SHEA
The Society for Healthcare
Epidemiology of America

Original Article

Characterization and evolution of infection control practices among severe acute respiratory coronavirus virus 2 (SARS-CoV-2)–infected healthcare workers in acute-care hospitals and long-term care facilities in Québec, Canada, Spring 2020

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Abstract

Objectives: In this study, we aimed to (1) estimate the severe acute respiratory coronavirus 2 (SARS-CoV-2) infection rate and the secondary attack rate among healthcare workers (HCWs) in Québec, the most affected province of Canada during the first wave; (2) describe the evolution of work-related exposures and infection prevention and control (IPC) practices in infected HCWs; and (3) compare the exposures and practices between acute-care hospitals (ACHs) and long-term care facilities (LTCFs).

Design: Survey of cases.

Participants: The study included Québec HCWs from private and public institutions with laboratory-confirmed coronavirus disease 2019 (COVID-19) diagnosed between March 1 and June 14, 2020. HCWs aged ≥18 years who worked during the exposure period and survived their illness were eligible for the survey.

Methods: After obtaining consent, 4,542 HCWs completed a standardized questionnaire. COVID-19 rates and proportions of exposures and practices were estimated and compared between ACHs and LTCFs.

Results: HCWs represented 13,726 (25%) of 54,005 reported COVID-19 cases in Québec and had an 11-times greater rate of COVID-19 than non-HCWs. Their secondary household attack rate was 30%. Most affected occupations were healthcare support workers, nurses and nurse assistants working in LTCFs (45%) and ACHs (30%). Compared to ACHs, HCWs in LTCFs had less training, higher staff mobility between working sites, similar PPE use, and better self-reported compliance with at-work physical distancing. Suboptimal IPC practices declined over time but were still present at the end of the first wave.

Conclusion: Québec HCWs and their families were severely affected during the first wave of COVID-19. Insufficient pandemic preparedness and suboptimal IPC practices likely contributed to high transmission in both LTCFs and ACHs.

(Received 2 December 2020; accepted 12 March 2021)

Healthcare workers (HCWs) have been at high risk of coronavirus disease 2019 (COVID-19) all over the world. As of July 2020, the proportion of HCWs infected among all COVID-19 cases varied between countries: 4.2% in China, 12% in Italy, 16% in Spain, 17.5% in Ontario, Canada, 17.8% in the United States, and 18% in France.[1-5]

In Canada, 53% of all cases during the spring of 2020 were reported by the Province of Québec, which has 23% (8.4 million) of the Canadian population.[6] In Québec, 25% of all confirmed COVID-19 cases were HCWs. Early in the pandemic, lack of clinical and epidemiological data, shortage of protective equipment, insufficient testing capacity (leading to prioritization of HCWs), delays in communication, and unpreparedness for epidemic response have been cited among the main reasons for the excess burden of COVID-19 in HCWs.[7,8] But all of these factors have been in constant evolution, as reflected by the ever-evolving infection prevention and control (IPC) guidelines during the first wave.[7]

In the few studies that have examined the HCW characteristics, the exposures and the IPC practices associated with the risk of

severe acute respiratory coronavirus virus 2 (SARS-CoV-2) infections in healthcare settings occurred in acute-care hospitals (ACHs). These studies had mostly cross-sectional designs and did not show the changes in protective measures and incidence of infection in the context of evolving local epidemics.[9-12] Limited information is available regarding HCWs in long-term care facilities (LTCF) who were severely affected by the COVID-19 epidemic worldwide.[13,14]

In this large study, we aimed to (1) estimate infection rates and secondary household transmission of Québec HCWs during the spring 2020 wave of COVID-19, (2) describe evolution of work-related exposures and IPC practices of SARS-CoV-2 infected HCWs, and (3) compare these exposures and practices between ACHs and LTCFs.

Methods

Study population

This survey of cases, conducted after the standard case investigation by public health, included any HCW, defined as a care provider and/or working in a healthcare setting in Québec province, who had a COVID-19 polymerase chain reaction (PCR)–confirmed diagnosis between March 1 and June 14, 2020. These HCWs were identified from the provincial database of all COVID-19 cases reported to public health, which included the HCW status identified during the public health investigation. Although data on all HCWs were used to estimate the global burden, only those aged ≥18 years, speaking French or English, having worked during the exposure period (defined as 3–10 days before symptoms onset or testing date) and, having survived their illness, were eligible for the survey.

Data collection

HCWs were contacted between May 6 and June 22, and eligible HCWs who agreed to participate were asked to complete a 30-minute phone or online questionnaire. The questionnaire was developed by the research team which included infectious disease, IPC and occupational health specialists (Supplementary Material online).

Participants were queried about their sociodemographic characteristics, their perceived likely source of exposure (workplace, household, travel, community, etc) and their job characteristics (occupation, facility, department, patient facing contacts). Questions about exposure to COVID-19 patients or colleagues and IPC practices during the exposure period were also asked, including details about personal protective equipment (PPE) worn when contacting nonsuspected COVID-19 patients, COVID-19 patients, and compliance with PPE doffing protocol. Additional data were collected regarding household size, the number of household members who developed COVID-19–compatible symptoms, and the first symptomatic person in the household according to the participant.

