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Health Care Workers not in the frontline are more frequently carriers of Coronavirus Disease 2019: The Experience of a Tertiary Portuguese Hospital

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SUMMARY

Background: Health care workers (HCWs) have a high risk of infection with coronavirus disease 2019 (COVID-19), especially those treating patients with confirmed or suspected diagnosis (front-line).
Aim: To evaluate the incidence and prevalence of the COVID-19 infection among HCWs and to analyse the risk factors and the clinical characteristics among infected ones.
Methods: Observational, retrospective, single-center study (Centro Hospitalar e Universitário de Coimbra, Portugal). Data were collected from March 1 to June 30, 2020.
Findings: Overall, 211 (2.63%) out of 8037 HCWs were diagnosed with COVID-19. Most of the infections occurred during the early stage of disease outbreak. Among the infected HCWs, only 20.9% (n=44) were from the front-line. Both front-line and non-front-line HCWs were exposed primarily to patients (48.6% in both groups), but the non-front-line were (presumably) more infected by colleagues (10.8% vs 24.8%, P=0.04). Front-line HCWs performed more family isolation than non-front-line (88.9% vs 82.5%, P>0.05) and presumably less family members were infected in the former group (19.4% vs 26.3%, P>0.05). The proportion of HCWs with asymptomatic infection was statistically significantly lower in the front-line group (2.4% vs 19.9%, P=0.05).
Conclusion: The prevention and control actions implemented were effective in mitigating the COVID-19 outbreak; HCW infections occurred mainly in the early stages. Non-front-line HCWs were at a higher risk, warranting specific attention and interventions targeting this group.

Introduction

On December 2019, the outbreak of Coronavirus disease 2019 (COVID-19) emerged in Wuhan, China. [1–3] On the January 30, 2020, the World Health Organization (WHO) declared a

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public health emergency of international concern. Later, on March 11, 2020, the outbreak was characterized as a pandemic, mainly because the virus was highly infectious and increasingly widespread throughout the world. It causes a severe acute respiratory syndrome (SARS) termed "SARS-CoV-2". [4].

Contrary to the already known SARS, COVID-19 was less virulent, with an expected lower mortality rate, but longer incubation periods which results in a significant number of asymptomatic carriers. [5—7] The number of confirmed cases continually grows globally, and nine months after the outbreak more than 32.7 million cases were reported and more than 991,000 deaths. [8].

Health care workers (HCWs) have been successfully fighting against COVID-19, facing a substantial risk of SARS-CoV-2 infection, with enormous personal and professional sacrifices. [9—12] However, asymptomatic transmissions could further increase the risk of superspreading in hospitals [13] and, due to exposure, HCWs are a particularly at risk population.

Although the evidence has remained scarce, few studies have determined the prevalence, exposure information, and clinical presentation of this infection in HCWs. Preliminary studies point to an overall infection rate of 0.89—11.1% [14—20] and to a case fatality rate of 0.69%. [17] However, they refer to specific contexts and countries (Netherlands, China, USA, Italy and Spain) which responded with specific measures to this pandemic. [14—20] Different countries, adopting different health and politic policies may have distinctive results, but all are important to adjust and optimize future responses.

This study aimed to evaluate the incidence and prevalence of COVID-19 infection among HCWs in one of the largest Portuguese Hospitals, analysing the risk factors and the clinical characteristics of affected HCWs. We were especially interested in comparing the risk between HCWs who were and were not in the frontline of care.

Methods

Participants, study design and setting

This was an observational, single-center study, retrospectively collecting epidemiologic and exposure data, clinical information and treatment specificities using complementary sources of data, collected both by the Occupational Health Department and by the Human Resources department. These data were collected by telephone interview and through self-reported forms and relate to the period from March 1 to June 30, 2020.

The "Centro Hospitalar e Universitário de Coimbra, EPE" (CHUC) is a large comprehensive tertiary and university hospital, with more than 1700 beds and 8037 HCWs. It is formed by a network of hospital units (2 general adult, 2 maternities, 1 paediatric, and 1 psychiatric unit), with services and technologies structured and integrated to provide a humanized, complete, close, reliable, and transparent service to society.

