Evidence-Based Practice Group Answers to Clinical Questions

The Risk of COVID-19 Infection Among Workers

A Rapid Review

By

Jeffrey Quon, DC, MHSc, PhD, FCCS(C)

Shawn Eapen, MSc

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for

Dr. Craig Martin
Manager, Clinical Services
Chair, Evidence-Based Practice Group

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About this report

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About the Evidence-Based Practice Group
The Evidence-Based Practice Group was established to address the many medical and policy issues that WorkSafeBC officers deal with on a regular basis. Members apply established techniques of critical appraisal and evidence-based review of topics solicited from both WorkSafeBC staff and other interested parties such as surgeons, medical specialists, and rehabilitation providers.

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Contact Information
Evidence-Based Practice Group
WorkSafeBC
PO Box 5350 Stn Terminal
Vancouver BC V6B 5L5

Email: craig.martin@worksafebc.com
Phone: 604 279-7417
Toll-free: 1 888 967-5377 ext 7417

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Objective:

To determine whether or not workers in any occupation are at greater risk of COVID-19 infection.

Methods:

Initial Search Strategy

A search was conducted on BIOSIS Previews (1969 to 2008), Embase (1974 to 2020 April 27), Medline Epub Ahead of Print, Medline In-Process & Other Non-Indexed Citations, Medline Daily Update and Medline (1946 to April 24, 2020), Joanna Briggs Institute EBP Database (Current to April 22, 2020), and Cochrane Clinical Answers (April 2020).

The following terms and search strategy were used:

1. ((SARS-CoV-2 or COVID-19 or (wuhan adj virus) or 2019-nCoV or (severe adj acute adj respiratory adj syndrome adj coronavirus adj "2")) AND ((occupation or occupational or work or working) and (cause or causation or (risk adj factor) or association or etiology))
2. ((SARS-CoV-2 or COVID-19 or (wuhan adj virus) or 2019-nCoV or (severe adj acute adj respiratory adj syndrome adj coronavirus adj "2")) AND ((occupation or occupational or work or working) and (incidence or prevalence))
3. ((SARS-CoV-2 or COVID-19 or (wuhan adj virus) or 2019-nCoV or (severe adj acute adj respiratory adj syndrome adj coronavirus adj "2")) AND ((occupation or occupational or work or working) and risk)
4. ((SARS-CoV-2 or COVID-19 or (wuhan adj virus) or 2019-nCoV or (severe adj acute adj respiratory adj syndrome adj coronavirus adj "2")) AND ((occupation or occupational or work or working) and epidemiology)
5. ((SARS-CoV-2 or COVID-19 or (wuhan adj virus) or 2019-nCoV or (severe adj acute adj respiratory adj syndrome adj coronavirus adj "2")) AND epidemiology

Initial Search Results

As of April 28, 2020, we had identified 1,284 electronic citations. Titles and abstracts of all 1,284 articles were reviewed for potential relevance, of which 54 were retrieved for full-text review.[1–54] Of the 54 full-text articles in total, 21 articles of variable designs and quality were retained and summarized for this review.[2,5,6,8,13,15–17,20,23,24,26,29,33,35,37,39,40,47,48,53]

Updated Search

An updated search strategy was repeated in OVID/Medline and the Joanna Briggs Institute EBP Database, from April 28, 2020 through May 15, 2020, this time with a focus on analytic epidemiologic studies that included a control group. For this purpose, the following sensitive search strategy was implemented to flag any relevant studies that contained any of our chosen text words regardless of whether or not they had been officially tagged and classified as analytic studies:

1.	cohort study.tw.	179916 citations
2.	case control study.tw.	87157 citations
3.	Covid-19.tw.	11423 citations
4.	1 or 2	265308 citations
5.	3 and 4	86 citations
6.	(workers or occupation).tw.	187781 citations
7.	5 and 6	3 citations
8.	from 7 keep 3	3 citations

Updated Search Results

From the updated search strategy, 3 additional articles were retrieved for full-text review.[55–57]

The medRxiv database was also searched for relevant pre-reviewed analytic studies. Using the search terms “COVID-19 AND relative risk,” we identified another 2 studies that were retained in this review.[58,59]

Finally, one updated systematic review from the grey literature was included, mainly because it included population-based risk data on both health care workers and non-health care workers in a Canadian jurisdiction (Alberta).[60]

In total, data from 27 full-text articles[2,5,6,8,13,15–17,20,23,24,26,29,33,35,37,39,40,47,48,53,55–60] were extracted for this review.

Study Characteristics and Results

Appendix 1 summarizes the characteristics and results of the studies included in this review.

Descriptive Studies

Twenty of the studies are descriptive in nature and report the frequency of lab-confirmed infection among mostly frontline health care workers (HCWs), almost all of whom were suspected of being exposed and were subsequently tested for COVID-19 infection. The case definition (usually including laboratory confirmation by reverse transcription polymerase chain reaction [RT-PCR] testing) is relatively universal between articles, however details about the study population and definition of a health

care worker, duration and timing of exposure, and other risk factors for transmission (including inadequacy of personal protective equipment [PPE]) are either unclear or vary considerably whenever described. In the presence of such heterogeneity in study populations and risk factor characteristics, it is not surprising that the prevalence of laboratory-confirmed COVID-19 among tested workers varies considerably, from 0% to 68%.[8,29]

Descriptive epidemiologic studies generally do not include control groups, therefore the relative risk of infection among workers versus other populations cannot be estimated. Even in the few descriptive studies that present detailed counts of cases according to occupational subgroups (e.g., nurses versus physicians), comparisons between these subgroups is not appropriate simply because their frequency distribution within these highly selected, higher risk samples of workers is not representative of their true distribution in the real-world populations we need to apply the results to.

Analytic Epidemiologic Studies

There are eight articles that include a control group and the corresponding potential to estimate the relative risk of COVID-19 infection between different populations of interest.[15,33,55–60]

1. The article by Guo et al. utilized a case-control design to compare infected orthopaedic surgeons (cases) in Wuhan to non-infected orthopedic surgeons (controls) within the same hospitals.[15] As both groups were “matched” in terms of occupation, it was not possible to analyse the effect of occupation as a risk factor for COVID-19. However, the study did show that use of PPE (and related training in appropriate use) was higher among non-infected than infected surgeons. Although the authors explicitly measured levels of other important risk factors, they did not use statistical methods to adjust (i.e., control) for the potential confounding effects of these variables. In the end, this study assessed only the crude (unadjusted) effect of protective work interventions (e.g., PPE use and training) but was neither designed nor capable of estimating the relative risk of infection between different groups or surgeons or between surgeons and other HCW groups.

2. The study by Pan et al. utilized a nationwide administrative cohort design to compare standardized rates of COVID-19 infection between health care workers (HCWs) in Wuhan on the one hand, and the general population on the other hand.[33] This study showed that HCWs had higher average daily rates of infection particularly during the early phases of the pandemic, however the overall risk of severe or critical illness from COVID-19 was not significantly different between groups. They reported a relative risk point estimate of 1.08, suggesting that HCWs had only an 8% higher risk of severe or critical disease from COVID-19 infection, however the confidence interval for that estimate was 0.96 to 1.21, meaning that an odds ratio as low as 0.96 (representing a 4% lower risk of severe or critical illness) was also compatible with the data. Hence the

conclusion that no statistically significant difference in the risk of severe or critical infection was found between groups.

