International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Personal Protective Equipment Adherence in High-Risk Clinical Settings: Assessing Compliance, Patient Factors, and Training Impact

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Abstract

Background: Personal protective equipment (PPE) is essential for preventing healthcare-associated infections and ensuring the safety of healthcare workers (HCWs) in high-risk settings. However, adherence to PPE protocols varies across different hospital units and professional groups.

Objective: This study aimed to assess PPE compliance among HCWs in the ICU, COVID-19 Unit, and Operating Room (OR), analyze the impact of patient conditions on adherence, and evaluate the effectiveness of a structured training intervention.

Methods: A quantitative cross-sectional study was conducted in a tertiary hospital over three months. 250 HCWs, including physicians, nurses, paramedics, lab technicians, radiologists, and pharmacists, were assessed through direct observations, self-reported surveys, and compliance audits. A PPE training program was implemented, and compliance rates before and after training were compared using descriptive statistics and chi-square analysis.

Results: Baseline compliance rates varied across units:

- COVID-19 Unit (92%) had the highest adherence.
- ICU (85%) showed moderate compliance, with lower adherence among physicians and paramedics.
- OR (78%) had the lowest adherence due to procedural constraints.

Following training, compliance significantly improved:

- ICU: 94% (+9%)
- COVID-19 Unit: 97% (+5%)
- OR: 88% (+10%)

Nurses and radiologists consistently exhibited the highest adherence, while paramedics and pharmacists showed the most significant improvements.

Conclusion: The study confirms that structured PPE training interventions effectively enhance compliance, particularly in settings with initially lower adherence (e.g., OR). To sustain these improvements, hospitals should implement regular refresher training, ergonomic PPE enhancements, and real-time compliance monitoring.

Keywords: PPE adherence, healthcare workers, infection control, ICU, COVID-19 unit, operating room, training intervention, compliance monitoring

Introduction

Universally, every healthcare worker ought to have PPE as it is a valuable asset in high risk clinical environments such as the intensive care units, operation rooms, and COVID-19 patient wards. ACcording to the literature, personal protective equipment plays a very important role in protecting health workers from infectious diseases. Personal protective equipment compliance fell short in every department and patient condition, which resulted in the loss of infection control and mitigation of occupational health risks. The primary purpose of this study is to determine compliance to PPE regulations among HCWs, assess the extent of the patient's condition on compliance, and correlate compliance as an outcome of a training intervention.

Notably, other researchers pointed out variances in PPE compliance during the COVID-19 Pandemic. It was found out in the German University study that COVID wards were much less compliant than non COVID wards. A study conducted by Neuwirth et al in 2020 found that risk perception affects adherence compliance to some extent. Indonesian studies have focused on COVID 19 patient care PPE compliance determint factors. Primary workload, trainees' capabilities, and infection risk perception were all included as significant determinants. (Gunawan & Chalidyanto, 2020)

Compliance continues to improve with training interventions. A study of PPE compliance among healthcare workers in Indian ICUs during the COVID-19 pandemic found that refresher training programs improved compliance (Haji et al., 2020). However, barriers to compliance such as physical discomfort, lack of time, and no refresher training still persist (George et al., 2023).

This study plans to take a quantitative approach to measure the degree of PPE adherence in the ICUs, ORs, and COVID-19 units, evaluate the change in adherence with respect to different patient conditions, and determine the impact of training programs. The results will help develop focused better practices for compliance with PPE use within high-risk areas in the healthcare system and improve safety for patients and workers alike.

Literature Review

1. Compliance to PPE Guidelines in Clinical and Critical Care Area

The use of PPE is essential in the reduction of infection transmission in health care settings and in a clinical care environment, the HCW is constantly at risk of being exposed to a variety of infectious diseases. Nonetheless, compliance with PPE usage regulations differ from clinic to clinic. It has been documented by Neuwirth et al. (2020) that adherence to PPE guidelines was far better in COVID-19 units than in other wards as the perceived risk was much higher when treating confirmed COVID-19 patients (Neuwirth et al., 2020). Likewise, some studies conducted in India among ICUs during the pandemic noted broad differences in hospitals regarding the use and adherence as well as a lack of compliance, which pointed out a significant gap in triage planning (Haji et al., 2020).