Data analysis

The numbers of all reported new infections from March 1 to June 14 were used to estimate cumulative incidences and 95% confidence intervals for HCWs and for non-HCWs aged 20–69 years. Numerators for health occupation rates were estimated assuming the same proportions in all HCWs as among survey participants. Denominators were taken from the 2016 Canadian Census, increased by 5% to account for the annual growth, and from the

College of Physicians of Québec and the Québec Orders of Nurses and Nurse Assistants.[15-18]

Secondary household attack rates were estimated in a subsample of 3,823 participants who lived in households with ≥2 members where the HCW was the first case.

Proportions or median and full range were calculated for each variable, and prevalence of IPC practices were estimated by type of patient exposure. The evolution of COVID-19 prevention and control measures was plotted by CDC week of symptom onset or testing if asymptomatic and trends were tested using a Cochrane-Armitage test. Changes were described for early spring (March 1–April 11), mid spring (April 12–May 16) and late spring (May 17–June 14). Characteristics, exposures and practices in ACHs and LTCFs, including participants working exclusively in one type of facility, were statistically compared using χ^2 tests.

Ethical aspects

This study was conducted under the legal mandate awarded by the National Director of Public Health of Québec under the Public Health Act. It was approved by the research ethics committee of the CHU de Québec–Université Laval. Verbal consent during phone interviews and/or electronic consent was obtained from all participants.

Results

Burden of COVID-19 among HCWs

In the provincial database, 54,005 confirmed COVID-19 cases occurred between March 1 and June 14, 2020, and 13,726 (25.4%) of these were HCWs. This proportion increased from 19.6% in early spring to 28.7% in mid-spring and declined to 25.5% by late spring (Fig. 1). The estimated rate of reported COVID-19 was 11 times greater in HCWs compared to non-HCWs aged 20–69 years (4.4% vs 0.4%). By occupation, the COVID-19 rate was highest among healthcare support workers (7.3%) and nurse assistants (7.4%), and it was lower in nurses (4.2%) and physicians (1.8%) (Fig. 2).

Survey participants

Among the 11,223 HCWs who were called, 8,482 (75.6%) were reached: 986 (11.6%) refused to participate, 198 (2.3%) did not meet the inclusion criteria (44 not a HCW, 58 not a COVID-19 case, 14 not English or French speakers, and 82 other reasons), 2,224 (26.2%) agreed to participate but did not complete the online questionnaire and 532 (6.3%) did not work during the exposure period. Thus, 4,542 participants remained for the analysis (Supplementary Fig. 1 online). Based on the information from the provincial database, sociodemographic characteristics, probable source of infection, occupation, and workplace were similar between participant and nonparticipant HCWs (data not shown).

Sociodemographic and work characteristics

Among the 4,542 participants, 92.3% reported the presence of symptoms, 79.2% were female, and the median age was 42 years. For the type of HCW, 35.1% were healthcare support workers (providing basic personal care like cleaning, dressing and feeding patients), 22.6% were nurses, 11.9% were nurse assistants, 6.0% were managers or administrative workers, and 3.1% were physicians (Table 1).
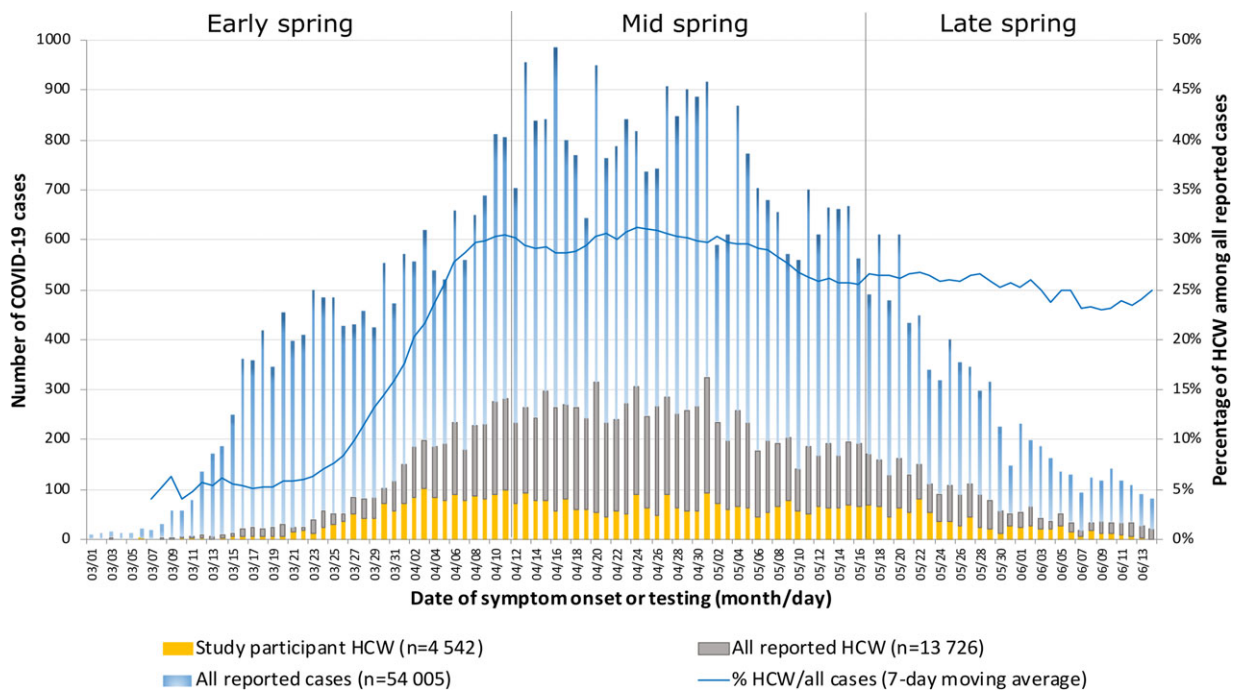
Fig.1. Number and percentage of reported COVID-19 cases, reported infected healthcare workers and participants to the study per day of symptom onset (or day of testing) and proportion of healthcare workers among all reported infections.
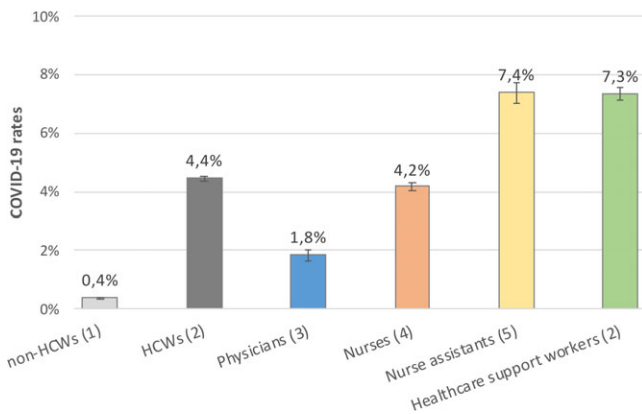Note. HCW, healthcare worker.

