncontrolled MRSA case could lead to the spread of the pathogen quickly, especially within high-risk wards and amongst vulnerable populations. These outbreaks would be extremely costly, as well as exceedingly dangerous, potentially posing additional health risks to those infected. While screening does not prevent MRSA infections in patients who are already infected, which would still require cost per treatment regardless, screening can identify these cases before they are able to spread the pathogen on to others.

2.5 ADDRESSING MRSA SCREENING NON-COMPLIANCE WITH EDUCATION

Previous studies have shown that educational interventions provided to medical staff have a positive impact on their compliance with performing their duties. Although there has been little research done specifically on the effect of educational interventions on MRSA screening compliance, many studies have been done examining the impact of interventions in other similar areas. Commonly, hand hygiene protocols are not well-followed. As a result, this is a significant area of interest for using educational interventions, which have had varying degrees of success (Borg et al., 2014; Eveillard et al., 2011; Sopirala et al., 2014).

A study completed in 2011 by Eveillard et al. involved providing an educational intervention to healthcare workers in four separate settings based on the hypothesis that the intervention would improve the workers' compliance with performing appropriate hand hygiene protocols. This program involved training in the protocols, which was divided into five different types of hand hygiene opportunities, as well as proper use of gloves. Across all four healthcare settings, 75 healthcare workers were involved in the intervention. The authors noted that significant improvements in compliance were seen in two of the five types of hand hygiene opportunities. These were hand hygiene opportunities after the last contact (e.g. a patient) in a series of contacts and in between two contacts in a series of contacts, with p-values of less than 10^{-7} and 10^{-5} respectively. They also noted a statistically significant decrease in compliance with hand hygiene before a single contact, with a p-value of less than 0.0001. In addition to hand hygiene opportunities, the use of gloves had no statistically significant changes. However, compliance with hand hygiene following the removal of the gloves did increase significantly. Based on these findings, the training program provided to the healthcare workers had a generally positive impact on their compliance with performing appropriate hand hygiene at various opportunities, thus supporting the authors' hypothesis. The results suggest that providing educational programs specific to areas of low compliance is more effective than less targeted approaches (Eveillard et al., 2011).

A similar study performed by Sopirala et al. (2014) provided staff nurses in a university hospital with training designed to target HCA infections. The authors hypothesized that providing such training through a more structured and organized program, Link Nurse Program, would improve compliance. This training included monthly education programs specific to MRSA and was designed to provide the nurses with assigned goals revolving around their positions as liaisons for the infection prevention personnel in the hospital. The authors of the study gathered pre- and post-intervention data which consisted of HCA-MRSA incidence, the incidence rates of total MRSA cases, non-HCA-MRSA cases, total cases of MRSA bacteremia (bacteria in the blood), cases of HCA-MRSA bacteremia, and cases of non-HCA-MRSA bacteremia. They also collected data regarding hand soap and/or hand sanitizer use in order to determine if there was any association between hand hygiene practices and HCA-MRSA incidence (Sopirala et al., 2014).

Following the intervention, the incidence rates of total MRSA, HCA-MRSA, total bacteremia, HCA-MRSA bacteremia alone, and non-HCA-MRSA bacteremia alone decreased, with p-values of 0.001, less than 0.001, less than 0.001, 0.003, and 0.015 respectively. The authors noted reduction in the incidence of HCA-MRSA, although this reduction was statistically insignificant, with p-values of 0.079. Despite this, there was an increase in both hand soap and hand sanitizer use, as well as general hand hygiene. Prior to the intervention, the rate of compliance with adhering to infection prevention protocols, such as wearing gowns and gloves, was 80%. During and after the intervention, this compliance rate rose to 90% and there was little variance from this number during data collection (Sopirala et al., 2014).

In addition to these studies, Borg et al. (2014) evaluated infection control and resource management via a cross-sectional ecological study that provided important insight into the way MRSA incidence is impacted by a multitude of factors that must be addressed when considering an intervention. They created a questionnaire designed to thoroughly examine areas of interest such as hand hygiene and MRSA incidence during 2010. The questionnaire was sent to various

European hospitals and the authors received 269 responses from 29 countries. It was determined that there was a lower incidence of MRSA when there are multi-faceted systems in place to focus on areas that may affect compliance. These systems included MRSA incidence surveillance, mandatory hand hygiene training, measures to ensure healthcare workers remain accountable for non-compliance, and the unified involvement of everyone who contributes to MRSA control measures. Collectively, having policies in place alone without a structured system in place to promote ownership and multidisciplinary teamwork did not improve compliance (Borg et al. 2014).

Likewise, a qualitative study performed by Efstathiou et al. (2011) examined what factors play a role in nurses complying with Standard Precautions, a set of guidelines provided by the CDC that explains appropriate infection control practices, such as hand hygiene. Through focus groups guided by the Health Belief Model, a behavioral framework, the nurses discussed factors that affected their own personal compliance with the CDC's Standard Precautions. Common factors included equipment being unavailable, having a heavy workload, having little or no time and feeling rushed, or being embarrassed (e.g. not wanting to follow a protocol because no one else is following it). Many of the factors overlapped between nurses, suggesting that some factors affecting compliance are behaviors that are being adopted from others. In this case, developing an intervention that addresses common factors that influence these behaviors is necessary (Efstathiou et al., 2011).

