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Short communication

Broad-based SARS-CoV-2 testing program for healthcare workers in a primary care hospital in France

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ABSTRACT

A broad-based SARS-CoV-2 testing program for all symptomatic healthcare workers (HCWs) was implemented in Tenon hospital, Paris, France. From February 26 to April 22, 2020, 701 symptomatic HCWs were screened, of whom 247 (35.2%) tested positive for SARS-Cov-2. Myalgia, fever, anosmia and ageusia were associated with RT-PCR positivity. Testing of HCWs is an essential step toward control of the epidemic. Further studies could establish clinical algorithms for SARS-CoV-2 diagnosis to compensate for RT-PCR test and chest CT limits or unavailability.

1. Introduction

The first three European cases of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections were reported in France on January 24, 2020 and the first death on February 15 [1]. Between February 26 and April 22, 2020, 595 patients were hospitalized in our establishment for SARS-CoV-2 infections, including 57 cases in intensive care unit and 113 deaths. We observed 247 cases of Healthcare worker (HCW) infections. HCWs are defined in the broadest sense as any staff working in the hospital, including cleaning or technical support, who might be exposed directly or indirectly to SARS-CoV-2, and are consequently at higher risk of contracting SARS-CoV-2 infection. Personal protective equipment (PPE) is advisable to ensure healthcare system functioning [2]. Based on the guidelines established by the French Infectious Diseases Society (SPILF-COREB) [3], mandatory precautions for the management of SARS-CoV-2 patients include droplets and contact precautions. On March 16, the day before the French national lockdown, these measures were extended to all hospital personnel. In order to prepare post-lockdown and to minimize a possible second epidemic wave, we felt it was important: i) to study whether the preventive measures adopted to protect HCWs were effective; ii) to identify symptoms predictive of SARS-CoV-2 infection, the objective being to detect it clinically: (a) in a specific context of shortage of masks and RT-PCR screening tests in France [4]; (b) in the context of possible false negatives with RT-PCR tests [5]; and (c) with the expectation of better performing tests (PCR and antigens) and chest CT with very good positive predictive value [6] but limited access.

2. Method

Between February 26 and April 22, 2020, in our hospital, broad-based screening for SARS-CoV-2 was implemented for all symptomatic HCWs exhibiting fever, respiratory symptoms (dyspnea, cough or sore throat) and/or any other clinical symptoms (e.g. myalgia, headache). The diagnosis of SARS-CoV-2 was performed by RT-PCR on a nasopharyngeal swab. During screening, age, occupation, comorbidities, temperature, oxygen saturation, and symptom history were recorded. On April 23, 2020, a telephone interview was conducted with HCWs positive for SARS-CoV-2 to collect information on possible modes of transmission and clinical outcomes. The questions regarding modes of contamination were: Do you think you were infected: i) in hospital with a patient positive for SARS-Cov-2; ii) in hospital with a colleague positive for SARS-Cov-2; iii) in the community, through family contacts, during transport, or during festive outings prior to the lockdown period? Differences in symptom frequency between positive and negative HCWs were evaluated using the Chi^2 and Fisher tests. The symptoms were summarized in a standardized questionnaire. All data were collected

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Table 1
Characteristics of healthcare workers screened for SARS-CoV-2 infection ($n = 701$) – Tenon Hospital, AP-HP, Paris, France.

