

Observational Study on the Appropriate Use of Personal Protective Equipment During the COVID-19 Pandemic: An Italian Experience

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Abstract

Introduction. During the COVID-19 pandemic, operating room nurses were at high risk of SARS-CoV-2 infection, making the appropriate use of personal protective equipment (PPE) essential to ensure staff safety and reduce viral transmission. This study aimed to evaluate operating room nurses' adherence to national recommendations on PPE use, investigate the association between PPE selection and COVID-19 infection, and assess nurses' involvement in developing perioperative COVID-19 protocols.

Methods. A cross-sectional exploratory study was conducted in 2021 using an online survey distributed through the Italian Association of Operating Room Nurses (AICO). Data from 153 operating room nurses were analyzed using descriptive statistics and chi-square tests.

Results. Most participants appropriately selected FFP2/FFP3 respirators and eye protection. Twelve nurses (7.8%) reported COVID-19 infection. Greater operating room experience was associated with infection, whereas no significant association emerged between PPE selection and infection. Only 36% of participants were involved in developing COVID-19 protocols.

Discussion. Operating room nurses generally adhered to national PPE recommendations. However, limited involvement in protocol development highlights the need to strengthen frontline staff participation in organizational decision-making during future infectious disease emergencies.

Keywords: Personal Protective Equipment, COVID-19, Perioperative Nursing, Operating Rooms, Infection Prevention, Occupational Health

Introduction

At the end of December 2019, a novel coronavirus (SARS-CoV-2) was identified in Wuhan, China (Zhu et al., 2020). The World Health Organization (WHO) subsequently designated the disease as COVID-19 (Lu et al., 2020; Rothan & Byrareddy, 2020). One month later, COVID-19 was declared a global pandemic (Cucinotta & Vanelli, 2020). The rapid worldwide spread of the disease placed an unprecedented burden on healthcare systems, with hospitals facing major challenges in the management of infected patients (World Health Organization, 2021a). In Italy, as in many other countries, strict public health measures were introduced to contain viral transmission (World Health Organization, 2021b). While the general population was required to remain at home, healthcare professionals continued providing direct patient care, exposing themselves to a substantial risk of infection (Rajnik et al., 2021). During the pandemic, operating rooms remained active for both COVID-19-positive and COVID-19-negative patients (The Lancet, 2020). Dedicated pathways and operating theatres were established to reduce the risk of transmission throughout the perioperative process (Istituto Superiore di Sanità, 2021; Dexter et al., 2020). National scientific societies, including the Italian Association of Operating Room Nurses (AICO) and the Italian Society of Anaesthesia, Analgesia, Resuscitation and Intensive Care (SIAARTI), issued recommendations regarding the appropriate selection and use of personal protective equipment (PPE) (AICO, 2021; SIAARTI, 2020). Appropriate PPE selection, together with adequate training in donning and doffing procedures, represented the cornerstone of infection prevention among perioperative healthcare professionals (Ortega et al., 2020).

Objectives

The primary objective of this study was to evaluate whether operating room nurses selected the appropriate PPE according to AICO and SIAARTI recommendations during the management of patients with SARS-CoV-2 infection. The secondary objective was to investigate the relationship between

inappropriate PPE use and the occurrence of COVID-19 infection among operating room nurses. A third objective was to determine whether perioperative teams had been involved in developing new organizational and clinical protocols for the surgical management of patients with COVID-19.

Methods

Study Design and Setting

A cross-sectional exploratory study was conducted in 2021. An online survey was made available to members of the Italian Association of Operating Room Nurses (AICO) through the association's official website for approximately three months. The survey link was reposted every 15 days to encourage participation.

The present study represents a secondary analysis of additional variables collected within the broader national survey of Italian operating room nurses conducted in 2021. Other outcomes derived from the same survey have been reported elsewhere (Ferraiuolo & Iezzi, 2026).

AICO is an Italian scientific association dedicated to promoting the professional development of perioperative nurses working within surgical teams at both national and international levels. The association supports the development of clinical guidelines addressing perioperative patient management, surgical safety, risk prevention, and quality improvement in operating room practice (AICO, n.d.).