3. The study by Nguyen is the one genuinely prospective cohort study that involved primary data collection and a very large sample size from both the United Kingdom (UK) and the United States (US).[59] Using a smartphone app with a guided interface, an inception cohort of more than 2 million participants was enrolled, 4.7% of whom identified themselves as frontline HCWs (FHCWs). Participants were encouraged to use the app daily, even if asymptomatic, to report information about personal demographics, comorbidity, symptoms, and COVID-19 testing experiences over time. Compared to the general community, FHCWs had 12-fold higher risk of reporting a positive test for COVID-19 (adjusted hazard ratio [aHR] = 11.7 [95% CI: 10.9-12.3]). This association was stronger for FHCWs in the UK (aHR, 12.5 [95% CI: 11.7-13.2]) than in US (aHR, 2.80 [2.09-3.75]). However, when adjusting for the effects of different variables that influence the probabilities of being tested in each country, the risk for FHCWs was still significantly greater than that of the general community, but not by nearly as much. In the UK, the aHR fell from 12.5 before to 1.92 (95% CI: 1.89 – 1.94) after adjusting for testing probability, while in the US, the aHR fell from 2.80 before to 1.29 (95% CI: 1.19 – 1.410) after the same adjustment. HCWs who reported having inadequate availability of PPE at work had a 26% increase in the self-reported risk of infection over general population controls. HCWs who reported directly caring for COVID-19 patients had 5- to 6-fold increases in the self-reported risk of infection.

   As a medRxiv publication this study had not yet been officially peer-reviewed. Also, the enrolled participants likely represent a biased sample as they were recruited through social media outreach and therefore had to have access to the internet and a smartphone. All data were self-reported and unconfirmed and therefore susceptible to differential rumination and recall bias, especially between workers in health care and those not in health care. On the other hand, this was a very large study with well-described methods. Their analysis also included a validation model which showed that participants who self-reported a positive COVID-19 test result also self-reported the presence of other appropriate clinical and historical characteristics that would normally predict the presence of a laboratory-confirmed infection.

4. A study by Ng and colleagues was framed as a retrospective cohort study involving 41 HCWs at a single hospital in Singapore.[55] All participants had been exposed to an aerosol-generating procedure for longer than 10 minutes, and at a distance less than 2 meters from an index COVID-19 patient. There were two internal comparison groups of HCWs: those who wore surgical masks (85% of participants) and those who wore N95 masks (15%). All participants were monitored daily while in self-isolation at home. No HCWs ended up developing symptoms or a positive test for COVID-19, and therefore no difference in risk was detected between workers using different mask types.

5. In another retrospective cohort study nurses and physicians at a single tertiary care hospital who developed acute respiratory symptoms and signs after a local outbreak were monitored, each for 2 weeks.[56] HCWs were classified as high risk department (HRD) workers if from a service where aerosol-generating procedures were used. Otherwise, they were classified as general department (GD) workers. Overall, compared to GD workers, HRD workers exhibited a 2-fold increase in the risk of having a confirmed COVID-19 infection (RR – 2.13 [95% CI: 1.45 – 3.95]). Degree of self-reported compliance to hand hygiene was also independently associated with risk of infection.

6. One retrospective cohort study was reported on only briefly in the form of a letter to a journal.[57] Yet it was based on data from 493 doctors and nurses within six departments at a single hospital in Wuhan that managed 28 confirmed and 58 suspected COVID-19 patients. The HCWs were classified into two groups: 1) those whose regular work required the use of N95 masks and frequent cleaning and disinfecting of their hands (N95 group), and 2) those who did not have these same requirements (no-mask group). Among 278 staff members (56 doctors and 222 nurses) in the N95 group, no cases of infection occurred despite more frequent contact with COVID-19 patients during work. In contrast, among 213 staff members (77 doctors and 136 nurses) in the no-mask group, 10 were confirmed as infected. An implausibly large effect size was reported (adjusted odds ratio = 464.82) and the precision of this point estimate was unstable (95% confidence interval: 97.73 – infinity). We therefore used raw data from the article to calculate an unadjusted effect size that was much smaller than the reported one, but still indicated that HCWs in the no-mask group were 28 times more likely to be infected than those in the N95 group (unadjusted OR = 28.46 [95% CI: 1.65 – 488.48]). Again, the precision of even our *less-implausible* point estimate is unstable due to the very small number of reported cases in one of the comparison groups.

7. In a recently updated systematic review from Alberta Health Services COVID-19 Scientific Advisory Group, an analysis of province-wide data was included showing the relative risk of both occupational and non-occupational-related COVID-19 infection among HCWs in Alberta.[60] Overall, the risk of occupational-plus non-occupational-related COVID-19 infection among HCWs in Alberta was 0.13%. However, based on data from case investigations, it was estimated that the risk of occupational-related infection on its own was only 0.01%, which is lower than the risk of COVID-19 infection in the general population (0.10%) of Alberta.

8. One final study was also framed as a prospective cohort study, however it was not clear that any follow-up data was collected after an initial baseline visit. All participants supposedly had “no known prior infection” at the time of study enrollment, yet at baseline testing 41 of 829 participants (5%) tested positive for COVID-19.[58] All but one of the positive tests occurred among HCWs. Therefore,

40 of 546 HCWs (7.3%) and only 1 of 283 non-HCWs (0.4%) tested positive. The authors reported this as a 7.0% (95% CI: 4.7% - 9.3%) greater absolute risk among HCWs. Normally, however, absolute risk differences are calculated from incidence rates, whereas in this study an absolute risk difference was inappropriately estimated from prevalence data. Nonetheless, the *prevalence* of COVID-19 in this study was highest among nurses (11.1%), followed by residents and fellows (3.1%), then by ICU workers (2.1%) and physicians (1.8%). Overall, nurses accounted for 62.5% of all infected HCWs.

Discussion:

In this rapid review, we identified 20 descriptive studies of mostly health care workers who varied in terms of their work environment, timing of exposure during the pandemic, and personal as well as clinical risk factors for COVID-19 infection. The prevalence of lab-confirmed COVID-19 in these studies varied between 0% and 68%.

We identified eight analytic studies that were heterogeneous in terms of participant selection criteria, work environment, and both the distribution and method of ascertaining important risk factors for disease. Overall, the quality of these studies is low, however of the two largest and best-described analytic studies, one reports a higher risk of infection among HCWs especially during the early phases of the epidemic in Wuhan, arguably before effective public health precautions and interventions were systematically in place.[33] Overall, the risk of infection was higher among HCWs but the risk of severe or critical illness did not differ between HCWs and the general population. In the other large analytic study, HCW status was associated with up to two-fold increases in the risk of a self-reported positive COVID-19 test.[59]

The grey literature publication from Alberta Health Services showed that overall, the risk of COVID-19 infection among HCWs in Alberta is 0.13%, which is greater than the 0.10% risk of infection among the general population. However, the authors emphasize that the infection rate in HCWs includes both occupational and non-occupational-related cases. The authors did not describe their criteria for distinguishing between occupational and non-occupational cases, but they estimated that specific occupation-related risk of infection in HCWs was only 0.01%, which is an order smaller than the general population risk of 0.10%. None of the other studies in this review attempted to make this important distinction between the risk of infection among HCWs on the one hand, and specific occupational-related (as opposed to community-related) infection among workers, on the other hand.