The ethical approval was granted by the CHUC Ethics Committee (CHUC-058-20). This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline. [21].

COVID-19 diagnosis procedures

A semiquantitative real-time reverse transcriptase-polymerase chain reaction (45 cycles) targeting SARS-CoV-2 E-gene was performed on nasopharyngeal swabs (based on the standard technique as recommended by the WHO and the National Guidelines). [22,23] Swabs were immediately placed for transportation, accommodated and delivered to CHUC central laboratory.

The swab collection was performed as soon as possible after a HCW presented any suspicious clinical symptoms according to the National Guidelines, [23] regardless of the background rate or exposure. As such, the sample was non-probabilistic by convenience throughout the study period. The unit of measurement for this study was the number of positive HCWs and not the number of positive samples.

Exposure factors, characteristics and outcomes

Age, sex, and job categories: physicians, nurses, health care assistants, and others (pharmaceuticals, technical assistants, diagnosis and therapeutic technicians) were collected for the whole population. In HCWs that were infected with COVID-19 we also collected: if they were working in the front-line (defined as those who worked in wards or departments that provided direct care to patients with confirmed or suspected COVID-19; non-front line included all the wards or departments that are dedicated to standard hospital functioning and do not provide direct care to patients with confirmed or suspected COVID-19), body mass index (BMI), presumed exposure to confirmed cases (patients, colleagues, family, unknown), if they performed family isolation (defined as living isolated from their family members), if the disease was transmitted to family, and their comorbidities, signs and symptoms (with duration), risk factors, and outcomes (e.g. hospitalization, intensive care unit admission, death).

Statistical analysis

To characterise HCWs with confirmed COVID-19 epidemiologically, we estimated the prevalence, the cumulative incidence, the average incidence rate, and the morbidity.

Continuous variables were described as means and standard deviations (SD) and categorical variables as frequency and percentages. To compare the individual characteristics, exposure information, signs and symptoms, and outcomes between the front-line and the non-front-line HCWs we used the Student's t-test (continuous variables) and the χ^2 test or Fisher's exact test (categorical variables). [24].

A 2-sided $P<0.05$ was considered statistically significant. All analyses were performed using SPSS statistical software version 23.0 (IBM Corp).

Results

COVID-19 incidence and differences per professional group

In total, 211 (2.63%) out of 8037 HCWs in CHUC were diagnosed with COVID-19. The characteristics of the population, as well as of the diagnosed and non-diagnosed professionals are shown in Table I. Nurses represent 37.3% of the total workforce but 52.6% of the infected (n=111), being the most affected professional group, followed by the health care assistants (22.2% of the workforce and 23.2% of the infected), physicians

Table I
Basic information for 8037 HCWs and 211 HCWs with confirmed COVID-19

Characteristic	No. (%)			Estimated prevalence (n=8037), %	Estimated cumulative incidence (n=8037), %	Average incidence rate (HCW per month)	Average morbidity
	HCWs (n=8037)	HCWs with COVID-19 (n=211)	HCWs without COVID-19 (n=7826)				
Age, mean (SD), years	45.6 (16.58)	43.11 (10.67)	45.1 (15.72)	2.63	2.66	0.007	1.48
Sex							
Men	2036 (25.3)	47 (22.3)	1989 (25.4)	0.58	0.59	0.002	0.24
Women	6001 (74.7)	164 (77.7)	5837 (74.6)	2.04	2.06	0.005	1.01
Professional group							
Physician	1712 (21.3)	34 (16.1)	1678 (21.4)	0.42	0.42	0.001	0.17
Nurse	2999 (37.3)	111 (52.6)	2888 (36.9)	1.38	1.39	0.003	0.66
Health care assistant	1782 (22.2)	49 (23.2)	1733 (22.2)	0.61	0.61	0.002	0.19
Others	1544 (19.2)	17 (8.1)	1526 (19.5)	0.21	0.21	0.001	0.10

HCWs, health care workers; COVID-19, coronavirus disease 2019; SD, standard deviation.
Note: No deaths were observed.

(21.3% of the population and 16.1% of the infected), and lastly by the other HCWs (19.2% of the population and 8.1% of the infected).

