

# An Analysis of the Effect of Personal Protective Equipment (PPE) Training Based on the Information–Motivation–Behavior Skills Model in the Practice of COVID-19 PPE Application

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**Objective:** The aim of this study is to improve the effectiveness of training in putting on and removing personal protective equipment (PPE) during COVID-19.

**Methods:** An information–motivation–behavioral skills (IMB) model intervention team was established with the adoption of the IMB model to intervene in putting on and removing PPE by medical staff during COVID-19. Specifically, the information intervention was strengthened through the formulation of the hospital manual for PPE application. In the present study's five-stage motivational interview, the personal motivation and social motivation of medical staff were deeply understood, helping the medical staff to improve their belief in the importance of correct PPE application and to establish the correct attitude toward PPE application. In terms of behavioral skills, there are numerous issues that could interfere with the establishment of proper PPE application, including material supply, double duty, simultaneous supervision of entering and leaving, continuous supervision, video supervision, and nosocomial infection inspection. The scores relating to PPE application knowledge and self-efficacy as well as the PPE usage qualification rate were calculated in the control group and the IMB intervention group and subsequently compared.

**Results:** For the control group and the IMB intervention group, the scores for PPE application knowledge were  $87.78 \pm 10.46$  and  $95.56 \pm 9.06$  points, respectively. For self-efficacy, the scores were  $25.19 \pm 0.97$  and  $33.79 \pm 2.05$  points, and the PPE usage qualification rates were 64.8% and 90.0%, respectively. The differences in all the scores were statistically significant between the two groups.

**Conclusion:** The application of the IMB model could improve the relevant knowledge relating to PPE application, strengthen the belief in the importance of and motivation for correct PPE application, improve the qualification rate for PPE application, and provide a theoretical and practical basis for reducing the occurrence of nosocomial infection.

**Keywords:** information–motivation–behavioral skills model, COVID-19, personal protective equipment

## Introduction

Novel coronavirus pneumonia (COVID-19) is an emerging infectious disease. As of 24:00 on May 25, 2020, China reported 129,913 confirmed cases,<sup>1</sup> and the total number of confirmed cases outside of China exceeded 275,763,346. COVID-19 can be transmitted through respiratory droplets and close contact and is highly contagious.<sup>1–3</sup> As they are in close contact with patients, medical personnel are at a high risk of nosocomial infection. An investigation showed that 41% of medical personnel who were infected with COVID-19 were infected as a result of nosocomial infection and the mortality rate was as high as 4.3%.<sup>4</sup> According to a survey, a total of 3019 medical staff infected with novel coronavirus in 422 health care facilities providing consultation and treatment services for patients with neocoronavirus, with a high

incidence of nosocomial infections. Personal protective equipment (PPE) is designed to reduce the risk of exposure for medical personnel while treating infected patients and being exposed to contaminated surfaces. PPE plays an important role in protecting medical personnel while treating patients in isolation and reducing the nosocomial infection rate. Previous studies have shown that medical personnel not effectively putting on and removing PPE is a significant risk factor for nosocomial infection.<sup>5</sup> The information–motivation–behavioral skills (IMB) model refers to an intervention that involved providing information about, motivation for, and establishing behavioral skills for a specific behavior and adopting targeted improvement measures to promote the establishment of an effective behavior.<sup>6</sup> It is a systematic, scientific, and prospective behavioral change model and has been widely applied in various fields of medical care.<sup>7,8</sup> As our hospital is a designated hospital for patients with COVID-19, this model was applied for the management of putting on and removing PPE by medical staff and achieved good results. The details are reported as follows.

## Research Subjects

A total of 106 medical staff members participating in COVID-19 treatment in our hospital from January 10, 2020, to March 10, 2020, were selected as research subjects using a convenience sampling method. The inclusion criteria were as follows: ① wearing PPE when offering first-line treatment to patients with COVID-19 and ② able to communicate effectively. ③ Volunteered to participate in this study and agreed to wear PPE to participate in the treatment of patients with COVID-19 and ④ had good physical condition, voluntarily enter the isolated ward and passed the tightness test of the mask. The exclusion criteria were as follows: ① unable to continue offering first-line treatment to patients for personal reasons and ② previous experience in putting on and taking off PPE (ie, PPE application) for SARS, H1N1, Ebola, etc. This study was conducted with approval from the Ethics Committee of The Second Hospital of Nanjing University of Chinese Medicine. This study was conducted in accordance with the declaration of Helsinki. Written informed consent was obtained from all participants.

