

# Personal Protection Equipment and Emergency Surgery during the COVID-19 Pandemic in Spain

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## ABSTRACT

**Introduction:** In December 2019, in Wuhan, China, a new viral disease, COVID-19, was diagnosed, and in January 2020, the first case was diagnosed in Spain. In April, Spain had reported more than 200,000 cases, 38,000 of which were health workers, representing more than 16% of the volume of contagion in the general population. The objective of our study was to determine the availability, characteristics of use, and the need for improvisation of personal protective equipment (PPE) during the first wave of the COVID-19 pandemic in Spain.

**Materials and methods:** An online, anonymous, prospective survey was carried out from April 2 to 15 by an e-mail invitation to 562 of the Trauma and Emergency Surgery sections of the Spanish Association of Surgeons. The survey collected demographic data, the region of clinical practice, patterns of PPE use in emergency surgeries, and the improvisation of equipment.

**Results:** Total 58 health workers from 12 communities completed the survey, 95% surgeons. Total 28% received training with PPE during the pandemic, and 44% rated it as insufficient. The PPE used in surgery were double glove (74%), face shield (72%), surgical glasses (67%), waterproof gown (67%), and boot covers (32%). Lack of N95/FPP2/3 was reported by 82% and other elements of PPE by 68%. More than half of the respondents (51%) improvised PPE.

**Conclusion:** The results reflect a low degree of training on PPE use before and during the first wave of the pandemic, the lack of PPE, especially masks, and the need to use nonapproved material as a protection mechanism.

**Keywords:** COVID-19, Pandemic, Personal protective equipment, Survey study.

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## INTRODUCTION

In December 2019, in Wuhan, China, several cases of severe acute respiratory syndrome due to coronavirus 2 (SARS-CoV-2) were diagnosed. This novel disease was called COVID-19.<sup>1</sup> Due to the lack of control of the initial outbreak and our society's current ability to use mass means of air transport, the virus's rapid global spread occurred. In March, the World Health Organization (WHO) declared the COVID-19 pandemic.<sup>2</sup> As of the first quarter of 2020, the whole world witnessed an escalation in the number of infected, leading the health systems of many countries to collapse, and to a shortage of personal protective equipment (PPE). By May 17, the WHO reported more than 4,400,000 confirmed cases worldwide, more than 180,000 of them in Europe, and Spain as the fourth country in the world with 230,183 cases reported. The global death toll by then had already exceeded 305,000.<sup>3</sup> The number of infected health sector professionals increased alarmingly, and in a statement dated April 30, 2020, the Spanish Collegiate Medical Organization requested the Minister of Health and the Minister of Labor that the medical profession has declared a risk because at that date the number of health professionals infected in Spain exceeded 38,000, which represented more than 16% of the volume of contagion in the general population.<sup>4</sup>

The high number of infected health personnel brought the focus of attention to the availability of PPE, its quality, and the protocols for its use, including the necessary training for its proper use. The high demand generated by the pandemic caused problems in the production and distribution of such products. On February 27, the WHO issued a statement with recommendations for their use during the pandemic, contemplating measures to optimize

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their availability and rationale.<sup>5</sup> Given the high rate of infection among healthcare personnel, and knowing that such equipment is essential to prevent infection in emergency surgeons, the trauma and emergency surgery section (STCU) of the Spanish association of surgeons (AEC) carried out a study to determine PPE availability, their characteristics, use habits and frequency, as well as ways to

improve them, if needed, anticipating an insufficiency scenario while the COVID-19 set place on Spanish soil.

### MATERIALS AND METHODS

The survey collected demographic data, measures adopted in the hospital where the respondents worked, and patterns of PPE use within the survey period. The demographic information requested age, gender, title, and location. It also asked about the preventive measures adopted, including PPE use training, placement and removal protocols, the existence of specific areas for donning and doffing, availability of such equipment, their utilization when performing their emergency surgery, and if there was a need to improvise in their absence. Questions were made about the presence of confirmed or suspected infected patients in their hospital and service and whether they had performed surgical procedures on COVID-19 patients to date. Finally, the participants were asked if they had been tested for COVID-19, either after having intervened infected patients or during the pandemic period as of the survey's closing date. The data collected for the different variables were analyzed using descriptive statistics, calculating frequencies, and percentages.