Screening characteristic	No. (%) Positive SARS-CoV-2 PCR test result ($n = 247$)	Negative SARS-CoV-2 PCR test result ($n = 454$)	OR (95% CI)	*P*-value
Age, median (IQR), y	36 (18–64)	36 (19–67)	1 [0,9–1]	0.943
Sex				
Male	76 (30.8)	109 (24)	0.7 [0.5–1]	0.053
Female	171 (69.2)	345 (76)		
Occupation				
Direct patient care	209 (84.6)	390 (85.9)	0.9 [0.5–1.4]	0.644
Nurse	68 (27.5)	102 (22.5)	1.3 [0.9–1.9]	0.136
Caregiver	56 (22.7)	63 (13.9)	1.8 [1.2–2.7]	0.003
Physician	44 (17.8)	79 (17.4)	1 [0.7–1.5]	0.891
Student	15 (6.1)	43 (9.5)	0.6 [0.3–1.1]	0.119
Other[a]	26 (10.5)	103 (22.7)	0.4 [0.2–0.6]	< 0.001
Environmental employees	18 (7.3)	31 (6.8)	1.1 [0.6–1.9]	0.820
Administrative assistants	10 (4)	28 (6.2)	0.6 [0.3–1.3]	0.237
Maintenance workers	10 (4)	5 (1.1)	3.8 [1.3–11.2]	0.014
Any comorbidities[b]	46 (18.6)	171 (37.6)	0.4 [0.3–0.5]	< 0.001
Days from symptom onset to screening, mean (SD)	3.3 (1–16)	5.8 (1–42)	0.9 (0.9–0.9)	< 0.001
Symptoms reported				
Cough	134 (54.3)	257 (56.6)	0.9 [0.7–1.2]	0.548
Myalgias	112 (45.3)	151 (33.3)	1.7 [1.2–2.3]	0.002
Headache	111 (44.9)	184 (40.5)	1.1 [0.8–1.6]	0.398
Fever	91 (36.8)	105 (23.1)	1.9 [1.4–2.7]	< 0.001
Coryza	79 (32)	192 (42.3)	0.6 [0.5–0.9]	0.008
Asthenia	77 (31.2)	132 (29.1)	1.1 [0.8–1.5]	0.562
Anosmia	62 (25.1)	23 (5.1)	6.3 [3.8–10.4]	< 0.001
Ageusia	48 (19.4)	25 (5.5)	4.1 [2.5–6.9]	< 0.001
Chills	40 (16.2)	64 (14.1)	1.2 [0.8–1.8]	0.455
Dyspnea	25 (10.1)	100 (22)	0.4 [0.2–0.6]	< 0.001
Diarrhea	16 (6.5)	57 (12.6)	0.5 [0.3–0.9]	0.013
Sweats	14 (5.7)	19 (4.2)	1.4 [0.7–2.8]	0.376
Sore throat	14 (5.7)	68 (15)	0.3 [0.2–0.6]	< 0.001
Nausea/vomiting	14 (5.7)	31 (6.8)	0.8 [0.4–1.6]	0.549
Chest pain	9 (3.6)	27 (5.9)	0.6 [0.3–1.3]	0.191
Abdominal pain	7 (2.8)	20 (4.4)	0.6 [0.3–1.5]	0.306
Conjunctivitis	2 (0.8)	9 (2)	0.4 [0.1–1.9]	0.344
Anorexia	2 (0.8)	5 (1.1)	0.7 [0.1–3.8]	0.100

Telephone interview characteristic[c]	$n = 201$ (%)	
Exposures		
Only patient exposure	69 (34.3)	–
Only colleague exposure	49 (24.4)	–
Only patient and colleague exposure	41 (20.4)	–
Only household/community exposure	19 (9.4)	–
Multiple exposure settings	15 (7.5)	–
Unidentified exposure	8 (4)	–
Outcomes		–
Emergency	4 (2)	–
Hospitalization	3 (1.5)	–
Intensive care unit admission	0	–
Death	0	–

[a] Physiotherapist, psychologist, dietician, pharmacist, radiological manipulator.

[b] Cardiovascular history (complicated hypertension, stroke, coronary artery disease, heart surgery, heart failure stage NYHA III or IV), insulin-dependent diabetes that is unbalanced or with complications, chronic respiratory pathology that may decompensate in viral infection, chronic kidney disease dialysis, treated cancer, congenital or acquired immunosuppression (drug: cancer chemotherapy, immunosuppressive chemotherapy, biotherapy and/or immunosuppressive dose corticosteroid therapy; uncontrolled HIV infection or with CD4 < 200/mm^3; following a solid organ or hematopoietic stem cell transplant; related to a malignant hemopathy being treated), cirrhosis at least stage B of the Child-Pugh classification, morbid obesity (body mass index > 40 kg/m^2), splenectomy, women in the 2nd and 3rd trimester of pregnancy, caregivers aged 70 and over.

[c] 46 missing answers (201/247).

prospectively in the DIAMM-G computer database (Micro6 Nancy, France) except for suspected mode of contamination. The study was approved by the French data protection authority (CNIL: No. 2217729). The statistical analyses were conducted on STATA software, version 14.0 (Statacorp, Texas, United States). A downward stepwise multivariate logistic regression including significant variables with *P*-value < 0.20 in univariate analyses was carried out. A correlation test on the different variables was performed to ensure their independence.

3. Results

Out of the 3030 HCWs working at our hospital, 701 (23.1%) reported symptoms between February 26 and April 22. All of them were screened and 247/741 (35.2%) tested positive for SARS-CoV-2, representing a prevalence of 247/3030 (8.1%). Among those having reported symptoms and tested positive for SARS-CoV-2 ($n = 247$), median age was 36 years (IQR, 18–64), 171 (69.2%) were female and 209 (84.6%) carried out direct patient care; the remainder included

Table 2
Multivariate logistic regression analysis of symptoms reported (455 no cases and 247 cases).