Although the focus being on hand hygiene and similar practices, these studies provide evidence that educational interventions can positively influence compliance with protocols and are, therefore, capable of influencing MRSA screening compliance. Some of the studies provide statistically significant data in favor of this assumption (Eveilliard et al., 2011; Sopirala et al., 2014). These studies help support the hypothesis that educational interventions can serve to positively impact compliance. Specifically, Sopirala et al. (2014) address several incidences of MRSA that could be affected by compliance, putting into perspective the scope of the problem. The improvement shown in the results provides solid evidence for the positive role of the intervention. Likewise, Eveilliard et al. (2011) provide a good example of how a well-structured intervention can be utilized in more than one healthcare setting. This suggests that the factors playing a role in non-compliance are common and not always unique to a specific healthcare setting. As seen in the other qualitative studies, behavior plays a significant role in compliance as well, such as those that may influence others to or to not comply with hospital policies. This needs to be considered during the development of an intervention (Borg et al., 2014; Efstathiou et al., 2011).

These studies, both quantitative and qualitative, provide insights into addressing non-compliance in healthcare settings. However, there are gaps in literature regarding interventions involving MRSA screening. While there is a commonality in the results of the studies that could be extrapolated to future studies that focus on MRSA, it is important to consider the effect of specific behaviors and circumstances (e.g. the absence of a MRSA surveillance system) on non-compliance, specifically those that may not often be considered (e.g. PCPs influencing each other’s compliance). As such, it would be beneficial to determine the effectiveness of such interventions on a broader spectrum of non-compliance rather than focus solely on hand hygiene.

2.6 PENNSYLVANIA ACT 52 AND MRSA SCREENING

In 2007, a law was passed in Pennsylvania that addressed healthcare-associated infections and the need to regulate their reduction and prevention. To comply with this law, a healthcare facility is required to develop and implement an infection control plan. Among the requirements are that the facility has to develop standardized culturing procedures and protocols, as well as a system that would identify patients who are infected with MRSA or other multi-drug resistant organisms. This system would have to include “any procedures necessary for requiring cultures and screenings for nursing home residents admitted to a hospital” and “the procedures for identifying other high-risk patients admitted to the hospital who necessitate routine cultures and screening” (Act 52 of 2007).

In accordance with this law, all University of Pittsburgh Medical Center (UPMC) hospitals and healthcare facilities, a system of which WPIC is a part, implemented protocols and systems that were designed to organize data collection, filing, and reporting, and to maintain a core set of standards throughout the entire healthcare system. These new protocols affected hospitals such as WPIC in that these facilities are required to monitor and report cases of MRSA as soon as they are detected. As such, one particular protocol requires that new patients being admitted to UPMC hospitals be screened for MRSA via a swab-sample culture during their admission process (Magee, 2015). This is necessary to prevent outbreaks of MRSA, so that potential cases can be properly isolated and treated according to CDC guidelines.

Despite Act 52’s being enacted, it is not always enforced. Government officials cannot assess the degree to which hospital staff adhere to the guidelines and protocols, because far too many healthcare facilities (e.g. nursing homes and hospitals) fall under jurisdiction of this law, and monitoring each one would not be feasible. As a result, compliance with performing MRSA screening tests suffers regardless of the law. While reasons for not complying with the swabbing protocol may differ from facility to facility, there is still a lack of knowledge of the law amongst physicians (Magee, 2015). This could directly affect MRSA screening compliance by facilitating a poor understanding of why the law applies to them. Further, this poor understanding could result in a lowered perceived importance of both the law and MRSA screening compliance.

2.7 WPIC'S SURVEILLANCE AND MRSA SCREENING SYSTEM

WPIC has explicitly laid out the procedure for obtaining a swab for testing. A physician is required to inform a patient that a MRSA test needs to be completed. If the patient provides consent, the physician follows the basic collection procedure by swabbing the inside of the patient's nostrils. Once the sample has been collected from the patient, the swab is returned to the transport tube which contains a transport medium in the ampule, the bulb end of the tube. The non-nutritious medium is utilized to prevent the swab from drying out in transit to the laboratory, which would affect the possibility of being able to culture any organisms ("*Specimen Collection Procedures Manual*", 2000).

WPIC has two protocols for collection and processing of MRSA swabs due to differences in types of admissions. However, both of them require that all new patients entering the hospital be flagged as high-risk for potentially having MRSA. The first protocol is utilized during admissions through the Diagnostic Evaluation Center (DEC), which is the area of the hospital involved in emergency admissions, such as emergency walk-ins ("Psychiatric Emergency Services"). A triage nurse begins the process by reviewing a new patient's history in order to determine if a swab is necessary. Once the patient is admitted, a physician will complete a general medical examination, as well as collect a swab sample. The second protocol involves any admissions that are processed in the admissions office. These admissions could include direct admissions, or patients admitting themselves, as well as consult and liaison admissions, which include patients who have been examined in other hospitals for other medical conditions and have been transferred to WPIC due to poor mental health. During the general medical examination, the PCP gathers a swab sample. The PCP is also responsible for filling out an orange form, which is used as an indication of whether or not the sample has been collected. In both cases, patients can refuse to provide a sample, in which case the test cannot be done (Magee, 2015).

