SARS-CoV-2 Infections Among Healthcare Workers Outside Hospitals

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Abstract

Most Covid-related infections and deaths occur in healthcare outside hospitals. We wished to explore SARS-CoV-2 infections among healthcare workers (HCWs) in this setting.

All healthcare providers in Stockholm, Sweden were asked to invite HCWs at work for a study of past or present SARS-CoV-2 infections among HCWs. This study reports the results from 839 HCWs, mostly employees of primary care centers, sampled in June 2020.

Prior infection, as measured using seropositivity, was found among 12% (100/839) of HCWs, ranging from 0–29% between care units. There was a significant trend of decreasing serology positivity by age (one sided p-trend 0.0467). Seropositivity was highest among HCWs < 40 years of age. Within this age group there was 19% (23/120) seropositivity among women and 11% (15/38) among men ($p < 0.02$). Current infection, as measured using PCR, was found in only 1% and the typical pre-symptomatic testing pattern found in only 2 subjects.

SARS-CoV-2 infections had been rather common among younger HCWs in this setting, but pre-symptomatic infection appeared to be uncommon. Sex differences in SARS-CoV2 specific seropositivity in HCWs younger than 40 years and older than 50 years can be due to exposure, behavior and/or immunological factors.

Introduction

The first wave of the COVID-19 epidemic started in March 2020 in Sweden [1], and the Stockholm region was particularly impacted. Governmental guidelines were swiftly implemented to manage the outbreak and related severe COVID-19 cases placing a burden on healthcare and hospital capacity. However, despite these guidelines, Sweden has now suffered two waves of the epidemic resulting in more than 900,000 individuals with SARS-CoV-2 infection and more than 13,700 COVID-19 deaths [2].

In February 2020, the WHO published guidelines on occupational safety for healthcare workers since they are in the front line of any outbreak [3]. The guidance names employers and managers in health facilities as responsible for the occupational safety of employees including providing adequate training, infection prevention and control (IPC) and personal protective equipment (PPE). Yet, in May 2020, about half of all confirmed cases of COVID-19 in Sweden were among healthcare staff [4]. By the end of May 2020, in the Stockholm region (with a population of about 2,300,000 inhabitants) about 2,127 individuals with COVID-19 had died and 806 had been admitted to the intensive care unit (ICU) [5]. Nationally, during the first wave there were 4,499 deaths due to COVID-19 [4]. Of these, 2,257 (50%) deaths occurred at care homes [6].

Rapid community transmission of COVID-19 was typical for the local outbreaks in Sweden and asymptomatic healthcare workers (HCW) in primary care, home healthcare, and palliative care likely had a distinctive role in the transmission events [3, 7]. Local rapid community transmission was most evident in local care homes, where a majority of COVID-19 deaths occurred in Stockholm during the first outbreak [1]. Although the Swedish Public Health Agency recommended that all healthcare staff with symptoms suspicious of COVID-19 should be tested for SARS-CoV-2, testing was low or absent during the first wave.

During the first wave of the epidemic in Sweden, testing for presence of SARS-CoV-2 was limited to patients admitted to hospitals. Ambulatory testing for suspected cases of COVID-19 at care homes was accessible and requested by physician in charge. To some extent, ambulatory testing was available for patients with co-morbidities in home-based care. PPE was generally scarce in Swedish healthcare and care homes received insufficient PPE for their staff [6, 8]. Simultaneously, primary care centers made medical assessments of patients with suspected COVID-19 at their outpatient infection clinics using IPC precautions, but without having access to testing.

Healthcare environment related infections not only endanger the patient but risk the healthcare personnel, and further, can quickly limit the healthcare units care capacity. Accumulating evidence indicate that staff in primary care, at homes and in palliative care were highly exposed to SARS-CoV-2 infections, and that a large fraction of the infections were asymptomatic [4, 5, 7, 8]. Therefore, it is important to efficiently detect and manage healthcare-related SARS-CoV-2 exposures. To assess the likely burden of SARS-CoV-2 infections among HCWs in primary care, at homes and in palliative care in Stockholm during the March-June 2020 SARS-CoV-2 outbreak, we recruited most of the healthcare personnel for SARS-CoV-2 antibody screening and SARS-CoV-2 RT-PCR testing.

