Fall 9-2020

PPE Compliance and Knowledge Among Healthcare Staff

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Abstract

Problem: One of the most important steps in infection prevention is the use of personal protective equipment (PPE) to protect patients and staff from infectious agents; yet, research indicates that PPE compliance remains suboptimal in many healthcare institutions.

Purpose: To identify the effect of a multidisciplinary education campaign on PPE compliance and knowledge among healthcare workers (HCWs) on a rehabilitation unit of a large, midwestern teaching hospital.

Methods: This project utilized pre-intervention observational audits and a survey to determine baseline PPE compliance and knowledge on the piloted units. A post-intervention survey was sent to HCW to assess for a change in knowledge.

Interventions: Educational material regarding proper PPE usage and knowledge gaps gathered from the pre-intervention survey was sent to all staff virtually. Educational materials were also posted throughout the unit and discussed during team huddles.

Results: Pre-intervention observational audits showed 21.64% (n=97) correctly donned and doffed PPE according to the institution's policy. Comparison of pre- to post-survey data showed no significant change in all four knowledge-based questions ($p=0.45$, $p=1.00$, $p=0.69$, $p=1.00$).

Conclusion: Staff showed knowledge regarding proper PPE use prior to the intervention. However, compliance was suboptimal. This data indicates

that despite staff being knowledgeable on proper use, other barriers exist that lead to a lack of compliance with PPE policies.

Key Words: PPE, compliance, Personal Protective Equipment, multidiscipline, education

Introduction

Healthcare-associated infections (HAIs) pose a threat to both patients and healthcare staff. HAI is defined as an infection that develops during treatment for another condition (Office of Disease Prevention and Health Promotion, 2019). Occurrence of HAIs can lead to severe, costly, and fatal consequences. Over one million HAIs occur across the United States (U.S.) health care system every year and lead to over tens of thousands of deaths annually (AHRQ, 2019). Additionally, HAIs cost hospitals between 28 and 45 billion dollars in direct costs per year (Stone, 2010).

Communicable diseases have been identified as a major factor that increases the risk for HAIs (Office of Disease Prevention and Health Promotion, 2019). A communicable disease is a disease that can be passed between patients and healthcare workers (HCWs) through a variety of routes. In the in-patient setting, many practices exist to prevent the spread of this type of disease. One of the most well-known and important steps in preventing the spread of communicable diseases is the use of personal protective equipment (PPE) (Wisconsin Department of Health Services, 2018). Despite evidence suggesting the effectiveness of PPE in infection prevention, research suggests that compliance of PPE use among HCWs continues to be suboptimal (Allen & Cronin, 2012; Jain, Dogra, Mishra, Thakur, & Loomba, 2013; Larkin, et al., 2017).

Available Knowledge

A review of the literature was completed to define the problem. Current articles in a selection of journals describe studies to indicate that PPE compliance is suboptimal in a variety of healthcare settings, including in-patient facilities. The research also strongly supports the importance of PPE in preventing infection. A literature review was conducted searching the databases CINAHL, PubMed, and ScienceDirect. The inclusion criteria were: articles published in English, published in the last ten years, from a peer-reviewed journal, and focused on PPE compliance and knowledge among HCWs. Exclusion criteria were articles not related to PPE compliance and knowledge, older than ten years, and articles without an English version available. One study by Larson (2004) was used despite being older than ten years old as it was determined to be of high-quality and contained an established survey tool that was modified and used to gather data in this project.

Overall, the literature showed that PPE compliance remains less than optimal across many healthcare institutions and remains an area for improvement at the piloted facility. Following review of the literature, it can be concluded that identifying barriers to PPE compliance is a key step in developing and implementing an effective intervention (Allen & Cronin, 2012; Alsmeyer, 2014; Andonian, et al., 2019; Baloh, et al., 2019; Bruce, 2013; Harrod et al., 2019; Jain, et al., 2013; Larkin et al., 2017). It was also found that PPE compliance is suboptimal among a variety of disciplines, and favored a multidisciplinary approach (Beam, et al., 2011; Doll, et al., 2017; Harrod, et al., 2019; Jain, et al., 2013; & Larkin, et al., 2017). Interventions studied within the research include