In an attempt to combat problems with compliance, as well as to adhere to Pennsylvania Act 52, WPIC adopted a surveillance system computer program based on UPMC's adaptation of its own online data collection system, Cerner, a computerized physician order entry system. By using this program, WPIC can track new patients entering the hospital and current patients in the hospital, as well as medical information, such as clinical test orders and the status of test results (Cerner). Having this information readily available and organized in one program facilitates observing trends in disease occurrences or in lab test data as they happen. Being able to identify trends of increased cases of MRSA early allows for immediate action to be taken, which could make a difference in combatting the spread of MRSA preventing an outbreak. By tracking physician compliance with swabbing protocol, it is also possible to determine if action needs to be taken to improve compliance amongst all of the physicians or single physicians, or if the current methods to maintain compliance are potentially having an effect over time.

WPIC has developed a component of the surveillance system program that is specific to the ordering and completion of MRSA screening tests. When new patients arrive at the hospital, they are flagged as high-risk for having MRSA. If a patient is to be admitted, a test order is placed to take a swab sample and send it to the laboratory to determine if the patient is positive for MRSA.

Once the order is placed, the primary care physician (PCP) responsible for acquiring that sample has 48 hours to do so due to the fact that MRSA is fast growing and symptoms can appear 48 hours after exposure. In addition, the MRSA test takes one to two days to complete and return, so tests that are ordered later within the 48-hour time frame could have little effect on preventing initial spread of infection (Borer et al., 2002). After this time period has passed, patients who test positive for MRSA have to remain flagged as high-risk and are isolated according to the protocols dictated by the CDC (Magee et al., 2014).

Orders that are placed in the system are color coded according to the amount of time they have been in the system. A green code indicates that the PCP has 48 hours to complete the swab. A yellow code indicates that there are 24 hours left to complete the swab. A red code signifies that the swab is due that same day. A white code signifies that the swab was not completed during the 48 hour period (Table 1). The system is updated with a swab's status if a MRSA culture has been performed and the laboratory staff have entered the results, or if the swab has not been completed. This allows WPIC's Infection Prevention Department to determine the PCPs' rate of compliance for each data collection cycle (Magee et al., 2014).

Table 1. An example of WPIC's surveillance system

Patient	MRN	Location	Admit Date	Start Date	Admit Institution	H&P
Patient 1		WPIC	1/1/2015	1/1/2015	Hospital A	Physician 1
Patient 2		WPIC	1/2/2015	1/2/2015	Hospital B	Physician 2
Patient 3		WPIC	1/3/2015	1/3/2015	Hospital C	Physician 3
Patient 4		WPIC	1/4/2015	1/4/2015	Hospital D	Physician 4

Completed
Due Tomorrow
Due Today
Not Completed

3.0 METHODS

3.1 DEVELOPING THE INTERVENTION

According to the staff in WPIC's Infection Prevention Department, based on the hospital staff's own efforts to improve compliance, the most common problems with compliance are lack of knowledge about the swabbing protocol and lack of knowledge of Act 52. As such, it was determined that the intervention should focus on reiterating the swabbing protocol and informing the PCPs about Act 52, as well as including a reminder of how the hospital's surveillance system works and why it is important.

Based on previous studies and WPIC's own minor success, an educational intervention was developed with five major components: Act 52 and its importance, the procedure for collecting the MRSA swab, the protocol for processing swabs, the monitoring system for the hospital, and a form of acknowledgement. The staff in the Infection Prevention Department reasoned that it would be difficult to give a presentation to all 34 of the hospital's PCPs at one time due to the fact that they had many tasks to complete throughout each day that required their attention and that they worked on alternating day and night schedules. The head of the department as well as the staff members involved in surveillance in the hospital believed that it would be especially difficult to reach the PCPs working night shifts. As such, they agreed that sending out an e-mail with a PowerPoint presentation to the PCPs would be the easiest way to provide them with the intervention.

The PowerPoint presentation was relatively short and concise, as advised by the staff, since the concern was making sure that the PCPs had more of an incentive to take part in it. It consisted of ten slides that served to outline what the PCPs' role in the swabbing process is and how that role is to be performed (Figure 1). The presentation also explained WPIC's surveillance software and the breadth of information it compiles. The final part of the presentation was a form of acknowledgement that summarized what had been stated in the presentation and a request for a signature indicating that the person had read and understood the information (Figure 2). Following completion of the presentation, it was sent to the staff overseeing the Infection Prevention Department for approval and appropriate changes were made where necessary.