The cumulative incidence of HCWs infected was 2.66, with an incidence rate of 0.007 HCW per month and an average morbidity of 1.48. All these indices corroborate the nurses being the most affected. No deaths were observed.

Monthly evolution of cases

Figure 1 shows the evolution of monthly COVID-19 infected HCWs in CHUC. It can be observed that most HCWs' infections occurred during the early stage of the outbreak (March and April 2020). From March to April a decrease was observed in the rate of physicians' infection, while a significant increase was observed in health care assistants. Nurses summed more infected individuals than all other together, in these two first periods. The number of HCWs infected with COVID-19 decreased dramatically in May and June 2020. However, the number of newly confirmed cases with COVID-19 in Portugal continued to increase.

Exposure differences between front and non-front-line HCWs

Among the 211 infected HCWs, only 20.9% (n=44) were from the COVID-19′ front-line (Table II). As expected, both front-line and non-front-line HCWs were exposed primarily to patients (48.6% in both groups), but the non-front-line were significantly more (presumably) infected by colleagues (10.8% vs 24.8%, P=0.04).

Front-line HCWs performed more family isolation than non-front-line (88.9% vs 82.5%, P>0.05) and less family members were infected in the former group (19.4% vs 26.3%, P>0.05). Also, the proportion of HCWs with asymptomatic infection was statistically significantly lower in the front-line (2.4% vs 19.9%, P=0.05) (Table II).

Clinical characteristics and treatment specificities of HCWs with COVID-19

Clinical characteristics of HCWs with confirmed COVID-19 are shown in Table III. The three most common comorbidities among all HCWs infected were respiratory disease (18.6%), hypertension (13.4%) and cardiovascular disease (4.7%). The six most common signs and symptoms were asthenia (64.2%), myalgias (61.5%), anosmia (53.9%), headaches (53.4%), cough (50.7%) and ageusia (50%).

There was no difference between front-line and non-front-line HCWs in subgroups of comorbidities, the majority of signs and symptoms [except for cough, more frequent in front-line (66.7% vs 46.6%, P=0.02)], risk factors, or severity criteria.

The mean days with signs and symptoms was 23.19 days (SD= 16.9), being significantly higher in front-line HCWs [30.4 (18.2) vs 21.5 (16.2), P=0.01].

Outcomes

Table IV shows the outcomes of HCWs with COVID-19. Overall, all HCWs were followed up by the occupational health department, 11.6% reported an additional follow-up by their family physician, 13.2% required a visit to the emergency department and 2.3% were hospitalized. None of the HCWs were admitted to the intensive care unit and no deaths were observed. Front-line HCWs have gone to the emergency department more often than the non-front-line HCWs (24.3% vs 10.2%, P=0.05).

Discussion

This was the first Portuguese and one of the few international studies providing insights into the COVID-19 infection among HCWs during the outbreak. This was based in a large comprehensive tertiary and university hospital, from the Central Administrative Region of the Country, less affected than the Northern and Southern ones.