The Italian Society of Anaesthesia, Analgesia, Resuscitation and Intensive Care (SIAARTI) is a scientific society that promotes the integration of clinical practice and research to improve clinical guidelines and therapeutic protocols while fostering collaboration among anaesthesiologists and intensive care professionals throughout Italy (SIAARTI, n.d.).

Participants

A total of 156 nurses voluntarily completed the questionnaire. Three respondents were excluded because they were not members of Italian operating room teams. Consequently,

153 nurses, selected from approximately 2,000 registered AICO members, were included in the final analysis.

Eligible participants were registered nurses actively working within Italian operating room teams involved in the care of patients with COVID-19 who provided informed consent before completing the survey. Nurses not working in COVID-19 settings or not belonging to Italian perioperative teams were excluded. As this was designed as a pilot study, no formal sample size calculation was performed.

Survey Instrument

The questionnaire consisted of 16 items.

The first section included seven questions collecting demographic and professional information, including age, sex, geographical area of employment, professional role, and responsibilities within the operating room team.

The second section consisted of eight multiple-choice questions and one open-ended question investigating the appropriate use of personal protective equipment (PPE) during the perioperative management of patients with COVID-19.

Specifically, participants were asked about:

- the type of respiratory protective device used during surgery on COVID-19-positive patients;
- the type of eye and face protection adopted;
- the airway management devices used during endotracheal intubation;
- the use of additional protective devices to reduce aerosol exposure during intubation;
- the availability of dedicated COVID-19 operating rooms;
- the availability of dedicated support personnel;
- nurses' involvement in developing COVID-19 perioperative protocols;
- occupational SARS-CoV-2 infection during the pandemic.

Statistical Analysis

Data were analysed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA).

Descriptive statistics included frequencies,

percentages, means, and standard deviations. Associations between participants' characteristics and study variables were explored using the chi-square (χ^2) test. Statistical significance was established at $p \leq 0.05$.

Ethical Considerations

The study involved adult healthcare professionals and collected no directly identifiable personal or patient data. Participation was voluntary and anonymous, and electronic informed consent was obtained before completion of the questionnaire. The study protocol was approved by AICO (Protocol No. 3, March 1, 2021) and conducted in accordance with applicable data protection regulations and the principles of the Declaration of Helsinki.

Results

Participant Characteristics

A total of 153 operating room nurses completed the survey, and all participants provided informed consent.

Female nurses represented the majority of the sample ($n = 98$, 64.1%). The mean age was 43.8 ± 10.0 years. Most participants worked in Southern Italy ($n = 49$, 32.0%) or Northern Italy ($n = 48$, 31.5%). The mean overall professional experience was 21.7 ± 11.9 years, while the mean operating room experience was 15.6 ± 11.1 years.

Sixty-three participants (41.1%) had fewer than 10 years of perioperative experience, 48 (31.5%) had between 11 and 20 years, and 42 (27.4%) had more than 20 years of experience.

The most frequently reported professional role was scrub nurse ($n = 105$, 68.6%), followed by anaesthesia nurse ($n = 28$, 18.3%) and circulating nurse ($n = 20$, 13.1%).

Participant characteristics are summarized in Table 1.

Personal Protective Equipment Used During Surgery for Patients with COVID-19

The FFP2 respirator was the most frequently reported respiratory protective device, being used by 96 participants (62.7%). Forty-eight nurses (31.3%) reported using an FFP3

respirator, whereas only nine participants (6.0%) used a surgical mask.

Regarding eye and face protection, most respondents reported wearing either a face shield or visor (58.2%). A further 28.1% used a combination of protective goggles and a face shield, while only 9.8% relied exclusively on protective goggles.

Table 1. Participant Characteristics.