Material And Methods

Study design and subjects

We asked the healthcare providers in Stockholm, Sweden to invite their employees to a study of past or present SARS-CoV-2 infections in the healthcare setting. The HCWs enrolled were from all professions: physicians, nurses, assistant nurses, psychologists, social workers, physiotherapists, healthcare administrators, medical secretaries occupational therapists, speech therapists, and nutritionists.

We report on the presence of SARS-CoV-2 viral RNA in throat swab samples and presence of SARS-CoV-2 specific antibodies in serum of HCWs in Region Stockholm, Sweden, in June 2020. An invitation was sent by e-mail to the operations managers in primary health care in the region of Stockholm. All units were offered to participate in a digital study information meeting at the end of May. The units who participated were 22 primary care centers, 2 care homes, and one palliative care unit representing approximately 900 employees. Recruitment was carried out in June 2020.

Healthcare staff on duty (hence without any disease symptoms) were eligible. To be included in the study, each study subject needed to provide a written informed consent form. For each unit included in the study, there needed to be an approval by the operations manager. Staff members were excluded if they were absent from work or had an incomplete consent form. Samples (throat swabs or blood samples) were excluded if they were invalid or absent. If both samples were invalid or absent, the individual was excluded.

Operations managers also reported measures taken to limit transmission of SARS-CoV2 (Supplementary information).

Methods

Viral RNA detection and antibody detection methods have already been described [9]. Briefly, viral RNA was extracted from throat swab samples using MGIEasy Magnetic Beads Virus DNA/RNA extraction kit and subjected to real-time PCR. Serological analysis (99.2% sensitivity and 99.8% specificity assay) was performed by IgG detection in inactivated serum. Antibodies were tested against three different variants of viral proteins (Spike trimers containing prefusion-stabilized spike glycoprotein ectodomain, Nucleocapsid protein and Spike S1 domain) and reactivity against at least two viral antigens was required for a sample to be assigned as IgG positive.

SARS-CoV-2 testing results (PCR and serology) were reported as proportions by workplace, age, and sex. A one-sided Cochran Armitage test for trend was used to examine patterns in serology prevalence by age. The analyses were done in SAS 9.4, Cary NC, USA.

Ethics declaration

The approval of the study was granted by the National Ethical Review Agency of Sweden (Decision number 2020 – 01620 and 2020 – 01881). Trial registration number: ClinicalTrials.gov NCT04411576. All methods in the study were carried out in compliance with the Helsinki declaration.

Results

A total of 25 different care units joined our study, from which 839 employees were enrolled (83% out of 1009 employees in total). The size of the workplaces varied as well as the participation rate at each workplace. The median age of employees was 47. Overall, 8/839 (1% were PCR positive and 100/839 (12%) of employees were serology positive at the time of sampling. Only three individuals were serology negative and PCR positive. Only two of these three individuals were strongly positive (CT value below 27.0 in the PCR).

PCR positivity ranged from 0-7% among the different workplaces and serology positivity ranged from 0-29% (6 workplaces had a serology prevalence among employees of over 20%) (Table 1).

Test positivity, both PCR and serology, did not differ overall by sex but there tended to be differences in certain age-strata. The prevalence of serology positivity was higher for women ages 20-40 than men while it was higher for men as compared to women in the ages 50 and above. There was a significant trend of decreasing serology positivity by age (one sided p-trend 0.0467) (Table 2).

Discussion

Main findings

Our most important finding is that young HCWs in primary care, at homes and in palliative care, particularly young women were frequently exposed to SARS-CoV-2 infections, as demonstrated by the over 22% seroprevalence among female HCWs in ages 20–29. This is a significant finding because it suggests that young HCWs at the front line in primary care, were exposed while providing care during the COVID-19 pandemic. Subsequently, HCWs in primary care may have been a source of nosocomial infections, at care homes and in palliative care. Sex differences in SARS-CoV2 specific seropositivity in HCWs younger than 40 years and older than 50 years can be due to by exposure, behavior and/or immunological factors.

We found a low prevalence of PCR positivity (1%) mostly coupled with serology positivity, suggesting that the PCR positivity was mostly post-symptomatic. This combination of test results likely reflects previous disease, where the affected subject returned to work after symptoms have resolved. The finding of many more HCWs with past infection than with pre-symptomatic infection indicates that the study was performed at a time when the first wave of the epidemic was already subsiding in the region.