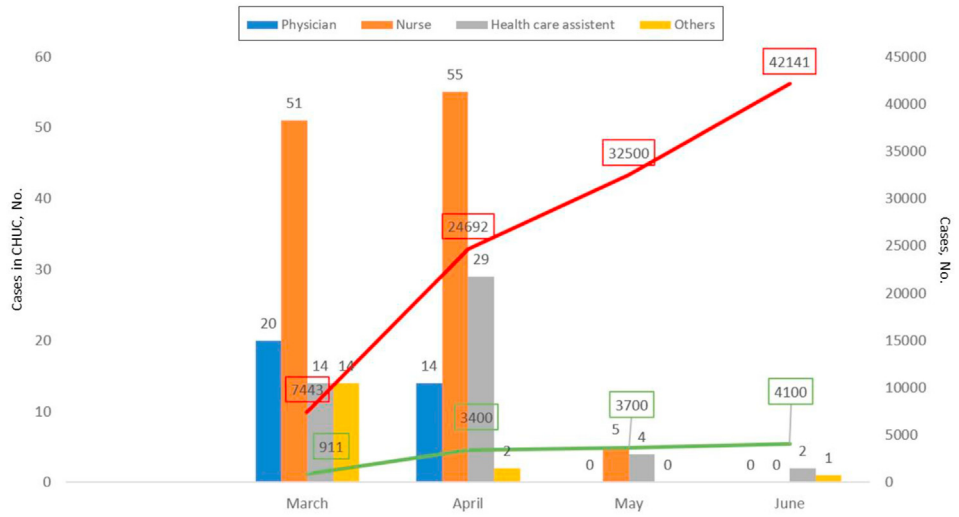

Figure 1. Monthly number of COVID-19 cases in HCWs in CHUC and overall cases in Portugal, per professional group. HCWs, health care workers; COVID-19, coronavirus disease 2019; CHUC, centro hospitalar e universitário de coimbra. The red line represents the progression of cases in general population (Portugal). The green line represents the progression of cases in Coimbra (central region).

Table II
Differences in exposure characteristics between front-line and non-front-line HCWs with confirmed COVID-19 (n=211)

Characteristic	No. (%)			*P* value[a]
	All (n=211)	Front-line HCWs (n=44)	Non-front-line HCWs (n=167)	
Age, mean (SD), years	43.11 (10.7)	41.95 (7.98)	43.42 (11.3)	0.41
Sex				
Men	47 (22.3)	12 (27.3)	35 (21)	0.37
Women	164 (77.7)	32 (72.7)	132 (79)	
Professional group				
Nurse	111 (52.6)	28 (63.6)	83 (49.7)	0.21
Physician	34 (16.1)	3 (6.8)	31 (18.6)	
Health care assistant	49 (23.2)	12 (27.3)	37 (22.2)	
Others	17 (8)	1 (2.3)	16 (9.5)	
Height, mean (SD), metres	1.66 (0.09)	1.67 (0.09)	1.65 (0.08)	0.34
Weight, mean (SD), kilograms	69.22 (15.2)	74.24 (21.9)	67.88 (12.6)	0.09
Body Mass Index				
Slimness (<18.49)	3 (1.7)	1 (2.7)	2 (1.4)	0.50
Normal (18.5–24.99)	92 (52.6)	16 (43.3)	76 (55.1)	
Pre-obesity (25–29.99)	53 (30.3)	12 (32.4)	41 (29.7)	
Obesity (>30)	27 (15.4)	8 (21.6)	19 (13.8)	
Presumed exposure to confirmed cases, yes				
Patients	85 (48.6)	18 (48.6)	67 (48.6)	0.99
Colleagues	38 (21.8)	4 (10.8)	34 (24.8)	0.04[b]
Family	7 (4)	0	7 (5.1)	0.15
Unknown	60 (35.1)	14 (38.9)	46 (34.1)	0.59
Performed family isolation, yes	145 (83.6)	32 (88.9)	113 (82.5)	0.35
Transmitted to family, yes	43 (24.9)	7 (19.4)	36 (26.3)	0.39
Prevalence of asymptomatic infection, No./total No. (%)	47/211 (22.3)	5/211 (2.4)	42/211 (19.9)	0.05[b]
Nurse	23 (10.9)	3 (1.4)	20 (9.5)	
Physician	9 (4.3)	1 (0.5)	8 (3.8)	
Health care assistant	12 (5.7)	1 (0.5)	11 (5.2)	
Others	3 (1.4)	0	3 (1.4)	

HCWs, health care workers; COVID-19, coronavirus disease 2019; SD, standard deviation.
[a] *P* values indicate differences between front-line and non-front-line HCWs from the results of a Student's t-test, χ^2 test, or Fisher exact test.
[b] Statistically significant.