Characteristic	n (%)
Female	98 (64.1)
Male	55 (35.9)
Mean age (SD)	43.8 (10.0) years
Northern Italy	48 (31.4)
Central Italy	42 (27.5)
Southern Italy	49 (32.0)
Professional experience, mean (SD)	21.7 (11.9) years
OR experience <10 years	63 (41.2)
OR experience 11–20 years	48 (31.4)
OR experience >20 years	42 (27.4)
Mean OR experience (SD)	15.6 (11.1) years
Scrub nurse	105 (68.6)
Circulating nurse	20 (13.1)
Anaesthesia nurse	28 (18.3)

Note. Percentages are calculated on the total sample (N = 153). Geographical area was not reported for 14 participants.

Airway Management Devices

Videolaryngoscopy was the preferred airway management technique during endotracheal intubation of patients with COVID-19, reported by 85 participants (55.6%).

The Macintosh laryngoscope remained widely used (41.8%), whereas only four respondents (2.6%) reported using a bronchoscope.

Sixty-one nurses (39.9%) indicated that additional protective devices, such as an aerosol box, were employed during intubation to reduce exposure to airborne particles.

Personal protective equipment and airway management practices are summarized in Table 2.

Development of COVID-19 Protocols and Operating Room Organization

Only 55 participants (36.0%) reported being actively involved in developing institutional

protocols for the surgical management of patients with COVID-19.

Most respondents (n = 136) stated that dedicated operating rooms had been established for patients with confirmed SARS-CoV-2 infection.

Furthermore, 68.6% reported providing support to surgical teams outside the operating room during procedures involving patients with COVID-19.

Organizational measures implemented during the COVID-19 pandemic are summarized in Table 3.

Table 2. Personal Protective Equipment and Airway Management Devices.

Variable	n (%)
Respiratory protection	
FFP2 respirator	96 (62.7)
FFP3 respirator	48 (31.3)
Surgical mask	9 (6.0)
Eye/face protection	
Face shield/visor	89 (58.2)
Goggles + visor	43 (28.1)
Goggles only	15 (9.8)
None	6 (3.9)
Intubation device	
Macintosh laryngoscope	64 (41.8)
Videolaryngoscope	85 (55.6)
Bronchoscope	4 (2.6)
Additional aerosol protection	
Yes	61 (39.9)
No	92 (60.1)*

Table 3. Organizational Management During the COVID-19 Pandemic.

Variable	n (%)
Participated in protocol development	55 (36.0)
Did not participate	98 (64.0)
Dedicated COVID-19 operating room available	136 (88.9)
No dedicated operating room	17 (11.1)
Dedicated perioperative nurse available	105 (68.6)
No	26 (17.0)
Sometimes	22 (14.4)

Association Between Type of Respiratory Protection and COVID-19 Infection

Table 4 summarizes the relationship between the type of respiratory protection used during surgery and the occurrence of COVID-19

infection according to professional role.

Among nurses using surgical masks, only one case of COVID-19 infection was reported, involving a scrub nurse. However, this finding should be interpreted cautiously because very few participants used surgical masks.

Most infections occurred among nurses wearing FFP2 respirators (n = 10). Of these, eight (80%) were scrub nurses and two (20%) were anaesthesia nurses.

Only one infection was reported among FFP3 users, again involving a scrub nurse.

Table 4. Association Between Professional Role, Type of Face Mask, and COVID-19 Infection.

Type of face mask	Operating room role	Infected, n	Infected, %	Not infected, n	Not infected, %
Surgical mask	Circulating nurse	0	—	1	12.5
Surgical mask	Anaesthesia nurse	0	—	2	25.0
Surgical mask	Scrub nurse	1	100.0	5	62.5
FFP2 respirator	Circulating nurse	0	—	16	18.6
FFP2 respirator	Anaesthesia nurse	2	20.0	11	12.8
FFP2 respirator	Scrub nurse	8	80.0	59	68.6
FFP3 respirator	Circulating nurse	0	—	3	6.4
FFP3 respirator	Anaesthesia nurse	0	—	13	27.7
FFP3 respirator	Scrub nurse	1	100.0	31	66.0

Overall, scrub nurses experienced the highest number of infections regardless of respirator type, probably reflecting their closer and longer exposure to the surgical field.