Fig. 2. COVID-19 rates and 95% confidence intervals for general population non-healthcare workers aged 20 to 69 years old (excluding healthcare workers), for healthcare workers and for some health occupations in Québec, March 1–June 14, 2020. Note. HCW, healthcare worker; public, working for the public health system. Source of denominators to estimate different rates:[1]Québec Statistic Institute, population of 2019.[2]Statistics Canada, 2016 Census (with an added 5% growth of HCW according to other sources).[3]College of Physicians of Québec, data updated in 2019.[4]Québec Order of Nurses, data updated 2019.[5]Québec Order of Nurse Assistants, data updated 2019.

Among participants, 48.2% worked in LTCFs (45.3% exclusively in LTCFs), 34.2% worked in ACHs (30.5% exclusively in ACHs), 9.5% worked in private residences for elderly, 5.6% worked in public community health centers, 4.8% worked in other residential facilities (care homes and assisted-living facilities), 4.4% worked in rehabilitation centers, 3.1% worked in private medical clinics, and 10.8% worked in other settings. Although 25.6% reported usually working in >1 facility, 10.5% did so during their exposure period, and this rate was twice as high in LTCF workers (8.3%) as it was in ACH workers (4.0%) (Table 1).

In LTCFs, most participants were healthcare support workers (48.2%), followed by nurses (15.8%) and nurse assistants (10.9%). In ACHs, most participants were nurses (37.1%), followed by healthcare support workers (19.3%), and nurse assistants (11.9%) (Table 1). Among the 1,386 HCWs exclusively working in ACHs, 37.5% worked in medical units, 18.3% worked in surgical units, 16.0% worked in emergency departments, 14.4% worked in geriatric departments, and 8.4% worked in intensive care units. Also, 20.6% worked in >1 department.

Secondary household transmission

In the 3,823 households analyzed, COVID-19 symptoms developed in 2,718 (29.8%) of 9,096 other household members, 1,915 (34.5%) of 5,543 adults, and 803 (22.6%) of 3,553 children <18 years old. The secondary attack rate decreased with larger number of household members from 39.9% in households of 2 members to 22.5% if ≥7 members. Overall, 55.8% of households had no secondary cases, 23.0% had all other members becoming sick, and 21.2% had some symptomatic members but not all (Table 2).

Exposure

The workplace was the perceived probable source of infection of 85.4% of participants: 33.7% indicated that their infection was likely transmitted from patients, 9.8% indicated that their infection was likely transmitted from infected coworkers, and 41.9% indicated that they could not determine whether their actual source of infection was patients or coworkers. Other reported sources of infection were household members (3.9%), extended family or other social contacts (0.7%), the community (1.2%), multiple possible sources including the workplace (5.8%), and unknown (2.8%).

Exposure to infected coworkers was reported by 56.9% of participants (Table 1). Exposure to patients with suspected or confirmed COVID-19 was reported by 3,411 (75.1%), of whom 36.7% worked

Table 1. Demographic and Employment Characteristics and Workplace Exposures to COVID-19 by Type of Facility