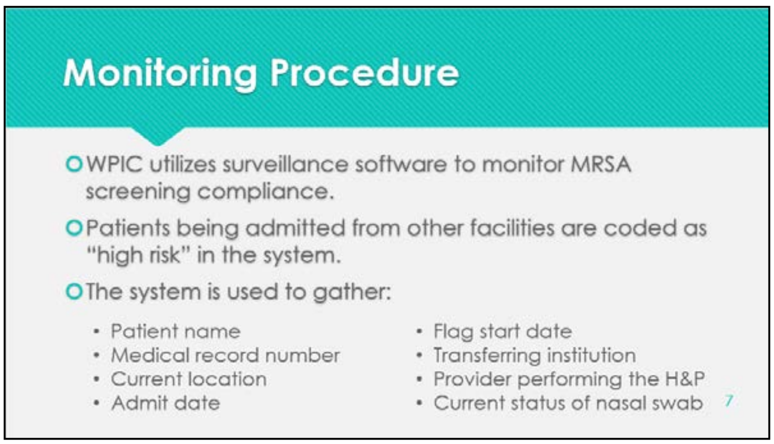

Figure 1. A slide from the intervention's PowerPoint presentation

Pennsylvania Act 52 Compliance and Swabbing New Patients for MRSA

- According to Act 52, all new patients arriving from external healthcare facilities are required to be swabbed for MRSA within 48 hours.
- Staff are expected to adhere to collection and processing process procedures to inhibit potential spread of HAIs, specifically MRSA.
- Use of the surveillance program utilized by WPIC is important for ensuring all MRSA cases are accounted for

By signing below, I acknowledge that I have read and understand the information provided regarding Act 52, compliance, and the procedures required for collecting swabs and monitoring their status.

Printed Name	Signature	Date

Figure 2. The form of acknowledgement provided with the presentation

Once they were emailed the presentation, the PCPs were given four days to read the slides, sign the form, and return it to the head of the Infection Prevention Department. They had the option of electronically signing the form and returning it via email, or delivering it in person. All of the forms were compiled and documented in order to make note of how many PCPs completed the intervention and which specific PCPs took part.

3.2 DATA COLLECTION, ORGANIZATION, AND ANALYSIS

To determine if the intervention was effective, it was necessary to gather baseline data according to WPIC's collection process. Instead of beginning a data collection cycle at the beginning of each month, one cycle would begin in the middle of the month and end in the middle of the next month. This data collection format coupled with approaching holidays made June the ideal target for baseline. Between the June and July collection cycles, the presentation was provided to the PCPs from July 6th to July 10th. They were encouraged to complete and return the form during this time. The entire data gathering process for this project spanned three months, from June until the middle of August, ultimately resulting in two and a half months of data.

The data were organized into separate spreadsheets and organized by patient, patient number, admission date, the facility from which the patient was transferred, the status of their MRSA swab test, the date it was completed if had been done, and the PCP responsible for completing their swab collection. If a swab was completed for a patient, the patient's record would be labeled with a 1. If the patient's swab was not completed, the patient's record would be labeled with a 0. The numbers of ones and zeroes were tallied for each date that an admission took place to determine the compliance rates per date. Because completed forms were available for specific

PCPs, these numbers were also tallied for each PCP who was assigned to complete a swab that month in order to determine if trends existed for each PCP individually. This was done to conclude if there was a general lack of compliance amongst the PCPs or if the compliance rates were affected by specific physicians with a particularly low likelihood of compliance.

In order to determine the effectiveness of the intervention, the data were examined via separate graphs per data collection cycle. By doing so, it was possible to visualize any trends that occurred during these time periods. Two sets of graphs were created from the data for each cycle. The first set of graphs show the compliance rates per day. The second set of graphs show the number of swabs completed and not completed by each specific PCP were also created to determine if there were patterns in compliance on an individual level.

4.0 RESULTS

Of the 34 PCPs who were emailed the presentation, 18 signed and returned the form of acknowledgement. Those who did not return the form could not be considered as having had taken part of the intervention. To take this into consideration, separate compliance rates were calculated for the PCPs who returned the form and the PCPs who did not return the form (Table 2).

In order to determine the effectiveness of the intervention, the data were examined via separate graphs per data collection cycle. By doing so, it was possible to visualize any trends that occurred during these time periods. Two sets of graphs were created from the data for each cycle. The first set of graphs show the compliance rates per day (Figure 3). The second set of graphs show the number of swabs completed and not completed by each specific PCP and were created to determine if there were patterns in compliance on an individual level (Figure 4).

For the month of June, the period before the intervention, swabbing compliance varied between 0% and 100%. A single compliance rate computed since this month was producing baseline data and none of the PCPs had received the intervention at that time. A total of 51 swabs were ordered during this month with 34 being completed, resulting in a compliance rate of 66.67%.