One potentially important confounder among most studies of HCWs is the differential probability of diagnostic testing between jurisdictions and, more importantly, the likelihood that case ascertainment is higher in HCWs than in the general population. Most jurisdictions must necessarily quarantine and test symptomatic HCWs to prevent transmission from infected workers in the occupational setting. Depending on the extent of differential testing between HCWs and members of the general population, the

relative risk of infection between HCWs and the general population could be spuriously increased. In Alberta, their province-wide data reportedly show 3.8- to 5.5-fold higher testing rates amongst healthcare workers than in the general Albertan population, and that greater than 90% of the cases involving healthcare workers in Alberta currently reflect community exposure. Meanwhile, the occupational risk is in fact lower than the population-based risk of documented COVID-19. The Alberta Health Services Report further suggests that the findings from their data are consistent with the estimates of risk seen in other low risk countries (which were also evaluated in their assessment of global HCW risk in the same report), reflecting both a relatively low exposure risk within healthcare settings currently, and potentially reflecting effectiveness of recommended PPE and other control measures such as symptom screening, visitor restrictions, dedicated care areas, continuous medical masking, physician distancing and other measures.[60]

Summary:

- In this rapid review, we found that the majority of retrieved epidemiological studies on COVID-19 are largely descriptive and vary significantly in terms of their sources of cases, and resulting distribution of environmental and personal risk factors for infection.

- A smaller number of epidemiologic studies of variable methodological and reporting quality utilize analytic designs to allow for an estimate of the relative risk of infection, mostly among HCWs in comparison to the general population.

- The level of evidence on this important subject is currently low, as is the consistency of findings between this small mix of studies. Currently, there is some evidence from two large cohort studies documenting that the overall incidence of COVID-19 infection is higher among some HCWs when compared to the general population. However in a single report from a local (Canadian) jurisdiction, the incidence and therefore relative risk of occupational-related COVID-19 infection, specifically, is lower in comparison to the general population.

- Based on the limited analytic epidemiologic research currently available, the general conclusion of this rapid review is that there is no consistent association between work within a specific occupation and a greater risk of COVID-19 infection.

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Appendix 1: Characteristics and Findings of Included Studies

Author	Study design/features	Primary sample size (analysed)	Country	Study population & setting	Exposure &/or case definition/history	Outcome (COVID-19) ascertainment	Intended objective or analysis	Data sources	Worker-related results	Comments
Baker	Cross-sectional prevalence study	144,944,620	US	Representative sample of workers across the US, across organizations of different size, and from both government and private workers, excluding military occupations.	Self-reported response (on O*NET survey): "How often does your current job require you be exposed to diseases or infections?" Never; Once a year or more but not every month; Once a month or more but not every week; Once a week or more but not every day; Every day.	None	Number of workers with potential exposure to COVID-19 (not actual disease) in US workplace	Standard Occupational Classification (SOC) codes from US national employment data (Bureau of Labor Statistics). Estimated exposure to infection in workplace using O*NET (survey-based job characterization data)	Of 144,944,620 workers in database, 26,669,810 (18.4%) reported being exposed > 1x / month; 14,425,070 (10.0%) > 1x / week. Proportion of workers exposed (once monthly and weekly, respectively) was highest for healthcare support workers (96.1% and 76.8%) and healthcare practitioners & technical workers (91.5% % and 77.8%), followed by those in protective services (52.1% and 0.5%) and community & social services (32.4% and 0%). For office & administrative support workers (e.g., patient representatives, couriers and messengers, and medical secretaries) the proportions exposed were 16.2% monthly and 13.2% weekly. No prevalence (of infection) data reported.	Estimation of prevalence of self-reported exposure, but not of workers who actually fall ill. No estimation of actual infection risk. Self-reported O*NET data are prone to recall bias and misclassification.
Burke	Surveillance case series	445	US	Close contacts with one of the first 10 cases of travel-related confirmed COVID-19 in US.	From contact tracing history: ≥ 10 minutes within 6 feet of a confirmed case.	Active monitoring about fever or other symptoms for 14 days from known exposure. Centre for Disease Control (CDC) surveillance, therefore lab-confirmation of cases is assumed.	Descriptive epidemiology of persons exposed to patients with confirmed COVID-19.	CDC direct surveillance and active monitoring of cases and persons under investigation (PUIs) through telephone, text, & in person inquiries.	445 close contacts (range of 1 to 201 contacts per case), of whom: 19 (4%) were household members (5 continued to have household exposure to confirmed case during isolation period); 104 (23%) were community members (spent ≥ 10 minutes within 6 feet of confirmed case; 100 (22%) were community members who were exposed in a healthcare setting; and 222 (50%) were health care personnel. During active monitoring, 54/445 (12%) close contacts developed new or worsening symptoms and become PUIs and were tested. Only 2 of 54 tested positive (both were household members of a case). Therefore, the symptomatic secondary attack rate was 0.45% (95% CI 0.12-1.6%) among all close contacts, and 10.5% (2.9-31.4) among household members. No secondary cases in health care personnel. No other close contacts tested positive. An additional 146 persons exposed	Zero cases of transmission to health care workers (HCW)-close contacts.

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									to the 2 secondary cases also were actively monitored, 18 (12%) of whom developed Sx, but all tested -ve (no tertiary transmissions).	
Burrer	Retrospective case series	9,282	US	Lab-confirmed COVID-19 cases in HCWs (voluntarily reported to CDC). Excluded: repatriations from Wuhan, and Diamond Princess cruise ship. For HCWs with relevant data: median age, 42 (IQR 32–54); females: 6,603 (73%); 38% reported ≥ 1 underlying health condition.	Not described	Lab-confirmed and reported to CDC	Descriptive epidemiology of HCWs with confirmed COVID-19	Voluntary standardized reports from Public Health Departments to CDC	Of 315,531 cases reported to CDC, only 49,370 (16%) included data on whether patient was a HCW. Of the 49,370 with data on occupation, 9,282 (19%) identified as HCWs. Only 1,418 of 9,282 (15%) had data on contact Hx. Of 1,418 HCW-patients with available data, 780 (55%) reported contact with a COVID-19 patient only in health care settings. 4,336 (92%) HCW patients reported ≥ 1 symptom (fever, cough, or shortness of breath); 8% reported no symptoms. Most HCWs with COVID-19 (6,760, 90%) were not hospitalized; however, severe outcomes (including 27 deaths) occurred across all age groups, most frequently in HCWs aged ≥ 65 years (who accounted for only 6% of all HCW-case-patients, but 37% of HCW-case-deaths).	Lots of missing values in dataset. Only 16% with data on occupation, and only 15% of identified HCWs with data on contact Hx. No appropriate denominators, therefore can't estimate risk. No control group, therefore can't estimate relative risk between HCWs and non-HCWs. Also, no control group data (to estimate relative risk of infection vs other groups. HCW status available for only 16% of reported cases nationwide; actual number of cases is underestimated. In states with more complete reporting HCWs account for 11% of cases. Nature of contact (i.e., risk level) with a confirmed cases are not known.
Cheng	Surveillance case series	1,275	China (Hong Kong [HK])	HCWs and patients at all hospitals in HK.	Contact tracing to identify: 1. HCWs who'd provided care for a case without appropriate personal protective equipment (PPE) and 2. Patients who stayed in same cubicle of index case (regardless of exposure duration).	Lab-confirmed	Infection control measures and descriptive epidemiology of 42 admitted and confirmed cases.	Surveillance data	Of 1,275 PUIs, 42 (3.3%) confirmed cases. Of the 42 cases: 20 (48%) males; median age, 59 (range, 22-91); 9 (21%) residents of mainland China (remainder from HK, but 5 had history of travel to mainland within past 14 days). Number of locally acquired cases increased significantly from day 33 to 42 when 28 confirmed cases were associated with 8 family clusters. One patient died (2.4%); 4 (9.5%) remained in critical condition as of day 42 of outbreak. Of 42 confirmed cases, 36 admitted to airborne infection isolation room (AIIR) facilities. Of 413 HCWs caring for these patients before lab-confirmation of SARS-CoV2, 11 (2.7%) had close unprotected contact requiring 14-day isolation. None became infected by end of quarantine. Nosocomial infection was not observed in these hospitalized patients.	Zero cases of transmission to HCW-close contacts.