audits, education in a variety of forms, visual aids, or a combination of interventions (Allen & Cronin, 2012; Alsmeyer, 2014; Andonian, et al., 2019; Beam, et al., 2011; Bruce, 2013; Larkin, et al., 2017; Mauger, et al., 2014; Tomas, et al., 2015). The interventions implemented within the research review were all suggested to be effective in improving PPE compliance and/or knowledge (Larkin, et al., 2017; Mauger, et al., 2014; Tomas, et al., 2015). However, many studies noted that further research to analyze the long-term effects of the interventions would be beneficial in determining long-term effectiveness.

In summary, the literature review indicated that a combination of education, visual aids, and audits with feedback have shown to be successful in increasing appropriate PPE compliance and staff knowledge. Additionally, the research supports a multidisciplinary approach to improve compliance as compliance was shown to be suboptimal among all HCWs. A majority of the research used audits or surveys to determine the intervention to be implemented and are recommended as an effective measurement tool for PPE use.

Rationale

The *Change Theory* by Kurt Lewin was utilized as the theoretical basis for this project (Petiprin, 2016). The *Change Theory* is a three-stage process that requires an individual to reject prior learning. The three stages in Lewin's theory are unfreezing, change, and refreezing (Petiprin, 2016). Unfreezing involves a process of letting go of the old pattern of practice or knowledge that is counterproductive. The second stage involves the changing of counterproductive

thoughts and behaviors. Finally, the refreezing stage involves making new thoughts and behaviors into a habit (Petiprin, 2016).

Lewin's theory guided this project. The behavior that was identified by the projects institutional leadership as counterproductive was low compliance of staff utilizing PPE correctly. The first step was to inform staff of this behavior and educate them on the consequences associated with noncompliance. During the first stage, investigators identified which knowledge and behaviors had become a pattern in order to address them, which was the rationale for the pre-intervention survey and audits. Additionally, Lewin's theory states that it is vital to overcome individual resistance and group conformity in this stage (Petiprin, 2016). Next, the implementation of a multidisciplinary educational intervention was used to change the behaviors and patterns of staff to increase PPE compliance. In this stage, staff were provided with education to support productive behavior change. Lastly, the investigators and team guided staff to establish new knowledge and practices as habits in the refreezing stage. Ideally, the staff will utilize their new knowledge and change their practice as guided through these three stages of Lewin's *Change Theory.*

Additionally, the *Iowa Model of Evidence-Based Practice to Promote Quality Care* (Titler, et al., 2001) was utilized as the framework for this project. The *Iowa Model* provides a guideline for decision making related to clinical and administrative practices that affect patient outcomes. It assists healthcare providers in translating quality research findings into clinical practice to improve patient outcomes, which is the goal of this project (Brown, 2014). The *Iowa*

Model is a multiphase model and was chosen to be the framework for this project as it is a streamlined change process that applied to the clinical question being explored. Additionally, the *Iowa Model* puts focus on organization collaboration as it incorporates the conduct and use of research as the guiding method for intervention protocol (Doody & Doody, 2011). Because the institution identified PPE compliance as a priority and there was a sufficient literature on possible interventions, it was identified that the change was appropriate for adoption into practice. These qualities aligned with the guiding principles of the *Iowa Model*.

Aims

Infection prevention is a top priority at many healthcare facilities. The institution identified infection prevention as a crucial area for improvement on the piloted units (S. Johnson, personal communication, November 26, 2019). Many approaches to increase staff knowledge and compliance have been explored. Evidence supports use of a variety of interventions including education, regular auditing, and visual aids (Allen & Cronin, 2012; Alsmeyer, 2014; Doll, et al., 2017; Larkin, et al., 2017). It also shows that the need for improvement lies within all disciplines (Mitchell, et al., 2013). Therefore, this project aimed to identify gaps in knowledge regarding PPE among HCWs, and barriers to PPE compliance. Furthermore, the goal was to develop and implement an educational intervention to study the effect it has on these variables. The clinical question for this project was: For healthcare professionals in the rehabilitation setting of a teaching hospital, how does a

multidisciplinary educational infection prevention campaign affect PPE compliance and staff knowledge?

