Lessons learnt from the COVID-19 pandemic: results of EAHP survey on the future crisis preparedness of hospital pharmacies

Daniele Leonardi Vinci,[1] Piera Polidori ,[2] Nenad Miljković,[3] Aida Batista,[4] Steffen Amann,[5] Despina Makridaki,[6] Stephanie Kohl [7]

[1]School of Specialization in Hospital Pharmacy, University of Palermo, Palermo, Italy
[2]Clinical Pharmacy, Institute Mediterranean per i Trapianti e Terapie ad Alta Specializzazione, Hospital Pharmacy Via Ernesto Tricomi, Palermo, Italy
[3]Hospital Pharmacy, Institute of Orthopaedics Banjica, Hospital Pharmacy, Belgrade, Serbia
[4]Pharmacy, Centro Hospitalar Vila Nova de Gaia/Espinho, EPE, Vila Nova de Gaia, Portugal
[5]Krankenhausapotheke (Hospital Pharmacy), Muenchen Klinik gGmbH, Munchen, Germany
[6]Pharmacy Services, "Sismanoglio- Amalia Fleming", General Hospital of Attica, Athens, Greece
[7]European Association of Hospital Pharmacists, 1200 Brussels, Belgium

Correspondence to
Stephanie Kohl, European Association of Hospital Pharmacists, Brussels 1200, Belgium; Stephanie.Kohl@eahp.eu

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ABSTRACT

Aim The present survey aimed to collect information on the lessons learnt from the COVID-19 pandemic by hospital pharmacists. It focused on the shortages of health goods and the experiences of hospitals during the first phase of the crisis.

Methods A 17-question survey was conducted by EAHP, looking at the experiences of hospital pharmacists during the COVD-19 pandemic. The survey ran from 16 September to 23 December 2020. Statistical analysis included backward stepwise logistic regression (BSLR), Pearson's χ^2 test, t-test and one-way ANOVA, as appropriate; $p \leq 0.05$ was considered statistically significant.

Results 1466 hospital pharmacists answered the survey fully. 58%, 63% and 69% of them experienced shortages in medicines, disinfectants and personal protective equipment (PPE), respectively. BSLR showed that being a COVID-19 dedicated hospital increased the risk of medicine shortages (OR 1.63, 95% CI 1.15 to 2.31) but the shortages of disinfectants and PPE were lower (OR 0.62, 95% CI 0.44 to 0.88; OR 0.60, 95% CI 0.42 to 0.85). Being a specialised hospital reduced the odds of medicine shortages (OR 0.59, 95% CI 0.40 to 0.88), while countries with a greater percentage of the population infected had increased odds for all three types of shortages (OR 1.16, 95% CI 1.01 to 1.23; OR 1.34, 95% CI 1.19 to 1.50; OR 1.21, 95% CI 1.09 to 1.35). The odds were also higher in answers submitted in September compared with December. The classes of medicines with highest reported shortages were anaesthetics, antibiotics and muscle relaxants. The main entities that provided support were the national competent authorities and manufacturers.

Conclusion Medicine shortages affected the work of hospital pharmacists during the early stages of the pandemic. The features of the crisis and the feedback described in this survey can provide interesting insights for a more resilient healthcare framework in the future.

INTRODUCTION

The year 2020 was a challenging one for healthcare professionals across the globe. Shortages of personal protective equipment (PPE), surface and alcoholic hand disinfectants and medicines as well as the uncertainty about treatment options shaped the work of the profession during the first wave of the SARS-CoV-2 pandemic. Together with its members, the European Association of Hospital Pharmacists (EAHP) closely monitored all developments linked to COVID-19 and started data collection and best practice sharing initiatives to support the work of hospital pharmacists.

To better understand the impact on the profession, EAHP's survey on the future crisis preparedness of hospital pharmacies gathered details on the most frequently experienced medicine shortages. It also took into account experiences gained and the approaches for crisis management and preparedness conducted in hospital pharmacies. The present work aimed to collect a comprehensive compendium about the experiences, problems and lessons learnt by hospital pharmacists during the COVID-19 pandemic.

