

# The COVID-19 Impact in Hospital Healthcare Workers: Development of an Occupational Health Risk Management Program

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## Keywords

COVID-19 · SARS-CoV-2 · Healthcare workers · Occupational health · Health management software

## Abstract

As with the SARS-CoV-1 outbreak in 2003–2004 and the MERS outbreak in 2012, there were early reports of frequent transmission to healthcare workers (HCW) in the SARS-CoV-2 pandemic. Our hospital center identified its first COVID-19 confirmed case on March 9, 2020, in a 6-day hospitalized patient. The first confirmed COVID-19 case in a HCW happened 3 days later, in a nurse with a probable epidemiological link related to the first confirmed patient. Our study's first objective is to describe and characterize the impact of the first 3 months of the SARS-CoV-2 pandemic on the Centro Hospitalar Universitário Lisboa Norte (CHULN). Our second objective is to report the performance of the CHULN Occupational Health Department (OHD) and the impact of the pandemic on CHULN HCW and its adaptation across national, regional, and institutional epidemiological evolution. Over the first 3 months, 2,152 HCW were screened (which represent 29.8% of the total HCW population), grouped in 100 separate identifiable clusters, each one ranging from 2 to 98

HCW. The most prevalent profession screened were nurses ( $n = 800$ ; 37.2%) followed by doctors ( $n = 634$ ; 29.5%). The main source of potential infection and cluster generating screening procedures was co-worker related ( $n = 1,216$ ; 56.5%). A patient source or a combined patient co-worker source was only accountable for 559 (26%) and 43 (2%) of cases, respectively. Our preliminary results demonstrate a lower infection rate among HCW than the ones commonly found in the literature. The main source of infection seemed to be co-worker related rather than patient related. New preventive strategies would have to be implemented in order to control SARS-CoV-2 spread.

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**COVID-19 impacto em profissionais de saúde de um hospital: desenvolvimento de um programa de gestão do risco em saúde ocupacional**

## Palavras Chave

COVID-19 · SARS-CoV-2 · Profissionais de saúde · Saúde Ocupacional · Software de gestão em saúde

## Resumo

À semelhança dos surtos de SARS-CoV-1, em 2003–2004 e de MERS, em 2012, a pandemia de SARS-CoV-2 apresentou, desde o seu início, relatos de transmissão frequente da doença a profissionais de saúde (PS). O nosso Centro Hospitalar identificou o seu primeiro caso confirmado de COVID-19 a 9 de março de 2020, num paciente hospitalizado há 6 dias. O primeiro caso de COVID-19 confirmado num PS ocorreu 3 dias depois, numa enfermeira com vínculo epidemiológico provavelmente relacionado com o primeiro paciente confirmado. O primeiro objetivo do nosso estudo é descrever e caracterizar o impacto dos primeiros 3 meses da pandemia de SARS-CoV-2 no Centro Hospitalar Universitário Lisboa Norte (CHULN). O nosso segundo objetivo é relatar o desempenho do Serviço de Saúde Ocupacional (SSO) do CHULN em relação ao impacto da pandemia no CHULN HCW e sua adaptação ao longo da evolução epidemiológica nacional, regional e institucional. Durante os primeiros três meses, foram rastreados 2.152 PS (o que representa 29,8% da população total de PS), agrupados em cem *clusters* distintos, cada um dos quais variando entre 2 e 98 PS. A profissão rastreada mais prevalente foi a de enfermeiro ( $n = 800$ ; 37,2%) seguido do médico ( $n = 634$ ; 29,5%). A principal fonte de infecção identificada (simultaneamente, geradora de procedimentos de triagem de *clusters*) esteve relacionada com outros colegas de trabalho ( $n = 1.216$ ; 56,5%). Uma fonte originada num paciente ou uma fonte combinada de paciente e colega de trabalho foram responsáveis por apenas 559 (26%) e 43 (2%) dos casos, respectivamente. Os nossos resultados preliminares demonstram uma taxa de infecção mais baixa entre os profissionais de saúde do que as comumente encontradas na literatura. A principal fonte de infecção parecia estar relacionada com colegas de trabalho e não com o paciente. Novas estratégias preventivas deverão ser implementadas para controlar a propagação do SARS-CoV-2 em contexto profissional.

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## Introduction

On December 8, 2019, a pneumonia outbreak of unknown etiology was first identified in Hubei City, Wuhan province, China. Chinese CDC reports the occurrence to the World Health Organization (WHO) China Country Office on December 31, 2019 [1, 2].

WHO names the disease COVID-19, an acronym for coronavirus disease 2019, on February 11, 2020 [3]. The agent causing the infection was a novel coronavirus des-

ignated SARS-CoV-2 by the Coronavirus Study Group [4, 5].

