COVID-19 – What We Know So Far About... the Risks to Health Care Workers

Introduction

PHO is actively monitoring, reviewing and assessing relevant information related to Coronavirus Disease 2019 (COVID-19). “What We Know So Far” documents are intended to provide a rapid review of the evidence related to a specific aspect or emerging issue related to COVID-19.

The development of these documents includes a systematic search of the published literature as well as scientific grey literature (e.g., ProMED, CIDRAP, Johns Hopkins Situation Reports) and media reports, where appropriate. Relevant results are reviewed and data extracted for synthesis. All “What We Know So Far” documents are reviewed by PHO subject-matter experts before posting.

As the COVID-19 outbreak continues to evolve and the scientific evidence rapidly expands, the information provided in these documents is only current as of the date of posting.

Key Findings

- Based on available information, the proportion of COVID-19 infection in health care workers (HCWs) varies widely across settings, roles and countries, method of testing and local prevalence. The incidence of COVID-19 among HCWs in studies using polymerase chain reaction (PCR) for diagnosis ranges from <1% to 18%. A number of studies report a several-fold higher incidence in HCWs compared to non-HCWs; however, there is likely substantial testing bias.

- Seroprevalence studies in HCWs have reported rates between 4% and 14%, depending on the jurisdiction. Most studies have reported similar, or lower, infection rates when compared to the general population.

- COVID-19 infections and transmission have been reported amongst clinical and nonclinical staff working in different health care settings. Multiple reports have identified higher infection risk among nonclinical staff and clinical staff on non-COVID-19 units suggesting that the source of infection may be colleagues or patients that were not initially suspected to have COVID-19.

- COVID-19 severity has been milder when compared to non-HCWs; however deaths attributed to COVID-19 have been reported for HCWs, especially among HCWs in older age groups (e.g., 65 years and older).

- Factors described as contributing to HCW infections include: inadequate or improper use of personal protective equipment (PPE), especially at peak times of COVID-19 incidence; unrecognized sources of infection in patients and colleagues; having a family member with...
COVID-19; and exposure in the community. Adherence to Droplet and Contact Precautions (among other Infection Prevention and Control [IPAC] measures at the organizational and individual levels) are reported by some authors as sufficient to protect HCWs against acquiring COVID-19.

- Aerosol-generating medical procedures (AGMP) have not been identified as a significant risk factor for COVID-19 infections.
- Universal masking by HCWs and patients in health care settings may reduce the risk of COVID-19 acquisition.

Background

Since December 31, 2019, when China issued a public statement on an outbreak of pneumonia originating in Wuhan, China, the global incidence of confirmed cases of COVID-19 has grown rapidly in the span of seven months to 18,902,735 cases as of August 7, 2020, and 709,511 deaths (based on the World Health Organization’s situation report August 7, 2020).\(^1\) Even as early as two months into the pandemic, 2,055 confirmed COVID-19 cases were identified in HCWs from 476 hospitals across China.\(^2\) In a report by Amnesty International, over 3,000 HCW have died of COVID-19 during the pandemic, and the actual number may be higher due to a lack of reporting in many areas.\(^3\) Given the transmissibility of Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2), there has been concern that SARS-CoV-2, like other coronaviruses (e.g., severe acute respiratory syndrome coronavirus [SARS-CoV] and Middle East respiratory syndrome coronavirus [MERS-CoV]), may cause large nosocomial outbreaks.\(^4\) It is important that we understand the potential risk factors for acquiring COVID-19 among HCWs to prevent infections in the health care system workforce and in the health care setting, in order to keep the health care system functioning.

Ontario Context and Epidemiology

A PHO report on COVID-19 in health care workers in Ontario noted 13 deaths reported among the 5,815 confirmed cases of COVID-19 in HCWs as of June 22, 2020, with an overall case fatality rate of 0.2%.\(^5\) The severity of COVID-19 infection was lower in HCW cases compared to that of the general population: hospitalization rates were 225/5,815 (3.9%) vs. 4,008/28,038 (14.3%); rates of admission to intensive care units (ICUs) were 54/5,815 (0.9%) vs. 855/28,038 (3.0%); case fatality rates were 13/5,815 (0.2%) vs. 2,606/28,038 (9.3%).

In a PHO report on the epidemiology of COVID-19 in Ontario, 6,418/38,680 (16.6%) of COVID-19 cases reported in Ontario occurred in HCWs as of July 25, 2020, with 233 requiring hospitalization and 57 requiring intensive care.\(^6\)

- 2,536/6,418 (39.5%) of cases in HCWs are associated with long-term care outbreaks.
- There have been 8 deaths reported for HCWs in long-term care homes with COVID-19, with a mortality rate of 8/2,536 (0.3%). The cause of death was not determined from this data.
- These cases include those that reported “yes” to any of the occupation of HCW, doctor, nurse, dentist, dental hygienist, midwife, other medical technicians, personal support worker, respiratory therapist and first responder. As a result, these cases do not distinguish between occupational and community-acquired infection.
It is important to note that data from the Canadian Institute of Health Information on Canada’s health workforce estimate that health care providers comprise approximately 2.2% of Ontario’s population. Although 16.6% of confirmed COVID-19 cases were reported in HCWs, there is substantial testing bias in these numbers and the incidence may be elevated by priority testing for HCWs in Ontario.

What Do We Know So Far About the Risk of COVID-19 in HCWs?

Based on the 48 publications reviewed in this document, the proportion of HCWs who have tested positive for COVID-19 varies from 0% to 52%. HCWs aged 60 years and above appear at risk for more severe outcomes. Some reports have identified a higher risk of infection among HCWs than the general population; however, these studies may have substantial testing bias as HCWs have been a priority population for PCR-based testing. In Denmark, 4% of HCWs were seropositive compared to 3% of blood donors; in one study from New York City, 13.7% of HCWs were seropositive compared to 14% of randomly tested residents of New York State. In another study from New York, 9.8% of HCWs tested had antibodies to SARS-CoV-2 compared to 16.7% (P < .01) of the general population in that area. Risk factors for HCW infections from regions with high incidence of COVID-19 included inadequate and/or inappropriate use of PPE and high intensity of work at peak times of the COVID-19 pandemic. In regions with lower incidence, HCWs were not at substantially higher risk than the general population.