METHODS

EAHP created and conducted the survey on the future crisis preparedness of hospital pharmacies using Survey Monkey. The online questionnaire, along with its objectives and timeline, was distributed to EAHP members through a continuous advertising campaign on social media (Facebook, Instagram, LinkedIn and Twitter) and via the EU Monitor to engage individual hospital pharmacists. There were 17 questions aimed at collecting the general characteristics of the participants and their affiliated institutions; medicine, disinfectant and PPE shortages; mitigating methods adopted for medicine shortages; type, source and utility of the support received; lessons learnt; and areas of improvement for future pandemics. The survey ran from 16 September to 23 December 2020. Data on the classes of medicines in shortage were compared with those of the 2019 survey on medicines shortages[1] to assess the impact of the pandemic on the pattern of classes of medicine shortages.

Statistical analysis

The answers from the participants who only filled out general questions about their country of origin and the hospital in which they worked were discarded from the analysis. Data on the participants and their affiliated institutions (month of response submission, country of origin, type of hospital, number of beds, whether the institution served as a COVID-19 centre, and the number of COVID-19 patients treated) were treated as categorical variables and summarised either as counts or as percentages. The answers to the questions regarding the shortage of medicines, disinfectants, and PPE were filtered for yes/no answers and treated as a binary response variable. Three backward stepwise logistic regression (BSLR) models based on the

Table 1 Response rates by participating countries

Country	Responses (n)	Country	Responses (n)
France	213	Finland	12
Italy	155	Romania	11
Turkey	151	Estonia	10
Germany	140	Sweden	9
Portugal	126	Luxembourg	8
Belgium	111	Norway	7
Czech Republic	73	Bosnia & Herzegovina	6
Spain	61	Iceland	6
Greece	52	UK	6
Hungary	45	Slovenia	5
Serbia	45	Montenegro	4
Austria	41	Denmark	3
Slovakia	40	Malta	3
Switzerland	32	Armenia	2
North Macedonia	25	Croatia	2
The Netherlands	15	Cyprus	2
Ireland	14	Lithuania	2
Poland	13	Others	4
Bulgaria	12	Total	1466

Note that all the countries for which only one survey was provided were grouped and reported as 'Others'.

Akaike Information Criterion were used to identify the independent variables associated with the binary outcomes of the shortages using all the aforementioned variables about participants and their institutions, excluding the country of origin, as possible predictors. Instead of the country of origin, the number of COVID-19 cases divided by the total population of the participant's country of origin was used, as it can be considered a standardised common term of comparison of the severity of the pandemic in the different countries over time. The number of COVID-19 cases by country at the date of the response submission and the countries' populations were extrapolated from the Johns Hopkins University[2] and World Bank[3] data. Models were checked for multicollinearity using the Variance Inflation Factor (VIF) and only variables with a VIF <5 were included. The model coefficients were reported as odds ratios (OR) with 95% confidence intervals (CI). Univariate analysis between data reported as counts was carried out using Pearson's χ^2 test and adjustment for multiple testing using the Bonferroni method was also performed. The 5-point Likert scale data were treated as interval variables, summarised using mean and SD, and tested either by t-tests or one-way ANOVA with Bonferroni correction for pairwise comparisons (BCPC), as appropriate.[4 5] All analyses were performed using R 3.6.3 (R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was set at $p<0.05$.

RESULTS

The final dataset included 1466 observations referring to hospital pharmacists from 40 countries. As shown in table 1, the top five countries for the number of answers (France, Italy, Turkey, Germany and Portugal) accounted for approximately 54% of the overall response rate. More descriptive data about the survey respondents are shown in table 2. The majority of surveys (almost 70%) were collected during November and December; 71% of participants were working in a hospital with 101–1000 beds and 85% of the hospitals were general or teaching/university hospitals. Most of the hospitals served as partly or totally dedicated 'COVID-19 centres' during the pandemic and, of these, most assisted more than 50 COVID-19 patients.