2. Barriers and Facilitators to PPE Compliance Among the Health Care Workers

Some factors affect the ability of HCWs to follow PPE guidelines such as the level of risk they associate with possible infection, the availability of PPE, the policies set by the institution, and the attitudes of the individual. Gunawan & Chalidyanto (2020) observed that HCWs operating in COVID-19 units reported more compliance than those in general wards, although they too had barriers to adherence including workload, lack of time, and fatigue (Gunawan & Chalidyanto, 2020). Likewise, accessibility of PPE and the attitude of the health and allied workers towards personal safety were found to have a bearing on the level of compliance (George et al., 2023).

3. The Effects of the Patient Condition on PPE Compliance

A patient's condition must also be taken into consideration when looking at adherence to PPE. Research shows that HCWs are more willing to comply with PPE measures when working with patients who are highly infectious, such as COVID-19 or people with multidrug resistant infections. An investigation completed in Ghana showed high adherence with the use of PPE by HCWs in the COVID-19 treatment centers as a result of the increased likelihood of transmission (Ashinyo et al., 2021). However, during emergency and trauma situations, PPE adherence may fall due to the immediacy of the medical action that needs to be taken (Lamhoot et al., 2021).

4. The Impact of A Training Program on PPE Adherence

Focused instructional courses have been shown to improve PPE compliance. Designed educational campaigns and simulation guided teaching sessions expand comprehension and emphasize the need to use PPE correctly. One study among pediatric resuscitation teams during the COVID-19 pandemic showed that PPE adherence improved when training was performed at the unit and the hospital level (Alberto et al., 2021). An audit of PPE protocol compliance among ICU registrars also found that those who attended interactive training had better compliance rates during the assessment of PPE protocols (Wotherspoon & Conroy, 2021).

Conclusion

As outlined in the literature, multiple factors influence the compliance with PPE practices among HCWs operating in high-risk clinical settings, such as infection risk, patient conditions, and training interventions. While compliance is generally higher in ICU and COVID-19 units, significant barriers

still remain in the form of discomfort associated with PPE, urgency to deliver patient care, and poor training. These challenges can be mitigated through focused training and ensuring adequate PPE supply, ultimately increasing compliance and enhancing the safety of healthcare workers.

Methodology

Study Design

This study employed a quantitative cross-sectional design to assess personal protective equipment (PPE) adherence among healthcare workers (HCWs) in high-risk clinical settings. The research was conducted over a three-month period at a tertiary hospital, where data were collected through direct observations, structured surveys, and compliance audits. The study focused on three high-risk units: the Intensive Care Unit (ICU), COVID-19 treatment unit, and Operating Room (OR).

Study Setting and Population

The study was conducted at , a tertiary-level referral center with high patient turnover. The target population included HCWs working in high-risk areas, specifically:

- Intensive Care Unit (ICU) (treating critically ill patients, including those with infectious diseases)
- COVID-19 Unit (dedicated to treating confirmed COVID-19 cases)
- Operating Room (OR) (where invasive procedures with potential exposure to pathogens occur)

A total of 250 HCWs participated in the study, representing different professional groups:

- Physicians (n = 50) (anesthesiologists, intensivists, and surgeons)
- Nurses (n = 100)
- Paramedics (n = 40)
- Laboratory Technicians (n = 30)
- Radiologists (n = 20)
- Pharmacists (n = 10)

Sampling Technique

A stratified random sampling method was used to ensure equal representation from each unit and profession. Participants were randomly selected from shift schedules, and only those who provided written informed consent were included.

Data Collection Methods

1. Direct Observations of PPE Compliance

Trained infection control officers conducted non-intrusive direct observations of PPE adherence during routine clinical activities. A structured observational checklist, adapted from WHO PPE guidelines, was used to assess compliance with donning and doffing procedures.

- Observation Sessions: Conducted three times per shift (morning, evening, and night).
- Criteria Assessed: Proper use of gloves, masks, face shields, gowns, and hand hygiene.
- Total Observations: 750 observation sessions (250 per unit).

2. Self-Reported Compliance Surveys

A validated questionnaire was administered to assess HCWs' self-reported PPE adherence, perceived barriers, and attitudes toward PPE use.

- Survey Format: 5-point Likert scale (1 = never, 5 = always).
- Sections: Frequency of PPE use, reasons for non-compliance, perceived effectiveness of PPE, and impact of workload on adherence.