The typical testing results found among subjects who will have symptomatic disease in the future (pre-symptomatic subjects; PCR positivity for high amounts of virus (CTvalue < 27) and lack of antibodies) was found in only 2/839 subjects, considerably lower than in a major hospital in the same region tested a few weeks earlier (57/9449 subjects) [9] also implying that the number of new infections was declining at the time of the present study.

The seroprevalence of SARS-CoV2 specific antibodies varied substantially between units (0–29%). Hence, it is possible that cluster outbreaks may have occurred within units and is in line with previous literature on the spread of SARS-CoV-2 among HCWs [10].

Strengths of the study include the fact that it is a rather large study with a high attendance rate among HCWs in areas of healthcare that were of particular importance in the epidemic. Furthermore, PCR testing and serology testing was performed simultaneously with advanced technology. Weaknesses of the study include the fact that it was launched at a time when most of the first wave of the epidemic was already over. We did not query the participants regarding symptoms or risk factors for infection. Moreover, results professional-specific data was not available.

Study findings in relation to previous research

In agreement with our results, many studies have reported an increased risk of exposure to SARS-CoV-2 among HCWs, in elderly care homes [11, 12], nursing facilities [13] as well as among the healthcare workers at hospitals [14–16].

Seropositivity was comparable to observational studies from hospitals in the same region and near in time [17, 18]. Participating in the active care of covid-patients was a significance risk factor for being seropositive. A similar association between front line covid care and seropositivity has been observed in a Danish study, screening healthy HCWs, in April 2020 [19]. Occupational exposure to infection has also been found and illustrated as an increased risk of severe covid among HCWs [20, 21].

Previous similar studies from other settings have found an overrepresentation of seropositivity in male HCWs, whereas in our study there was not an overall sex difference [17, 19].

In our study, there was a significant decrease of seropositivity with age, which can be due to the that staff with a higher age to a larger extent than otherwise have taken on other tasks than caring for patients with acute infections, during the Covid-19 epidemic.

Conclusions

Our findings reveal that especially young HCWs in primary care, care homes and palliative care in Stockholm were highly exposed to SARS-CoV-2. Young individuals have a higher tendency to suffer SARS-CoV-2 infection as asymptomatic COVID-19 disease [22] and thus, young HCWs in primary care may have been a source population of nosocomial infections. Prioritizing infection prevention and control including sufficient and adequate personal protective equipment, and vaccination for all HCWs may be important to prevent nosocomial infections and to prevent infection as an occupational injury during an ongoing pandemic.

Declarations

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Author contributions

MF: Study coordination, writing; SSH: study management, writing; VNP: writing; SA: study management, manuscript revision; KME: study management, manuscript revision; JD: Conception and design; writing. JD and KME are guarantors of the study.

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Competing interests

The authors declare no competing interests.

Data availability

The data constitutes sensitive data about health of human research subjects and thus cannot be directly deposited openly. However, pseudonymised, individual-level data that allow full replication of the results in this article are freely available from joakim.dillner@sll.se or from the Karolinska University Hospital data analysis department: tableau.karolinska@sll.se.

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Tables

Table 1. Descriptive statistics for workplaces included in the study and distribution of SARS-CoV-2 testing results by workplace