Medicine, disinfectant and PPE shortages

For 59% (n=861) of respondents, medicine shortages during the COVID-19 pandemic posed significant problems in delivering the best care to patients and/or operating the hospital pharmacy, while 38% (n=558) of respondents did not experience any notable problems and 3% (n=47) chose the 'Don't know' option. As shown in figure 1A, the BSLR, which considered medicines shortage as a binary outcome, included as independent variables: date of survey submission, whether the hospital was a COVID-19 dedicated centre, type of hospital, and the percentage of the population infected. Furthermore, the factors which statistically significantly increased the odds of a medicine shortage causing problems in delivering the best care to patients were: submission of the survey in September (OR 1.85, 95% CI 1.22 to 2.80), being a partly or totally dedicated COVID-19 centre (OR 1.74, 95% CI 1.26 to 2.38 and OR 1.63, 95% CI 1.15 to 2.31, respectively) and an increasing percentage of COVID-19 cases in the overall population (OR 1.16, 95% CI 1.01 to 1.23). The only factor associated with significant odds reduction was being a 'specialised' hospital rather than a general hospital (OR 0.59, 95% CI 0.40 to 0.88). This category included psychiatric, geriatric, paediatric and oncology hospitals.

A shortage of disinfectants was reported by 63.3% (n=928) of the participants; 34.7% (n=509) did not experience disinfectant shortage and <2% (n=29) were unsure. As shown in figure 1B, the BSLR, which considered the presence or absence of disinfectant shortages as an outcome, included as independent variables: date of survey submission, number of hospital beds, whether the hospital was a COVID-19 dedicated centre and the percentage of the population infected. The factors significantly associated with increased odds of disinfectant shortages were the submission of the survey in September (OR 3.19, 95% CI 2.07 to 4.91), October (OR 3.82, 95% CI 2.51 to 3.02) and November (OR 2.24, 95% CI 1.66 to 3.02), and the percentage of the population infected (OR 1.34, 95% CI 1.19 to 1.50). The only factor significantly associated with a reduced odds of disinfectant shortage was being a totally dedicated COVID-19 centre (OR 0.62, 95% CI 0.44 to 0.88), while being a partly COVID-19 centre, although displaying an OR <1, did not reach statistical significance. Finally, although all levels of the number of hospital beds >100 showed an increase in the odds of experiencing a shortage of disinfectants, the only one for which statistical significance was achieved was the group with 500–1000 beds.

Almost 70% (n=1005) of the participants reported PPE shortages, while 24.8% (n=364) and 6.6% (n=97) did not experience a PPE shortage or didn't know, respectively. As shown in figure 1C, the BSLR which considered the presence or absence of PPE shortage as the outcome included as independent variables: the date of survey submission, whether the hospital was a COVID-19 dedicated centre, and the percentage of the population infected. The factors that significantly increased the odds of PPE shortage were submission of the survey in September (OR 1.74, 95% CI 1.31 to 2.31), October (OR 2.38, 95% CI 1.60 3.53) and November (OR 2.50, 95% CI 1.64 to 3.80) compared with December, and the percentage of the population infected (OR 1.21, 95% CI 1.09 to 1.35). The only factor significantly associated with a reduced odds of PPE shortages was being a partly dedicated COVID-19 centre (OR 0.60, 95% CI 0.42 to 0.85), while being a total COVID-19 centre, although displaying an OR <1, did not reach statistical significance.

Table 2 Descriptive statistics (n=1466) of survey respondents stratified by medicine, disinfectant and PPE shortages