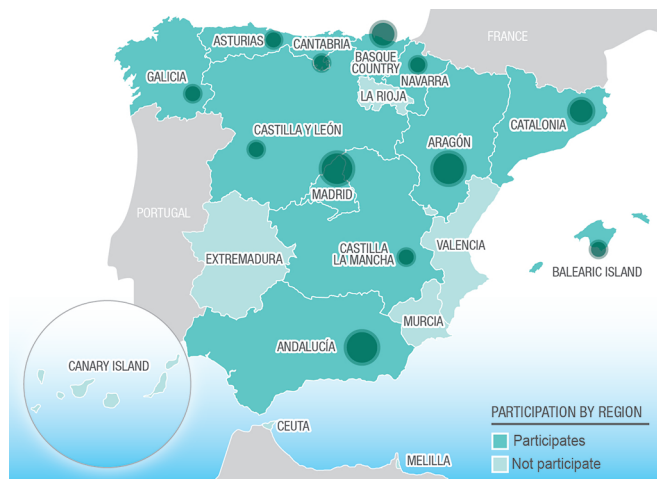
### RESULTS

A total of 58 (10%) of the professionals invited completed the survey, 32 (55%) men and 26 (45%) women, the majority (57%) between 31 and 45 years old. The vast majority (95%) were surgeons and a few surgical residents (3%) and emergency physicians (2%). The answers received were from 12 of the 17 autonomous communities, with the most significant number coming from Aragón (13), Andalucía (11), Madrid (9), and Catalonia (8), representing 22, 19, 16, and 14%, respectively (Fig. 1). Most respondents (83%) joined the COVID reaction committee of their affiliated hospitals. Development of work protocols and facilities adaptation was reported by 71%, organization of specific operating rooms for COVID-19 cases by 86%, and a similar figure admitted patients to their services. Open surgery on suspected or confirmed cases was reported by 43% and laparoscopic procedures by 39%. Only 17% informed to have commercial systems installed to filter the pneumoperitoneum,

which pushed 59% of them to improvise an alternative filtration equipment.

With COVID-19 patients admitted to the service, 86% wore surgical masks when passing the plant, and only 24% used N95/FPP2/3. More than half reported not having received training on PPE use before the infected numbers spiked, and a third of those who did rate it as insufficient. When the admission of new victims of the virus increased significantly, more than a third of the survey respondents continued without training. At the same time, the perception of insufficiency rose to 45%. However, a visible checklist when donning the equipment was reported by 61%, and two-thirds used peer support to check appropriate protection. They also reported the existence of a checklist to be used when removing protective equipment (61%), visible in the same area where they were brought in, specially designated for both operations (60%).

Seventy-two percent of respondents routinely performed seal tests on the N95/FPP2/3 mask upon donning. Among those with a beard, 40% had difficulty adjusting it over the nose or under the chin, so half of them needed to shave to improve the fit. The elements of PPE used routinely during the surgery reported were a double glove, face shield, surgical glasses, waterproof gown, and boot covers (Fig. 2). However, only 40% claimed to use all the listed components. When asked if they experienced a lack of PPE elements and specifically FPP2/3/N95 masks, the vast majority answered affirmatively that more than half needed to reuse it. The vast majority were forced to wear it throughout the watch (Fig. 3). The provision of various protection elements was reported as insufficient, for which more than half had to use unapproved and improvised equipment (Fig. 4). Almost half (46%) of the study participants did not feel protected by wearing PPE during emergency surgery. Even though 33% of the study participants had symptoms suggestive of COVID-19 by the date of the study, only 19% had undergone some diagnostic test after performing surgery in COVID-19 patients, and only one-quarter of the participants