Methods

Context

The project was implemented on two inpatient rehabilitation units at a large, midwestern teaching hospital. The two units have a total of 58 beds. Patient population on these units include patients rehabilitating from surgery, strokes, traumatic brain injuries, and other complications requiring additional care and therapy. The units are staffed with nurses, nursing assistants, physical therapists, occupational therapists, speech therapists, and clinicians. The staff from these disciplines have been trained to the piloted unit's "Transmission-based Precautions (Isolation)" policy and were the population of this study. Inclusion criteria included any of the staff in a role mentioned above that entered a contact or enteric isolation room on the piloted units. Exclusion criteria for participants included environmental services and dietary staff.

There were many key stakeholders involved in this project. Stakeholders included both patients and any staff on the unit. The infection prevention team, nurse educators, and the unit's leadership team are also key stakeholders. Project members included: investigators, nurse managers, a clinical nurse specialist, infection prevention manager, unit practice council members, and a statistician. Leadership played an active role throughout the project and were supportive of project implementation.

Interventions

Modifications to the initial intervention were made due to a pandemic that occurred during the study period. The piloted unit's response measures restricted any in-person education. Therefore, the intervention was implemented virtually. The intervention was a virtual, multi-disciplinary education program. Content distributed in the virtual education program was determined based on data gathered in the pre-intervention phase and the needs of the staff as determined by management and the facility's infection prevention manager. All the material was approved by nurse managers, the infection prevention team, and the clinical nurse specialist before being sent to staff. Educational material was sent to all staff participating in the project from the pilot units (nurses, nursing assistants, providers, physical therapists, occupational therapists, and speech therapists).

The educational material was sent out twice during the two-week intervention period. The first time it was sent to the staff. The second time it was sent to the unit manager one week after staff received the material. The material sent to staff contained an explanation of why the intervention was being implemented virtually, facts on the importance of PPE policy compliance, and statistics from the observational audits collected during the pre-intervention stage. Additionally, the material included instructions on how staff can access their facility's PPE policy and who to contact for questions, barriers identified in the surveys and audits to proper PPE donning and doffing, a link to a visual aid for proper donning and doffing technique, and a video demonstration of how to properly don and doff PPE per the facility's policy. Finally, the material

contained contact information of the investigators and management, and staff were encouraged to reach out to them with any additional questions. After reading through the educational material and watching the video demonstration, staff were asked to complete a post-intervention survey to assess PPE knowledge.

Study of the Interventions

The evaluation measures that were used to evaluate the success of implementing this intervention were audits performed by trained investigators and a survey. Observational audits were completed to measure baseline PPE compliance rates and surveys measured staff knowledge and perception of PPE use. The audit tool utilized was adapted from a tool by Telford, et al. (2018). Permission for use was granted and modifications were made based on the institutions "Transmission-based precaution (Isolation)" policy and with recommendations from a leader of the institution's infection prevention team.

The survey tool utilized was adapted from a tool by Larson (2004) and was shown to have a test-retest reliability coefficient of 0.86 and a standardized alpha coefficient in item analysis of 0.80. Permission for use of the survey tool was obtained. The survey contained four Likert scale questions, one open-ended question, and four multiple-choice questions. Likert scale questions were utilized for statistical analysis to compare pre- and post-intervention PPE knowledge. The open-ended and multiple-choice questions were utilized to identify gaps in PPE knowledge among staff. The areas identified for improvement guided the education included in the intervention.

Measures

Much of the research suggested that observational audits and surveys are an effective measurement tool for PPE use. As a result, an established audit and survey were modified and utilized as tools in this study to measure PPE compliance and knowledge. The goal for this project was to complete the observational audits pre- and post-intervention. Pre-intervention audits served as baseline data and showed investigators that PPE compliance was suboptimal on the piloted units. Unfortunately, due to the COVID-19 pandemic and the response measures at the facility, investigators were unable to perform post-intervention audits to determine if there was a change in compliance following the educational intervention. The same survey tool was given to staff both pre- and post-intervention to assess for change in knowledge. Staff were able to complete the survey via a virtual link. Staff were ensured that the survey was confidential.