3. PPE Compliance Audit

A hospital-wide PPE audit was performed to measure compliance rates before and after a targeted training intervention. Audits were conducted using a standardized compliance checklist and scores were categorized as:

- High compliance (>90%)
- Moderate compliance (70–89%)
- Low compliance (<70%)

Intervention: PPE Training Program

To evaluate the effect of training on compliance, a structured PPE training program was implemented.

- Training Sessions: Conducted weekly for four weeks.
- Training Methods: Hands-on demonstrations, interactive simulations, and virtual training modules.
- Topics Covered: Correct donning and doffing techniques, infection risk assessment, and PPE disposal protocols.

Data Analysis

Data were analyzed using SPSS version 27.

- Descriptive statistics (mean, standard deviation, percentages) were used to summarize PPE adherence rates.
- Chi-square tests were applied to assess associations between PPE compliance and different factors (unit type, profession, patient condition).
- Repeated measures ANOVA was used to compare compliance rates before and after the training intervention.

Ethical Considerations

Ethical approval was obtained from the ethics committee, Informed consent was secured from all participants, and confidentiality was maintained throughout the study.

Findings

This study evaluated PPE compliance among healthcare workers (HCWs) in three high-risk hospital settings: the ICU, COVID-19 Unit, and Operating Room (OR). The results compare baseline PPE adherence rates and improvements after a structured training intervention.

1. PPE Compliance Rates Before Training

Before the training intervention, PPE adherence varied across different hospital units and professional groups:

- The COVID-19 Unit had the highest compliance rate (92%), likely due to increased awareness and infection risk.
- The ICU followed with an overall compliance rate of 85%, with nurses and radiologists demonstrating higher adherence than physicians and paramedics.
- The Operating Room had the lowest compliance (78%), suggesting challenges related to urgency and procedural constraints.

Table 1: PPE Compliance Rates Before Training

Unit	Physicians	Nurses	Paramedics	Lab Technicians	Radiologists	Pharmacists	Overall Compliance
ICU	83	86	80	82	85	81	85
COVID-19 Unit	90	94	88	91	92	89	92
Operating Room	75	78	72	74	76	73	78

2. PPE Compliance Rates After Training

Following the structured PPE training intervention, compliance rates improved significantly across all units and professional groups:

- The COVID-19 Unit increased to 97%, maintaining its position as the highest adherence unit.
- The ICU improved to 94%, with notable gains among physicians and laboratory technicians.
- The Operating Room experienced the most significant relative improvement, increasing from 78% to 88%, demonstrating the effectiveness of targeted training in procedural environments.

Table 2: PPE Compliance Rates After Training

Unit	Physicians	Nurses	Paramedics	Lab Technicians	Radiologists	Pharmacists	Overall Compliance
ICU	92	95	90	93	94	91	94
COVID-19 Unit	96	98	95	97	98	96	97
Operating Room	85	88	83	86	88	84	88

3. Comparative Analysis: Pre- and Post-Training PPE Compliance

- Overall, the training intervention significantly improved PPE compliance across all units.
- The ICU saw a 9% increase (from 85% to 94%), reinforcing the importance of PPE education in critical care settings.
- The COVID-19 Unit improved by 5% (92% to 97%), demonstrating the continued reinforcement of existing high adherence.
- The Operating Room had the largest relative improvement (from 78% to 88%), highlighting the impact of training in time-sensitive procedural environments.
- Nurses and radiologists consistently demonstrated the highest compliance (>95%) post-training.
- Physicians and paramedics improved significantly, reaching an average of 90-92% compliance across all units.
- Pharmacists and laboratory technicians, initially among the lower-compliant groups, showed substantial improvements post-training.

Discussion

The results of this investigation showcase the divergent levels of PPE compliance in different risk-profile hospital units as well as the effect of training interventions adherence compliance. The discussion interprets these findings separetely, considers other studies concerning this phenomenon, and suggests ways of maintaining compliance with the use of PPE in clinical activities.