Characteristic	Total No. (%)	Type of Facility			
		ACH No. (%)[a]	LTCF[a] No. (%)	Other[b] No. (%)	Several[c] No. (%)
	4542	1,386 (30.5)	2,058 (45.3)	903 (19.9)	195 (4.3)
Age, median Y (full range)	42 (18–82)	39 (18–82)	44 (18–74)[d]	44 (19–73)	38 (18–67)
Sex, female	3,624 (79.8)	1,099 (79.3)	1,646 (80.0)	726 (80.4)	153 (78.5)
Presence of COVID-19 symptoms	4,191 (92.3)	1,301 (93.9)	1,862 (90.5)[cd]	846 (93.7)	182 (93.3)
Profession			d		
Healthcare support workers	1,594 (35.1)	267 (19.3)	992 (48.2)	300 (33.2)	35 (18.0)
Nurses	1,024 (22.6)	514 (37.1)	325 (15.8)	137 (15.2)	48 (24.6)
Nurse assistants	541 (11.9)	151 (10.9)	286 (13.9)	91 (10.1)	13 (6.7)
Administration/Managers	273 (6.0)	89 (6.4)	89 (4.3)	85 (9.4)	10 (5.1)
Housekeeping	164 (3.6)	42 (3.0)	95 (4.6)	22 (2.4)	5 (2.6)
Physicians	140 (3.1)	67 (4.8)	14 (0.7)	18 (2.0)	41 (21.0)
Other types of work	806 (17.7)	256 (18.5)	257 (12.5)	250 (27.7)	43 (22.1)
Public facility[e]	3,684 (81.1)	1,366 (98.6)	1,703 (82.8)[d]	425 (47.1)	190 (97.4)
Mobility					
Work in >1 facility habitually	1,161 (25.6)	222 (16.0)	530 (25.8)[d]	214 (23.7)	195 (100)
Work in >1 facility during exposure period	477 (10.5)	56 (4.0)	170 (8.3)[d]	86 (9.5)	165 (84.6)
Work in ≥3 facilities during exposure period	107 (2.3)	8 (0.6)	46 (2.2)[d]	18 (2.0)	35 (17.9)
Work in >1 department during exposure period	516 (11.4)	285 (20.6)	84 (4.1)[d]	70 (7.8)	77 (39.5)
Work shift			d		
Day (8:00 h–16:00 h) or day/evening (8:00 h–24:00 h)	2,853 (62.8)	809 (58.4)	1,288 (62.6)	629 (69.7)	127 (65.1)
Evening (16:00 h–24:00 h)	781 (17.2)	254 (18.3)	399 (19.4)	110 (12.2)	18 (9.2)
Night (00:00 h–8:00 h) or evening/night (16:00 h–8:00 h)	491 (10.8)	117 (12.8)	226 (11.0)	75 (8.3)	13 (6.7)
Rotating shift	417 (9.2)	146 (10.5)	145 (7.1)	89 (9.9)	37 (19.0)
Exposure					
Contact with COVID-19 infected coworkers	2,582 (56.8)	767 (55.3)	1,224 (59.5)[d]	489 (54.2)	102 (52.3)
Contact with patients	4,047 (89.1)	1,214 (87.6)	1,938 (94.2)[d]	720 (79.7)	175 (89.7)
Contact with COVID-19 patients	3,411 (75.0)	1,037 (74.8)	1,699 (82.6)[d]	527 (58.4)	148 (75.9)
Nonexclusive COVID-19 unit	2,160 (63.3)	566 (54.6)	1,111 (65.4)[d]	397 (75.3)	86 (58.1)
Exclusive COVID-19 unit	1,251 (36.7)	471 (45.4)	588 (34.6)[d]	130 (24.7)	62 (41.9)
Exclusive COVID-19 ICU unit	83 (2.4)	73 (7.0)	0 (0.0)	5 (1.0)	5 (3.4)
Emergency department	226 (6.6)	193 (18.6)	0 (0.0)	8 (1.5)	22 (14.9)
Direct care to COVID-19 patients	2,822 (82.7)	844 (81.4)	1,446 (85.1)[d]	414 (78.6)	118 (79.7)
Attendance at AGMPs	136 (4.0)	93 (9.0)	25 (1.5)[d]	7 (1.3)	7 (4.7)

Note. ACH, acute-care hospital; LTCF, long-term care facility; ICU, intensive care unit; AGMP, aerosol-generating medical procedure.
[a]Healthcare workers with exclusive work in acute-care hospitals or long-term care facilities.
[b]Other reported facilities: private residences for elderly, community health centers, other residential facilities (care homes and assisted-living facilities), rehabilitation centers, private medical clinics, COVID-19 clinics, ambulances, laboratories, pharmacies, public health department, others.
[c]Several types of facilities. For example, if working in several LTCFs, they were classified as LTCF.
[d]Test χ^2 comparing acute-care hospitals versus long-term care facilities statistically significant ($P < .05$).
[e]All facilities where participant works are public.

in exclusively dedicated COVID-19 units. Compared with ACHs, HCWs in LTCFs more often had contact with patients and with COVID-19 patients in nonexclusive units (Table 1).

Pandemic preparedness and IPC practices

Overall, 10.9% participants reported having received no IPC training about COVID-19 since February 2020, and 33.6% reported having received only written or posted recommendations. In early spring, no training was reported by 19.0%, and this rate declined to 3.5% in late spring, whereas the percentage who only received written recommendations remained similar (Fig. 3). Absence of training was more frequently reported by healthcare support workers (16.3% vs 8.3% of nurses and 7.5% of all other HCWs; $P < .01$) and by HCWs working in nonexclusive COVID-19 units (12.6% vs 6.1% for exclusively dedicated COVID-19 units; $P < .01$). In

Table 2. Number and Proportions of Households According to the Number of Secondary COVID-19 Cases and Secondary Attack Rate by Household Size