A total of 56 medical workers who started offering first-line treatment from January 10, 2020, to February 10, 2020, were selected as the control group. Of these, two were unable to continue offering first-line treatment for personal reasons, so a total of 54 subjects were included in the control group and completed the study. The experimental group (IMB group) consisted of 50 medical workers who started offering first-line treatment from February 11, 2020, to March 10, 2020, and the IMB model was implemented in this group for the management of putting on and removing PPE. There were no statistical differences in age, gender, educational background, professional title, working years, and other social demographic data between the two groups.

## Research Methods

### The Control Group

In terms of PPE application, the control group was managed using conventional methods. The hospital set up PPE management, and eight medical staff, nursing staff, and infection control specialists with experience in emergent infectious diseases were selected to undertake the PPE management. Team members were responsible for formulating the PPE procedures, giving theoretical lectures, demonstrating protective skills, and providing operational guidance to the control group upon entering first-line work. The PPE knowledge assessment, self-efficacy questionnaire, and PPE qualification survey were carried out one by one.

### The Experimental Group

An IMB PPE management team was set up. The PPE management team for the experimental group consisted of the same members of the PPE management team for the control group. To ensure the quality of the intervention, the IMB group leader conducted unified training, the PPE knowledge assessment, the self-efficacy questionnaire, and the PPE qualification survey for the IMB group.

#### Information Intervention: Relevant Education

① Knowledge of COVID-19: Members of the IMB management group organized for the medical staff studied the latest version of the COVID-19 prevention and control protocols, the diagnostic and treatment protocols, and other relevant

guidelines issued by the country to enable the medical staff to have a clear understanding of COVID-19; related theoretical knowledge, such as etiology; epidemiological characteristics; clinical classification; manifestations; diagnostic criteria; treatment, prevention; and nursing points and informed them of the necessity of standardizing the method of PPE application.

② Manual of PPE application: Based on the Guidelines on the scope of use of common medical PPE in the prevention and control of pneumonia in COVID-19 (trial),<sup>9</sup> Technical guidelines for COVID-19 prevention and control in healthcare settings (first edition),<sup>10</sup> How to put on and remove PPE (issued by the World Health Organization), and Reference of the previous experience in our hospital in fighting with COVID-19, the IMB management team formulated the procedure manual for PPE application. The manual included a schematic diagram of humans putting on and removing PPE; this was easy to understand and memorize during training.

③ Post-training: Since there are many steps in the process of putting on and removing PPE, a designated PPE area was created in the ward to facilitate the process, and an appropriately sized poster of the schematic diagram was posted. The necessary items were placed in the designated area in the correct sequence, as depicted in the poster.

④ PPE video: According to the steps outlined in the procedure manual, the IMB management team made a video of how to put on and remove PPE in real life and posted it on the WeChat platform using the video feedback method so that the medical staff in the IMB group could watch it several times to fully learn the process.

### Motivation for Intervention and Self-Efficacy Enhancement

COVID-19 is highly contagious, the outbreak is spreading fast, and to date, there is no specific treatment or vaccine. Medical staff involved in first-line treatment may have anxiety and fear due to the risk of infection or may be too relaxed due to a lack of understanding of the disease. Low PPE self-efficacy among medical staff could lead to improper protection. Therefore, specific motivational interviews were used at various times for the medical staff participating in first-line work to improve PPE self-efficacy. The specific methods were as follows:

① Unintentional stage: The IMB management group conducted face-to-face interviews with the IMB group to understand their psychological state and needs and encouraged them to express their thoughts and concerns about first-line work and the process of PPE application. The interviewers paid close attention during the interviews to show respect, ensure that they fully understood the subjects, and increase the IMB group's level of trust in the management team members.

② Intentional stage: Through conversation, the importance and necessity of correct PPE application were emphasized to the IMB group. The IMB group, in turn, shared their level of confidence in the process of PPE application with the management team. By sharing their successful experiences in participating in major public health events, the management team demonstrated the importance of the proper application of PPE in effectively avoiding COVID-19 infection, strengthened the awareness of PPE in the IMB group, and timeously corrected the negative feelings and psychological difficulties of the IMB group in the face of the epidemic.