The disease spreads fast across the country and, soon after, across the world leading the WHO to declare the COVID-19 outbreak as a global health emergency, on January 30, 2020 and as a global pandemic on March 11, 2020. The last time had been in 2009 for the H1N1 influenza pandemic [6, 7]. Infections from SARS-CoV-2 are now widespread [8].

SARS-CoV-2 is the seventh coronavirus known to infect humans, the third that can cause severe disease, but the first and only human coronavirus with pandemic potential [9–11]. There is an equal likelihood of contagion for any person or worker. When we consider healthcare workers, namely, the ones dedicated to the diagnosis, treatment and care of infected patients, or laboratory professionals that directly manipulate biological products containing the virus, one could say that they have a specific risk that bears a higher probability of infection, which necessarily determines the need for specialized protection measures [12]. Similar to the SARS-CoV-1 outbreak in 2003–2004 and the MERS outbreak in 2012, there were early reports of frequent transmission to healthcare workers (HCW), including several with fatal outcome [13]. They are expected to be one of the groups most exposed to SARS-CoV-2 infection, and surveillance of the proportion of seropositive HCW is an important indicator of the spread of the virus [14].

Our hospital center identified its first COVID-19 confirmed case on March 9, 2020, in a 6-day hospitalized patient. The first confirmed COVID-19 in a HCW happened 3 days later, in a nurse with a probable epidemiological link related to the first confirmed patient. The Occupational Health Department (OHD) started its follow-up program of risk contacts and suspected cases evaluation that ended up with the development of a new dashboard, which allows daily reports to each involved department or ward supervisor, hospital directors and Portuguese Health Authority.

The health information system includes the standardization of criteria and the dissemination of data processing methodologies in order to allow the comparison of health indicators that will provide information on best practices [15, 16].

Our goal is to ensure the transparency of the entire COVID-19 prevention process in the OHD, fundamental for HCW management decisions [17].

### Objectives

Our study's first goal is to describe and characterize the impact of the first 3 months of the SARS-CoV-2 pandem-

**Table 1.** COVID-19 screening results during the first trimester of the pandemic at CHULN

	1st month, <i>n</i> (%)	2nd month, <i>n</i> (%)	3rd month, <i>n</i> (%)	Total, <i>n</i> (%)
Total exposure screening	1,177 (47.4)	465 (18.7)	510 (20.6)	2,152 (100)
Sex				
Women	921 (78.2)	374 (80.4)	395 (77.5)	1,690 (78.5)
Men	256 (21.8)	91 (19.6)	115 (22.5)	462 (21.5)
Occupation				
Doctor	397 (33.7)	105 (22.6)	132 (25.9)	634 (29.5)
Nurse	427 (36.3)	182 (39.1)	191 (37.5)	800 (37.2)
Nurse aid	303 (25.7)	118 (25.4)	120 (23.5)	541 (25.1)
Technician	102 (8.7)	37 (8.0)	32 (6.3)	171 (7.9)
Clerk	83 (7.1)	20 (4.3)	25 (4.9)	128 (5.9)
Cleaning staff	17 (1.4)	1 (0.2)	4 (0.8)	22 (1.0)
Other	5 (0.4)	2 (0.4)	6 (1.2)	13 (0.6)
Age, years				
Mean	40.9	40.2	40.5	40.6
Standard deviation	12.2	12.2	12.2	12.2
Maximum; minimum	20; 70	20; 69	22; 68	20; 70
Source				
Unknown	152 (12.9)	70 (15.1)	63 (12.4)	285 (13.2)
Patient	287 (24.4)	105 (22.6)	167 (32.7)	559 (26.0)
Co-worker	684 (58.1)	276 (59.4)	256 (50.2)	1,216 (56.5)
Patient + co-worker	43 (3.7)	0 (0.0)	0 (0.0)	43 (2.0)
Cohabitant	5 (0.4)	4 (0.9)	8 (1.6)	17 (0.8)
Non-cohabitant family	1 (0.1)	9 (1.9)	8 (1.6)	18 (0.8)
Community	5 (0.4)	1 (0.2)	8 (1.6)	14 (0.7)
Cluster				
Total	43	27	30	100
Maximum; minimum per cluster	2; 98	2; 47	2; 85	2; 98
Exposure risk				
Symptomatic	353 (30.0)	138 (29.7)	133 (26.1)	624 (29.0)
High risk	365 (31.0)	126 (27.1)	199 (39.0)	690 (32.1)
Low risk	418 (35.5)	181 (38.9)	151 (29.6)	750 (34.9)
Asymptomatic without contact	40 (3.4)	17 (3.7)	12 (2.4)	69 (3.2)
Did not answer	1 (0.1)	3 (0.6)	15 (2.9)	19 (0.9)
OHD action				
Active symptom surveillance	461 (39.2)	175 (37.6)	135 (26.5)	771 (35.8)
Negative PCR screening	603 (51.2)	261 (56.1)	332 (65.1)	1,196 (55.6)
Positive PCR screening	60 (5.1)	12 (2.6)	15 (2.9)	87 (4.0)
PCR screening declined	12 (1.0)	–	1 (0.2)	13 (0.6)
Asymptomatic without contact	33 (2.8)	15 (3.2)	12 (2.4)	60 (2.8)
Did not answer	1 (0.1)	2 (0.4)	15 (2.9)	18 (0.8)
Portuguese Health Authority	3 (0.3)	–	–	3 (0.1)
Corrupt data	4 (0.3)	–	–	4 (0.2)