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Folgueira	Case series	2085	Spain	HCWs (hospital employees)	Workers were said to have had "confirmed exposure" but otherwise not described. Different risk groups: high = emergency room or area with concentration of COVID-19 patients; medium = occasional contact with cases (e.g., surgery, oncology); & low = workers not in contact with cases (e.g. pharmacy, kitchen)	Lab-confirmed (PCR testing of naso- and oropharyngeal swabs)	Descriptive epidemiology in HCWs.	Direct surveillance	Of 6800 hospital employees, 2085 (30.6%) were tested, 2286 samples in total. 791/2085 (30.6%) confirmed infections, representing 11.6% of all hospital workers. No statistically significant differences in proportions infected between high risk areas (close contact with patients) and lower risk groups. Most cases were mild and managed at home under self-isolation, however 23 (3%) required hospitalization, 2 needed ventilation in ICU. No fatalities.	No testing of asymptomatic persons, but personnel with only mild symptoms were proactively tested. Evolution of cases during same period was similar between hospital staff and patients attending ER; transmission dynamics appeared similar in patients as in HCWs. "This experience is similar to the (one) communicated from Wuhan verified by the WHO Joint Mission and also from recent experiences at hospital in the Netherlands, where most of the infections of HCW were related to household or community contacts. These are clear arguments against a major factor of occupational risk and it has been also the experience of similar follow up of HCW infection in China (4) and Europe (5)."
Guo	Cross-sectional survey & 2:1 nested case-control	72 (24 cases)	China (Wuhan).	Cases: orthopaedic surgeons & trainees from 8 hospitals. Excluded: surgeons assisting in fever clinics & designated COVID-19 wards. Controls: sampled from uninfected orthopaedic surgeons in same department as the case, at same hospital. Mean age: cases, 36.1 (SD, 6.3; range, 25-48); controls, 36.9 (SD 5.9, range 26-51). Males: cases, 95.8%; controls, 100%. All but 1 case (with diabetes) in good health before infection.	Self-reported responses to online questionnaire.	In 21 cases, +ve RT-PCR or antibody test. In 3 cases, -ve lab tests, but +ve history of exposure plus +ve clinical symptoms & CT chest findings.	To identify risk factors for COVID-19 infection by comparing characteristics of infected surgeons to uninfected surgeons.	Online self-administered questionnaire.	No apparent differences in baseline demographic variables, adherence to hand-hygiene, or insufficient early access to PPE between groups. Rate of infection at different hospitals ranged from 1.5% to 20.7% of surgeons. In cases: top 5 Sx: fever 83.3%, cough 62.5%, fatigue 70.8%, diarrhea 37.5%, headache 33.3%; CT evidence of ground-glass opacity and consolidation in 87.5%; 0 deaths (all "cured"); suspected sites of exposure: general wards 79%, public places at hospitals 21%, operating rooms 12.5%, ICU 4%, outpatient clinics 4%, ORs 12.5%, community 4.2%); 15 admitted to hospital, 9 self-isolated at home or hotel; 0 deaths (all recovered). Compared to controls, other risk factors (bivariate results only): not wearing N95 (OR 5.2), severe fatigue during 2 months before outbreak (OR 4.0), exposure to unmasked patients with suspected COVID-19 (OR 6.05),	No multivariate results to show "adjusted" (independent) effects of potential risk factors. No comparison between surgeons (HCWs) & non-surgeons (non-HCWs), or between surgeons in different exposure-risk categories (therefore no estimation of relative risk or odds ratios for different groups). At time of outbreak, orthopedic surgeons didn't regularly use PPE on wards. Cases in surgeons peaked before those in community, suggesting in-hospital rather than community source of exposure.

Author	Study design/features	Primary sample size (analysed)	Country	Study population & setting	Exposure &/or case definition/history	Outcome (COVID-19) ascertainment	Intended objective or analysis	Data sources	Worker-related results	Comments
									training in prevention measures (OR 0.12), wearing respirator or mask all the time (OR 0.15 and therefore *not* wearing = OR 6.67). Median incubation, 4 days.	
Heinzerling	Outbreak investigation, prospective cohort	145	US (California, Solano County)	Hospital HCWs who developed symptoms within 14 days of exposure to index patient. Stratified into "CDC guidance" risk categories. Those at medium or high risk were actively monitored. Low risk HCWs self-isolated and were passively monitored. Overall, 43 (36%) became symptomatic within 14 days and underwent testing, of whom 95% were either medium or high risk for infection, 16% were males, 51% were RNs.	Exposure to Index patient, who was admitted to "Hospital A" Contact tracing identified 145 potentially exposed, but after initial interview, 24 were classified as having no identifiable risk.	Lab (RT-PCR) using swab samples taken only from HCWs who developed Sx.	To characterize (describe) and compare exposures among HCWs who did and did not develop COVID-19.	Potentially exposed HCWs identified through review of index patient's medical record. Telephone interviews only of HCWs who developed Sx & were tested.	Of 145 potentially exposed and interviewed, 24 were deemed to have no identifiable risk. Of 121 remaining, distribution by risk category was: 14 (11.6%) high, 80 (66.1%) medium, & 27 (22.3%) low risk. During monitoring, 43/121 HCWs developed Sx & were tested; only 3/43 (7%) tested +ve for SARS-CoV-2. Risk factors (bivariate only): frequent close contact, performing physical examinations, exposure to nebulizer treatments, longer duration exposure to index patient (2 HCW at high risk were present [one for 3 hours] while patient was on BiPAP [bilateral positive airway pressure]) ventilation without PPE). Third remaining HCW was considered at medium risk and was in close contact with index patient for 2 hrs, but not during AGP (aerosol-generating procedures).	Very small number of cases. Framed as a cohort study, but no comparison of HCWs to non-HCWs, therefore no estimation of relative risk between HCWs and non-HCWs. This study reported first known cases of supposedly occupationally-acquired COVID-19 in the US. Asymptomatic HCWs were not tested or interviewed. Of 43 tested HCWs, 6 refused to participate or were lost to follow-up.
Htun	Surveillance & cross-sectional survey	1,524 closely monitored (10,583 overall under surveillance)	Singapore	All HCWs at single acute care hospital & infectious disease centre. 1645 physicians, 4273 nurses, 1875 allied health professionals, 2790 administrative & ancillary staff.	Potential exposure criteria: HCW having worked in past 14 days, or being in close community contact of a confirmed case outside of work.	Active surveillance and daily reporting of temperature and sickness status of all HCWs, particularly those deployed to high risk areas. PCR testing of nasopharyngeal swabs only from 2020/02/07 onward.	Describe HCWs who did and did not develop COVID-19.	Active surveillance data, self-reporting & monitoring of fever and symptoms, daily telephone follow-up of discharged HCWs after hospital care.	Of 10,583 total HCWs, 1,524 were closely monitored & fit-tested for N95 respirators: 363 physicians, 661 nurses, 119 allied health professionals, 381 ancillary staff, plus 17 staff who had travelled to China in preceding 14 days. 287 illness episodes involving 266/1,524 closely-monitored staff (17%) working in high-risk areas. Of 287 illness episodes (fever and/or acute respiratory episodes), 167 (58%) had PCR testing of nasopharyngeal swabs (implemented only from 2020/02/07 onward). No +ve tests were found.	Zero lab-confirmed cases were found. Only 58% of HCWs with Sx were tested. No estimation of true incidence of confirmed infection among all HCWs. No comparison/control group to test effectiveness of either early detection, PPE of related infection control measures.
Ing	Case series extracted from literature review	198	Canada (principal author only)	Physicians worldwide, excluding those aged ≥ 90.	Unclear	Reported death attributed to COVID-19.	To quantify risk of COVID-19 infection and mortality among working physicians.	Google search (in English, Farsi and Chinese). Publicly available websites, databases, media reports and other information sources.	Of 198 physician deaths, missing information for 49. Age: median 66, mean 63.4, range 28-90. Specialties (most common ones): 78 (40.6%) "GP/emergency room," 11 (5.8%) medicine, 9 (4.7%) dentistry, 8 (4.2%) otorhinology, 8 (4.2%) unknown, 7 (3.7%) ophthalmology, 7 (3.7%)	All cases taken from grey literature sources (PubMed search reportedly yielded revealed zero relevant citations. No denominators (no risk estimates).