Most studies to date have not quantified the nosocomial risk to HCWs. A number of reports have documented HCW exposures to infected family members, unrecognized infection among patients and/or colleagues, and community contacts, which may contribute to the risk of infection among HCWs. Adherence to standard IPAC measures (e.g., hand hygiene, environmental cleaning, appropriate use of PPE), universal masking, and short duration of contact with patients appear to reduce the risk of HCW infections.

Incidence of COVID-19 in HCWs

Published incidence of COVID-19 in HCWs reviewed here ranges from a low of <1% to a high of 18%. Compared to the general population, two reports found that the incidence of COVID-19 by PCR in HCWs appear higher than that of the general population. However, the source of acquisition of COVID-19 was either not explored or attributed to exposure to nonpatient sources. Priority testing for HCWs in many countries may also bias the reported rates of infection among HCWs.

- In a report by the Canadian Institute for Health Information, more than 9,650 staff members at long-term care homes had been infected with COVID-19 as of May 25, 2020, representing more than 10% of Canada’s number of confirmed cases. Nine deaths in HCWs infected with COVID-19 were reported. The report does not explore the source of exposure for these staff members and the level of adherence to IPAC recommendations at the organizational and individual levels.

- In a report published by Alberta Health Services (AHS), 0.14% of HCWs tested positive by PCR compared to 0.1% of the general population. HCWs were tested at a rate five times higher than
Twenty-two (2.4%) physicians tested positive for COVID-19 out of 933 tested as of April 27, 2020, representing 0.30% of all 7,408 AHS physicians. Twenty of these infections were linked to a single community outbreak and the other 2 cases were under investigation. Only 12 (0.01%) HCWs testing positive were deemed due to occupational exposure.

- Schiavone M et al. reported on HCW infections in a tertiary care hospital in Lombardy, Italy in the early stage of the COVID-19 outbreak. As of March 30, 2020, 65/400 (16.3%) adult patients with COVID-19 admitted to a tertiary care hospital in Lombardy were HCWs. The proportion of HCWs infected was about 9 times higher than the estimated 1.87% of HCWs in the adult Italian population. The authors noted that a shortage of PPE and lack of a standardized HCW screening protocol were factors leading to this high rate of HCW infection.

- Khalil A et al. reported on the results of universal screening of HCWs at a hospital in London. Between March 17 and April 16, 2020, more than half of the staff had been tested and 47/266 (18%) tested positive by reverse transcription polymerase chain reaction (RT-PCR) of nasopharyngeal swabs, with 16/47 (34.0%) being asymptomatic at the time of testing. It is not reported to what extent these infections were acquired at work and what factors place HCWs at higher risk for infection.

- At two teaching hospitals in the Netherlands where 1,353 symptomatic HCWs with fever or respiratory symptoms were screened for COVID-19, Kluytmans-van den Bergh MFO et al. found 86 (1% of all HCWs) tested positive by RT-PCR on oropharyngeal samples. The 86 HCWs worked in 52 different departments. Three of them (3%) had a history of travel to countries with high COVID-19 prevalence; 21/86 (24%) had no patient contact during their work. At the start of the screening, there were only 14 COVID-19 patients in the two hospitals and only 3/86 (3%) reported having been exposed to an inpatient with a known COVID-19 diagnosis before their symptom onset. Also, 54/86 (63%) HCW cases reported having worked while symptomatic. The authors noted that as asymptomatic HCWs were not tested, and oropharyngeal swabs may have slightly lower sensitivity than a nasopharyngeal swab, the observed 1% prevalence may be an underestimate.

- In a report by Wee LE, Sim XYJ et al., 14 (0.15%) of 9,322 HCWs at a hospital in Singapore tested positive for COVID-19 from January 1 to April 22, 2020. All presented with mild upper respiratory tract infection symptoms (see entry below for source of exposure).

- Staff members at a teaching hospital in Cambridge were screened between April 6 and 24, 2020 using a real-time RT-PCR on oropharyngeal and nasopharyngeal swabs. Of those tested, 31/1,032 (3%) asymptomatic and 26/169 (15.4%) symptomatic HCWs tested positive for COVID-19. Rivett L et al. noted that those working in areas with laboratory-confirmed patients, patients with high clinical suspicion of COVID-19, or patients awaiting test results (i.e., patients exposed to COVID-19 who may be incubating infection), were significantly more likely to test positive than those working in areas with no known or suspected COVID-19 patients (P = .0042).
HCW COVID-19 INCIDENCE COMPARED TO NON-HCWS IN SEROLOGY-BASED STUDIES

Due to asymptomatic and minimally symptomatic COVID-19 infections, as well as testing priorities and/or limitations in comparisons of HCWs to non-HCWs, using RT-PCR for diagnosis may be associated with substantial testing bias. HCWs have typically been a priority population for testing by RT-PCR. Seroprevalence studies can overcome this bias through more systematic testing and identification of milder previous cases. The studies summarized below demonstrate that in most jurisdictions, the seroprevalence of COVID-19 infections among HCWs compared to non-HCWs was similar, or lower than the general population if PPE supplies were adequate.

- Moscola J et al. investigated the prevalence of SARS-CoV-2 antibodies among HCWs in New York City with 5,523/40,329 (13.7%, 95%CI 13.4%–14.0%) seropositive. The estimated seroprevalence of New York State was 14.0%.50

- In another study from a New York hospital, Jeremias A et al. report that 1,699/3,046 (56%) of hospital employees underwent antibody testing, 617 (20%) RT-PCR testing, and 359 (12%) had both. There were 167 HCWs (9.8%) seropositive for SARS-CoV-2 compared to 16.7% of the general population (P < .001).

- In hospitals in the Capital Region of Denmark, 29,295 HCWs were voluntarily screened by point-of-care serology testing for SARS-CoV-2 IgM and IgG antibodies between April 15 and 23, 2020. Out of the 28,792 HCWs who provided their test results, Iversen K et al. reported that 1,163 (4.04%) were seropositive, a rate significantly higher than the 3.04% of 4,672 blood donors, P < .001.

- A prospective study of SARS-CoV-2 carriage using quantitative RT-PCR (RT-qPCR) on nasopharyngeal swabs and seroprevalence of SARS-CoV-2 IgG antibodies was conducted at a tertiary hospital for infectious diseases in Belgium, involving staff working at 7 COVID-19 units reserved for patients with probable or confirmed COVID-19, 2 COVID-19 intensive care units and the emergency department. Positivity of COVID-19 by RT-qPCR was 3% on day 1 and 2.4% on day 15. Meanwhile, seroprevalence among staff members was 11% on day 1 and 12% on day 15, which the authors noted were 2.5 times higher than the seroprevalence of 4.3% for Belgian blood donors on April 14. Univariate analysis shows that neither gender, age, being a member of the nursing/medical staff nor working in either unit was a risk factor for infection. Martin C et al. attribute these findings to good adherence with PPE measures—medical and paramedical staff wore FFP2 masks (equivalent to N95 respirators).