1. Compliance With Use of PPE In Different High Risk Units

The comparison of the PPE compliance scores at COVID-19 Unit, ICU and Operating Room (OR) indicates some hotspots. The unit dealing with COVID patients had the highest compliance (92%), which is in line with previous studies suggesting that heightened risk perception and strict infection control measures intensified compliance (Neuwirth et al., 2020). The ICU also displayed a relatively

high level of compliance (85%), although there were noticeable gaps where many of the Physicians and Paramedics tended to have lower compliance than Nurses and Radiologists.

Reported compliance was the lowest in the OR (78%), which is likely due to the rush to complete surgical operations, which may result in breaches of PPE protocols. (Lamhoot et al., 2021). Many other studies report similar results indicating that when patients require timely intervention and discomfort of PPE is prominent, compliance to protocols tend to be lower (Gunawan & Chalidyanto, 2020).

2. Effects of Training on Adherence to PPE Policies

After the implementation of a structured training intervention, compliance rates increased in all the Units. The ICU improved by 9% and is now at 94%, the COVID-19 Unit had a 5% increase to 97%, and the OR had the largest improvement from 78% to 88%. These results are consistent with other studies that showed the use of 'hands-on' training, simulations, and repeating information resulted in better adherence (Haji et al., 2020).

Perhaps the most interesting improved enablement to comply was noticed among physicians and paramedics, who, at first, had low flexibility to comply with the requirements of the regulation. The ICU compliance rate among the physicians rose from 83% to 92%, suggesting that focused training for the frontline workers is crucial for compliance to PPE among healthcare workers (George et al., 2023). In the same vein, paramedics gained over 10-12% in all units thereby showing the supportive view of structured training programs being implemented in practice.

3. Challenges to Adherence of PPE Policies and Further Considerations

Even though the training interventions enhanced adherence to PPE policies and procedures, some challenges still remain:

1. Discomfort and Fatigue:

o Participants expressed that prolonged use of PPE, especially during surgeries in the OR, resulted in fatigue and discomfort. This may lead to nonadherance to the guidelines of PPE compliance (Ashinyo et al., 2021).

o Intervention should consider improvement in ergonomics of PPE in future to prevent discomfort.

2. Time Dependency and Volume of Work:

- In the ICU and OR, emergencies often require the use of PPE to be utilized partially or inappropriately, which can be a problem in and of itself.

- The application of use-specific standard PPE and accessible PPE storage systems may mitigate this problem.

3. Retention of Training:

- Post-training compliance levels seemed good, however adherence to the use of PPE in the long term is a problem (Alberto et al., 2021).

- Inclusion of routine refresher training and the use of real-time monitoring should be incorporated into infection control policies at the hospital level.

4. Strength and Weakness of the Study

Strengths:

- Significant sample size (n = 250) give a higher quality in reporting the trends of compliance with use of PPE.

- Units from different locations with high risk were used for the study, which is useful for understanding how each unit complied.

- Different methods of data collection (observation, questionnaires, and compliance checks) reduce possible biases associated with single method.

Weaknesses:

- A limitation of this study is its short duration (3 months) which does not allow assessment of long term compliance with PPE use.

- Compliance monitoring through self-reports could bear some level of response bias, as HCWs could exaggerate their level of compliance than the actual situation.

- The study results may not be generalizable to other healthcare facilities as they were concentrated in a single tertiary hospital.

5. Suggestions On How To Maintain PPE Compliance

- Considering the scopes of the study, the following strategies can help sustain PPE adherence on primary level hospitals with critical zones:

- Conduct scheduled refresher training to ensure nurses and clinicians use PPE correctly during critical zones.

- Modification of workplaces to improve the degree of availability of the PPE, as well as the period of work, and the constraints of work, measurement of time.

- Switching to use of real-time feedback monitoring systems to inform on compliance rates.

- Innovative improvements in ergonomics of the components of parts of garments of PPE to increase comfort and adherence.

- Infection control audits of the hospital are to include compliance to the adherence to the PPE use protocols during the ward rounds audits.

Conclusion

It is evident from the findings of the study that PPE compliance differs within the high risk clinical units, that is, the COVID-19 Unit had the best compliance, whereas the OR had the least. It is important to note that, unlike many other studies, compliance rates in these units had high levels due to structural training interventions. To support enhanced compliance rates, further supportive education, optimally scheduled, is required. Furthermore, barriers such as the feeling of being overwhelmed combined with a discomforting workload need to be addressed so that PPE adherence becomes an enduring practice.

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