Variable		No. of Persons Living With the COVID-19 HCW							% of All Infected Persons
		1	2	3	4	5	≥6	Total (≥1)	
Households, no. (%)		1,335	809	984	442	156	97	3,823	55.8
Secondary cases in the household, no. (%)	0	803 (60.1)	476 (58.8)	518 (52.6)	217 (49.1)	76 (48.7)	44 (45.4)	2,134 (55.8)	0
	1	532 (39.9)	179 (22.1)	201 (20.4)	85 (19.2)	30 (19.2)	18 (18.6)	1,045 (27.3)	38.4
	2	NA	154 (19.0)	132 (13.4)	52 (11.8)	20 (12.8)	9 (9.3)	367 (9.6)	27.0
	3	NA	NA	133 (13.5)	43 (9.7)	13 (8.3)	7 (7.2)	196 (5.1)	21.6
	4	NA	NA	NA	45 (10.2)	7 (4.5)	9 (9.3)	61 (1.6)	9.0
	5	NA	NA	NA	NA	10 (6.4)	4 (4.1)	14 (0.4)	2.6
	6	NA	NA	NA	NA	NA	5 (5.2)	5 (0.1)	1.1
	7	NA	NA	NA	NA	NA	1(1.0)[a]	1 (0.0)	0.3
Persons, no.		1,335	1,618	2,952	1,768	780	643	9,096	
Persons with COVID-19 symptoms, no.		532	487	864	498	187	146	2,718	
Secondary attack rate (95% CI)		39.9% (37%–43%)	30.1% (28%–32%)	29.3% (28%–31%)	28.2% (26%–30%)	24.0% (21%–27%)	22.5% (19%–26%)	29.9% (29%–31%)	

Note. NA, not applicable; CI, confidence interval.
[a]The household with 7 secondary cases had 7 persons living with the infected HCW.

LTCFs, 13.9% of HCWs had no training, compared with 5.7% in ACHs ($P < .01$), a difference that persisted in late spring (5.3% vs 1.9%) (Supplementary Fig. 2 and Supplementary Table 1 online).

On a self-reported basis, consistent practice of hand hygiene after patient contact was done by 89.4% of participants and slightly improved throughout the study period ($P < .01$) (Fig. 3). The main reasons for not carrying out hand hygiene were lack of available sink, soap, or hydroalcoholic solution (36.7%); lack of time (35.2%); and forgetting (18.3%) (Fig. 4). Consistent physical distancing during meals increased from 32.6% to 60.8% from early to late spring ($P < .01$), whereas always wearing a mask when <2 m from coworkers increased from 19.2% to 52.3% during this period ($P < .01$) (Fig. 3).

Compared with ACHs, HCWs from LTCFs similarly practiced hand hygiene (88.8% vs 89.3%; $P = .75$), but they more often kept physical distance (56.3% vs 36.8%; $P < .01$) or wore masks (56.3% vs 36.8%) during contact with other HCWs (Supplementary Fig. 2 online).

During contacts with non–suspected COVID-19 patients, 29.7% of the 3,699 responders reported not having used any PPE, whereas 66.6% wore a surgical mask and 36.7% used full PPE (ie, mask, ocular protection, gloves, and gown). Full PPE use was more frequent in LTCFs (40.7%) than in ACHs (34.3%; $P < .01$) (Table 3). Throughout the study period, we detected a significant decrease of HCWs wearing no PPE ($P < .01$), from 63.7% during early spring to 6.1% in late spring (Fig. 3).

During non–aerosol-generating contacts with COVID-19 patients, almost all (97.7%) of the 3,249 participants reported always using some PPE: 70.5% wore a surgical mask and 6.9% wore a N95 respirator. Full PPE with a surgical mask was consistently used by 59.3% of HCWs, slightly lower in LTCFs than in ACHs (58.1% vs 62.5%; $P = .03$), but much higher among those working in exclusively dedicated COVID-19 units than in nonexclusive units (73.4% vs 50.8%; $P < .01$). The proportion of participants in full PPE increased over the study period ($P < .01$), from 32.5% in early to 79.5% in late spring (Fig. 3). The main reported reasons for not always using the recommended PPE were lack of equipment (54.9%), lack of access to equipment (17.9%), and employers' instructions (5.6%). Lack of and difficult access to PPE were the main reasons for not wearing PPE throughout the study period, both in ACHs (71.6%) and in LTCFs (76.9%) (Fig. 4).

Aerosol-generating medical procedures were attended by 136 (3.0%) participants, of whom only 35.1% always wore the recommended PPE (ie, N95 respirator, eye protection, gloves and gown) (Table 3). Noncompliance with the doffing protocol after contact with COVID-19 patients was reported by 23.6% of participants (Table 3), a proportion that decreased from 27.7% in early spring to 16.7% in late spring. The following reasons were most frequently reported: absence or difficult access to garbage can or hand hygiene material (33.4%), prolonged use or reuse of PPE items (29.1%), and lack of protocol (17.3% and 31.3% in early spring) (Fig. 4).