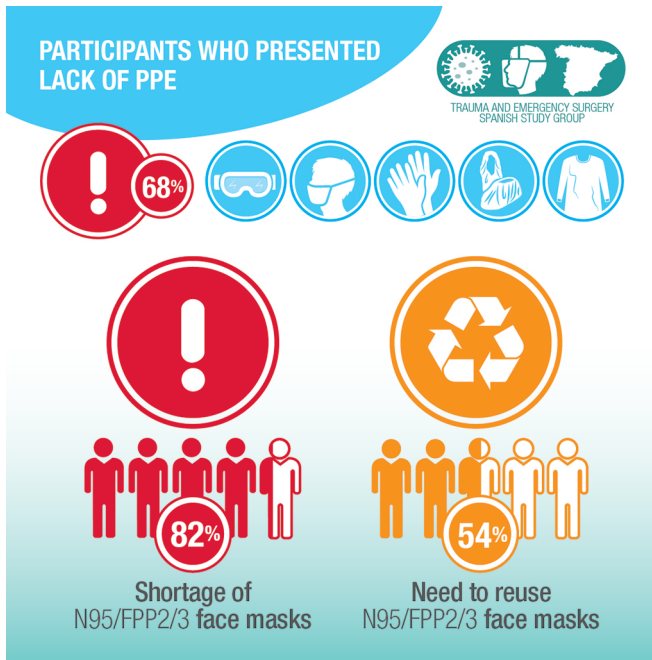


Region	Number of Participants
ARAGÓN	13
ANDALUCÍA	11
MADRID	9
CATALONIA	8
BASQUE COUNTRY	6
BALEARIC ISLAND	3
CANTABRIA	2
GALICIA	2
NAVARRA	1
ASTURIAS	1
CASTILLA-LA MANCHA	1
CASTILLA Y LEÓN	1

Fig. 1: Spanish map showing the responses and participation in the study



Fig. 2: Elements of PPE used routinely during emergency surgery in Spain during the first wave of COVID-19



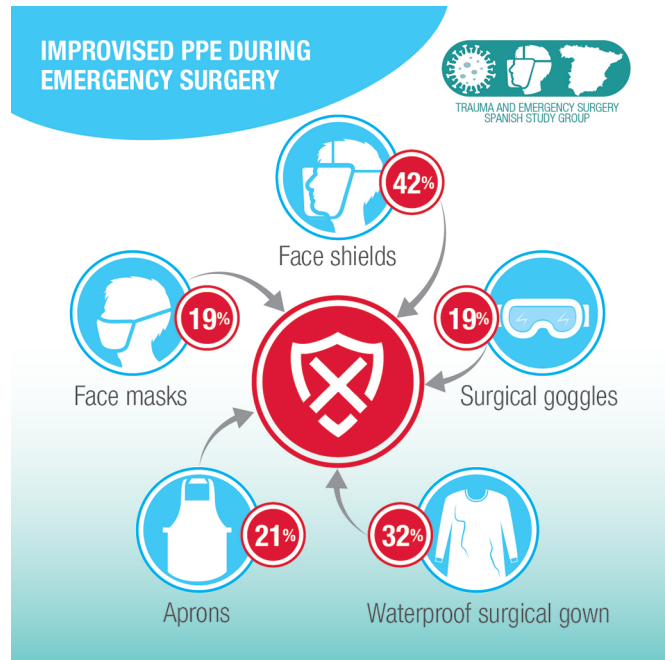
**Fig. 3:** Lack of PPE elements and specifically N95/FPP2/3 masks during the studied period

(26%) experienced some screening test for the disease during the period of the study.

## DISCUSSION

Our study portrayed the use of PPE by emergency surgeons for a short period, while the highest record of SARS-CoV-2 infections in Spain was achieved: the first 15 days of April 2020. By the date the survey was carried out, the country registered 6,055 confirmed cases per day.<sup>3</sup> The national health system was at the limit of its capacities. The health personnel were over-required, which could partly explain the low participation level in the survey, 10% of the invitations sent. The other aspect that could influence was the overload of information circulating through multiple media about the new disease. The participants' geographical distribution was heterogeneous, with higher participation by surgeons from Aragón, Andalucía, Madrid, and Catalonia. The lack of surgeons' involvement from the Valencian Community, La Rioja, Extremadura, and the Canary Islands, from which no response was obtained, is striking. Despite the care overload that was experienced on those dates, it is essential to highlight the commitment and leadership of surgeons during the pandemic. In our study, the vast majority of participants (83%) were integrated into the COVID response committees of their respective hospitals, contributing to the preparation and adoption of measures to guarantee their services' continuity. It is interesting to note that at the time of conducting the survey, the vast majority of respondents already had the operating room set up to operate on COVID-19 patients; this finding highlights the effort and organizational capacity of the study's services. The AEC supported this commitment assumed at the individual level in each hospital by developing and publication of clinical practice guidelines and consensus documents available on the association's website.<sup>6</sup>

The results of the survey show that training for the use of PPE before and during the pandemic was deficient: less than half (47%) before the pandemic and even more deficient during its