- Between April 13 and 19, 2020, 279/341 (81.8%) emergency department (ED) staff from a hospital in Utah were voluntarily tested for IgG antibodies for COVID-19. Results for 270 staff members tested showed 16 (5.9%) positives, a rate much higher than the 0.1% amongst people in Utah who reported positive PCR results to public health at that time. Madsen T et al. postulate this was due to a greater risk of exposure to COVID-19-infected patients in the ED setting. Since the test was offered as a service to ED employees, information on test positivity by staff role (i.e., physician, nurse, etc.) and exposure history was not available. The authors also noted that interpretation of the results remains in question as the test used has yet to be validated by the United States Food and Drug Administration.
• At the peak of the COVID-19 outbreak in Spain, 54/578 (9.3%) randomly recruited HCW from a reference hospital for COVID-19 infection in Spain were seropositive for IgM and/or IgG and/or IgA antibodies against SARS-CoV-2, from March 28 to April 9, 2020. Garcia-Basteiro AL et al. describe this as compatible with the 7.1% seroprevalence for the province of Barcelona during April 27 to May 11, as reported by the Ministry of Science. Higher availability of PPE and prompt implementation of HCW screening and quarantine are believed to have contributed to the number of infected HCWs. Meanwhile, the authors noted that 15/65 (23.1%) of HCWs who tested positive for COVID-19 by serology and/or real-time RT-PCR were asymptomatic.

HCW COVID-19 INCIDENCE IN RELATION TO ROLES OR WORKPLACE SETTINGS

COVID-19 transmission among clinical and nonclinical staff has been reported to occur in a variety of hospital departments, long-term care homes, outpatient settings, and across a variety of practice specialties and roles. Nurses have higher reported rates of COVID-19 while physicians were reported to have a higher risk of death in one paper. Working in high-risk areas (such as units designated for COVID-19 patients) was cited by some reports to be a risk factor for HCWs acquiring COVID-19, but others found similar risk regardless of job function or location, one reported higher risk at general hospitals, working in areas not designated for COVID-19, or non-front-line positions. One study found that professional category, working in units designed for COVID-19, having daily contact with patients with COVID-19, age and gender were not significantly associated with the risk of acquiring COVID-19. There is a paucity of data on the risk of occupationally-acquired COVID-19.

• A report by the Italian National Institute of Health on April 16 states that COVID-19 in HCWs accounted for 10.7% of all 168,941 cases, with a median age of 48 years. Nurses and midwives together represent 43.2% (6,988/16,179) of HCWs with epidemiological data, followed by medical doctors at 22.0% (3,574/16,179). Working in hospitals or in emergency care services (i.e., ambulance services) was the perceived source of infection in 70.9% of 11,738 cases with data on source of infection.

• Among the 206 HCWs who died from COVID-19 were 119 medical doctors (57.8%), including 66 general practitioners; 34 nurses (16.5%), with 50% were working in nonhospital health care facilities; 17 nurse aides (8.3%); and 12 dentists (5.8%). About 43% happened in those aged 60-69 years and 20% in those aged 70–79 years. Lapolla P et al. conclude that the intensity of the COVID-19 outbreak in Italy; the recruitment of elderly, retired doctors; and shortages of PPE, particularly in nonhospital care, may be relevant factors contributing to the elevated number of fatalities among HCWs in Italy.

• Wang X et al. characterized a group of 1,271 HCWs with symptoms consistent with COVID-19 and testing positive at a health care system in Massachusetts as nurses or physician assistants (26.5%); technologists or nursing support (17.8%); physicians or trainees (7.4%); and other unspecified professions (48.3%). The median age was 39 years.

• In the report by Keeley AJ et al., 282/1,533 (28%) of symptomatic HCWs at a teaching hospital in the United Kingdom tested positive between March 16 and 29, 2020. Infected HCWs worked in a variety of roles. For the 52 HCW cases with occupational role information, 25 were nursing staff; 8 were doctors; 9 were other clinical staff with patient contacts; 9 were laboratory or secretarial staff; and 1 worked in cleaning services.
From February 24 to May 3, 2020, 1,045 symptomatic HCWs at a hospital in London were tested by RT-PCR nose and throat swab starting a week after a surge in COVID-19 admissions. Zheng C et al. reported that for HCWs with available data, 498/958 (52%) tested positive and clinical staff were more likely to test positive (7.3%) than nonclinical staff (2.8%). HCWs from the ED and acute medicine were more likely to test positive (17.3% and 10.4% respectively) than those from the ICU (2.6%). Possible explanations include PPE use in the ICU and potentially lower infectivity in the patients who were 7 to 10 days into their illness. In the ED, patients may be in the early stage of COVID-19 with higher levels of viral shedding and/or may not be suspected.

Amongst the 166 staff members with COVID-19 at a 5,200-bed general hospital in Wuhan, where testing for COVID-19 was mandatory for all symptomatic staff and voluntary for any other staff, Gong H et al. reported that 26 (15.7%) were nonclinical staff. The remaining 140 (84.3%) were clinical staff, of whom 46 (32.9%) worked in areas for COVID-19 patients.

At a hospital in Wuhan designated for COVID-19 patients, 28/72 (38.9%) of clinicians with acute respiratory illness tested positive for COVID-19 by RT-PCR, including 18/33 (54.5%) who worked in high-risk departments that routinely perform AGMPs and 10/39 (25.6%) who worked in general departments. The risk of infection for HCWs was not found to be higher for tracheal tube removal, CPR, fiber bronchoscopy (RR for each of these 3 procedures were 0.63, 95% CI: 0.06–7.08; P > .05); and sputum suction (RR = 0.43, 95% CI: 0.12–1.55; P > .05). In a multivariable logistic regression model after controlling for gender and HCW type, Ran L et al. found a higher risk of acquiring COVID-19 for missed hand hygiene after patient contact in high-risk departments (RR = 3.07, 95% CI: 1.14–5.13; P < .01); missed hand hygiene after patient contact in general departments (RR = 2.45, 95% CI: 1.45–4.03, P < .05); and working in high-risk departments (RR = 2.30, 95% CI: 1.30–3.77, P < .05).