Discussion

The results of this study show the high risk of COVID-19 among Québec HCWs during the first pandemic wave. Healthcare support workers, nurses, and nurse assistants were the most affected HCWs. Several problems related to pandemic preparedness and IPC measures were identified, many of which were still reported at the end of the first wave: insufficient IPC
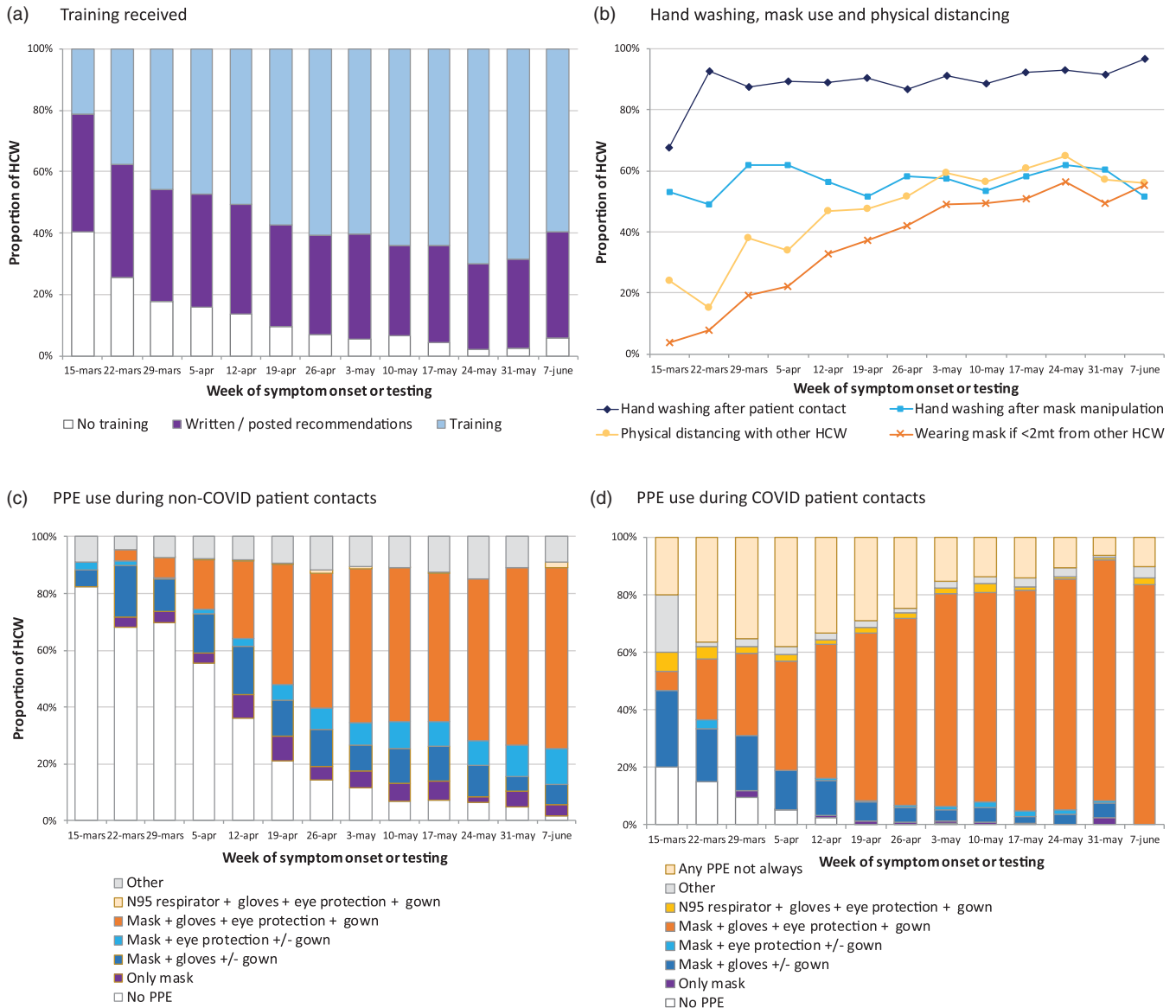
(a) Training received

(b) Hand washing, mask use and physical distancing

(c) PPE use during non-COVID patient contacts

(d) PPE use during COVID patient contacts

Fig. 3. Temporal evolution of the infection prevention and control practices among HCWs infected with COVID-19.
Note. HCW, healthcare worker; PPE, personal protective equipment.

training, lack of protocols and PPE, high interinstitutional and interdepartmental HCW mobility, and breaches in IPC practices at the individual level. Although training and staff mobility were worse in LTCFs than in ACHs, PPE practice was similar, and compliance with physical distancing and mask use during contact with colleagues was better in LTCFs.

Our results indicate an 11-times higher risk of COVID-19 in HCWs than non-HCW adults, and this is one of the highest risk levels published to date. It is probably overestimated by the greater access to SARS-CoV-2 PCR detection tests of HCWs compared to the rest of the adult population; hospitalized symptomatic patients, LCTF residents, and symptomatic HCWs in contact were prioritized for testing from March to end of May. The testing policy might also have led to underestimation of SARS-CoV-2–infected HCWs, as shown by the low proportion of asymptomatic cases reported (8%), compared to 16% among

HCWs from Ontario.[5] A prospective online study found an infection rate of 2.7% (2.9% in the United Kingdom and 1.8% in the United States) among frontline HCW participants, 11.6 times higher than in the general community.[19] Ontario reported a rate 5.5 times higher for HCWs compared with non-HCWs.[5] In Scotland, hospital HCWs had a 3.4 times higher prevalence of SARS-CoV-2 antibodies than age- and sex-matched controls of general population (14.5% vs 4.8%).[20] In Wuhan, the attack rates among HCWs were 5.4 times higher than among non-HCWs.[21]