③ Preparation stage: The understanding of COVID-19 and the importance of proper PPE application were continuously strengthened in the IMB group. Various measures were used to provide information, and a combination of theoretical knowledge and practical skills were imparted. Various methods were adopted to guide PPE application. According to the PPE application situation of the IMB group, the training and management scheme for PPE application was formulated.

④ Change stage: The training and management program for PPE application was reviewed with the subjects in the IMB group, and timely adjustments and corrections to the program were made by evaluating and receiving feedback to ensure the feasibility of the program implementation.

⑤ Maintenance stage: The management group regularly communicated with the IMB group to establish a belief in the importance of correct PPE application and enhance their confidence in PPE for preventing nosocomial infection. According to their knowledge and PPE application behaviors, the management team provided the IMB team with guidance to help them correctly understand the significance of PPE application for the prevention and control of nosocomial infection. The self-management awareness and ability were improved, and the PPE application behaviors were supervised correctly. Subjects in the IMB group were encouraged to maintain positive protective attitudes and behaviors, and colleagues were fully encouraged to supervise and support them to ensure that subjects in the IMB group continued to use their PPE correctly.

### Behavioral Interventions: Improve the Qualification Rate for PPE Application

In the IMB-based PPE application management, informational and motivational interventions provided a basis for behavioral intervention. Based on the knowledge of and motivation for PPE application, the behavioral intervention would become the

most important step for qualified PPE application. The behavioral interventions conducted in this study were as follows: ① Adequate supplies: If the PPE is too small, it will lead to exposed skin, and if it is too large, it will be loose. In both instances, the PPE application will be unsatisfactory. Therefore, for the purposes of this study, the hospital deployed materials in a unified manner to ensure sufficient PPE for staff in high-risk departments, such as isolation wards, to avoid unsatisfactory PPE application resulting from a lack of properly sized PPE. ② Double duty and supervision: The double-duty system was implemented, requiring staff on duty to leave and incoming staff to enter at the same time, giving them an opportunity to supervise each other in the correct application of PPE. ③ Strengthen supervision: An infection supervisor post was created. The infection supervisor was posted at the gate of each isolation ward 24 hours a day to conduct a PPE qualification inspection on all staff entering the isolation ward. A surveillance video was set up in the PPE application area, and supervision was conducted via video monitoring. The supervisor then offered timely advice via the intercom if they observed non-standard behavior, and they urged the staff member to improve in their PPE application efforts. ④ Prompt correction: Daily inspections were carried out by the members of the nosocomial infection control team who analyzed and discussed problems relating to PPE application through onsite inspection and video surveillance playback. Measures for correction were put forward to standardize the behavior of the medical staff.

## Evaluation Indicators

### Test of Theoretical Knowledge

The theoretical knowledge paper on COVID-19 prevention and control and PPE application was issued by the IMB management team, with a total score of 100 points. On February 10 and March 10, the control group and the IMB group were tested, and their knowledge of COVID-19 and PPE application were compared.

### Self-Efficacy

In the present study, the Chinese version of the General Self-Efficacy Scale (GSES) was used to measure the participants' belief in the importance of PPE application. The GSES was developed by Schwarzer et al and translated and revised by Wang Caikang et al in 2001. The GSES has good reliability, with an internal consistency coefficient Cronbach's  $A = 0.87$ , a retest reliability  $r = 0.83$ , and split-half reliability  $r = 0.82$ , all of which show high reliability and validity.<sup>11–13</sup> This scale has 10 items rated on a four-point Likert scale. The higher the total score, the higher the belief of the subject in the importance of PPE application. On February 10 and March 10, the PPE self-efficacy was measured and compared between the control group and the IMB group.

### Qualification Rate of PPE Application

Direct observation methods were adopted by the IMB management team to observe and record the medical staff putting on and removing the PPE. The qualification ratio of PPE application is the number of people qualified in PPE application divided by the total number of people. Those qualified in the two subprocesses of PPE application were considered to be qualified. A staff member's qualification in PPE application was judged according to the standard PPE application process issued by the hospital.

## Statistical Analysis

The SPSS 20.0 statistical software was used for analysis. Measurement data were expressed as the mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ). The *t*-test was used for comparison between the groups. The chi-squared test was used for the comparison of the countable data, and  $P < 0.05$  was considered statistically significant.

## Results

### Comparison of the PPE Knowledge Between the Two Groups

The PPE knowledge scores of the medical staff in the IMB group were significantly better than in the control group ( $P < 0.05$ ; see Table 1).