Table 2. The MRSA swabbing compliance rates divided by month and participation status

	JUNE	INTERVENTION	**JULY**		**AUGUST**	
	All PCPs		*Only PCPs WITH Intervention*	*Only PCPs WITHOUT Intervention*	*Only PCPs WITH Intervention*	*Only PCPs WITHOUT Intervention*
Completed Swabs	34		20	21	8	7
Incomplete Swabs	17		7	12	2	3
Rate	**66.67%**		**74.07%**	**63.64%**	**80%**	**70%**

Following the intervention, swabbing compliance still fluctuated some between 0% and 100%, but this fluctuation was noticeably milder than during the pre-intervention period. Because there were PCPs who did not take part in the intervention, two separate compliance rates were obtained. For the PCPs who had taken part in the intervention, a total of 27 swabs were ordered. Of these swabs, seven swabs were not completed, resulting in a compliance rate of 74.07%. For the PCPs who had not taken part in the intervention, a total of 33 swabs were ordered. Of these swabs, 12 swabs were not completed, resulting in a compliance rate of 63.64%.

During the August data collection period, swabbing compliance remained steady at 100% until the end of the period where there were only two incidents of non-compliance. For the PCPs who had taken part in the intervention, a total of 10 swabs were ordered. Of these, two swabs were not completed, resulting in a compliance rate of 80%. For the PCPs who had not taken part in the intervention, a total of 10 were ordered. Of these, three swabs were not completed, resulting in a compliance rate of 70%.

To determine if there was a difference between July and August's data compared to June, separate regressions were performed using Stata on each month's data. These regressions yielded p-values of 0.0039 for July and less than 0.001 for August. The separate p-values for the months following the intervention were both statistically significant. The difference between these two p-values may suggest that the intervention was increasingly effective over time. However, without a longer study period and multiple interventions, this cannot be determined from the data.