Table III
Differences in clinical characteristics of 211 Front-Line and Non-Front-Line HCWs with confirmed COVID-19

Characteristic	No. (%)			*P* value[a]
	All (n=211)	Front-line HCWs (n=44)	Non front-line HCWs (n=167)	
Comorbidities				
Hypertension	23 (13.4)	5 (13.5)	18 (13.3)	1.00
Diabetes	2 (1.2)	1 (2.7)	1 (0.7)	0.38
Cardiovascular disease	8 (4.7)	3 (8.1)	5 (3.7)	0.37
Respiratory disease	32 (18.6)	9 (24.3)	23 (17)	0.34
Neoplasia	6 (3.5)	1 (2.7)	5 (3.7)	1.00
Liver disease	1 (0.6)	0	1 (0.7)	1.00
Haematological disease	3 (1.8)	1 (2.9)	2 (1.5)	0.51
Kidney disease	4 (2.3)	1 (2.7)	3 (2.2)	1.00
Neurological disease	3 (1.7)	0	3 (2.2)	1.00
Other	22 (12.6)	2 (5.4)	20 (14.6)	1.00
Signs and symptoms				
Fever	63 (31.0)	12 (28.6)	51 (31.7)	0.69
Cough	104 (50.7)	28 (66.7)	76 (46.6)	0.02[b]
Dyspnoea	42 (20.6)	12 (28.6)	30 (18.5)	0.15
Myalgias	126 (61.5)	29 (69.0)	97 (59.5)	0.26
Headaches	109 (53.4)	24 (57.1)	85 (52.5)	0.58
Anosmia	110 (53.9)	23 (54.8)	87 (53.7)	0.90
Ageusia	102 (50.0)	24 (57.1)	78 (48.1)	0.29
Asthenia	131 (64.2)	29 (69.0)	102 (63.0)	0.46
Diarrhoea/gastrointestinal symptoms	65 (32.7)	15 (36.6)	50 (31.6)	0.54
Odynophagia	53 (26.0)	11 (26.2)	42 (25.9)	0.97
Risk factors				
Smoker	20 (11.4)	3 (8.1)	17 (12.2)	0.46
Immunosuppression	2 (1.2)	0	2 (1.5)	1.00
Pregnancy	1 (0.6)	1 (0.8)	0	0.17
Days with signs and symptoms	23.2 (16.9)	30.4 (18.2)	21.5 (16.2)	0.01[b]
Severity criteria				
Fever >38° C for more than 2 days or fever again	13 (6.7)	0	13 (8.4)	0.07
Dyspnoea at rest or small efforts	9 (4.6)	4 (10)	5 (3.2)	0.08
Thoracic pain	10 (5.1)	2 (5)	8 (5.2)	1.00
Persistent vomiting or diarrhoea	1 (0.5)	0	1 (0.6)	1.00

HCWs, health care workers; COVID-19, coronavirus disease 2019; SD, standard deviation.
[a] *P* values indicate differences between front-line and non-front-line HCWs from the results of a Student's t-test, χ^2 test, or Fisher exact test.
[b] Statistically significant.

Table IV
Outcomes of 211 Front-Line and Non-Front-Line HCWs with confirmed COVID-19

Outcomes	No. (%)			*P* value[a]
	All (n=211)	Front-line HCWs (n=44)	Non front-line HCWs (n=167)	
Followed by family physician	20 (11.6)	7 (19.4)	13 (9.5)	0.13
Went to the emergency department	23 (13.2)	9 (24.3)	14 (10.2)	0.05[b]
Was hospitalized	4 (2.3)	1 (2.7)	3 (2.2)	1.00
Was admitted to the intensive care units	0	0	0	NA
Death	0	0	0	NA

HCWs, HCWs, health care workers; COVID-19, coronavirus disease 2019; NA, not applicable.
[a] *P* values indicate differences between front-line and non-front-line HCWs from the results of χ^2 test or Fisher exact test.
[b] Statistically significant.

Overall, 2.63% of HCWs were infected with COVID-19. This infection rate was similar to previous international studies, that reported rates between 0.89 to 2.94%. [14—17,19] Moreover, the results also showed that front-line HCWs were less infected than non-front-line HCWs (0.55 vs 2.08%, respectively). This trend was also confirmed by previous studies [15] and could be explained by different reasons. The more likely explanation is that the front-line services were organised primarily and as a priority compared to the non-front-line ones, and thus, have had faster and better performance, circulation,

hygiene and safety protocol training, as well as have had more access to the mandatory full body personal protective equipment (PPE). It was well reported that insufficient PPE was available at the beginning of the outbreak for "non-essential wards" (non-front-line ones). In addition, at the beginning of the outbreak, patients who were admitted to hospital without respiratory symptoms and/or any other symptoms were not tested for COVID-19 and this led to several asymptomatic cases that were only confirmed at a later date.