ic on the Centro Hospitalar Universitário Lisboa Norte (CHULN) quantified in the total number of cases identified, number of suspected cases officially reported to the OHD and their clinical and epidemiological characteristics.

Our second objective is to report the performance of the CHULN OHD and the impact of the pandemic on the CHULN HCW and its adaptation across national, regional, and institutional epidemiological evolution.

## Materials and Methods

In order to answer our first objective, we developed a cross-sectional study, involving all 7,220 workers of the CHULN, between March 11 and June 12. Our inclusion criteria were: (1) being a CHULN HCW; (2) with symptomatology suspicion of COVID-19; (3) having a high-risk or low-risk contact with a known COVID-19 patient or colleague. No exclusion criteria were listed. Participation was voluntary. To meet our second objective, we carried out a narrative analysis of the OHD performance, during the evolution of the pandemic, and its adaptation effort by developing

a software application (dashboard) to help gather, process, study and provide all data to all relevant partners.

In accordance with the Portuguese Health Authority, ECDC and the WHO, we use the following definitions: (i) *symptomatology suspicious of COVID-19*, we [18] included any HCW with at least one of the following symptoms: cough, fever, shortness of breath, sudden onset of anosmia, ageusia or dysgeusia (additional less specific symptoms included headache, chills, muscle pain, fatigue, vomiting and/or diarrhea); (ii) *high-risk exposure (close contact)*, we considered any HCW providing care to a COVID-19 confirmed case or handling specimens from a COVID-19 case, without recommended Personal Protective Equipment (or with a possible breach of PPE) or having had face-to-face contact with any COVID-19 case within 2 m for >15 min [18–20]; (iii) *low-risk exposure* was defined as any healthcare worker providing care to a COVID-19 case, or laboratory workers handling specimens from a COVID-19 case, wearing the recommended PPE or having had face-to-face contact or been in a closed environment with any COVID-19 case within 2 m for <15 min [18–20].

All selected cases whether, self-reported or reported by the wards, underwent a detailed medical interview in order to discriminate any associated symptoms and to scrutinize the nature of the contact with the aim of classifying the associated infection risk. All symptomatic HCW underwent an immediate nasopharyngeal swab to determine the presence of SARS-CoV-2 through a Reverse Transcription Polymerase Chain Reaction (RT-PCR) test. All asymptomatic high-risk contacts performed a nasopharyngeal swab to determine the presence of SARS-CoV-2 through a RT-PCR 4–5 days after the suspicious contact. All laboratory-positive cases begun sick leave and were reported to the national COVID-19 patient registry. All laboratory-negative persons as well as all asymptomatic low-risk contacts begun an active daily symptom surveillance until the 14th day after the suspected contact and were reported to the OHD in case of any symptomatology. Any set of HCW being surveyed from one common COVID-19 patient were grouped in a cluster. Data were gathered from the CHULN OHD digital archive.

## Results

Over the first 3 months, 2,152 HCW were screened (which represent 29.8% of the total HCW population), grouped in 100 separate identifiable clusters, each one ranging from 2 to 98 HCW.

Our screened population (Table 1) had a mean age of 40.6 years and was composed mainly of females ( $n = 1,690$ ; 78.5%). The most prevalent occupations screened were nurses ( $n = 800$ ; 37.2%) followed by doctors ( $n = 634$ ; 29.5%) and nurses aid ( $n = 541$ ; 25.1%). Technicians and clerks had a minor impact ( $n = 171$ ; 7.9% and  $n = 128$ ; 5.9%, respectively).

One relevant fact uncovered was that the main source of potential infection and cluster generating screening procedures was co-worker related ( $n = 1,216$ ; 56.5%). A patient source or a combined patient co-worker source

was only accountable for 559 (26%) and 43 (2%) of cases, respectively. In 285 of the situations screened (13.2%), no source was identified. Familial and community sources had residual influence on the cases screened. The relative proportions of all variables identified remained constant throughout the 3 months of screening.

Risk classification was evenly distributed with an overall prevalence of 29.0, 32.1 and 34.9% for symptomatic HCW, high-risk and low-risk exposure, respectively.