**Table 1** Comparison of the Scores of Putting on and Removing PPE Knowledge Between the Two Groups ( $\bar{x} \pm s$ )

Items	The Control Group (n=54)	The Experimental Group (n=50)	t value	P value
The scores of putting on and removing PPE knowledge	87.78 $\pm$ 10.46	95.56 $\pm$ 9.06	2.52	0.02

**Table 2** Comparison of the PPE Self-Efficacy Between the Two Groups ( $\chi^2$ , P value)

Items	The Control Group (n=54)	The Experimental Group (n=50)	t value	P value
PPE self-efficacy	25.19 $\pm$ 0.97	33.79 $\pm$ 2.05	-36.973	P<0.01

## Comparison of Self-Efficacy Between the Two Groups

The PPE self-efficacy scores of the medical staff in the IMB group were significantly better than in the control group ( $P < 0.05$ ; see Table 2).

## Comparison of the Qualification Rate of PPE Application Between the Two Groups

The qualification rate for PPE application in the IMB group was significantly higher than in the control group ( $P < 0.05$ ; see Table 3).

## Discussion

This study implemented a series of PPE wear and tear management measures from the aspects of information, motivation, behavior skills and so on at the early stage of the epidemic of COVID-19 based on the IMB model. We found that the process was scientific and reasonable. The results showed that the implementation of the IMB model improved the qualified rate of PPE wear and tear of medical personnel, and provided valuable practical experience for the management of PPE wear and tear during the COVID-19.

The proper preparation of the medical staff in PPE application is critical in COVID-19 care.<sup>5</sup> A full set of PPE includes protective clothing, gloves (three layers), a hat, an eye mask, an N95 mask, shoe covers, and a face screen. In addition, according to relevant guidelines, PPE should be properly worn following the sequence in accordance with the regional protective requirements. According to the literature, the PPE application process includes more than a dozen steps, all of which are complex and time consuming.<sup>14,15</sup> COVID-19 is highly contagious, and the epidemic is developing rapidly; therefore, inadequate PPE protection may expose the skin and mucous membranes of medical staff, increasing the risk of nosocomial infection.<sup>16</sup> However, excessive protection may lead to the waste of protective materials and environmental cross infection.<sup>17</sup> The IMB model involves multiple links to behavioral change, such as PPE information, motivation, and behavioral skills, and it has been widely applied.<sup>8,18,19</sup> Information is a prerequisite for healthy behavior.

**Table 3** Comparison of the Qualification Rate of Putting on and Removing PPE Between the Two Groups

Items	Qualified Number of Putting on and Removing PPE (Number, %)	Unqualified Number and Time of Putting on and Removing PPE (Number, %)
The control group (n=54)	35(64.8%)	19(35.2%)
The experimental group (n=50)	45(90.0%)	5(10.0%)
$\chi^2$	9.277	
P value	<0.01**	

Note: \*\*P<0.01.



The present study provided practical PPE knowledge, guidance, information supplementation, and correction for medical staff. In the five-stage motivational interview used in the study, the personal motivation and social motivation of the medical staff were deeply understood. This helped the medical staff improve their belief in the importance of correct PPE application and establish good PPE application attitudes. In terms of behavioral skills, there are many things that could interfere with the establishment of proper PPE application, such as material supply, double duty, simultaneous supervision of entering and leaving, continuous supervision, video supervision, and nosocomial infection inspection. A series of scientific and reasonable PPE application management interventions based on the IMB model conformed to the rules of behavior establishment and improved the qualification rate for PPE application by supplying information, increasing motivation, and impacting the behavioral skills related to PPE application. After the intervention, the knowledge related to PPE application, the self-efficacy, and the qualification rate increased in the IMB group. This was of great significance in preventing, reducing the incidence of, and controlling nosocomial infections.

The present study had some limitations. Due to limited time and resources, only 104 subjects were included in the study, which cannot represent the whole population. In addition, the subjects were chosen from personnel in various echelons of the hospital, which could cause the results to be susceptible to various factors that are unrelated to what is being tested. Subsequent studies could improve on the research methodology and expand the sample size to ensure that the research results are more informative.

## Conclusion

In the present study, it showed that the application of the IMB model could improve the relevant knowledge relating to PPE application, strengthen the belief in the importance of and motivation for correct PPE application, improve the qualification rate for PPE application, and provide a theoretical and practical basis for reducing the occurrence of nosocomial infection.

## Disclosure

The authors report no conflicts of interest in this work.

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