Our results indicated that most HCWs were infected during the early stage of the COVID-19 outbreak (March and April) and that after the different infection prevention and control actions were taken by the hospital, they were very effective in preventing or limiting transmissions. This dynamic and beneficial change was the result of a set of strict prevention and control actions that the hospital adopted. In March, a hospital building (former general hospital) was assigned to receive all the exclusive cases of COVID-19. This allowed physical isolation between the different hospital buildings of all suspected cases, confirmed or not with COVID-19. Additionally, all procedures, use of PPE per service, circuit of patients and HCWs, and the criteria for admission in the other hospital buildings were also standardized, hospital visits were prohibited and actions to reduce HCW's circulation were implemented, the accumulation of jobs in other hospitals by HCWs was suspended, teleworking was proposed, the use of a surgical mask in any non-attendance hospital area was imposed and finally the COVID-19 contingency plan was created, including a "crisis office" (which provided accommodation for HCWs, were responsible for COVID-19 testing, among others) with support telephone lines. In April, five more dedicated services were commenced (also exclusive to COVID-19); systematic screening of elective surgical patients (and for all scheduled admissions) was mandatory and "special wards" were created to receive patients who were only waiting for the results of the COVID-19 test and, after it, they were referred to the dedicated services of COVID-19 or to general care.

In accordance with other studies, nurses are the most infected professional group. This may be justified by its philosophy of caring, with great proximity and a longer intervention time. [25] In addition, nurses are the most numerous professional group in a hospital and who perform the most technical procedures, maintaining a greater direct contact with infected patients.

A total of 0.58% of HCWs with COVID-19 were asymptomatic and this corroborates the results of previous studies. [15] Evidence about the risk of transmission from asymptomatic carriers is still scarce, although the viral load of asymptomatic patients seems to be similar to those detected in symptomatic patients, which could support the transmission chains and super-spread in hospitals. [7,26] Asymptomatic HCWs might become a transmission chain for patients, colleagues and the community. These were more often non-front-line HCWs.

Although fever was very common in other studies, in our study it was not frequent. [14,27] Other symptoms such as cough, myalgias, headaches, anosmia and ageusia were more common. Front-line HCWs spent more days with signs and symptoms when compared with non-front-line HCWs, which could be explained by higher viral loads.

In general, and after the presence of signs and symptoms, all HCWs were tested for COVID-19 and started immediate self-isolation and treatment if needed. This may indicate that early diagnosis and treatment provide a favorable outcomes for HCWs and patients with COVID-19. In addition and contrary to other studies, no HCWs have died or been in intensive care. [17,28].

Our results should be interpreted while considering some limitations. Firstly, we cannot deny that probably missed asymptomatic cases among all HCWs could preclude lower estimates of infection rates, morbidity, and all the sequential analysis. A seropositive analysis across the entire workforce would probably have revealed more cases, as suggested by a prospective multicentre study in the UK hospitals (18%, 95% CI 17.0 to 18.9). [29] Secondly, and based on the previous limitation, probably we also missed asymptomatic cases in family members. Family members of HCWs were tested for COVID-19 if they had symptoms, as recommended. This could have led also to lower estimates of infection. Thirdly, although there has been a large reduction in cases of infected HCWs (and these are most likely due to the actions taken by the hospital), we cannot confirm that with certainty, much less establish causality. At last, some cases of infected HCWs had been fully treated by family physicians and this led to a report of exposure and clinical characteristics delay and this probably wasn't very accurate, imposing some uncontrolled level of recall bias.

Conclusions

The infection rate was very similar to those reported in the literature. Non-front-line HCWs were at a higher risk of COVID-19 infection during the early stages of the outbreak. For this reason, specific attention and interventions targeting this group should be promoted.

Author contributions

RF, AAM and AM designed and coordinated the study. ES, RB, VP and IA were responsible for data collection and accuracy confirmation. ES drafted the manuscript with contributions of the other authors and performed the data analysis. RF made substantial contributions to the data analysis and revisions to the manuscript.

Conflict of interest statement

Authors declare no conflicts of interest.

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