During this first trimester, 1,283 RT-PCR were prescribed, which diagnosed 87 cases of COVID-19 among HCW (6.8%) which represent 4.0% of screened HCW and 1.2% of the total HCW. By the end of June, Portugal counted 42,171 confirmed cases (about 0.41% of the Portuguese population) [21, 22]. During the course of our study, Portugal had a 14-day incidence rate average of 48.94 per  $10^5$  (reaching a 103.4 peak by week 15) [8].

## Discussion

The 1.2% infection rate among HCW and the 6.8% of positive results obtained from all swabs prescribed in our study during the first 3 months of the pandemic were considerably lower than the ones found in the literature.

Wu and McGoogan [2] found an incidence of COVID-19 among HCW of 3.8% ( $n = 1,716$  HCW confirmed cases out of 44,672 total confirmed cases). Within the same time span, but in a Tertiary Hospital in Wuhan, China, Lai et al. [23] found an infection rate of 1.1% (110 of 9,684) among hospital HCW.

In Lombardy, Italy, one study found 8.8% ( $n = 139/1,573$ ) of positive results [24]. Although we could not find a concrete regional 14-day incidence rate per  $10^5$  data, by the time of the study, Lombardy was the most affected Italian region [25]. In Verona, a total of 11,890 specimens collected in a combined mass screening and contact tracing strategy targeting close contacts, 238 positive swabs were obtained, yielding a cumulative incidence of 4.0% [25]. The higher results could be explained because Italy reported a much higher incidence of disease in the community (128,948 confirmed cases which account for about 0.2% of the total population) [8].

In a Madrilene hospital 11.6% ( $n = 791$ ) of all hospital HCW tested positive for SARS-CoV-2 (38%) [26]. This result is higher than ours because a high 14-day incidence rate was observed [8].

In Newcastle, researchers found 14% ( $n = 240$ ) positive tests for HCW [27]. At the Sheffield Teaching Hospitals, 282 HCW were positive for SARS-CoV-2, which repre-



sents a 1.65% cumulative incidence out of the 17,000 employed staff [28].

In the Netherlands, a study involving 1,653 symptomatic HCW, 6% ( $n = 86$ ) had a positive SARS-CoV-2 RT-PCR test (1%) [29].

In our OHD CHULN, we chose to classify and stratify the risk of exposure [18–20] and to identify the most probable source of infection rather than to infer the risk and source of infection by relying on the characteristics of specific HCW activities such as working in the first line versus non-first line of care, or working in a COVID versus non-COVID dedicated ward or ICU, or yet dealing directly or not with patients as some of the cite authors do [2, 23–29]. By doing so, we found that 56.5% of potential HCW infection and cluster generating screening procedures were co-worker related. Regardless of the specific activity, a patient source or a combined patient/co-worker source was only accountable for 26 and 2% of cases, respectively and in 13.2% of the situations screened, no source was identified. As familial and community sources had residual influence on the cases screened, our data point to the fact that in the first 3 months of pandemic in our hospital centre, HCW mainly infecting each other during meals, break periods or in locker rooms.

Since early January, CHULN OHD became involved in the adaptation effort to the new reality through: (1) articulation with other hospital sectors in the design of a contingency plan; (2) development of training and information actions for HCW; (3) design and implementation of a surveillance plan of HCW with exposure to COVID-19 patients and early diagnosis of positive cases; (4) identification of HCW considered to have greater sensitivity to the development of disease with greater severity, that allow ending with a dashboard that help OHD managing HCW health and prevention strategies.

## Conclusions

Our preliminary results demonstrate a lower infection rate among HCW than the ones commonly found in the literature. The main source of infection seemed to be co-worker related rather than patient related. New preventive strategies would have to be implemented in other to control SARS-CoV-2 spread.

The generalized use of the software application developed in our hospital would be beneficial not only to optimize human resources, but also to standardize data upload to regional and national authorities and to provide common ground to scientific pandemic impact comparison.

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## Statement of Ethics

This research complies with the guidelines for human studies and was conducted ethically in accordance with the World Medical Association Declaration of Helsinki receiving the scientific ethical approval of the Lisbon's Medical Academical Center and the Centro Hospitalar Lisboa Norte Ethics Committee. Gathered data were based on SCHULN OHD clinical records and were previously anonymized, thus informed consent was not required.

## Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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## Author Contributions

L.M.-G. is accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. L.M.-G. and E.S.-L. were responsible for data acquisition, design, analysis, and interpretation of data. J.R., D.F., A.C., R.L., J.S., C.A., and O.S. were responsible for data acquisition. E.S.-L., F.S., and A.S.-U. were responsible for revising it critically for important intellectual content and final approval of the version to be published.

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