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									cardiology, 6 (3.1%) anesthesiology, 6 (3.1%) psychiatry, 6 (3.1%) general surgery, 6 (3.1%) obstetrics & gynecology. Distribution by country (top 3): 79 (40%) Italy, 43 (22%) Iran, 16 ((8%) China, 14 (7%)	
Koh	Case series	25	Singapore	Multiple occupations (staff in the tourism, retail and hospitality industry, transport and security workers, and construction workers) associated with "probable occupationally acquired COVID-19) among first 25 locally transmitted cases in Singapore.	Not clearly determined or described.	Not described	Description of cases	Daily reports from Ministry of Health, Singapore.	Of first 25 locally transmitted cases, 17 (68%) were "probably" related to occupational exposure. Occupations: Zero HCWs; 4 staff in retail selling health products to Chinese tourists; 3 multinational corporation staff attending an international business meeting; 2 workers from same construction site; other assorted occupations represented by only 1 case each.	No estimation of risk. Table of frequencies by occupation is presented in absence of methods or other data.
Lan	Case series	690	Asian countries adjacent to mainland China (Hong Kong, Japan, Singapore, Taiwan, Thailand, & Vietnam)	Any COVID-19 cases extracted from government investigation reports.	Occupation classified by 2 occupational physicians reviewing each report (using International Standard Classification of Occupations). Two risk categories: 1. Close contact with confirmed case at work; or 2. Unknown transmission source (contact history but likely infected at work).	Cases accepted as reported by government agencies.	Description of outbreak characteristics by occupation, based on following each country for 40 days after 1st locally transmitted case, (excluding all imported cases).	Publicized government investigation reports from 6 Asian countries.	Of 690 cases, 103 (14.9%) were classified as work related: HCWs, 22% of cases; drivers and transport workers, 18%; services and sales, 18%, cleaning and domestic workers, 9%, and public safety workers, 7% of cases. Possible work-related transmission in 47.7% of early cases (within 10 days of early outbreak). Workers accounting for highest proportions of cases: health care (22%), and drivers & transport (18%)	No estimation of risk due to absence of appropriate denominators.
McMichael	Case series	167	US (Seattle & King County, Washington). Long-term care facility (later, 30 other facilities affected). Index patient dx on 2020/02/28.	Residents, visitors and HCWs at > 100 long-term care facilities. Median age: residents, 83 (range, 51-100); visitors, 62.5 (52-88); HCWs, 43.5 (21-79).	Index case: 73 yr old woman in skilled nursing facility. 30 other facilities with $\geq$ 1 case, with 3 facilities linked by common staff.	Lab-confirmed (RT-PCR).	Description of cases in long-term care facilities	Outbreak & case investigations. Telephone interview of cases (or proxy if patient was intubated). Email contact with long-term care facilities. Surveillance using countywide databases to identify influenza-like illness clusters and emergency acute care admissions.	Of 167 confirmed cases, 101 (60%) residents, 50 (30%) HCWs, 16 visitors. 90% of residents had chronic underlying health condition. Comorbidity among HCWs: hypertension, 4 (8%); cardiac disease, 4 (8%), renal disease, 0; diabetes 5 (10%); obesity, 3 (6%); pulmonary disease, 2 (4%). CFR: overall, 21%; for HCWs, 0% (but 6% hospitalized). HCW occupations: physical therapists, occupational therapist assistants, speech pathologists, environmental care [housekeeping, maintenance], nurses, certified nursing assistants, health information officers, physicians, and case managers). Qualitative findings	No denominators, therefore no estimation of risk within or between groups. Not all residents and staff were interviewed and tested (possible under-ascertainment of cases).