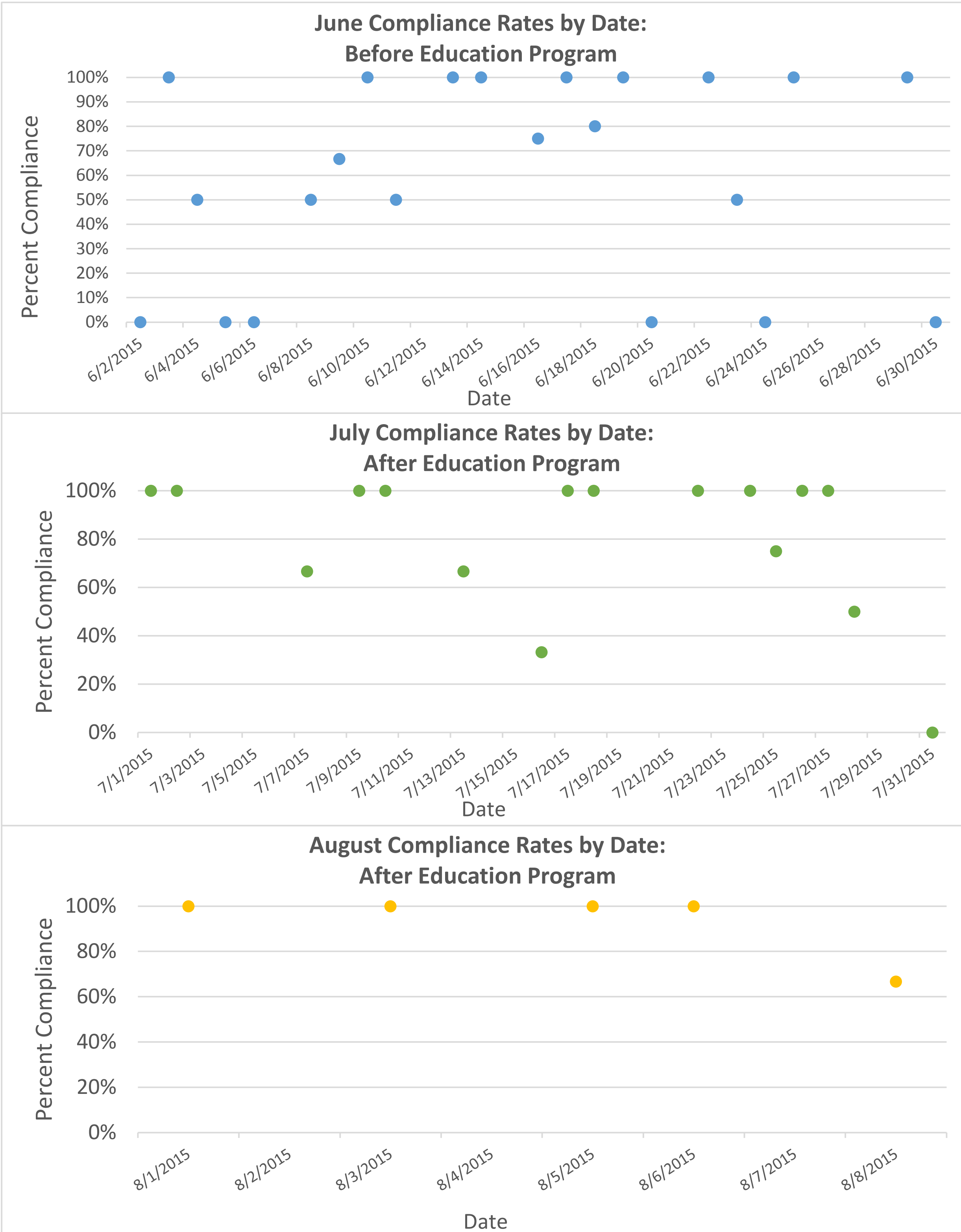

Figure 3. MRSA swabbing compliance over the study period

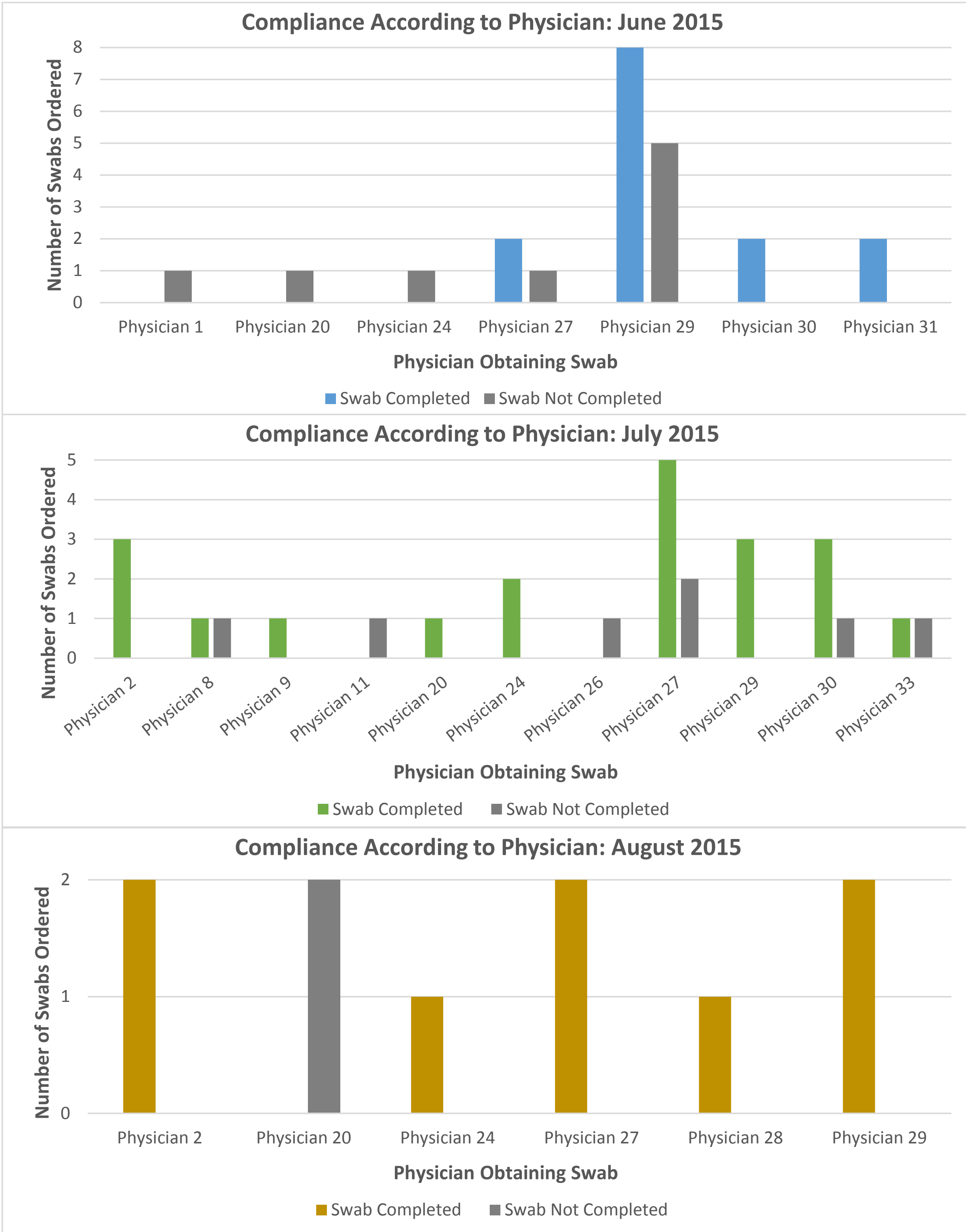

Figure 4. MRSA swabbing compliance per physician for each month of the study

Note: Some physicians are not listed because not all physicians participated

5.0 IMPLICATIONS OF THE RESULTS

Over the course of the project, there was a noticeable increase in MRSA swabbing compliance. The baseline data collection period of June had the most obvious inconsistency and, after the implementation of the intervention, this inconsistency became less pronounced (Figure 3). In general, this suggests that the intervention had a positive effect on the PCPs' compliance with swabbing protocol. Specifically, while compliance of both groups of PCPs (those who completed the intervention and those who did not) increased following the intervention, those PCPs who completed the intervention had higher rates of compliance than did those who did not. The data suggested that there was no association between specific physicians and lack of compliance (Figure 4). The significance of the two separate post-intervention p-values, 0.0039 and less than 0.001 respectively, suggests that the intervention had an increasingly positive impact when viewed from month to month.