In the seroprevalence study of patient-facing HCWs (including students) in hospitals in the Capital Region of Denmark, Iversen K et al. noted that medical students had the highest seroprevalence of 14.97% (103/688) but that might be attributed to a high level of transmission at a university club for medical students in the early days of the epidemic. Laboratory personnel had the lowest seroprevalence of 1.93% (25/1,292). Seropositivity was correlated with the percentage of COVID-19 patients admitted at individual hospitals, Pearson's correlation coefficient = 0.85 (95% CI 0.13–0.98); P = .03. It is important to note that the authors did not explore the intensity of patient admission with COVID-19, the nature of IPAC policies and measures in place in the hospitals and the level of adherence, and the availability of PPE. Reported seroprevalence was significantly higher in the following groups:

- Frontline HCWs (doctors, medical students, nurses, nurse students, assisting nurses) vs. other HCWs: 779/17,135 vs. 384/11,657; Risk Ratio (RR) = 1.38 (95% CI 1.22–1.56); P < .001
- HCWs from dedicated COVID-19 wards vs. frontline HCWs in other wards: 95/1,321 (7.19%) vs. 696/15,983 (4.35%); RR = 1.65 (95% CI 1.34–2.03); P < .001
- HCWs with regular patient contact vs. those with no patient contact: 787/18,484 (4.26%) vs. 152/4,363 (3.48%); RR = 1.22 (95% CI 1.03–1.45); P = .02
- Male HCWs vs. female HCWs: 331/6,077 (5.45%) vs. 832/22,715 (3.66%); RR = 1.49 (95% CI 1.31–1.68); P < .001
• HCWs < 30 years of age vs. those aged ≥ 30 years: 5.29% of 4,760 vs. 3.79% of 24,032; RR = 1.40 (95% CI 1.22–1.60); P < .001

• Based on a multivariable logistic regression model, Garcia-Basteiro AL et al. found that the professional category, working in COVID-19 units, daily contact with patients, close contact with a COVID-19 patient, age or sex were not significantly associated with seropositivity.49

• Over a 30-day observation period starting February 21, 2020, 1,303 nasopharyngeal swabs taken from HCWs were tested based on risk assessment of close contacts with confirmed or suspected cases at a hospital in Italy.54 23 HCWs tested positive (1.4% of 1,303 swabs), including 16 physicians, 5 nurses and 2 social health assistants. The average age was 48.6 years. Vimercati L et al. describe the low HCW infection rate as likely due to adoption of IPAC measures, administrative strategies, environmental control and PPE use, with measures to avoid overcrowding.

• In a retrospective study aimed at evaluating the occupational infection risk among HCWs in a designated hospital for COVID-19 in Wuhan, Lai X et al. reported 110/2,009 (5.5%) of COVID-19 patients were HCWs as of February 9, 2020, including 62/110 (56.4%) nurses, 26/110 (23.6%) physicians and 22/110 (20.0%) health care assistants.28 Nurses younger than 45 years of age working in non-front-line positions were more likely to be infected than front-line physicians 45 years of age or older (incident rate ratio = 16.1; 95% CI 7.1–36.3). Source of exposure and adherence to IPAC measures was not reported.

• As part of a COVID-19 outbreak investigation at a long-term care skilled nursing facility in California where two residents tested positive for COVID-19 on March 28, 2020, all residents and staff members were screened between March 29 to April 10.34 Dora AV et al. reported that 8/136 (6%) staff members had positive PCR test results, representing 3 registered nurses and 5 licensed vocational nurses.

• In a cross-sectional study of 145 hospitals in Wuhan, 1,279/2,457 (52.1%) HCWs with COVID-19 were nurses, 826/2,457 (33.6%) were doctors and 352/2,457 (14.3%) were other medical staff.15 Zheng L et al. noted that infection rates were higher for HCWs (2,457/117,100 [2.1%]) compared to nonclinical staff (47,549/11,094,900 [0.4%]), P < .001; for nurses (1,279/57,700 [2.2%]) compared to doctors (826/43,100 [1.9%]), P = .001; and for general hospitals (2,193/74,944 [9.3%]) compared to specialized hospitals (140/17,565 [5.7%]), P < .001 and community hospitals (124/24591 [5.05%]), P < .001). Routine use of PPE in specialized hospitals and fewer COVID-19 patients seen in community and specialized hospitals, are potential explanations offered by the authors for the higher infection rates in HCWs in general hospitals.

• Health care staff with symptoms compatible with COVID-19 were screened by RT-PCR on nose and throat swabs in England,55 including mainly hospital employees with some local general practitioners and ambulance service staff. Between March 10 and 31, 2020, 240/1,654 (14.5%) staff members tested positive. Where information on staff role was available, 128/834 (15%) of patient-facing staff (e.g., nurses, doctors, allied health professionals, porters, etc.) tested positive; 14/86 (16%) of nonpatient-facing staff who were potentially at higher risk of nosocomial exposure (e.g., domestic and laboratory staff) tested positive. Odds ratio of patient-facing vs. nonpatient-facing staff getting COVID-19 was 1.08 (95% CI: 0.59–1.97). For nonclinical staff (e.g., clerical, administrative, information technology, secretarial, etc.), 20/109 (18%) tested positive. The odds ratio of COVID-19 in patient-facing vs. nonclinical staff was 1.24 (95%
Hunter E et al. observed no evidence of a significant difference between these groups \( (P = .71) \), and conclude that their isolation protocols and PPE seemed sufficient to prevent high levels of nosocomial transmission to frontline staff in their setting.

**Clinical Presentation of COVID-19 in HCWs**

Available data in this review show a full spectrum of clinical presentations in HCWs with COVID-19 infection, from asymptomatic, mild infections to severe infections requiring hospitalization or resulting in death. Data from cases reported in Ontario indicate less severe outcomes for HCW patients compared to the general population. However, both Ontario and international data reviewed indicate that HCWs 60 years of age and above are at risk for more severe outcomes.