Variable	Levels	Sub-levels (no of COVID-19 dedicated hospital beds)	Responses		Medicine shortage (Yes)		Disinfectant shortage (Yes)		PPE shortage (Yes)	
			N	%	N	%	N	%	N	%
Date	December		500	34.11	295	20.12	282	19.24	300	20.46
	November		507	34.58	304	20.74	331	22.58	362	24.69
	October		246	16.78	123	8.39	170	11.60	189	12.89
	September		213	14.53	139	9.48	145	9.89	154	10.50
No of beds	101–500		648	44.20	355	24.22	407	27.76	446	30.42
	501–1000		394	26.88	246	16.78	263	17.94	271	18.49
	<100		115	7.84	59	4.02	56	3.82	71	4.84
	>1000		252	17.19	164	11.19	157	10.71	175	11.94
	MV		57	3.89	37	2.52	45	3.07	42	2.86
Type of hospital	General hospital		821	56.00	502	34.24	537	36.63	567	38.68
	Teaching/university		420	28.65	259	17.67	251	17.12	278	18.96
	Other		97	6.62	47	3.21	52	3.55	68	4.64
	Psychiatric		62	4.23	23	1.57	49	3.34	47	3.21
	Oncology		30	2.05	16	1.09	18	1.23	20	1.36
	Geriatric		22	1.50	11	0.75	14	0.95	17	1.16
	Paediatric		14	0.95	3	0.20	7	0.48	8	0.55
If COVID-19 dedicated	No (n=302)	NA	302	100.00	140	46.36	198	65.56	219	72.52
	Partly (n=693)	>50	248	35.80	180	26.00	170	24.50	177	25.50
		26–50	153	22.10	92	13.30	104	15.00	110	15.90
		6–25	194	28.00	106	15.30	120	17.30	139	20.10
		<5	63	9.10	26	3.80	38	5.50	46	6.60
		Don't know	34	4.90	22	3.20	27	3.90	27	3.90
		MV	1	0.10	0	0.00	0	0.00	0	0.00
	Yes (n=471)	>50	299	63.50	209	44.40	185	39.30	193	41.00
		26–50	75	15.90	40	8.50	36	7.60	37	7.90
		6–25	67	14.20	35	7.40	36	7.60	40	8.50
		<5	7	1.50	1	0.20	2	0.40	2	0.40
		Don't know	21	4.50	9	1.90	10	2.10	13	2.80
		MV	2	0.40	1	0.20	2	0.40	2	0.40

For the three types of shortages (medicines, disinfectants and PPE), only the number (n) and percentage (%) of 'Yes' responses were reported. Regarding the 'If COVID-19 dedicated' field, the percentages reported for each sub-level about the number of COVID-19 dedicated hospital beds are estimated on the reference number for each of the three levels (No, Partly, Yes).
MV, missing values; NA, not applicable; PPE, personal protective equipment.

Classes of medicine shortages

The survey also considered the most common classes of medicine shortages. As shown in figure 2A, anaesthetics were most affected by shortages (46%, n=670), followed by antibiotics (37%, n=539), muscle relaxants (29%, n=425), benzodiazepine (26%, n=380) and opioids (22%, n=316). Antimalarial and antiviral drugs, in particular, also deserve mention as they were reported to be in shortage by 13% (n=193) and 12.5% (n=183), respectively, of the survey respondents and were widely used (or misused), especially during the early stages of the COVID-19 outbreak. The comparison between the present survey and the survey carried out in 2019 was performed using only the therapeutic groups included in both surveys. In particular, antibiotics, antiviral drugs and antifungal drugs in the 2020 survey were put together in a new categorical variable 'antimicrobials' in order to meet the same structure as the 2019 survey, in which those medicines were grouped together. It should be noted that not only hospital pharmacists working at hospitals that exclusively catered for COVID-19 patients participated in the 2020 survey but also those who continued to provide care to other patients for which the hospital activity was reduced. This may have contributed to the higher shortage reporting rate detected in 2019 compared with 2020. Therefore, a direct comparison of the number of shortages reported/not reported between these surveys would not have produced any meaningful result. For this reason, we considered the relative increase/decrease in the frequency of shortage reporting for a specific class of medicine compared with the total number of shortages reported for all other medicines. By doing this, we were able to mitigate the distortions caused by the differences in the reporting rate of shortages and to better determine any variation in the type of medicine shortages. Furthermore, in both surveys, other classes of medicines that unfortunately did not overlap were also included, which were not taken into account for the comparison as their differences in terms of medicine class and reporting rate could have introduced further distortion in the analysis.

In figure 2B it can be seen that the frequencies that resulted in a statistically significantly increase in 2020 compared with 2019 were those relating to anaesthetics ($\chi^2_{(1,\ 6117)}=242.37$, $p<0.001$) and antimicrobials ($\chi^2_{(1,\ 6117)}=16.03$, $p<0.001$). The classes of medicines for whom the relative frequency of reporting shortages decreased in a statistically significant manner were: cardiovascular agents ($\chi^2_{(1,\ 6117)}=184.64$, $p<0.001$), corticosteroids ($\chi^2_{(1,\ 6117)}=14.50$, $p=0.001$), endocrine agents ($\chi^2_{(1,\ 6117)}=81.93$, $p<0.001$) and gastrointestinal drugs ($\chi^2_{(1,\ 6117)}=74.66$, $p<0.001$).

