
The transmission mode of SARS-CoV-2 is not fully understood; it is thought to be spread mostly by respiratory droplets and direct contact (4–6). The median incubation period is ≈5 days (7,8). Among symptomatic patients, men are affected slightly more frequently than women (9,10). COVID-19 has many manifestations, ranging from mild upper airway symptoms to acute respiratory distress syndrome. Common signs and symptoms of COVID-19 include fever, cough, sputum production, and fatigue (11,12). A high proportion of hospitalized COVID-19 patients have concurrent conditions such as arterial hypertension, diabetes mellitus, or coronary heart disease (13–17).

In March 2020, Rothe et al. published evidence of asymptomatic SARS-CoV-2 transmission (18), and evidence that asymptomatic or presymptomatic persons can transmit SARS-CoV-2 infection has continued to increase (19,20). In many healthcare settings, the number of persons with asymptomatic SARS-CoV-2 infection is unknown. Asymptomatic persons and healthcare workers can contract and spread the infection among hospitalized patients. Many hospitalized patients, who frequently are >65 years of age, have concurrent conditions, or both, are at risk for severe COVID-19.

In consideration of these circumstances, hospitals must take precautions to prevent the spread of SARS-CoV-2. For example, some hospitals might screen patients for SARS-CoV-2 infection within 24 hours before an elective intervention (21). Some well-resourced healthcare settings in high incidence areas might benefit from testing patients without COVID-19 symptoms (22). In the canton of Zurich, Switzerland, 4 hospitals introduced universal admission screening of all hospitalized patients in April 2020. We used the results of this screening to assess SARS-CoV-2 prevalence among hospitalized patients and to evaluate the additional yield of a universal screening strategy compared to a symptom-driven approach.

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Methods and Materials

Study Population Characteristics
The canton of Zurich is a region in northeast Switzerland that has a population of ≈1.5 million inhabitants. The canton has 32 registered hospitals, of which 31 publicly report annual discharge numbers. These 31 hospitals discharged 237,919 patients in 2018 (23). During April 1–24, 2020, four hospitals conducted universal admission screening for SARS-CoV-2 (Table 1). The participating sites included the 3 largest hospitals in the canton, which accounted for ≈44% of discharges in 2018 (Table 1). Screening periods ranged from 11–24 days. The Zurich Cantonal Ethics Commission (Req-2020-00441) waived the requirement for a formal ethical evaluation according to the Swiss Human Research Act.

Testing for SARS-CoV-2
During the screening period, the hospitals tested all patients ≥16 years of age for SARS-CoV-2 infection, regardless of signs or symptoms. At the time, the health authorities of the canton supported the policy of universal admission screening. Hospital staff informed admitted patients about SARS-CoV-2 testing as a new routine diagnostic procedure. Staff collected a nasopharyngeal swab sample from each patient and tested the samples by PCR. A single laboratory conducted diagnostic procedures for the University Hospital of Zurich (USZ) and GZO Wetzikon (GZO). The other 2 hospitals, City Hospital Triemli (STZ) and Cantonal Hospital Winterthur (KSW), sent samples to separate laboratories. The laboratory that conducted diagnostic procedures for USZ and GZO also tested and confirmed all SARS-CoV-2–positive samples from patients at STZ and a random subset of SARS-CoV-2–positive samples from patients at KSW. PCR methods varied among the participating study sites (Appendix Table 1, https://wwwnc.cdc.gov/EID/article/27/2/20-2318-App1.pdf).

Symptom Information Collection
Hospital staff assessed each patient for signs and symptoms of COVID-19 at admission. In accordance with guidance provided by the Swiss Federal Office for Public Health, staff considered cough, dyspnea, temperature ≥38.0°C or feeling feverish, sore throat, and myalgia as possible signs and symptoms of COVID-19 (24). The assessment focused on symptoms at the time of the nasopharyngeal sample. Staff also noted whether suspected COVID-19 was the primary reason for admission. Before beginning the study, all participating sites agreed to prospectively collect these variables and document them in medical records. Staff extracted these data from the medical records and entered them into an electronic case report form. When information in the medical chart was inconclusive, we contacted the treating physician or the patient for clarification. At admission, patients were categorized as asymptomatic, (i.e., absence of all COVID-19 signs or symptoms) or symptomatic (i.e., presence of ≥1 COVID-19 sign or symptom). We compared our results with cantonal data (COVID-19 Informationen Schweiz, https://www.corona-data.ch).

Statistical Analyses
We analyzed deidentified patient data submitted through an electronic case report form. We conducted statistical analysis using R version 3.3.2 (The R Foundation, https://www.r-project.org). We analyzed the medians and interquartile ranges of continuous variables and frequencies of categorical variables.

Results
Incidence of COVID-19
In the canton of Zurich, which has ≈1.5 million inhabitants, the first case of COVID-19 was documented on February 27, 2020 (25; Figure 1). The daily incidence of new SARS-CoV-2 infections peaked at 364 cases on March 23, 2020. During the screening period (April 1–24, 2020), the median daily incidence was 40 cases (interquartile range [IQR] 27–87 cases), corresponding to a rate of 2.7 cases/100,000 inhabitants (COVID-19 Informationen Schweiz, https://www.corona-data.ch).

Study Population
Hospital staff screened 2,807 patients for SARS-CoV-2 infection (Table 2). The median age was 60 years (IQR 39–74 years); 1,368 (48.7%) patients were men.