- HCWs with symptoms consistent with COVID-19 at a tertiary hospital in Spain were tested by PCR on nasopharyngeal swabs. García IS et al. reported that between February 24 and April 30, 2020, 652 symptomatic HCWs out of 1,911 staff members were tested and 213/1,911 (11.1%) HCWs tested positive: 11 required hospitalization, 1 required intensive care and no one died. The median age was 42 years (IQR: 34–52). The actual number of HCW cases could be higher as testing was only offered to symptomatic HCWs present to occupational health and the authors reported the test used had a relatively low sensitivity value (approximately 76%).

- In London, England, self-declared healthy HCWs were recruited to assess asymptomatic COVID-19 infections by serology. During the first 5 weeks, Treibel TA et al. noted 44/400 (11%) HCWs tested positive, with 12/44 (27%) reporting no symptoms in the week before or after positivity.

- In a cross-sectional study of 145 hospitals in Wuhan, Zheng L et al. found that case fatality rates were lower for HCWs \( (17/2,457 \text{ [0.69%]} \) compared to non-HCWs \( (2,518/47,549 \text{ [5.30%]} \), \( (P < .001) \). The authors noted that most in-service HCWs are under the age of 60 who may have a lower mortality risk.

- In a designated hospital for COVID-19 in Wuhan, Lai X et al. reported 93/110 (84.5%) HCW cases had nonsevere COVID-19, 1/110 (0.9%) died. The median age was 36.5 years (IQR: 30.0–47.0).

- Ing EB et al. identified 278 physicians and dentists from various specialties who died with COVID-19 infection as of April 15, 2020. There was identifiable practice specialty information for 254 physicians indicating the following breakdown of mortality by specialty from greatest to lowest: 107 (42%) general practitioners and emergency physicians; 16 (6%) dentists; 13 (5%) internal medicine specialists; 11 (4%) general surgeons; 9 (4%) otorhinolaryngologists; 8 (3%) cardiologists; 8 (3%) ophthalmologists; 7 (3%) obstetricians and gynaecologists; 6 (2%) anaesthesiologists; 6 (2%) psychiatrists; 5 (2%) respirologists; 5 (2%) epidemiologists; 4 (2%) infectious disease specialists; and 4 (2%) oncologists.

**Exposures with No Transmissions**

Five of the articles reviewed reported no acquisition of COVID-19 among a total of 270 HCWs exposed plus 5,544 person-hours of exposure. Four of these reports involved exposure in general wards and ICU due to delayed diagnosis of COVID-19, and the authors attributed the lack of transmission to adherence to standard IPAC measures (e.g., hand hygiene, environmental cleaning) or universal masking. Exposure to AGMPs was noted in two reports, and no transmission to HCWs was noted when either respirators or surgical masks were used. Other factors suggested for the lack of transmission include...
short duration of contact with patients\textsuperscript{11} and appropriate use of PPE.\textsuperscript{9} Specific examples include the following:

- An ED patient in Hong Kong was admitted to a general ward for pneumonia.\textsuperscript{8} 71 staff members were potentially exposed; 30 became symptomatic and were tested; none tested positive. Amongst the exposed staff members were 7 close contacts—one wore a surgical mask while taking blood; the other 6 wore N95 respirators when interacting with the patient. Wong SC-Y et al. noted that heightened alertness to hand hygiene and environmental cleanliness, amongst other IPAC measures, protected staff from COVID-19 transmission from patients.

- Eleven HCWs in Hong Kong had been in close contact with 6 patients with COVID-19 without appropriate PPE (N95 respirator, isolation gown, gloves, eye protection and optional hair cover), while these patients initially received care in non-airborne infection isolation facilities.\textsuperscript{46} Cheng VCC et al. noted that none of the 11 HCWs were infected by the end of a 14-day quarantine period; however, it is not reported whether the absence of infection was based on symptoms or testing. In addition, nature and extent of exposure for HCWs was not described. A universal masking policy was in place before any patients with COVID-19 were detected in Hong Kong.

- An afebrile patient with mild respiratory symptoms was diagnosed with COVID-19 on transfer to another facility a day after admission in Switzerland.\textsuperscript{11} Twenty-one HCWs were exposed (16 were exposed for less than 30 minutes in total); all adhered to basic hygiene measures but none wore a face mask. All tested negative for COVID-19 at 7 days after exposure. Canova V et al. note that routine short clinical examinations and short periods of physical contact did not place the HCWs at risk sufficient for them to have acquired COVID-19.

- No patient-to-HCW transmission was detected at a tertiary hospital from February 5 to March 18, 2020, when 73/126 (57.9\%) of HCWs exposed to 5 patients diagnosed with COVID-19 after admission to were tested after they developed symptoms.\textsuperscript{8} Use of N95 respirators were extended from caring for patients with pneumonia to all patients as of February 28. Wee LE and Hsieh JYC et al. attributed the lack of patient-to-HCW transmission in part to the use of appropriate PPE. Of the 126 exposed HCWs, 3 did not comply with PPE policies. It is not reported how well HCWs complied with hand hygiene and environmental cleaning and how much these contributed to the lack of infection in HCWs.

- A report by Alberta Health Services found no evidence of AGMP as a cause for COVID-19 based on data from an estimated 5,544 person-hours of HCW exposure to 132 inpatients, using recommended PPE (i.e., gowns, gloves, medical masks, and face shield or goggles in routine care and the addition of N95 respirator for any AGMP).\textsuperscript{25} Authors state that “these data support that the virus is not airborne in the setting described and that precision of execution of IPC precautions and PPE use protects HCWs.”

- A case report by Ng K et al. reported that 41 HCWs had been exposed to one patient during AGMPs (endotracheal intubation, extubation, noninvasive ventilation and exposure to aerosols in an open circuit) for at least 10 minutes within 2 m of the patient—35 (85\%) wore a surgical mask and 6 (15\%) used an N95 respirator.\textsuperscript{10} All 41 HCWs tested negative on day 14 after their last exposure. The authors suggest that surgical masks, hand hygiene and other standard procedures were sufficient to protect HCWs from being infected.
Exposures with Transmissions

**INADEQUATE PPE FOR INTERACTING WITH PATIENTS WITH COVID-19**

A few authors have identified shortage of PPE, inadequate PPE, and not using facial protection as risk factors for HCWs acquiring COVID-19 infections. These risks may also be magnified when inadequate PPE coincided with high intensity of work at peak times of the COVID-19 pandemic, and with suboptimal adherence to IPAC measures. It is important to note that most of these authors did not investigate the level of adherence to IPAC measures (e.g., hand hygiene, environmental cleaning, PPE removal technique) and alternate source of infection for the HCWs (i.e., from co-workers or the community).