The project team determined that based on research, and the inability to complete post-intervention audits, that it would be beneficial to continue auditing after the original study period to monitor compliance long-term. The suggestion of continued audits was communicated to leadership on the unit. The initial cost for this project to the investigators was minimal, as investigators completed all the audits. However, there would be a cost associated with the continued assessment of compliance if the institution had to pay individuals for their time to complete audits.

To improve the value of the audits, inter-rater reliability was tested between auditors. This was done by completing three audits independently on the

same observation and comparing the results of these audits. The audits were the same between both investigators, thus ensuring interrater reliability. At times, investigators were unable to complete full audits. If parts of the audits were missed, they were marked "not visualized" and the incomplete data was excluded from the results. All the surveys were fully completed.

Analysis

The initial plan was for the investigators to perform audits prior to the implementation of the intervention for baseline data on PPE compliance that could be compared to audits obtained following the intervention. However, due to the pandemic, only baseline audits were obtained and no statistical analysis between pre- and post-intervention audits were done. Instead, data gathered from the baseline audits were calculated to provide staff with baseline compliance statistics and details on where breaks in compliance most often occurred. Therefore, instead of using the audits to examine the effectiveness of the intervention, the audits were utilized to better understand current compliance within the units, and trends in PPE practices using percentages.

A survey to assess PPE knowledge was sent to staff before the implementation of the intervention that gathered data that was compared to the data obtained from the survey sent out after the intervention. The same survey was sent both pre- and post-intervention and was compromised of multiple-choice, sequence, and Likert-scale questions. The Likert-scale questions were compared across the pre- and post-intervention groups with a two-

sample t-test. The rate at which the multiple-choice and sequence questions were answered correctly was compared across these groups with Fisher's exact test.

Ethical Considerations

The investigators did not identify any conflicts of interest or need for formal ethics review. All staff received the same education on proper PPE usage. Additionally, all staff had adequate resources to locate the policy and had the opportunity for any questions to be answered. The project was submitted and received approval from both the piloted institution and the University's Institutional Review Boards (IRBs).

Results

Data

The data analyzed from the survey are responses from 48 nurses prior to and 36 nurses following an educational intervention on personal protective equipment (PPE). The assessment tool consisted of four six-point Likert-scale items (Questions 1-4). For three of the four items, a "Strongly agree" was coded as 6 and "Strongly disagree" as 1. One of the items ("I don't have time to stay informed about available guidelines and guideline updates") was reverse-coded such that a "Strongly disagree" was coded as 6. The average across all four questions was computed for each nurse and compared across the pre- and post-intervention groups. In addition to the four Likert-scale items, four knowledge questions (Questions 6-9) were asked. These were answered either correctly or incorrectly, resulting in a binary response for each nurse.

The audit data reviewed was split up into four sections: setup, donning PPE, doffing PPE, and use of PPE. Auditors either marked "yes" "no" or "not visualized" for each point. Setup was further broken down into: door signage visible, isolation cart within reach, and correct signage on the door. The donning and doffing PPE sections were further broken down based on the correct steps as per the institution's policy. The correct steps for donning PPE are: hand hygiene performed before gathering supplies, staff donned gown first, staff donned gloves second, the gown was security correctly (closed and tied), and gloves and gown were donned outside of the room. The correct steps for doffing PPE are: staff doffs gown and gloves in one motion (or gown first), staff disposes PPE in the trash in patients' room, staff doffed PPE without visible contamination to themselves, staff performs hand hygiene after doffing. The final section was use of PPE and had one aspect: PPE was only worn inside the isolation room.

Methods

For the survey data, the average to Questions 1-4 was compared across the pre- and post-intervention groups with a two-sample t-test. The rate at which the knowledge questions were answered correctly was compared across these groups with Fisher's exact test.

For audit data, only baseline data was obtained. Thus, percentages were calculated to show baseline compliance rates.