Association Between Professional Characteristics and COVID-19 Infection

Overall, twelve participants (7.8%) reported

Table 5. Association Between Operating Room Practice Characteristics and COVID-19 Infection.

Variable	Category	Infected, n	Infected, %	Not infected, n	Not infected, %	p value
Age	<48 years	7	58.3	89	63.1	0.742
Age	>48 years	5	41.7	52	36.9	0.742
Operating room experience	<10 years	2	16.7	61	43.3	0.037
Operating room experience	11–20 years	3	25.0	45	31.9	0.037
Operating room experience	>20 years	7	58.3	35	24.8	0.037
Geographical area of employment	Northern Italy	4	33.3	44	34.6	0.970
Geographical area of employment	Central Italy	4	33.3	38	29.9	0.970
Geographical area of employment	Southern Italy	4	33.3	45	35.4	0.970
Operating room role	Other roles	2	16.7	46	32.6	0.253
Operating room role	Scrub nurse	10	83.3	95	67.4	0.253
Type of respiratory PPE	FFP2 or FFP3 respirator	11	91.7	133	94.3	0.707
Type of respiratory PPE	Surgical mask	1	8.3	8	5.7	0.707
Eye and face protection in the operating room	Goggles and/or face shield	12	100.0	135	95.7	0.466
Eye and face protection in the operating room	None	0	0.0	6	4.3	0.466
Endotracheal intubation device	Macintosh laryngoscope	3	25.0	61	43.3	0.218
Endotracheal intubation device	Videolaryngoscope	9	75.0	80	56.7	0.218
Protective device used during endotracheal intubation	Yes	5	41.7	56	39.7	0.895
Protective device used during endotracheal intubation	No	7	58.3	85	60.3	0.895

occupational COVID-19 infection. Associations between professional and perioperative practice characteristics and COVID-19 infection are presented in Table 5.

Operating room experience was the only variable significantly associated with infection (χ^2 , $p = 0.037$). Nurses with more than 20 years of perioperative experience showed the highest infection rate.

No statistically significant associations were found between COVID-19 infection and age, geographical region, professional role, type of respiratory protection, eye protection, intubation device, or use of additional aerosol-protection devices.

Discussion

This study investigated whether Italian operating room nurses adhered to national recommendations for the management of patients with COVID-19 and the appropriate use of personal protective equipment (PPE) (AICO, 2021; SIAARTI, 2020). The findings provide valuable insight into perioperative clinical practice during the pandemic and may support healthcare organizations in improving preparedness for future infectious disease emergencies (FNOPI, 2022).

The COVID-19 pandemic placed unprecedented pressure on healthcare systems worldwide (SAGES, 2022). Maintaining the safety of healthcare professionals while ensuring continuity of surgical care became a major organizational challenge (CDC, 2021). During the first pandemic waves, shortages of PPE and rapidly evolving recommendations increased uncertainty among perioperative teams (AORN, 2021). Consequently, evaluating compliance with national guidelines is essential for improving future emergency preparedness.

Appropriate Use of Personal Protective Equipment

Overall, the results demonstrate a high level of adherence to national recommendations. More than 90% of participants reported using FFP2 or FFP3 respirators when caring for patients with COVID-19, suggesting widespread implementation of infection prevention measures within Italian operating rooms.

Similarly, almost all participants reported wearing appropriate eye protection, either as a face shield or in combination with protective goggles. Considering that ocular mucosa may

represent a potential route of viral transmission, these findings indicate good compliance with recommended protective measures.

Nevertheless, a small proportion of nurses continued to use surgical masks during procedures involving patients with COVID-19. Although this represented only a limited number of participants, inappropriate PPE selection may increase occupational risk while simultaneously reflecting inadequate dissemination or implementation of institutional recommendations.