- A case report by Baker MA et al. described 44 HCWs potentially exposed without adequate PPE for a median of 45 minutes (range 10–720). Three (6.8%) tested positive for COVID-19, one of whom likely was infected by a household member and may not be related to this exposure. The other two HCWs had extended face-to-face contact, including performing procedures such as nasogastric tube placement.

- In a case report by Heinzerling A et al, 3 HCWs tested positive when 43/121 potentially exposed HCWs were tested as they developed symptoms. The index patient was managed with standard precautions and underwent multiple AGMPs, including nebulizer treatments, non-invasive ventilation with bilevel positive airway pressure (BiPAP), endotracheal intubation and bronchoscopy. COVID-19 was diagnosed several days after transfer to another hospital. Risk factors for transmission include AGMPs (being present for or assisting with nebulizer therapy: P = .04; being present for assisting with BiPAP: P = .06); prolonged contact (over 2 hours) (P = .06); performing a physical examination (P = .02). In the second hospital where the patient remained on a closed system ventilator from arrival to diagnosis, no COVID-19 cases were detected in the 8 symptomatic HCWs tested out of 146 HCWs exposed.

- Gong H et al. reported two peaks of HCW infection at a 5,200-bed general hospital in Wuhan, where testing for COVID-19 was mandatory for all symptomatic staff and voluntary for any other staff. Timing of the two peaks coincided with the COVID-19 epidemic peaks in China. The first peak happened between January 20 and 26 when experience with COVID-19 was limited, enforcement of IPAC procedures was limited, and PPE supply was inadequate. The second peak happened between February 4 and 8 when IPAC practices improved and PPE access improved and the infection rate subsequently reduced.

- Using official government data, Zheng L et al. identified 2,457 HCW infections reported in 145 hospitals in Wuhan. The majority of HCW cases were confirmed between January 20 and February 5, 2020, whereas less than 10 cases per day were confirmed after February 28. The authors attributed the higher rates in the early phase to shortages of HCWs and PPE, as well as physical and mental exhaustion from long working hours.

- Between March 19 and June 29, 2020, 15/26 HCWs at a dialysis unit in England designated for COVID-19 patients became symptomatic; 6/26 (23%) tested positive by PCR on nasopharyngeal swabs. In two satellite dialysis units serving symptom-free patients, 17/48 HCWs became symptomatic and none tested positive. As PPE was not in short supply, Gray S et al. suggest that HCWs caring for suspected or confirmed COVID-19 dialysis patients are at high risk of COVID-19 with the existing level of PPE, which include surgical masks, plastic aprons, protective eyewear and gloves.
CARING FOR PATIENTS NOT DIAGNOSED WITH COVID-19

Asymptomatic, presymptomatic, and pauci-symptomatic individuals are a potential source of infection for HCWs. The wide spectrum of clinical presentation overlaps with other common illnesses resulting in a delay in diagnosis if COVID-19 is not suspected. One study of HCW infections noted that no transmissions occurred as a result of COVID-19 unit exposures, and the only patient exposures occurred in patients not initially suspected of having COVID-19. To mitigate these risks, a number of authors point to the importance of maintaining awareness of the risk of exposure and reinforcing strict adherence to IPAC measures (e.g., Routine Practices), including proper use of PPE.

- In the retrospective study described above that evaluates the occupational infection risk among 110 HCWs with COVID-19 in a designated hospital for COVID-19 in Wuhan, Lai X et al. found that 65 (59.1%) attributed their infection to contact with patients who were later diagnosed with COVID-19. HCWs working with non-COVID-19 patients (73 [1.6%] infected out of 4,433 HCWs) were more likely to be infected than HCWs working with COVID-19 patients (17 [0.5%] infected out of 3,110 HCWs); (incident rate ratio, 3.1; 95% CI: 1.8–5.2; P < .001). The authors proposed that insufficient protective measures in non-COVID-19 clinical departments increased the risk for HCWs to become infected at work.

- Zabarsky T et al. reviewed exposures in HCWs with COVID-19. During the 4-month study, 1,534 HCWs were tested for SARS-CoV-2 by PCR and 96 (6.3%) tested positive, including 18 exposed to COVID-19 patients and 6 to infected co-workers within 6 feet for longer than 15 minutes; 10 exposed to co-workers beyond 6 feet or for shorter duration of time; and 13 (13.6%) exposed to either a family member or in the community within 6 feet for longer than 15 minutes. All of the patient exposures were on unsuspected patients on non-COVID-19 wards.

- In a study of 138 hospitalized patients at a university hospital in Wuhan, 40 (29.0%) were HCWs of which 31 (77.5%) worked on general wards, 7 (17.5%) in ED, 2 (5.0%) in ICU. Wang D et al. note that one patient who was transferred to the surgical department is thought to have infected at least 10 HCWs before COVID-19 was identified. However, the study has limited description around type of and adherence with IPAC precautions, and the possibility of exposure outside of work was not investigated.

- Kang SK analyzed data from the Korea Centers for Disease Control and Prevention and reported that 101/10,062 (1.0%) COVID-19 cases were HCWs thought to have been infected at work as of April 5, 2020, including 11 doctors, 82 nurses and 8 other HCW categories. The source of infection was cited as providing treatment to patients without a COVID-19 diagnosis (66/101, 27.4%), working during an outbreak in hospitals (32/101, 13.3%), and performing screening tests for COVID-19 (3/101, 1.2%). No HCWs acquired their infection from providing treatment to patients with a confirmed COVID-19 diagnosis.

- At a hospital in Wuhan designated for COVID-19 patients where 28/72 (38.9%) clinicians with acute respiratory illness tested positive for COVID-19 by RT-PCR, Ran L et al. found that the risk of infection was lower if there was contact with a confirmed COVID-19 patient (RR = 0.36, 95% CI: 0.22–0.59; P < .01), or if there was contact with a suspected COVID-19 patient (RR = 0.49, 95% CI: 0.27–0.89; P < .05).

- In the study by García IS et al., the proportions of HCWs with COVID-19 did not differ significantly by the level of exposure risk: 52/572 (9.1%) in the high exposure group, 94/761 (12.4%) in the medium exposure group, 9/105 (8.6%) in the low exposure group, 58/460 (12.6%)
amongst nurses in hospital wards and hemodialysis unit (P = .123). Incidence of HCW cases peaked 14 days before the peak in admissions due to COVID-19, and 9 days before the peak in notified cases in the region. In addition, temporal clusters in 3 departments (oncology, dermatology and neurology) and 1 profession (heads of department) were identified, suggesting that transmission among HCWs accounted for part of the cases.