The fact that the intervention had positive results means that this type of educational program or similar programs could be used in similar settings to address MRSA screening non-compliance. The format that was used for the intervention is very adaptable for other settings because it is possible to replace the information regarding swabbing protocols that are specific to WPIC. In addition to adapting screening protocols, the general information about MRSA, such as its pathogenesis, can be used in many different settings, including other hospitals and nursing homes.

Several factors may have affected the results. That there was a small time frame for the project should be taken into consideration, due to the fact that there was a short amount of time for trends to emerge, even though significant trends are clearly beginning to develop between July and

August. These data were likely also affected by the small sample size, as in some cases, such as in August, it only took one event of non-compliance to change the trend from 100% compliance for the entire month.

Because WPIC is host to a residency program, a number of residents rotate in and out of the hospital consistently. As a result, the number of PCPs can fluctuate, as well as which PCPs are present. These PCPs may only be in the hospital for one data collection period or they may be present for more than one. Maintaining a successful intervention in this environment would involve providing the intervention between every month to ensure that all PCPs are receiving the information despite however long they are to be working in the hospital.

In addition to possibly being affected by fluctuating numbers and which PCPs were present during the study period, the intervention covered only the technical aspects of MRSA swabbing and did not address compliance in a multifactorial way and include other circumstances involved in screening. As such, influencing behaviors, other than those that would have been affected by the training provided, would not have been impacted by the intervention. In other words, the intervention did not address factors such as the PCPs not having as much time to collect the swabs or how lack of compliance by one PCP could influence another PCP's compliance. Further, the intervention did not take into consideration outside influences, such as events (e.g. Grand Rounds) required that the PCPs may have had obligations to which may have affected their willingness or ability to participate in the intervention.

5.1 LIMITATIONS

Because participation in the project was largely voluntary, there was little incentive for the PCPs to complete the intervention. As a result, only slightly more than half of the PCPs in the hospital responded and returned their forms. This small sample size could have negative effects on the data, including reduced statistical power. Reduced statistical power could lead to results that are not as reproducible in future studies because the study being used to design the new study is not strongly designed. This could be problematic if one wanted to reproduce the study on a larger scale. The data from the reproduced study may yield results that are different from what would be expected compared to the original study. The voluntary basis of the intervention also could have resulted in bias, as returning the forms was a type of self-reporting. In addition to this, there may have been some level of sample bias if those who were participating and were not participating were doing so because of specific reasons, such as having more or less free time.

The project lasted only three months which likely affected the project in that there was less time to observe the effects of the intervention, and less time to implement subsequent interventions. Having only one presentation may have not been enough to truly observe influence of education over swabbing compliance. However, trends still emerged despite this which suggests that even with limited time, the intervention's effect was still notable.

5.2 FUTURE DIRECTIONS

Because this was a pilot study, the sample size was small and the time frame for the project was short. In future studies, it would be beneficial to increase the length of time for study so that multiple interventions can be provided instead of just one. In addition to having an extending period of time to collect data, a larger sample size must be used in order to ensure greater statistical power and significance of results. Involving more than one healthcare facility could provide the appropriate number of individuals for a future sample, as well as the addition of diversity in the dynamic in which protocols are followed.

During this project, information regarding which specific factors may have played a role in the PCPs not complying and taking part in the intervention was not obtained. In future studies, it would be beneficial to gather this information. Obtaining information about factors that influence compliance prior to formation of the intervention could be useful to making the intervention more specific and functional. After the intervention, interviewing PCPs who did not participate would provide crucial information as to what factors may still be addressed and may have been overlooked in further studies.

5.2.1 The Health Belief Model

To create and implement an adequate and functional intervention, organization and structure is key. This can be done by way of theoretical frameworks that have been created to make assessments to determine a problem, use information gathered from those assessments to form an appropriate intervention, and to implement the intervention. Specifically, the Health Belief Model (HBM) has been utilized as a framework for healthcare-behavior-based interventions and research. The HBM is a behavioral model that is used to explain health-related behaviors and what affects them, and has been extremely useful in healthcare settings. It can be used to evaluate a person's frame of mind on a specific health-related topic and determine what is necessary to change a behavior, such as changing from unhealthy eating choices to healthy eating choices. The HBM is comprised of six major constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. These constructs help to determine the perceived risk and benefits of a health behavior in which a person is taking part (“Health Belief Model”, n.d.).

Perceived susceptibility is the opinion a person holds regarding the likelihood of getting a condition (“Health Belief Model”, n.d.). In terms of MRSA compliance, a PCP may determine that the perceived susceptibility or threat of a new patient actually having MRSA as slim. As a result, she approaches the subject more lightly than she should, or she may prioritize such that MRSA screening is of lower importance to them. She might see a new patient who seems relatively healthy and feel that swabbing them for MRSA would be added effort and not worth the time since she may not be as likely to be affected. Adopting this mindset could result in a seemingly healthy person spreading MRSA to more vulnerable populations in the hospital, possibly causing outbreaks that could have deadly results.