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									of outbreak facilitation: staff working while with Sx, working at ≥ 1 facility, not familiar or compliant with PPE, inadequate infection control supplies & practices, low index of suspicion, limited availability of testing	
Novel Coronavirus Pneumonia Emergency Response Epidemiology Team	Case series	72,314	China	All cases diagnosed nationwide through 2020/02/11.	Varied	Lab-confirmed, suspected (+ve clinical and exposure history), clinically diagnosed (in Hubei Province only, with lung imaging), or asymptomatic (+ve test but no symptoms).	Explore patient characteristics, including health worker membership or active employment at a health facility, exposure history, comorbidity, & case severity.	China's Infectious Disease Information System (surveillance data), which captures mandatory data reporting for COVID-19.	Of 72,214 cases overall, 44,672 (61.8%) were confirmed, 16,186 (22.4%) suspected, 10,567 (14.6%) clinically diagnosed and 889 (1%) asymptomatic cases. Age: 77.8% were 30-69 years old. Males 51.4%. Farmer or labourers 22.0%. Place of diagnosis, Hubei 74.7%. 85.8% reported Wuhan-related exposures. 80.9% classified as mild. Case-Fatality Rate (CFR): 2.3%. Occupation: retirees had highest CFR (5.1%). Patients in Hubei Province had > 7-fold higher CFR at 2.9% compared to other provinces (0.4%). Comorbidity effect: 10.5% CFR in presence of cardiovascular disease, 7.3% if diabetes, 6.3% chronic respiratory disease, 6.0% hypertension and 5.6% if cancer. CFR = 49.0% for critical cases. Subgroup analysis: 1,716 HCWs infected, of whom 5 (0.3%) died. 64% of all HCW cases found in Wuhan City, 23.3% found in Hubei Province (excluding Wuhan), and 12.7% in the other provincial level administrative divisions (PLADs)	Proportions based on total number of cases in the denominator. No appropriate denominators for estimation of risk within groups, or relative risk between groups.
Pan	Administrative cohort	32,583	China (Wuhan)	Of 32,583 confirmed cases, overall, 48.4% males, median age 56.7 (range, 0-103; IQR, 43.4-66.8; 74.3% were aged 40-79)	Epidemic conditions in Wuhan.	Lab-confirmed COVID-19 (based on RT-PCR assay or high throughput sequencing of nasopharyngeal swabs). Definition of HCW "case" = patient working in a hospital or clinic. Cases per day per million people, were estimated by patient age, sex, health care occupation, and residential district across 5 time periods (using number of cases in each period divided by number of	Observational intervention study to assess effects of nonpharmaceutical public health interventions on rates of COVID-19 infections over 5 time periods: 1. Before 2020/01/10, no intervention; 2. 2020/01/10-22, mass migration; 3. 2020/01/23 - 02/01, city lockdown & home quarantine; 4. 2020/02/02-16, intensified measures & central quarantine/treatment; 5. After 2020/02/17, community universal symptom survey.	Administrative data. Cases and clinical severity from municipal Notifiable Disease Report System. Area population sizes from Wuhan Statistical Yearbook 2018.	Of 32,583 confirmed cases, 32,325 had complete data. Overall, 4.6% of all cases were HCWs. Daily rate of cases in local HCWs (130.5 per million [95%CI, 123.9-137.2]) was > than that in general population (41.5 per million [95% CI, 41.0-41.9]) over whole study period. Rate among health care workers peaked in the third period (617.4 per million [95% CI, 576.3-658.4]), but decreased in last 2 periods when comprehensive personal protective equipment was more widely used. Risk of severe or critical disease was lower in females than males (RR, 0.9 [95% CI 086-0.93]); but no different between **HCWs and non-HCWs (RR, 1.08 [0.96 - 1.21])**.	Incidence rates were estimated using rate standardization methods. Administrative data did/does not include clinical data (symptoms, signs, incubation period, time to admission or discharge, or nature of treatments). Risk of infection in HCWs was higher than that of general population, however risk of severe or critical disease was the same.

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						days in each period (33, 13, 10, 15, and 21 days) and the subtotal population size in each stratum.			Reproduction number (Rt = mean # secondary cases generated by a typical primary case at time t in a population): peaked at 3.82 during period 2, then fell below 0.3 on 2020/03/01. Rate of cases in HCWs was substantially higher than in general population during Periods 2 (mass migration, beginning of hospital crowding) and 3 (during initial lockdown interventions, inadequate availability of testing, and shortage of PPE supplies and training), indicating high risk of nosocomial infection.	
Park	Surveillance case series	1,145	South Korea	Cluster of cases at a call centre employing 811 employees, distributed among 4 different floors of a 19-story commercial and residential building. A total of 922 employees, 203 residents, & 20 visitors in building. 225 household contacts, and persons who stayed > 5 minutes near building (identified using cell phone location data) were also tested and monitored.	Patients under investigation (PUI) worked, lived or visited at building between 2020/02/21 and 03/08. Monitored for 14 days. Building was closed on 2020/03/09 (immediately after outbreak reported).	Over 14-day monitoring, confirmed cases (PUI with +ve RT-PCR) were either symptomatic at time of testing, pre-symptomatic (developed symptoms eventually during monitoring), or asymptomatic (no symptoms during monitoring).	Describe epidemiology of COVID-19 outbreak in a call centre in South Korea	Direct surveillance and monitoring. Face-to-face interviews with cases to collect clinical data. Cell phone data to identify non-occupants who were in proximity to building.	1,143 of 1,145 PUIs (99.8%) were tested, of whom 97 (8.5% [95% CI, 7.0-10.3]) were confirmed +ve. Of 857 with available demographic information: 620 (72.3%) female; mean age 28 (range 20-80). 94 of test-confirmed cases (97%) were working on same floor of initial outbreak. With 216 employees on that floor, attack rate was 95/216 = 43.5% (95% CI 36.9-50.4%). Of 97 with +ve test, 89 (91.7%) were symptomatic at testing, 4 (4.1%) were presymptomatic & later developed Sx within 14 days of monitoring), and 4 (4.1%) were still asymptomatic after 14 days of isolation. Average number of household contacts per confirmed case-patient was 2.3). Transmission to 34 of 225 household contacts = secondary attack rate of 16.2%. Among household contacts of 11 presymptomatic and 4 asymptomatic case-patients, none had COVID-19 symptoms or tested positive after 14 days of quarantine.	Testing was offered to all occupants of building. Confirmed cases were isolated. Negative-test patients were mandated to quarantine for 14 days and were retested. Household contacts of +ve-test patients were also tested & monitored for 14 days. Cases in this outbreak could not be tracked to another cluster making it difficult to identify an actual index patient. Primary attack rate among workers building-wide was 8.5%, but on one floor (where an early case originated from) was 43.5%.
Pung	Case series	36	Singapore	Residents with confirmed COVID-19	From interviews	Respiratory sample positive for SARS-CoV-2, using a laboratory-based PCR test.	To analyse three clusters of COVID-19 in Singapore to assess interactions and possible modes of transmission.	Surveillance data, case interviews and contact tracing, data from mandatory reports of COVID-19 cases.	Of 36 "confirmed cases", 17 tested positive while in Singapore, 5 of whom were shopkeepers at a market frequented by Chinese tourists (including one tour group in whom a cluster of cases was later confirmed).	Description of small case series involving 3 different cluster outbreaks. No estimation of risk.