- Yau K et al. identified 2 possible index cases (1 patient and 1 asymptomatic HCW) for a COVID-19 outbreak at a hemodialysis centre in Ontario, where 11/237 (4.6%) patients and 11/93 (12%) staff tested positive by RT-PCR of nasopharyngeal swabs between April 8 and 25, 2020. The outbreak occurred despite symptom-based screening of patients (from a month prior); cohorting of patients with COVID-19; Droplet and Contact Precautions in affected area of the dialysis unit; and universal masking of staff (as of March 26). It is not known to what extent routine HCWs adhered to IPAC recommendations. However, 6 (55%) of the patient cases and 6/11 (55%) HCW cases were asymptomatic at the time of testing. In view of the potential for asymptomatic and presymptomatic transmission, the authors conclude that universal screening of all patients, implementation of Droplet and Contact Precautions for all patients until outbreak resolution, isolation of infected patients during dialysis and home quarantine for infected staff (regardless of symptoms) were essential in containing the outbreak.

- Serial antibody (IgM and IgG) levels were measured in all patients and staff at a pediatric dialysis unit in Indiana for two weeks. All patients and HCWs wore surgical masks at all times at the dialysis unit. By the end of the two weeks, 3/13 (23%) patients and 11/25 (44%) HCW seroconverted. Other than a febrile patient who tested positive by PCR a week before the study began (and has been dialyzed in an isolation room since), no participants had symptoms during the 21 day follow-up period. No HCW who directly cared for the PCR-positive patient seroconverted. 2/11 HCWs who cared for 2 patients with subclinical seroconversion developed antibodies for COVID-19. Hains DS et al. noted that transmission from other health care settings or the community cannot be ruled out.

**COLLEAGUES AND COMMUNITY EXPOSURES**

Given the extent of presymptomatic and pauci-symptomatic COVID-19 transmission, it is often challenging to identify the precise source of infection. A number of reports have described the likely source of HCW transmissions to have occurred in households, the community, or from colleagues. COVID-19 transmission from asymptomatic, presymptomatic, and symptomatic colleagues likely represents a substantial proportion of HCW cases and is frequently reported in public health investigations of HCWs.  

- In the Zabarsky T et al. study discussed above, 16/96 (16.7%) of the HCW cases attributed their source of exposure to infected HCWs who were either asymptomatic or pre-symptomatic (11), or symptomatic (5) while at work.

- In the Keeley AJ et al. study discussed above, 18/48 HCW cases with information on symptoms had worked at least one full shift with symptoms which were subsequently attributed to COVID-19, potentially exposing other staff and patients to the infection.

- In a report by Wee LE, Sim XYJ et al., 14 (0.15%) of 9,322 HCWs at a hospital in Singapore tested positive for COVID-19 from January 1 to April 22, 2020. Epidemiological investigation revealed 4 cleaners (two clusters of 2) who shared off-site accommodations, and 2 social workers sharing the same cubicle less than one metre apart at work with no interaction outside work—one
social worker reported having returned to work while symptomatic. The 2 social worker cases represent HCW-to-HCW spread of COVID-19 within the hospital but outside of clinical areas.

- Schwierzeck V, König JC et al. reported on a COVID-19 outbreak in a pediatric dialysis unit in Germany where the source of infection for 7 HCWs, 3 patients and 1 accompanying person was attributed to a HCW who did not get tested for COVID-19 until two days after symptom onset.\(^{38}\)

- In the study by Zheng C et al. (see above), the authors proposed that exposure to a community source accounts for a substantial portion of COVID-19 infection in staff given the large number of infections in nonclinical staff, and the matching epidemic curves of staff and patient infections with the peak of staff infections occurring a week before patient admissions peaked.\(^{12}\) In addition, Zheng C et al. note that doctors had the highest rate of infection at 10.5% but the least documented sick leave at 0.19 sickness episodes per staff member (compared to 0.30 and 0.29 sickness episodes per staff member for clinical staff and nonclinical staff, respectively). While coverage for highly specialized HCWs is challenging, the authors suggest that mildly ill staff members who continue working pose an ongoing transmission risk to staff and patients.

- In a staff screening study by Rivett L et al. described above, genetic sequence analysis identified 2 additional staff cases who worked in the ward of one of the clusters. These 2 staff members had previously been admitted to hospital with severe COVID-19 infection and may have spread the infection to other HCWs on the ward.\(^{39}\)

- At a teaching and tertiary care hospital in Turkey, Çelebi G et al. observed that 14/50 (28%) HCWs with COVID-19 were asymptomatic. Using binary logistic regression analyses, inappropriate use of PPE during the care of suspected or confirmed cases of COVID-19 (OR = 11.3, CI = 2.2–59.4, p = .04) and staying in the same personnel break room as other HCWs without wearing a medical mask for more than 15 minutes (OR = 7.4, CI = 1.9–29.0, p = .04) were found to be statistically significant risk factors for SARS-CoV-2 transmission to HCWs. The incidence of COVID-19 in HCWs dropped following the introduction of additional measures to prevent transmission including: mandatory masking by HCWs in all areas; no eating in all personnel break rooms; no face-to-face sitting while dining at central cafeteria; and providing new break rooms with windows for fresh air ventilation in 2 COVID-19 inpatient clinics.\(^{40}\)

- In a retrospective study by Lai X et al. discussed above, 12/110 (10.9%) HCW cases attributed their infection to contact with colleagues.\(^{28}\)

- A report by the Centers for Disease Control and Prevention on the characteristics of HCWs with COVID-19 between February 12 to April 9, 2020 noted that 9,282/49,370 (18.8%) cases with occupational information identified themselves as healthcare providers (HCP).\(^{26}\) Among 1,423 HCPs who reported contact with confirmed COVID-19 cases, 780 (55%) reported contact in a health care setting only within the 14 days before illness onset (nature of contact is unknown); 384 (27%) reported household exposure only; 187 (13%) reported community exposure only; 72 (5%) reported multiple exposure settings. The authors noted that these figures did not take into consideration exposure to unrecognized sources, including presymptomatic or asymptomatic persons at work and in community.