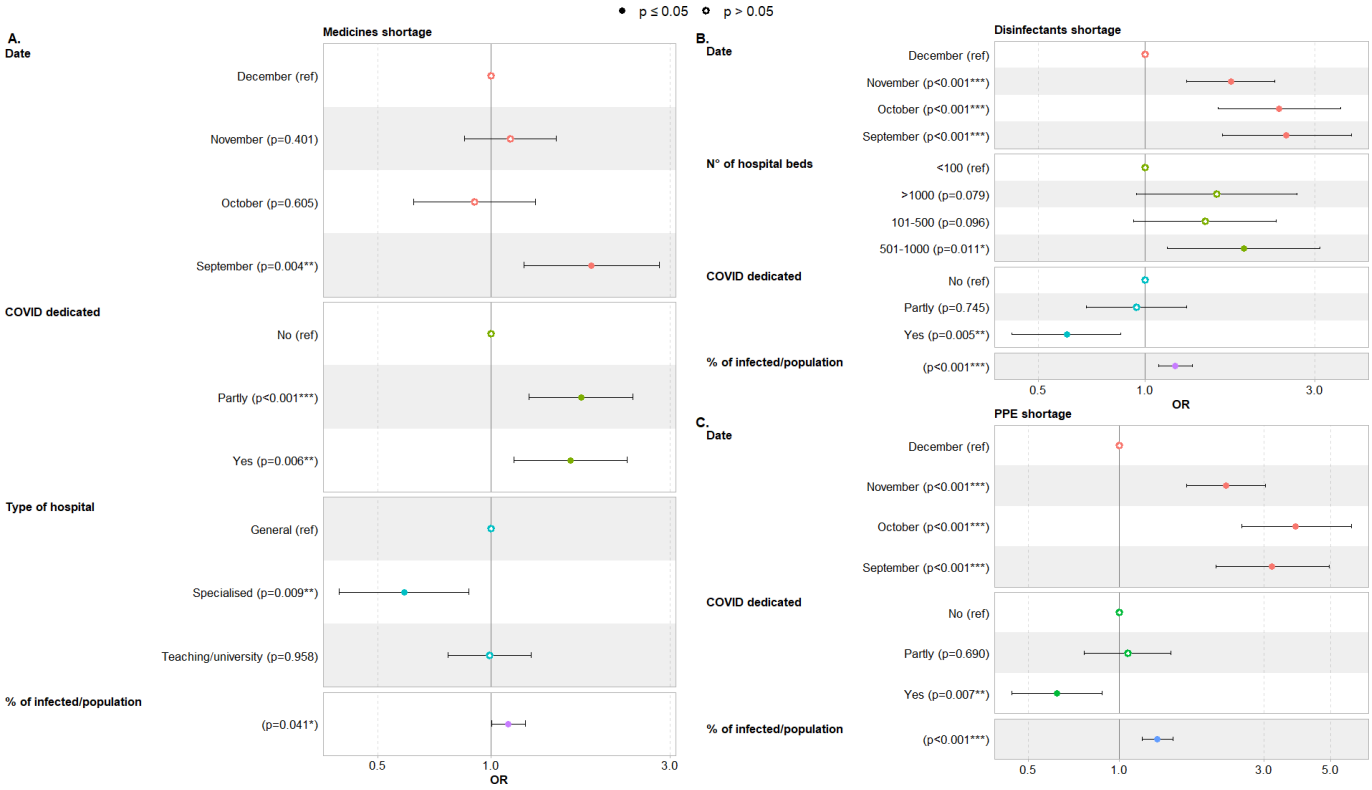

Figure 1 Backward stepwise logistic regression models selected according to the Akaike Information Criterion for medicines (A), disinfectants (B) and personal protective equipment (PPE) (C) shortages. Only Yes/No answers were taken into account for each model as binary outcomes. The regression coefficients are reported as OR ±95% CI (coloured dots and black lines). Ref, reference level. *p<0.05; **p<0.01; ***p<0.001.