Interestingly, the choice of respirator appeared to vary according to professional role. Current national recommendations advise that healthcare professionals performing aerosol-generating procedures, particularly anaesthesia personnel, should preferentially wear FFP3 respirators because of their higher filtration efficiency. However, FFP3 respirators were more frequently reported among scrub nurses than anaesthesia nurses, suggesting that PPE allocation was not always fully aligned with exposure risk (AICO, 2021; SIAARTI, 2020).

Airway Management and Aerosol Protection

The widespread use of videolaryngoscopy observed in this study is consistent with international recommendations advocating techniques that maximize the distance between healthcare professionals and patients during airway management (Peng et al., 2020; Tompkins et al., 2010).

Many participants also reported using additional protective devices, including aerosol boxes, during endotracheal intubation. These devices were introduced in several institutions during the early stages of the pandemic despite limited evidence regarding their effectiveness (Coccolini et al., 2020). Their adoption reflects the rapid implementation of innovative protective strategies under emergency conditions.

COVID-19 Infection Among Operating Room Nurses

Only 7.8% of participants reported occupational COVID-19 infection during the study period.

Interestingly, no statistically significant association emerged between the type of

respiratory protection used and infection. This finding suggests that SARS-CoV-2 transmission is influenced by multiple factors beyond PPE selection alone, including duration of exposure, environmental ventilation, adherence to donning and doffing procedures, community transmission, and overall infection prevention practices.

Conversely, nurses with more than 20 years of operating room experience demonstrated a significantly higher likelihood of infection. Although the study design does not allow causal inference, this finding may reflect increased cumulative exposure or the assignment of more experienced nurses to high-risk surgical procedures throughout the pandemic.

Furthermore, scrub nurses accounted for most reported infections. Their continuous proximity to the sterile surgical field and prolonged exposure during operative procedures may explain this observation.

Staff Involvement in Developing COVID-19 Protocols

One of the most important findings of this study concerns the limited involvement of frontline nurses in developing institutional COVID-19 protocols.

Only approximately one-third of participants reported participating in protocol development, despite being directly responsible for implementing these procedures in clinical practice.

Clinical protocols represent an essential tool for translating scientific evidence into standardized perioperative care (Wang et al., 2020). Excluding frontline professionals from protocol development may reduce staff engagement, limit protocol applicability, and negatively influence adherence to organizational changes (Thiruvengkatarajan et al., 2020).

Future emergency planning should therefore promote multidisciplinary collaboration involving perioperative nurses, anaesthesia professionals, surgeons, and hospital leadership to ensure that clinical protocols are both evidence-based and operationally feasible (Calamandrei et al., 2008; World Health Organization, 2020).

Strengths and Limitations

This study represents one of the first national surveys investigating PPE use among Italian operating room nurses during the COVID-19 pandemic.

However, several limitations should be acknowledged. First, the cross-sectional design prevents conclusions regarding causality. Second, all data were self-reported and therefore may be subject to recall and response bias. Third, participants were recruited exclusively through AICO membership, potentially limiting the generalizability of the findings to all Italian operating room nurses. Finally, the relatively low number of COVID-19 infections reduced the statistical power to detect associations between PPE use and infection.

Despite these limitations, the study provides valuable evidence regarding perioperative practice during a public health emergency and highlights important organizational aspects that may inform future preparedness strategies.

Conclusions

The COVID-19 pandemic emphasized the critical importance of protecting perioperative healthcare professionals while maintaining safe surgical services.

This exploratory study demonstrates that Italian operating room nurses generally adhered to national recommendations regarding the appropriate use of personal protective equipment during the care of patients with COVID-19. Compliance with recommended respiratory and eye protection was high, suggesting successful implementation of infection prevention measures across participating institutions.

Nevertheless, frontline nurses were only marginally involved in developing institutional COVID-19 protocols. Greater participation of perioperative professionals in organizational decision-making may improve protocol implementation, strengthen staff engagement, and enhance preparedness for future public health emergencies.

Future research should evaluate the long-term impact of infection prevention strategies, investigate factors influencing PPE adherence, and assess the effectiveness of multidisciplinary approaches to emergency planning within perioperative settings.

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