- In a report published by Alberta Health Services, 145/159 (91.2%) of HCWs with COVID-19 in Alberta as of April 27, 2020 reflect community exposure.\(^{25}\)
• In the report discussed above by Hunter E et al., the pattern of staff’s test-positivity rates was observed to reflect that of community transmission. The authors suggest that the community may be the primary source of exposure for most staff in that setting, given that positivity rates are not significant different between patient-facing, nonpatient facing, and nonclinical staff.\(^{55}\)

• In a survey by Jin YH et al. on the perceived cause of COVID-19 for 103 HCWs at a hospital in Wuhan, 5 (4.9%) reported the community as the likely source of infection; 1 (1%) attributed the infection to handling biological specimens in the laboratory; 87 (84.5%) reported the working environment in hospital was the cause of their infection (i.e. 64/87 (73.6%) had close contact with confirmed patients); 36/87 (41.4%) had exposure to colleagues with confirmed COVID-19; and 15/87 (17.2%) had close contact with suspected patients.\(^ {33}\) Meanwhile, 46/103 (44.7%) HCWs reported having worked more than seven hours a day. It is not certain to what extent long working hours actually increase the risk of COVID-19 in HCWs, as Jin YH et al. also found a low level of adherence to general IPAC measures by many of the HCWs who completed the survey.

• In the report \textit{WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19)}, 2,055 COVID-19 laboratory-confirmed cases have been reported among HCWs from 476 hospitals across China as of February 20, 2020. Investigations among HCWs suggest that many may have been infected within the household rather than in a health care setting.

\section*{Universal Masking}

Wearing a surgical or procedure mask—by HCWs and/or patients—at all times as a source control measure in health care settings to protect others from the wearer are mentioned in seven of the reports reviewed to have a potential role (among other IPAC measures) in protecting patients and HCWs from COVID-19. While there are no high quality studies that have demonstrated the effectiveness of universal masking by HCWs, several observational studies have proposed an association between universal masking and decreasing incidence of HCW COVID-19.\(^ {41,53,57}\)

• At a health care system with 12 hospitals in Massachusetts, 9,850 HCWs with symptoms consistent with COVID-19 were tested by RT-PCR between March 1 and April 30, 2020; 1,271 (12.9%) tested positive for COVID-19.\(^ {53}\) As part of a multipronged strategy to control the COVID-19 outbreak, universal masking of HCWs was introduced on March 1, and on March 25 universal masking was implemented with all patients. Wang X et al. evaluated the effect of universal masking on HCW COVID-19 infections and observed a significantly lower rate of SARS-CoV-2 positivity among HCWs after the implementation of a universal masking policy for HCWs and patients. Before universal masking, positivity rates increased exponentially from 0% to 21.32%; after implementing universal masking for HCWs and patients, positivity rates dropped linearly from 14.65% to 11.46% (P < .001). The authors suggest universal masking may decrease transmission between patients and HCWs and among HCWs, even at a time when COVID-19 incidence continued to rise in Massachusetts. However, the authors noted that other interventions inside and outside the health care system may also contribute to the reduction in HCW testing positive for COVID-19.

• At a tertiary hospital in Germany, 957 staff with suspected exposure to COVID-19 were tested between March 11 and April 17, 2020 by RT-PCR on naso-oropharyngeal swabs; 52 (5.4%) tested positive, of whom 33 (63.5%) were clinical staff.\(^ {57}\) For source of exposure, 39 COVID-19-positive staff reported having had contact with someone who tested positive, out of whom 21 involved contact at work: from patients 1/39 (2.6%) and 20/39 (51.3%) from other staff. Schwierzeck V,
Correa-Martinez CL et al. reported that epidemiological follow-up found no nosocomial transmission amongst patients and staff since universal masking policy for all staff and visitors while on the hospital premises was implemented.

- In the study by Wong SC-Y et al. described above, none of the 30 HCWs tested positive for COVID-19, despite having potentially been exposed to a patient who was only diagnosed with COVID-19 on day 3 of hospitalization. The authors noted that universal masking by staff may have played a part amongst other IPAC measures in protecting them from COVID-19 transmission from patients.

- Kang SK reported that only 1% of COVID-19 cases in Korea occurred in HCWs thought to have been infected at work (see above), and suggest that universal masking by HCWs and patients is one of the measures contributing to such low rate.

- In the report above by García IS et al., HCWs did not systematically wear face masks outside of patient care activities until March 13 to 16. After noting an increase in cases, most departments started systematically wearing face masks at all times in the hospital; shared meals during the night shifts were stopped; HCWs were instructed to keep a distance of at least 2 m in the dining room; and ward rooms were disinfected on March 13 and 16. Since March 17, the authors noted a decline in incidence of HCWs with COVID-19 (from a daily median of 4.5 cases before March 17 to a daily median of 4.0 cases since March 17), despite an increasing number of patients admitted with COVID-19.

- In the study by Baker MA et al. described above where a patient was not diagnosed with COVID-19 until day 13 of hospitalization, the authors noted that the low rate of HCW infection (3/44; 6.8%) may partly be attributed to the universal masking policy that started 7 days into the patient’s hospitalization.

- In the Martin E et al. study described above, universal masking across all units of the hospital was introduced on April 1, when COVID-19 incidence peaked in the community. The authors believe such policy may contribute toward the levelling of seroprevalence among the 326 HCWs working in highly-exposed units who were tested twice in 2 weeks between April 15 and May 18—11% (on day 1 of testing) and 12% (on day 15 of testing).

**Conclusion**

HCWs are at an increased risk for exposure to COVID-19 and several studies have reported higher disease incidence compared to the general population. HCWs are likely exposed to additional risk as a result of their interactions with patients with known, but particularly to unrecognized COVID-19, which was more pronounced at the early stage of the pandemic when knowledge of COVID-19 was nascent, compounded by increased workloads and a limited supply of PPE. Seroprevalence studies have commonly found that the rate of HCW infections are similar to that of the general population, suggesting substantial testing bias in the literature and the effectiveness of PPE if supplies are adequate. As our knowledge in COVID-19 grows and PPE supplies stabilize, it will be important to reassess whether the occupational risk of COVID-19 in HCWs is or is not higher than the background risk in the community. Available data have shown that occupational infection with COVID-19 could be prevented when stakeholders work together to ensure HCWs are familiar with and adhere to Routine Practices for all patient contacts, and to Droplet and Contact Precautions for non-AGMP interactions with patients with confirmed or suspected COVID-19.
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Citation

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