Results

Table 1 shows the mean (standard error mean) for the average of Questions 1-4. Additionally, it shows the count (percent) of correct answers for

each of the four knowledge questions. The average response on the Likert-scale questions was very similar (and positive) across the two groups: 5.1 in the pre-intervention responses and 5.2 in the post-intervention responses on a 6-point scale. Similarly, the percent correct on each of the four knowledge questions were similar from pre-to-post. The percent of nurses answering correctly was highest for Questions six, eight, and nine, with a notably lower correct response rate for Question seven. None of the statistical tests performed resulted in statistically significant differences across the two groups.

Audit data indicated that all four sections (setup, donning PPE, doffing PPE, and Use of PPE) were completed correctly 21.6% (n=97) of the time. Staff entered contact or enteric isolation rooms without utilizing any PPE 21.6% (n=30) of the time. These observations were not included in the subsequent calculations. Table 2 breaks down each section of the audit and shows percentages of visualized observations that were done correctly per section. If aspects of the section were "not visualized," or if staff did not wear PPE during the encounter, the audits were excluded from data analysis.

A few additional percentages were calculated to further understand the data. The most common step missed when donning PPE was hand hygiene. Twenty percent (n=97) of the time staff did every other aspect of the audit correctly except hand hygiene prior to putting on PPE. Donning was completed in the incorrect order 22% (n=97) of the time, most frequently donning gloves before gown.

Discussion

Summary

The first key finding of this project was that PPE compliance was suboptimal. PPE was worn correctly only 21.6% of the encounters that were audited. This finding confirmed the need for an intervention to help address PPE compliance on the piloted units. Survey results indicated high PPE knowledge both pre- and post-intervention. This indicates that the staff knows how to properly utilize PPE, but not translating into practice. Thus, it is important to identify what barriers to proper PPE usage exist to implement strategies that address barriers and improve compliance.

Additionally, findings from the audits indicated that staff doffed PPE correctly (72.1%) more consistently than donned PPE correctly (34.6%). This is contradictory to the literature review conducted, as many of the studies reviewed for this project indicated that doffing is often the area of concern (Antonian, et al., 2019; Baloh, et al., 2019; Beam, et al., 2011; Doll, et al., 2017; Mitchel, et al., 2013; Okamoto, et al., 2019; & Tomas, et al., 2015). This finding supports the implementation of pre-intervention audits and surveys to help identify the areas for improvement specific to the institution.

One key aspect of the audits that was consistently done well was room set up. If a patient was on contact or enteric precautions, the room had the correct signage visible and the isolation cart within reach for 99.3% of encounters. The literature search completed for this project identified visual aids have shown to be an effective intervention (Allen & Cronin, 2012; Alsmeyer, 2014; Doll, et al., 2017; Larkin, et al., 2017). However, investigators did not implement visual aids,

as the findings from the audits indicated this was already successfully being implemented at the institution.

There were no statistically significant changes in the data analyzed from the survey results. This was likely due to high scores on the pre-intervention survey. Staff knowledge did not decrease post-intervention, but also did not have much room to improve given the high score on the pre intervention survey. One question was added to the post-intervention survey that was not on the pre-intervention survey and that was "did you find this information helpful?" Staff were asked to answer this "yes/no" question. 94.3% (n=35) staff members indicated that the educational intervention was helpful.

Interpretation

Suboptimal PPE compliance was reported in much of the literature review completed for this project (Allen & Cronin, 2012; Jain, Dogra, Mishra, Thakur, & Loomba, 2013; Larkin, et al., 2017). This was consistent with the findings from this project. Many of the studies reviewed for this project implemented an educational intervention utilizing audits and surveys revealing a variety of results. This project implemented a multidisciplinary virtual education campaign to address low PPE compliance. Due to the COVID-19 pandemic, post-intervention audits could not be obtained to identify if the intervention affected PPE compliance. However, since the survey was completely online, results were obtained pre- and post-intervention. Survey results indicated that a multidisciplinary education campaign did not show statistically significant

improvement in PPE knowledge among staff members. This was consistent with some of the studies reviewed in the literature.

The biggest reason investigators believe there was a difference between observed and anticipated outcomes was due to the COVID-19 pandemic. Post-intervention audits were not able to be completed, which was one of the measurements to identify intervention effectiveness. While the survey provided useful information, staff performed well on the pre-intervention survey, and thus the intervention would not have allowed for much improvement. The audit data would have been beneficial in determining the effectiveness of this intervention. It can be inferred that because PPE knowledge was high pre-intervention and compliance was low, barriers other than lack of PPE knowledge exist that influence PPE compliance.