**Fig. 4:** Use of improvised equipment while performing emergency surgery

development, where only 28% received training and the training received was rated as insufficient by about half (44%). Several factors have been able to justify this phenomenon: the overload of care, the rapid increase in the number of cases, and the shortage of material available for training. This finding has been previously studied by Amerita and collaborators who reported in a study of 222 health workers that many do not receive formal training to use this equipment, and those who do receive it qualify it as suboptimal and lacking criteria demonstrating efficacy.<sup>7,8</sup> We consider that this lack of preparation could have contributed to the high infection figures of health personnel registered at the national level. A positive aspect that contrasts with these results is that more than half had a specific area and a protocol for donning and doffing protective equipment. This measure is essential to minimize the risk of infection, especially while removing the contaminated equipment.<sup>9</sup> One of the techniques described to minimize the risk during placement and removal of the equipment is placement and verification of the technique by a colleague,<sup>10,11</sup> which was applied by more than two-thirds of the participants.

Another fundamental aspect of minimizing the risk of infection by SARS-CoV-2 is the proper selection and use of the mask. Although checking the appropriate seal of the N95/FPP2/3 masks is essential, a third of the participants did not perform it. To ensure proper protection, the mask must offer an adequate seal to the facial contour, and there must be no space for the entry of infectious agents between these two surfaces. For this reason, it is essential to check when placing it.<sup>12,13</sup> This aspect of its use deserves to be highlighted in male healthcare personnel with beards since wearing it can create an obstacle to proper sealing. Our survey revealed that half of the population studied who wore a beard required shaving to facilitate the mask's sealing. Facial hair poses a problem for the fit of N95/FPP2/3 masks, which is why some authors and the centers for disease control and prevention (CDC) even recommend using powered air-purifying respirators (PAPRs) equipment for healthcare personnel with beards. The PAPR does not require a tight seal to the



face and can offer a level of protection even higher than the N95/FPP2/3 masks.<sup>14</sup> Sandaradura et al. report that, in a population of 105 male healthcare personnel, none with beards could pass the seal tests for N95/FPP2/3 masks.<sup>15</sup> Despite shaving and the absence of facial hair, an adequate seal is not always achieved with the N95/FPP2/3 masks, so it is essential to carry out sealing and adjustment tests by each center's occupational medicine service.<sup>16,17</sup> Another relevant aspect of our study was the high degree of scarcity of said components of the protective equipment, which led to the need to use them for periods longer than those for which they are designed. Some publications warn about the risk of contagion when used in such conditions.<sup>18</sup> Although this finding has also been described in other studies during the pandemic, the magnitude of the shortage of masks reported by the participants in our study (greater than 80%) and other components of the PPE, greater than 51%, is striking. When comparing our results with those obtained by the survey carried out by the Royal College of Surgeons of 1,200 NHS surgeons in the United Kingdom during the pandemic, there is a significant difference, since they reported that 30.5% experienced a lack of N95/FPP2/3 masks and 32.8% valued the provision of PPE as insufficient.<sup>19</sup>

Our survey also reflected the need to use unapproved and sometimes improvised equipment. Several recently published works report experiences with the improvisation of PPE using 3D printers, with which they have developed everything from N95/FPP2/3 masks to face shields, using composite polyamide components.<sup>20</sup> Although such solutions in times of deficiency are undeniable extreme, they do not always offer adequate protection because they are not approved and tested to guarantee their effectiveness. Another important aspect is the feeling of confidence and security that this makeshift equipment offers to the surgeon. Our study shows that almost half did not feel protected wearing PPE and having to use nonapproved or reused material could contribute to that feeling of lack of adequate protection. Improvised PPE can favor health personnel's contagion since they can provide a false sense of security, although they do not provide sufficient protection. The National Commission for Health of China reported 3,300 infected health workers and at least 22 deaths. The figures for Italy are approximately 20% of the health personnel involved in treating these patients.<sup>21</sup> In Spain, the number of health personnel infected has been very high. However, the number of infected is challenging to determine considering the low level of tests performed during the study period and the lack of updated publication by official sources.

Our study presented several limitations: the level of responses was low and the absence of these from a quarter of the autonomous communities. The study's duration was limited to the pandemic's initial period when the infected curve was at its highest. We understand that the study design may have been influenced by the degree of motivation and the experience lived by the designers. Despite the limitations, we consider the results obtained very useful, mainly when considering that it highlights the need to guarantee PPE in sufficient quantity and quality. It also highlights the obligation to develop PPE donning and doffing training programs and proven mask sealing programs, especially if we consider the possibility of a second wave of infections in the fall.

## ETHICAL STANDARDS

This article does not contain any studies involving human or animal participants performed by any of the authors.

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