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Razzak	Simulation modelling study	n/a	US	Target population is US hospital workers during a pandemic, assuming observed patient death rates from 2 examples primarily 1. Hubei and 2. Italy; but also 3. Wuhan City, and 4. South Korea.	"100 patient deaths" from COVID-19 (proxy measure of exposure & number of cases in healthcare system).	Hospital worker infections & deaths (estimated per 100 patient deaths).	To estimate rates of infection or death per million population during a pandemic.	Publicly available data, multiple sources. Use of observed Hubei and Italy rates of infection and death to estimate expected US rates (adjusted for number of hospital workers per bed in US compared to China and Italy). Point estimates calculated using Monte Carlo modelling, adjusted for hospital workers per beds in US.	Based on hospital worker infections rates per 100 deaths observed in Hubei (108.2) and Italy (94.1), expected number of infections in US hospital workers would be 53,640 (Hubei model) and 53,097 (Italy model). Availability of PPE to high-risk workers would reduce counts to 28,100 and 28,354 (Hubei and Italy models, respectively). Restricting workers aged $\geq$ 60 from direct patient care would reduce respective counts to 1,985 and 2,002. Restricting workers aged $\geq$ 50 would reduce respective counts to 564 and 569.	Estimation of burden of disease (infections) and related deaths from COVID amongst US hospital workers under hypothetical scenarios. Assumes similar transmission dynamics between different countries. No hypothetical control group or estimation of relative risk between hospital workers and non-hospital workers.
Roxby	Surveillance Case series	142	US	Residents of senior independent and assisted living (SIAL) communities. Mean age: residents 86 (range 69-102); staff 40 (range 16-70). Females: residents 79%; staff 72%. had $\geq$ 1 medical condition.	2020/03/05-09, 2 residents of independent & assisted living (IAL) facility were hospitalized for confirmed COVID-19 infection.	All residents and staff at IAL facility were tested, completed a questionnaire, then only residents were re-tested 7 days later. (Staff were not retested as no new facility exposure had occurred.)	Describe epidemiology of COVID-19 among residents and staff at independent and assisted living facility.	Direct surveillance and interviews.	Of 142 residents and staff members tested, 42% residents and 25% of staff members reported Sx at initial testing. 3/80 3.8%) residents & 2/62 (3.2%) staff members tested +ve. The 3 residents had no Sx at initial testing, although 1 had earlier cough that had resolved. 1 resident initially -ve was +ve 7 d later, but had no Sx on both occasions. Impression: So few cases at this SIAL compared to Seattle skilled nursing facilities (SNFs); probably due to greater social distancing and less contact with HCWs in SIALs.	Ascertainment of Sx by questionnaire may be affected by recall bias and/or rumination. Asymptomatic and symptomatic persons were tested: crude infection rate (not adjusted for exposure-risk level) was 3.8% for residents, 3.2% for staff.
Kluytmans-van den Bergh	Cross-sectional study ("with short-term follow-up")	1353 (86 analysed)	Netherlands	Healthcare workers in 2 Dutch Hospitals who suffered fever or mild respiratory symptoms in last 10 days, without history of travel to China or Northern-Italy, or antecedent exposure to an in-patient know to have COVID-19.	No known exposure.	Voluntary testing of symptomatic HCWs (with fever or respiratory symptoms). RT-PCR on oropharyngeal samples.	To test for prevalence of undetected COVID-19 among HCWs.	Structured interviews to document symptoms for all HCWs with confirmed COVID-19.	Of 9,705 HCWs, 1,353 (14%) were screened (doesn't say how many didn't volunteer to be screened or tested), of whom 86 (6%) were infected with SARS-CoV2 (an unexpectedly high prevalence). Only 3 infected HCWs mentioned exposure to an inpatient with COVID-19. Median, age 49 (range 22-66); 15 (17%) male. Symptoms: 46 (53%) had fever; 80 (93%) met a case definition of fever and/or coughing and/or shortness of breath. Only 2 of 86 (3.7%) HCWs were hospitalized, with no critical cases or deaths. Authors suggested that expansion of the case definition of SARS-CoV2 to included myalgia and/or severe malaise would capture all 86 HCWs (100%) with COVID-19.	Estimation of prevalence of infection (6%) only among those voluntarily tested. Without a Hx of known contact with a case, or of travel to high risk places, a substantial proportion of HCWs were thought to have acquired infection in the community from an undetected source. Re-designation of fever as only an optional criterion, and addition of severe myalgia and general malaise to case-definition may improve sensitivity of symptom-based screening.

Author	Study design/features	Primary sample size (analysed)	Country	Study population & setting	Exposure &/or case definition/history	Outcome (COVID-19) ascertainment	Intended objective or analysis	Data sources	Worker-related results	Comments
Wang	Case series	26	China (Shandong Province)	Patients with confirmed COVID-19, hospitalized. Median age, 42 (IQR, 34-53). 11/26 males.	Transmission: 11 patients or their family members worked at same supermarket; 2 patients had visited Wuhan in December 2019.	Lab (PCR assay or gene sequencing of swab samples). CT also done.	Report of clinical features of 25 patients with confirmed COVID-19 who were admitted to Liaocheng Infectious Disease Hospital.	Review of medical records, verified by 2 physicians.	Of 26 subjects: 5 smokers, 3 students (ages ≤ 18). Most common occupations: 16 retail staff (11 patients or their family members worked at same supermarket). Multiple symptoms in 12 patients. First symptom: fever, 54%; cough, 31%; no symptoms or signs, 7%. Mean incubation time, 4.5 days. CT findings: pneumonia, 24%. Comorbidities: Hypertension, diabetes, cardiovascular and cerebrovascular disease, malignant tumour, HIV.	No estimation of risk possible. No mention of any cases among HCWs.
Xueqiu (English abstract of Chinese language publication)	Case series	346	China (Guangzhou)	Mean age, 38 years.	?	?		?	Of 346 cases, 58 (16.8%) were severe, 1 death (CFR 0.29%). No infection among medical staff reported.	Limited information from English language abstract (from Chinese language publication).
Nguyen	Prospective cohort	2,810,103 users. 2,135,190 with prospective longitudinal data	UK & US	General community, including 99,795 frontline HCWs (FHCWs = those reporting direct contact with suspected or confirmed cases) who reported information through the COVID Symptom Study smartphone application. Recruited through social media outreach.	Epidemic conditions. Participants reported if they worked in HC and if yes, whether they had direct contact. Median follow-up of 18.9 days (IQR: 5.1-26.1).	Self-report of receiving a +ve test	Relative hazard of reporting +ve COVID-19 test, adjusted for age, time & country (predictors of obtaining a test) in stratified analysis; and also adjusted for sex, comorbidity, smoking status, & BMI (a priori covariates). Effects of PPE use (always, sometimes, or never); availability (enough when needed, had to reuse, or not enough);	Participants used a guided interface smart app daily, even when asymptomatic, to report baseline & longitudinal, prospective collection of demographic, comorbidity, symptoms, and COVID-19 testing information.	At initial enrollment, 134,885 (4.8%) were FHCWs. Baseline prevalence of COVID-19 +ve cases = 2,747 per 100,000 FHCWs vs 242 per 100,000 in general community. Analysis excluded 670,298 who had follow-up < 24 hours, plus 4,615 with baseline +ve test. Final analysis of 2,135,190 in prospective inception cohort: 99,795 (4·7%) identified as FHCWs. Median age, 44 (IQR, 32-57). Effect of being FHCWs: (adjusted hazard ratios (aHRs) from stratified analysis: compared to general community, FHCWs had aHR = 11.7 (95% CI: 10.9-12.3) for reporting a +ve test; with stronger association in UK (aHR, 12.5 [11.7-13.2]) than in US (aHR, 2.80 [2.09-3.75]). Multivariable-adjusted inverse probability weighted aHRs (to adjust for probability of being tested in each country): showed less difference, but still higher association in UK (aHR = 1.92 [1.89-1.94]) than in US (aHR = 1.29 [1.19-1.410]). PPE & close contact: Compared to FHCWs endorsing adequate PPE availability, those endorsing inadequate PPE availability had aHR = 1.26 (1.06-1.5) for	Not yet peer-reviewed, but for now, concludes that even with adequate PPE, caring for patients with documented COVID-19 may be associated with increased risk among FHCWs compared with the general population. Potential selection bias: recruitment through social media outreach & need of smartphone; all data are self-reported, not confirmed; HCWs may have differential recall bias; stratified analysis adjusted only for age, date & country. Strengths: 1) regression model showed that reports of +ve testing were predicted by antecedent reporting of loss of smell/taste, fatigue, persistent cough and loss of appetite; 2) to adjust for country-specific predictors of obtaining a COVID-19 test, inverse probability weighting as a function of frontline HCW status and other factors, such as age and symptom burden was done separately for each country;