Overall, 30% of other household members developed COVID-19–compatible symptoms, highly suggestive of COVID-19 given their epidemiological link with a laboratory-confirmed case. This rate might have been underestimated because asymptomatic secondary cases were not detected. This rate is higher than the 17% pooled estimation from a recent meta-analysis of published studies in which secondary attack
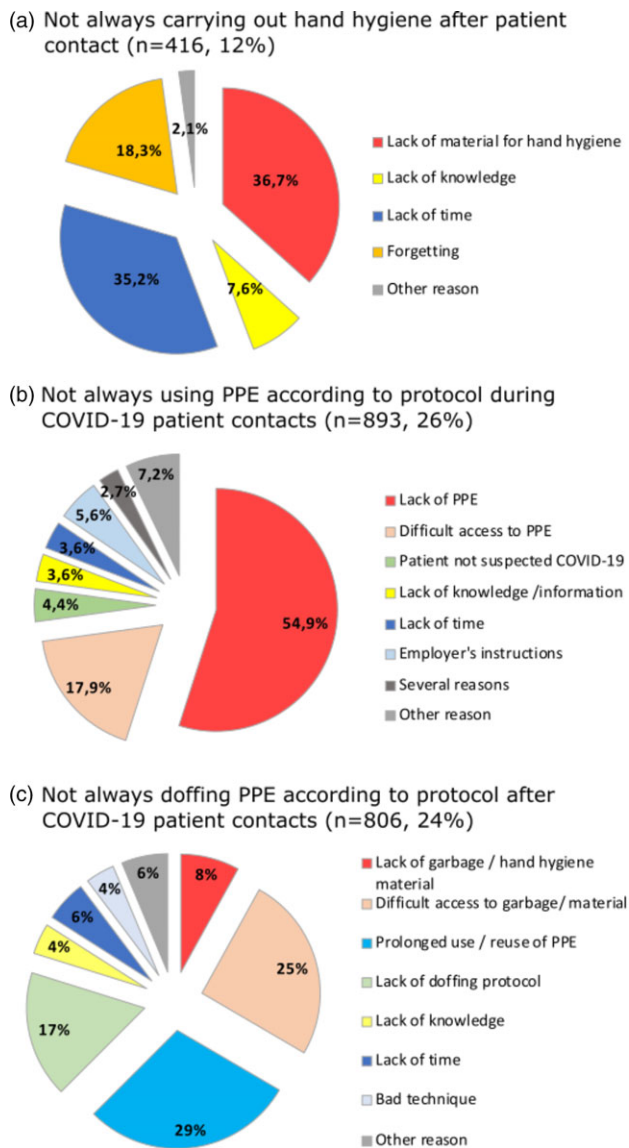
(a) Not always carrying out hand hygiene after patient contact (n=416, 12%)

- Lack of material for hand hygiene — 36,7%
- Lack of knowledge — 7,6%
- Lack of time — 35,2%
- Forgetting — 18,3%
- Other reason — 2,1%

(b) Not always using PPE according to protocol during COVID-19 patient contacts (n=893, 26%)

- Lack of PPE — 54,9%
- Difficult access to PPE — 17,9%
- Patient not suspected COVID-19 — 4,4%
- Lack of knowledge /information — 3,6%
- Lack of time — 3,6%
- Employer's instructions — 5,6%
- Several reasons — 2,7%
- Other reason — 7,2%

(c) Not always doffing PPE according to protocol after COVID-19 patient contacts (n=806, 24%)

- Lack of garbage / hand hygiene material — 8%
- Difficult access to garbage/ material — 25%
- Prolonged use / reuse of PPE — 29%
- Lack of doffing protocol — 17%
- Lack of knowledge — 4%
- Lack of time — 6%
- Bad technique — 4%
- Other reason — 6%

Fig. 4. Reasons for incorrect hand hygiene after patient contact, incorrect PPE use during contacts with COVID-19 patients, and noncompliance with PPE doffing protocol. Note. PPE, personal protective equipment.

rates in households varied between 4% and 36%.[5] Patient-facing staff, mostly nurses and physicians, have been identified as occupations at highest risk, but most of these studies were hospital based.[12,13,22-24] In our study, 35% of all infected HCWs were healthcare support workers (51% in LTCFs), 23% were nurses, 12% were nurse assistants, and 45% worked in LTCFs. These findings are fairly similar to the US data, in which the most affected occupations were healthcare support workers (32%) and nurses (30%) and most (67%) of infected HCWs worked in nursing homes and residential care facilities.[14]

Among study participants in contact with COVID-19 patients, 37% worked in COVID-19–dedicated units (2% intensive care units) where exposure to COVID-19 is constant but HCWs appeared better trained and seemed to use PPE more rigorously,

as shown in the current study. Although some studies have shown that working with COVID-19 patients increased the risk of infection,[9,12,25,26] others have described similar risk for those with or without contacts with COVID-19 patients and for those working in high-risk versus low-risk departments.[10,27-29]