Workplace	Total number of employees	n Participating employees	Participation rate (%)	Age (median; min-max)	PCR positive n (%)	Serology positive n (%)
Primary health care (PHC)	32					
Alby PHC		27	84%	47 (47/50)	2 (7%)	5 (19%)
Axelsbergs PHC	43	25	58%	39 (39/40)	0 (0%)	2 (8%)
Bredäng PHC	22	24	109%	45,5 (52,5/44)	0 (0%)	1 (4%)
Danvikens PHC	14	14	100%	46 (45/49)	0 (0%)	4 (29%)
Djurö PHC	21	20	95%	50 (50/50)	1 (5%)	1 (5%)
Ektorps PHC	40	31	78%	49 (48,5/49)	0 (0%)	3 (10%)
Familjeläkarna	287	128	45%	41 (41/41)	1 (1%)	20 (16%)
Fisksätra PHC LNP1	17	12	71%	56,5 (62/53)	0 (0%)	1 (8%)
Fittja PHC	26	22	85%	49 (52/48)	0 (0%)	2 (9%)
Flemingsbergs PHC	42	29	69%	41 (42,5/41)	0 (0%)	4 (14%)
Gustavbergs PHC	150	150	100%	49 (45/51,5)	1 (1%)	13 (9%)
Helsa PHC, Älta	26	27	104%	41 (39/46)	0 (0%)	2 (7%)
Kvarnholmens PHC	9	9	100%	45 (53/45)	0 (0%)	2 (22%)
Salems PHC	Unknown	47	Unknown	49 (43/52)	0 (0%)	5 (11%)
Sickla Hälsocenter	40	32	94%	48,5 (44/49)	1 (3%)	1 (3%)
Storvretens PHC	30	7	23%	52 (43,5/52)	0 (0%)	1 (14%)
Sätra PHC	18	17	94%	42 (42/50)	0 (0%)	0 (0%)
Tullinge PHC	50	41	82%	49 (46/51)	0 (0%)	10 (24%)
Tumba PHC	40	43	108%	50 (50/49)	0 (0%)	5 (12%)
Tungelsta PHC	14	8	57%	43,5 (57/36)	0 (0%)	2 (25%)

Vaxholms PHC	25	14	56%	48 (48/53)	0 (0%)	3 (21%)
Care home						
Attendo Lindhovs-Hemmet	Unknown	41	Unknown	48 (45,5/50)	1 (2%)	2 (5%)
Attendo Solbacken	Unknown	30	Unknown	45,5 (44/46,5)	0 (0%)	1 (3%)
Palliative care unit						
Maria Regina Hospice	50	24	48%	51,5 (55/51)	1 (4%)	7 (29%)
Total	1009	839	83%	47 (45/48)	8 (1%)	98 (12%)

Table 2. Distribution of SARS-CoV-2 testing results by age and sex			
Age*	**Participants n**	**PCR positive n *%(**	**Serology positive n (%)**
All ages	**839**	**8 (1%)**	**100 (12%)**
Women	434	2 (0%)	51 (12%)
Men	405	6 (1%)	49 (12%)
<30 years	**59**	**0 (0%)**	**9 (15%)**
Women	32	0 (0%)	7 (22%)
Men	28	0 (0%)	2 (7%)
30-39 years	**199**	**4 (2%)**	**29 (15%)**
Women	88	1 (1%)	16 (18%)
Men	111	3 (3%)	13 (12%)
40-49 years	**227**	**3 (1%)**	**24 (11%)**
Women	119	1 (1%)	12 (10%)
Men	108	2 (2%)	12 (11%)
50-59 years	**229**	**1 (0.4%)**	**28 (12%)**
Women	138	0 (0%)	14 (10%)
Men	91	1 (1%)	14 (15%)
60+ years	**125**	**0 (0%)**	**10 (8%)**
Women	57	0 (0%)	2 (4%)
Men	68	0 (0%)	8 (12%)
*One-sided Cochran Armitage test for trend by age and serology prevalence, p-value = 0.0467			

Supplementary Information

IPC meaures in PHC resported by operations managers, as examples of how PHC units adapted their work in as a part of the COVID-19 pandemic response.

Planning and management:

- Rescheduling of physical meetings to digital meetings or telephone calls, or home visits, depending on the patients' needs.
- Possibility to work from home for staff.
- Triage of patients in the telephone and at the entrances was re-inforced, to make sure patients with symtoms suggestive of COVID-19 were separated from other patients.

- Staff we re-directed to work with new tasks. The need for telephone counselling increased, as did the need for home visits.
- Infection units for patients with suspected COVID-19 were started on site or at a nearby site using staff from collaborating PHC units.
- Booked appointments for sampling at laboratories, in order to minimize crowding in waiting areas.
- Meetings were moved to a larger room to make it easier to keep a safe distance.

On-site infection prevention and control measures (IPC):

- PPE was used as recommended by guidelines for all patients with symtoms suggestive of COVID-19, at infection care units.
- Adjustments of the physical environment with sign indicating appropriate IPC measures for patients such as keeping a safe distans and washing hands.
- Use of PPE: Units started using visirs in all patient encounters.