Author	Study design/features	Primary sample size (analysed)	Country	Study population & setting	Exposure &/or case definition/history	Outcome (COVID-19) ascertainment	Intended objective or analysis	Data sources	Worker-related results	Comments
									reporting a +ve test. Compared to FHCWs reporting adequate PPE who did not care for COVID-19 patients, HCWs caring for patients with documented COVID-19: aHRs for +ve test = 4·95 (95% CI: 4·14 to 5·92) if adequate PPE and 6·06 (95% CI: 4·65-7·88) if inadequate PPE. Practice location: Compared to general community, frontline HCWs more likely to report +ve test, aHR = 24·3 (95% CI: 21·8 to 27·1) for those working in inpatient settings; 16·2 (95% CI: 13·4 to 19·7) for nursing homes; 11·2 (95% CI: 8·44 to 14·9) for hospital-based clinics; 7·86 (95% CI: 5·63 to 11·0) for home health sites; 6·94 (95% CI: 5·12 to 9·41) for freestanding ambulatory clinics; and 9·52 (95% CI: 7·49 to 12·1) for all others.	3) among FHCWs, effect of PPE was examined.
Ng	Retrospective cohort	41	Singapore	HCWs at a single hospital.	Exposure to aerosol-generating procedures > 10 minutes @ < 2 meters from index patient originally admitted for severe pneumonia before Dx with COVID-19. 85% wore surgical, 15% wore N95 masks.	PCR assay for SARS-CoV-2	Descriptive	Daily Sx monitoring while in self-isolation at home. All had nasopharyngeal swabs tested.	Zero HCWs developed Sx. Zero +ve tests for COVID-19. No observed difference in outcomes between different mask groups.	Small study with zero events.
Ran	Retrospective cohort	83 (72 = 87%)	China (Wuhan)	HCWs (clinicians & nurses only), ages > 18 with acute respiratory signs in a single tertiary care hospital.	Inception point: outbreak of COVID-19. Sx: cough, fever, brachypnea, chest distress, headache, hempotysis, other acute respiratory illness, diarrhea. Exposure groups: high risk department (HRD) = use of aerosolizing procedures; otherwise low risk general department group (GD).	Radiology & RT-PCR Dx of SARS-CoV-2.	Relative risk comparing outcomes between HRD & LRD; Mantel-Haenszel tests & logistic regression to identify confounders & interactions. Survival analysis to compare effect of work-hours per day.	Online questionnaires about sociodemographic, symptoms, contact Hx, medical practice, hand hygiene and PPE.	39 GD, 33 HRD. Median age, 31 (IQR: 28-40). Bivariate effects: relative risk (RR) of infection of HCW was associated with diagnosed family member (DFM)(RR, 2.76 [95% CI, 2.02-3.77]), diagnosed patient (DP) (0.36 [0.22-0.59]), suspected patient (SP) (0.49 [27-0.89]); and unqualified hand-washing (2.64 [1.04-6.71]), suboptimal hand-washing (3.10 [1.43-6.73]), suboptimal hand-hygiene after contact with patients (2.43 [1.34-4.39]) and improper PPE (2.82 [1.11-7.18]). Overall, HRD was 2.13 (95% CI, 1.45-3.95) times more at risk of infection. Significant interactions for male*HRD (among nurse & clinician HCWs), clinician*HRD (among both sexes), and among both genders and both HCW-types, unclean hands after contact with patients	Small sample size. Retrospective, therefore data prone to recall bias & unmeasured confounders. Single centre (limited generalizability). Significantly longer work-hours/day associated with HRD, but effect wasn't examined after adjusting for other variables.

Author	Study design/features	Primary sample size (analysed)	Country	Study population & setting	Exposure &/or case definition/history	Outcome (COVID-19) ascertainment	Intended objective or analysis	Data sources	Worker-related results	Comments
									(UHA)*HRD, UHA*GD, and clean hands*HRD. Survival analysis: median work-hours per day was 10 hours in HRD, and not estimable for GD.	
Wang (b)	Retrospective cohort - letter to editor	493	China (Wuhan)	HCWs (doctors & nurses) from 6 departments.	d2 groups: N95 masks & regular hand hygiene group (respiratory medicine, ICU & infectious diseases; no-mask group (hepatobiliary & pancreatic surgery, trauma & microsurgery, & urology).	Chest CT & "molecular" diagnosis.		Active monitoring.	HCWs with COVID-19: zero cases in N95 group. Group with no-mask, 10 of 215 infected (4.65%) vs 0% in N95 group. "Adjusted OR" = 464.82 (95% CI: 97.73 - infinity). Unadjusted ORs (95% CI): Nurse vs doctor, OR = 0.04 (0.005 - 0.31).	No non-HCW control group. No detailed methods; unclear how the adjusted OR (464.82) was calculated.
Alberta Health Services, COVID-19 Scientific Advisory Group	Administrative cohort	137 HCW cases; 4,307 general population cases	Canada (Alberta)	HCWs (excluding some physicians), and general population.			A comparison of HCW risk in multiple countries was conducted however this review focuses on the Alberta statistics	Alberta Health Services data.	Risk of infection estimates for HCWs (not including some physicians): 0.01% occupational, 0.13% occupational plus non-occupational exposure overall. For non-HCWs (general population): 0.10% overall. **Occupational risk for HCW (0.01%) is lower than general population risk (that includes non-HCW workers (0.10%)**. Relative risk for occupational plus non-occupationally exposed HCW vs non-HCW: 1.32 (95% CI: 1.11-1.56). Absolute risk difference HCW vs non-HCW: 0.13% - 0.10% = 0.03% (or 3.2 [95% CI: 1.0 - 5.4] per 10,000 population). Note however, occupational risk difference would be 0.01% - 0.10% = -0.99% occupational risk difference for HCWs.	Results do not compare differential risks in hospital versus community care. The overall population, case and death rate data came from reliable sources (government and academic). However, most mortality data for HCWs came from news outlets (except for China)
Barrett	"Prospective cohort"	829	US (New Jersey)	546 HCWs & 283 non-HCWs with no known prior infection at inception and during early phases of community transmission. Large university & 2 university-affiliated hospitals. Exclusion: fever $\geq$ 100.4.	HCW vs non-HCW status; level of contact and/or exposure risk to COVID-19 patients.	SARS-CoV-2 infection confirmed by RNA in oropharyngeal swabs.	Determine prevalence of SARS-CoV-2 infection in cohort of HCWs during early phase of community transmission.	REDCap-based online screening, questionnaires; in-person temperature & swab collection;	Prevalence of COVID-19: At baseline, 41 of all participants (5%) tested +ve. 40 (7.3%) in HCWs; only 1 (0.4%) in non-HCWs representing a 7.0% (95% CI: 4.7% - 9.3%) greater absolute risk for HCWs, particularly nursing staff, who accounted for 62.5% of infected HCWs). 65.9% of infected participants reported no symptoms in the previous week and 82.9% reported no close contact with suspected or confirmed cases outside of work. Prevalence of +ve test by occupation: nurses, 11.1%; ICU workers, 2.1%; physicians, 1.8%; residents and fellows, 3.1%. Median % time spent in patient rooms: nurses 50%; other HCWs, 20%.	Not clear that longitudinal data were collected even though framed as a prospective cohort study. No incidence data.

Appendix 2: WorkSafeBC - Evidence-Based Practice Group Levels of Evidence (adapted from 1,2,3,4)

1	Evidence from at least 1 properly randomized controlled trial (RCT) or systematic review of RCTs.
2	Evidence from well-designed controlled trials without randomization or systematic reviews of observational studies.
3	Evidence from well-designed cohort or case-control analytic studies, preferably from more than 1 centre or research group.
4	Evidence from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments could also be
5	Opinions of respected authorities, based on clinical experience, descriptive studies or reports of expert committees.

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