Similarly as with perceived susceptibility, perceived severity involves what the person believes the repercussions of getting a specific illness or condition may be, and how serious it could be (“Health Belief Model”, n.d.). If a PCP believes that MRSA is not likely to cause someone a severe illness, she will not have the impetus to collect the swab and complete the test. As with the susceptibility construct, she may also assume that a healthy person is not infected and may not think the test is necessary. Such behaviors could also result in outbreaks in vulnerable populations.

Perceived benefits refers to what a person believes the outcomes of performing a positive action to be regarding a negative health behavior (“Health Belief Model”, n.d.). If a PCP was informed of the risks and reminded of the importance of MRSA screening, whether through an educational intervention or some other method, she would have to personally assess this importance and determine if screening is beneficial. The intervention should be tailored to and be as informative as possible on the subject in order to ensure that the PCP understands all of the factors involved in MRSA screening, such as the risks associated with not performing the test.

Perceived barriers would be anything that a person believes to be a negative effect of performing the guided action (“Health Belief Model”, n.d.). Barriers to MRSA screening could be a lack of time, a lack of equipment, and a lack of knowledge. An appropriate intervention should be based on the knowledge of factors that are known to be driving forces in non-compliance. As such, part of the intervention would have to be identification of contributing factors in non-compliance, as well as ways to address these factors.

Cues to action involves providing a person with the reminders to complete her behavior (“Health Belief Model”, n.d.). This could come in the form of educational information, personalized reminders, and other things to ensure that she is well-informed. Some studies have shown that healthcare workers have not complied with specific protocols due to lack of knowledge (Borg et al., 2014). For PCPs, non-compliance could be the result of not being up-to-date on specific swabbing protocols and are, therefore, reluctant to collect the swab. Continuing education should be a focal point in an intervention for this reason.

As a continuation to this point, self-efficacy involves helping a person to feel confident in her own abilities, especially in terms of changing her behavior for the better (“Health Belief Model”, n.d.). A PCP may feel uncomfortable collecting a swab if she is not as familiar with the process. Providing this intervention frequently and on a regular basis would not only promote quick recall when necessary, but would also keep them informed if and when collection protocols change. This could allow them to feel more confident when approaching the swabbing process.

Because different institutions will have different factors that are responsible for a problem, it is necessary to consider the HBM through the lens of those specific institutions. The study conducted by Efstathiou et al. (2011) shows that when the HBM is used as a framework for developing an intervention addressing the problem of compliance in healthcare settings, it has a positive impact. Utilizing this model allowed the authors to identify which behaviors were responsible for poor compliance with necessary protocols (Efstathiou et al., 2011). While the authors did not develop an intervention based on their findings, it would be possible in the future to create an intervention based on the information they acquired because they have a clearer understanding of which behaviors have the biggest impact on compliance. When applied to WPIC, the HPM could similarly be used to determine what factors most likely have an impact on willingness to comply with swabbing protocols for just WPIC itself. It would make it possible to be able to provide a framework that the hospital could follow that surrounds its specific protocols, and, thus, create an intervention that could provide more structure and function within the scope of the hospital’s goals and procedures. As such, adopting the HBM when formulating an intervention could address factors that would make a PCP unwilling or reluctant to collect the swabs, as well as other factors, such as how resident rotations may impact compliance. In addition, interventions formed with the HBM can also be utilized universally in more than one setting within the UPMC system, as all healthcare facilities that are under the jurisdiction of UPMC are required to follow the same protocols. In short, the HBM can lay the groundwork for a more solid and permanent intervention that touches upon multiple factors that contribute to non-compliance.

6.0 CONCLUSION

MRSA infections are a potentially devastating condition that can be spread rapidly in healthcare settings. There has been sufficient evidence presented in previous studies suggesting that MRSA incidence and prevalence has been increasing in the United States for the past 10 years. MRSA screening tests are protocols that can be used to identify cases of MRSA before they can spread the pathogen to other patients in a healthcare facility. As such, screening has a positive impact on preventing outbreaks in these facilities, especially among vulnerable populations. However, often times, screening protocols in healthcare facilities are not followed. Studies have shown that providing physicians with an educational intervention is useful in improving MRSA swabbing compliance.

The trends that can be observed in the data collected during this project suggest that with persistent interventions and providing information to PCPs at WPIC, there will be an improvement in compliance over time, and these data can be a guide for the expansion of such an intervention to other facilities in the same healthcare system. Because the results of this study were statistically significant, it is worth continuing to explore the possibilities of more advanced and complex interventions surrounding swabbing compliance. In addition, utilizing theoretical frameworks such as the Health Belief Model could greatly improve the functionality of an educational intervention by not only providing structure, but providing a targeted response to factors that directly affect compliance, such as a lack of knowledge in the subject. Further, future studies could utilize this project as a basic guide to the formation of potential interventions.

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