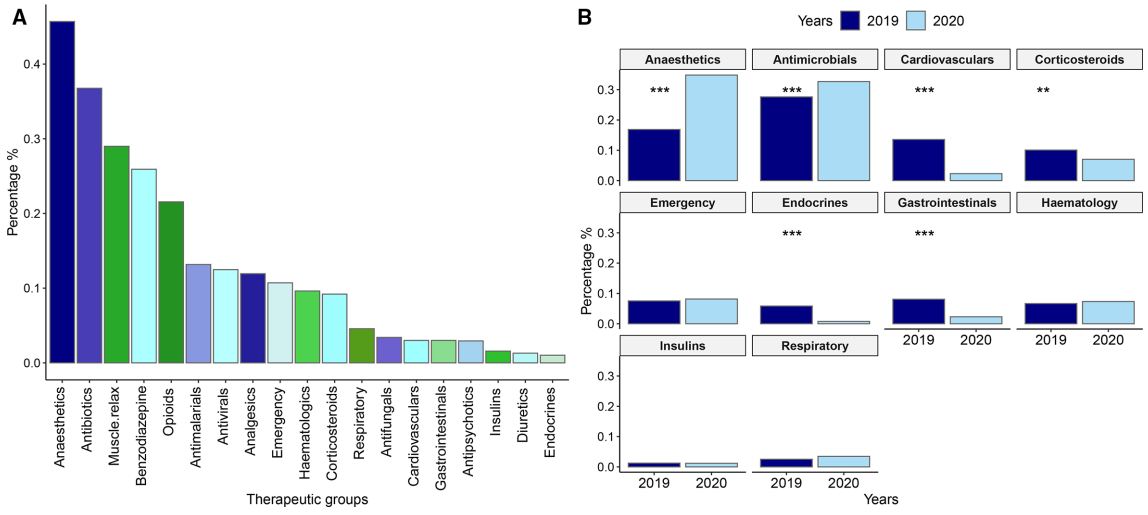

Figure 2 Medicine shortages according to type of medicine. (A) Percentage of medicine shortages reported for all types of medicines included in the 2020 survey. The percentages were calculated for each type of medicine by dividing the number of shortages reported by the total number of answers. (B) Comparison of medicine shortages in 2019 versus 2020 for types of medicines included in both surveys. The percentages were calculated by dividing the number of shortages reported for a specific type of medicine by the total number of shortages reported for all types of medicines included in both surveys. Statistically significant differences in the frequencies of medicine shortages reported for each type of medicine between the two surveys were evaluated using Pearson's χ^2 test. P values were adjusted for multiple testing using the Bonferroni method. **p<0.01; ***p<0.001.

All the other comparisons (insulin, emergency, respiratory and haematology medicines) did not reach statistical significance.

Shortage mitigation methods and source, type and usefulness of the support received

The top three methods adopted to address the shortages were: therapeutic substitution (42%, n=620), creating additional strategic stock at local, regional or national level (38%, n=557) and borrowing medicines from other hospitals (35%, n=512). Importing medicines from another country (33%, n=478) and generic substitution (31%, n=448) were also reported mitigation strategies, while the least selected methods were compounding/production of medicines in the pharmacy (28%, n=405) and using medicines from central contingency reserves kept at national level (27%, n=403). The entity that provided the most support to overcome medicine shortages (57%, n=838) was the country's National Competent Authority (NCA), followed by manufacturers and the Scientific Societies and Healthcare Professional Organisations (SSHPO), which were reported in 39% (n=571) and 20% (n=300) of the answers, respectively. The main type of support received by the respondents was the allocation of contingency stocks to their hospital (51%, n=741), followed by feedback received from manufacturers on the availability of medicines (46%, n=675) and the expected duration of shortages (40%, n=584). Guidelines were the least chosen type of support (26%, n=380) for those who reported receiving support provided by the SSHPO.