Several factors related to insufficient pandemic preparedness were identified. Nearly half of infected HCWs had either no IPC training (11%) or received only written recommendations (34%). Lack of IPC protocol was frequently reported during early spring. These factors have been described as barriers for compliance with protective measures, whereas formal trainings and PPE observers reduced occupational infection.[9,29-31] In terms of human resources management, even before the pandemic, a shortage of nurses and healthcare support workers forced a substantial proportion of HCWs to work overtime or in several departments or sites.[32] This trend continued throughout the study period and most acutely in LTCFs, even if it was identified as a critical risk factor early in the pandemic.[33] At the onset of the pandemic, given limited access to masks and insufficient COVID-19 epidemiological knowledge, PPE was recommended in Québec only for HCWs providing care to COVID-19 patients, but mask use for all patient and other coworker contacts was recommended only at the end of May 2020.[34] Lack or insufficient access to PPE was reported by participants throughout the study period as the main reason for not wearing PPE during interactions with COVID-19 patients. Inadequate PPE and PPE shortages increased the risk of SARS-CoV-2 infection among HCWs, whereas consistently wearing a mask protected HCWs from infection in different settings in the United States, the United Kingdom, and China.[19,35-37] Finally, frequent unprotected contacts with colleagues were reported during all the study periods, suggesting a lower perception of infection risk from coworkers than from patients. Interaction with SARS-CoV-2–infected coworkers increased risk of infection by 74% in a large German study.[27] All of these risk factors appear to have decreased during the first pandemic wave but remained fairly common, even at the end of the study period.

Our study has several strengths and limitations. This case series is large and represents well the conditions of infected HCWs but not noninfected Québec HCWs. This study was adequate to identify occupations and settings most affected by COVID-19 in absolute terms, to identify important gaps in IPC measures, and to compare ACHs and LTCFs. Without a control group of noninfected HCWs, however, we were unable to estimate the impact of the various factors on the risk of COVID-19. Self-reporting of IPC practices, like hand hygiene and physical distancing, might suffer from desirability bias. Information about other important individual and organizational factors, such as ethnicity, type of training, testing strategies, human resources issues or work organization, was not collected. Despite these limitations, this study is one of the most complete published descriptions of the COVID-19 epidemic among HCWs in a large healthcare system and the evolution of IPC measures during the first pandemic wave.

In conclusion, Québec HCWs and their families were severely affected during the first wave of COVID-19. Lack of preparedness, gaps in IPC, and a low perception of risk from contacts with coworkers likely contributed to their infection. HCW safety will require broader occupational health and safety approaches using the hierarchy of preventive measures and involving both HCW representatives and managers.

Table 3. Use of Personal Protective Equipment (PPE) by Type of Exposure to Patients and Type of Facility

	Type of Patient Exposure								
Variable	Non–suspected COVID-19 Patient			COVID-19 Patient Excluding AGMP[a]			AGMP With COVID-19 Patient		
Frequency	Any frequency[b]			Always			Always		
Healthcare facility	All	ACH	LTCF	All	ACH	LTCF	All	ACH	LTCF
PPE used									
No. of participants	3,699	1,076	1,795	3,249	975	1,635	131[c]	95	22
No PPE	1,100 (29.7)	313 (29.1)	553 (30.8)	74 (2.3)	13 (1.3)	45 (2.8)[d]	1 (0.8)	1 (1.1)	0 (0.0)
Surgical mask	2,462 (66.6)	725 (67.4)	1,177 (65.6)	2,290 (70.5)	691 (70.9)	1140 (69.7)	50 (38.2)	30 (31.6)	10 (45.5)[d]
N95 respirator	111 (3.0)	66 (6.1)	21 (1.2)[d]	223 (6.9)	172 (17.6)	23 (1.4)[d]	65 (49.6)	57 (60.0)	3 (13.6)[d]
Mask/respirator + eye protection	1,800 (48.7)	525 (48.8)	912 (50.8)	2,071 (63.7)	832 (85.3)	1,199 (73.3)[d]	82 (62.5)	63 (66.3)	9 (40.9)[d]
Surgical mask + eye protection + gloves + gown	1,357 (36.7)	369 (34.3)	731 (40.7)[d]	1,928 (59.3)	609 (62.5)	950 (58.1)[d]	32 (24.4)	18 (19.0)	6 (27.3)
N95 respirator + eye protection + gloves + gown	15 (0.4)	5 (0.5)	5 (0.3)	66 (2.0)	53 (5.4)	6 (0.4)[d]	46 (35.1)	43 (45.3)	2 (9.1)[d]
PPE doffing									
No. of participants				3,427	1,018	1,710			
Always doff PPE per protocol				2,619 (76.4)	779 (76.5)	1,312 (76.7)			

Note. ACH, acute-care hospital; AGMP, aerosol-generating medical procedures; LTCF, long-term care facility; PPE, personal protective equipment.
[a]AGMP: aerosol-generating medical procedures that include aspiration of tracheal secretions in an intubated or tracheotomized patient, autopsy, bronchoscopy, cardiopulmonary resuscitation, child nasopharyngeal suction, manual ventilation before intubation, nasopharyngeal or oropharyngeal surgery, sputum induction, tracheal intubation or extubation.
[b]Frequency of PPE use not reported for contacts with non–COVID-19 patients.
[c]5 participants with no information on the frequency of PPE use.
[d]χ^2 test or Fisher exact test comparing acute-care hospitals with long-term care facilities. Statistical significance at $P < .05$.

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