Another variation made to this project due to the pandemic was the delivery method of the intervention. The initial plan was to deliver short, in-person education sessions that would have included interactive education, such as the use of glow germ, as this has shown some effectiveness in past studies (Allen & Cronin, 2012; Andonian, et al., 2019; Beam, et al., 2011; Bruce, 2013; Larkin, et al., 2017; & Tomas, et al., 2015). Following COVID-19 precautions, in person educational sessions were not possible. Therefore, education was delivered virtually and may have impacted project outcomes. One could argue that virtual education would not be as effective, as staff could skim through or disregard the education material. Additionally, virtual education misses the opportunity to do any hands-on interaction. Interestingly, the survey asked staff what form of

communication is most beneficial to them, and the most common answer was e-mail or online (23%), supporting the use of a virtual intervention. It is also cost-effective, can be accessed at the user's convenience, repeated as needed, easily replicated, and provides a safe learning environment, which is required during a pandemic. Ultimately, more research needs to be done on the most effective education delivery method.

Despite the lack of clinically significant data, staff reported that the education intervention was helpful. Additionally, the intervention was inexpensive and required minimal resources other than time. Because staff felt the intervention was useful, it is worth considering as a cost-effective intervention to improve PPE knowledge and compliance. Further research is needed on effective delivery method for an intervention addressing PPE.

Limitations

One key aspect of this project was obtaining baseline information to understand current gaps in knowledge and barriers to PPE usage for staff. This allowed the intervention to the specific needs of the piloted units. However, this limits the generalizability of the project.

One limitation noted was the Hawthorne effect. Investigators introduced themselves and the project to the unit before implementation. They also checked in with the charge nurses daily during the auditing period to identify which patients were on contact or enteric precautions. Thus, the staff could identify the investigators and their purpose for being there. This could have altered the

results for audit compliance, as investigators' presence may have influenced the staff's PPE decisions knowing they were being audited.

Another limitation was that staff often doffed PPE in the patient's room with the door closed. This limited the ability for investigators to fully see the doffing process. If investigators were not able to view the doffing process in full, it was marked "not visualized" and this data was excluded from the final percentages.

Conclusion

Use of PPE is a standard practice in healthcare institutions across the United States in preventing the spread of HAIs. HAIs are not only costly but potentially fatal. Proper use of PPE is one of the best ways to protect patients and healthcare workers from HAIs (Wisconsin Department of Health Services, 2018). Despite this knowledge, research has indicated that compliance rates for proper PPE usage are suboptimal, thereby, putting patients and staff at risk for developing HAIs. This project sought to identify current compliance rates for proper PPE usage, gaps in knowledge and barriers for consistent usage, and an effective intervention to improve staff knowledge and compliance. The main finding of this project was that while knowledge on the proper use of PPE was adequate, compliance rates were very low.

While this project could be easily implemented in a variety of settings to improve PPE compliance and knowledge, adjustments would need to be made to improve the effectiveness of the intervention. Further research is recommended to identify why adequate staff knowledge of PPE is not being implemented into

practice. Methods to overcome barriers is also recommended. Finally, if an educational intervention is going to be explored to address the identified barriers, research should be done to determine the most effective form of education delivery method.

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Table 1

Survey Results

	Avg Q1-Q4	% correct Q6	% correct Q7	% correct Q8	% correct Q9
Pre	5.1 (0.1)	45 (94)	28 (58)	43 (90)	48 (100)
Post	5.2 (0.1)	31 (89)	20 (59)	34 (94)	36 (100)
p-value	0.34	0.45	1.00	0.69	1.00

Table 2

Audit Results

	Yes	No	Not Visualized	Did not utilize PPE for encounter	Visualized observations done correctly per section (%)
Setup	138	1	0	0	99.3%
Don PPE	37	70	2	30	34.6%
Doff PPE	49	19	41	30	72.1%
Use of PPE	96	5	8	30	95%