Symptoms reported	*P*	Odds ratio	95% CI
Myalgia	0.001	1.83	[1.27–2.62]
Fever	0.005	1.72	[1.17–2.53]
Coryza	0.003	0.57	[0.39–0.82]
Anosmia	0.000	9.53	[5.31–17.1]
Dyspnea	0.000	0.30	[0.177–0.52]
Diarrhea	0.006	0.41	[0.22–0.78]
Sore throat	0.001	0.32	[0.17–0.62]

```
Logistic model for RésultatsPCR, goodness-of-fit test

      number of observations =       701
number of covariate patterns =        71
          Pearson chi2(63)   =     63.83
               Prob > chi2   =    0.4472
```

administrative assistants, environmental service employees, and maintenance workers. Occupations strongly positively associated with SARS-CoV-2 positivity were maintenance workers (OR = 3.8; 95% confidence interval (CI): 1.3–11.2) and caregivers (OR = 1.8; 95% confidence interval (CI): 1.2–2.7). Among the 201/247 (46 missing answers) HCWs contacted by phone, 178 (88.5%) retrospectively reported on their hospital-acquired infection. Clinically speaking, 194 (96.5%) never needed hospitalization, 4 (2%) went to the emergency room, 3 (1.5%) were hospitalized. No intensive care hospitalizations or deaths were reported.

In univariate analysis, myalgia, fever, anosmia and ageusia (general non-respiratory symptoms) were positively associated with test-positivity. The two symptoms most strongly associated with SARS-CoV-2 positivity were anosmia (OR = 6.3; 95% confidence interval (CI): 3.8–10.4), reported by 25.1% of test-positives, and ageusia (OR = 4.1; 95% confidence interval (CI): 2.5–6.9) reported by 19.4% of test-positives. On the other hand, diarrhea and respiratory symptoms (dyspnea, sore throat and coryza) were negatively associated with the disease (Tables 1 and 2). The model included all variables except ageusia. In multivariate analysis, SARS-CoV-2 infection was significantly positively associated with anosmia (OR = 9.5; 95% confidence interval (CI): 5.3–17.1), myalgia (OR = 1.8; 95% confidence interval (CI): 1.3–2.6) and fever (OR = 1.7; 95% confidence interval (CI): 1.2–2.5). SARS-CoV-2 infection was significantly negatively associated with coryza (OR = 0.6; 95% confidence interval (CI): 0.4–0.8), diarrhea (OR = 0.4; 95% confidence interval (CI): 0.2–0.8), sore throat (OR = 0.3; 95% confidence interval (CI): 0.2–0.6) and dyspnea (OR = 0.3; 95% confidence interval (CI): 0.2–0.5). The curve of the number of HCWs tested positive daily for SARS-CoV-2 is congruent with the curve corresponding to patients in the hospital (Fig. 1). It began to decline about ten days after masks began to be worn continuously by HCWs and the French lockdown was put in place, whereas the total number of patients hospitalized for SARS-CoV-2 in all French hospitals continued to rapidly increase before leveling off.

4. Discussion

Contrary to what was described at the outset of the epidemic [7,8], the symptoms significantly associated with positive