Another aspect considered in the survey was the usefulness of the help received from each of the aforementioned supporting entities. In particular, the respondents were asked to assign a 5-point Likert scale score ranging from 1 ('not useful') to 5 ('extremely useful'). The highest mean usefulness score was assigned to the NCA (mean=3.2, SD=1.15), followed by the SSHPO (mean=3.10, SD=1.21) and manufacturers (mean=3.06, SD=1.07). However, these mean differences were very small and did not show any statistical significance. For this reason, a more in-depth analysis on the usefulness score was performed by dividing the respondents according to their answers about the medicine shortages (yes/no, the answer 'don't know' was excluded by the analysis) and COVID-19 dedicated status (no, yes and partly) and tested for possible differences on the usefulness score using the Student t-test and one-way ANOVA followed by BCPC. From figure 3A it can be seen that the usefulness score was significantly lower for participants who reported medicine shortages compared with those who did not for the support provided by NCA ($t_{(1169)}$=2.82, Cohen's d=0.17, p=0.005) and manufacturers ($t_{(1139)}$=4.06, Cohen's d=0.25, p≤0.001). The usefulness score assigned to SSHPO did not differ significantly between the two groups, probably suggesting that this kind of support assumed marginal importance during the management of medicine shortages. Regarding the COVID-19 dedicated groups, the one-way ANOVA results reported in figure 3B show that the only statistically significant difference between the three COVID-19 dedicated groups was seen for the usefulness score assigned to manufacturers ($F_{(2,1164)}$=4.088, p=0.017), which was higher for partly and totally COVID-19 dedicated hospitals compared with those not COVID-19 dedicated. These findings were confirmed by the BCPC, which showed a statistically significant difference between the hospitals that were partly COVID-19 dedicated versus not COVID-19 dedicated (p=0.025) and those totally COVID-19 dedicated versus not COVID-19 dedicated (p=0.031). These results show that, in COVID-19 dedicated hospitals, the manufacturers' support provided the most impact.

Lessons learnt and future preparedness

Handling a higher workload and stress (n=951) as well as quickly adapting the processes and practices at the hospital pharmacy (n=942) were lessons that almost 65% of participants learnt during the first peak of the pandemic, followed by working with scarce resources which was reported by 55% (n=813) of respondents. The proper handling of PPE (43%, n=627) and the assessment of therapeutic options despite the limited availability of scientific data (37%, n=543) ranked in fourth and fifth place as learning points from the pandemic. Concerning the areas of improvement to better prepare pharmacy services for future pandemics, almost half of the respondents indicated that improvements are needed in hospital stock management (49%,