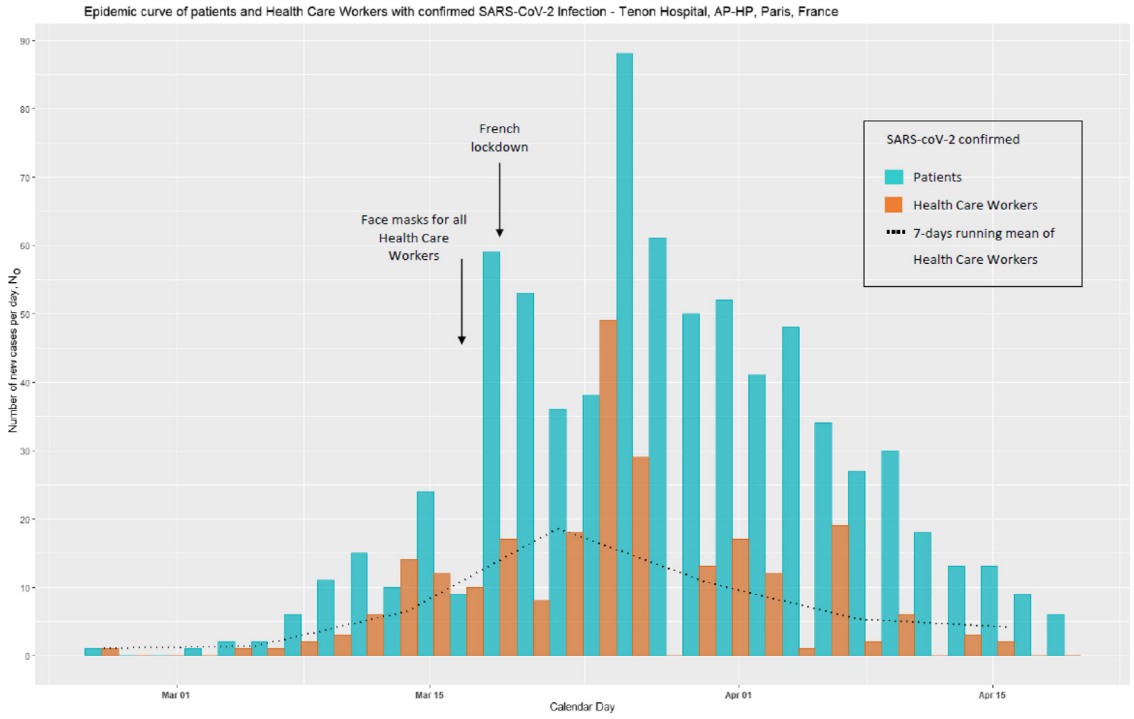

Fig. 1. Epidemic curve of patients and Health Care Workers with confirmed SARS-CoV-2 infection - Tenon Hospital, APHP, Paris, France.

SARS-CoV-2 infection are generally non-respiratory. It also bears mentioning that in our study, the incidence rate among HCWs was probably underestimated because at first, only HCWs with fever and respiratory signs were encouraged to come for testing; only later was the clinical picture widened to include other possible signs of SARS-CoV-2 infection.

While reported a steep decrease in the curve corresponding to the number of HCWs tested positive for SARS-CoV-2 on a day-to-day basis, we were unable to determine whether or not it was closely associated with the PPE adopted for the protection of HCWs in an unconfined population. The high level of hospital-acquired infection reported in our study is probably overestimated by self-reporting in the absence of precise contact screening with risk stratification inside and outside the hospital. For example, the possibility that hospital-acquired contamination may have been overestimated so as to have it recognized as an occupational disease cannot be ruled out. In a retrospective analysis of documented cases, a majority of hospital-acquired infections occurred prior to systematic testing of patients and the general adoption of protective measures [1].

Even though the numbers are small, our study highlights an increasing risk among maintenance workers (OR 3.8 [1.3–11,2 95% CI; *P*: 0.014). The cleaning staff included in the "maintenance workers" group are not part of the hospital staff insofar they are often employed by a private company. While some of them were included in our study when they showed symptoms, the results are not exhaustive of this group. As proof, we have included them more widely in our current serological study (data not shown); out of the first 50 serologies performed in the cleaning agents, 23/50 were negative and 27/50 (54%) were positive, 9 of whom were included in the present RT-PCR study, i.e. 7/10 PCR positive and 2/5 negative, which effectively illustrates the limits of RT-PCR.

More generally, our findings data highlight a group of in-hospital workers who may have been widely contaminated in the social conditions of living and transport during a lockdown period. This is particularly the case at the hospital for cleaning staff, firemen, security guards, kitchen staff... This highly diversified population requires special attention in terms of screening, information and isolation of positive persons in the event of a second wave. As a means of overcoming RT-PCR and chest CT limits, decision algorithms based on clinical and biological criteria of SARS CoV-2 infection such as those applied in our study could be useful for public health purposes, particularly with regard to a population of highly exposed paucisymptomatic healthcare workers, and possibly in emerging countries. In numerous countries, large-scale population testing is impossible due to the limited availability and costs of RT-PCR kits and CT-scan. Pre-test probability combining clinical and biological features should be the subject of prospective or retrospective studies with a control group.

Lastly, testing of HCWs is an essential step to control this epidemic. The Centers for Disease Control and Prevention [9] recently provided guidance on the appropriate use of HCW testing, which can be considered in four situations: Testing HCWs with signs or symptoms consistent with COVID-19; Testing asymptomatic HCWs with known or suspected exposure to SARS-CoV-2; Testing asymptomatic HCWs without known or suspected exposure to SARS-CoV-2 for early identification in special settings (e.g., nursing homes); Testing HCWs who have been diagnosed with SARS-CoV-2 infection to determine when they are no longer infectious.

Further studies should make it possible to distinguish between community –, home –, and health care – acquired exposures [10].

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments.

Contribution of authors

Dr Chas had full access to all data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis; concept and design: all authors; acquisition, analysis, or interpretation of data: Chas, Nadal, Denis, Pialoux; drafting of the manuscript: Chas, Nadal, Pialoux; critical revision of the manuscript for important intellectual content: all authors; administrative, technical, or material support: Chas, Nadal, Morand–Joubert; supervision: Pialoux.

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Disclosure of interest

The authors declare that they have no competing interest.

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