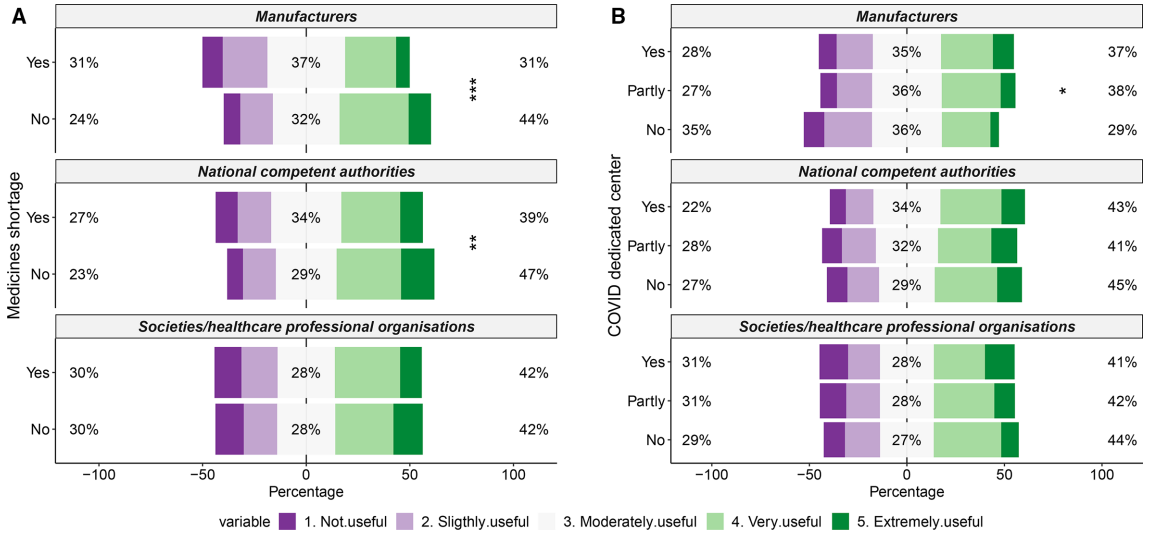

Figure 3 5-point Likert scale of usefulness of the support provided by manufacturers, national competent authorities and societies/healthcare professional organisations split by medicine shortages (A) and COVID-19 dedicated hospital (B) groups. Data are reported as the percentage assigned for each point of the Likert scale. The statistical significance refers to the results of the t-test for the medicine shortages group and one-way ANOVA for the COVID-19 dedicated hospital group. *p<0.05; **p<0.01; ***p<0.001.

n=721), communication with authorities (47%, n=688), crises and surge management (47%, n=688), the use of preparedness protocols (47%, n=682) and communication with other healthcare professionals (46%, n=674). Only 28% (n=404) of respondents indicated communication with the management of the healthcare facility as an area for improvement.

DISCUSSION

The pandemic represented an insidious challenge for hospital pharmacists and, more broadly, for every health system. The shortage of medicines, which can be considered a recurring phenomenon in itself, assumed a specific pattern that, in many cases, reflected the increased therapeutic needs represented by the care of patients with COVID-19[6] . In this context, this survey represents an opportunity to assess the magnitude of the impact of the pandemic on hospital pharmacists and their work, aimed at assuring and providing access to the best care and therapies for the patient. The results of the survey show that the most predisposing factor for medicine shortages was being a healthcare facility totally or partially dedicated to the management of COVID-19 patients, reiterating once again that the lack of medicines mainly affected those centres most involved in the fight against COVID-19. The same centres, on the other hand, reported a reduced shortage of disinfectants and medical devices and this unexpected result may underly all the efforts made by countries to guarantee a priority supply chain of disinfectants and PPE where they were most needed. Another aspect to take into account is the date of submission of the survey, which provides some interesting data. Specifically, the fact that shortages were reported more in September than in December could indicate two different phases of the pandemic—the first more disastrous and unprepared, the second characterised by a more structured and resilient supply chain. Furthermore, the significant association between the percentage of the infected population with increased odds of all three types of shortages assessed suggests that the countries hit hardest by the pandemic were those in which the procurement of health goods was the greatest problem. Moreover, the fact that anaesthetics, antimicrobials, muscle relaxants, benzodiazepine and opioids were the most reported classes of medicines in short supply and that, for many of them, there was a significant relative increase in the frequency of shortage reporting compared with the 2019 survey, is a clear expression of how the pandemic has polarised the shortage phenomenon. This can be further confirmed by the reduced frequency of shortage reporting for other classes of medicines such as cardiovascular, gastrointestinal and endocrine medicines not directly used in the care of patients with COVID-19 and may suggest that, during the pandemic, all other comorbidities were neglected. Additionally, the fact that the usefulness score reported by those who experienced a relevant medicine shortage was significantly lower than the score assigned by those who did not for the two most relevant sources of support (NCA and manufacturers) might imply that, for those hospitals, the help received was not enough to ensure adequate patient care. Finally, the high rate of responses reporting stress management and the need to quickly adapt processes and practices at the hospital pharmacy as lessons learnt from the pandemic, as well as the need for improvements in stock management and communication with authorities and other health professionals as further areas for improvement, demonstrate the difficulties encountered during the first pandemic wave, characterised by a constant change in the available evidence and in the epidemiological situation which has produced the need for a frenetic update of therapeutic protocols/guidelines and medicine inventories.

CONCLUSION

This survey represents a picture of the COVID-19 health emergency from the perspective of the hospital pharmacist, which shows how a global pandemic can affect the magnitude and type of health goods shortages. The feedback provided by the respondents highlighted many weaknesses in management of the pandemic, which can be considered a starting point to plan a more resilient health framework capable of preventing or mitigating the impact of future pandemics.

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ORCID iDs
Piera Polidori http://orcid.org/0000-0001-8496-9908
Stephanie Kohl http://orcid.org/0000-0003-0324-7976

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