Table 1. Characteristics of 4 hospitals in study on severe acute respiratory syndrome coronavirus 2, canton of Zurich, Switzerland, 2020

<table>
<thead>
<tr>
<th>Hospital</th>
<th>No. beds</th>
<th>No. patients in 2018</th>
<th>Screening period</th>
</tr>
</thead>
<tbody>
<tr>
<td>GZO Wetzikon</td>
<td>156</td>
<td>10,368</td>
<td>2020 Apr 8–2020 Apr 24</td>
</tr>
<tr>
<td>Cantonal Hospital Winterthur</td>
<td>445</td>
<td>27,451</td>
<td>2020 Apr 9–2020 Apr 19</td>
</tr>
<tr>
<td>City Hospital Triemli</td>
<td>396</td>
<td>24,335</td>
<td>2020 Apr 8–2020 Apr 24</td>
</tr>
<tr>
<td>University Hospital of Zurich</td>
<td>941</td>
<td>41,916</td>
<td>2020 Apr 1–2020 Apr 24</td>
</tr>
</tbody>
</table>
and 1,439 (51.3%) women. At admission, 529 (18.8%) patients had ≥1 sign or symptom of COVID-19: 205 (7.3%) had temperatures ≥38.0°C or felt feverish, 192 (6.8%) had cough, 282 (10.0%) had dyspnea, 30 (1.1%) had sore throats, and 27 (1.0%) had myalgia. A total of 164 patients (5.8% of the whole study population) were hospitalized primarily for suspected COVID-19.

**PCR Results**

Overall, 68 (2.4%) patients tested positive for SARS-CoV-2 RNA by PCR. Of the 529 patients with ≥1 sign or symptom of COVID-19, 60 (11.3%) tested positive. In contrast, only 8 (0.4%) of 2,278 patients without symptoms tested positive (Table 2). SARS-CoV-2 infection was diagnosed in 6 (8.8%) patients at GZO, 6 (8.8%) patients at KSW, 16 (23.5%) patients at STZ, and 40 (58.8%) patients at USZ. Asymptomatic SARS-CoV-2–positive patients were identified at all 4 hospitals: 1 (12.5%) patient at GZO, 3 (37.5%) patients at KSW, 1 (12.5%) patient at STZ, and 3 (37.5%) patients at USZ.

Of the 164 patients admitted primarily for suspected COVID-19, 52 (31.7%) tested positive for SARS-CoV-2 infection by PCR. Of all SARS-CoV-2–infected patients, 38 (55.9%) had temperatures ≥38.0°C or felt feverish, 40 (58.8%) had cough, 27 (39.7%) had dyspnea, 8 (11.8%) had sore throats, and 13 (19.1%) had myalgia. Among symptomatic COVID-19 patients, the most common manifestations were cough and fever (27; 45%), cough and dyspnea (17; 28.3%), and dyspnea and fever (14; 23.3%) (Figure 2). The absence of COVID-19 signs or symptoms yielded a negative predictive value of 99.6% for SARS-CoV-2–infection.

**Discussion**

In this prospective multicenter study, hospital staff tested 2,807 patients, of whom 2,278 (81.2%) did not have signs or symptoms of COVID-19. In total, 68 (2.4%) patients were tested positive for SARS-CoV-2 infection by PCR. Of SARS-CoV-2–positive patients, 8 (11.8%) were asymptomatic, corresponding to 0.4% of patients without

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total</th>
<th>PCR results for severe acute respiratory syndrome coronavirus 2</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Negative</td>
</tr>
<tr>
<td>Total</td>
<td>2,807</td>
<td>2,739 (97.6)</td>
</tr>
<tr>
<td>Hospital</td>
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<tr>
<td>GZO Wetzikon</td>
<td>283</td>
<td>277 (97.9)</td>
</tr>
<tr>
<td>Cantonal Hospital Winterthur</td>
<td>409</td>
<td>403 (98.5)</td>
</tr>
<tr>
<td>City Hospital Triemli</td>
<td>583</td>
<td>567 (97.3)</td>
</tr>
<tr>
<td>University Hospital Zurich</td>
<td>1,532</td>
<td>1,492 (97.4)</td>
</tr>
<tr>
<td>Median age, y (IQR)</td>
<td>60 (39–74)</td>
<td>60 (39–74)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>1,368</td>
<td>1,330 (97.2)</td>
</tr>
<tr>
<td>F</td>
<td>1,439</td>
<td>1,409 (97.9)</td>
</tr>
<tr>
<td>Symptoms</td>
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<tr>
<td>Any symptom of coronavirus disease</td>
<td>529</td>
<td>469 (88.7)</td>
</tr>
<tr>
<td>Fever/feeling feverish</td>
<td>205</td>
<td>167 (81.5)</td>
</tr>
<tr>
<td>Cough</td>
<td>192</td>
<td>152 (79.2)</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>282</td>
<td>255 (90.4)</td>
</tr>
<tr>
<td>Sore throat</td>
<td>30</td>
<td>22 (73.3)</td>
</tr>
<tr>
<td>Myalgia</td>
<td>27</td>
<td>14 (51.9)</td>
</tr>
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</table>

*Values are no. (%) except as indicated.
signs or symptoms of COVID-19. We found that 99.6% of patients without COVID-19 signs or symptoms tested negative for SARS-CoV-2 infection.

On March 16, 2020, the rapid increase in COVID-19 incidence prompted the government of Switzerland to implement and enforce preventive measures including social distancing and the closure of restaurants, bars, entertainment businesses (e.g., cinemas, libraries, museums), and all shops that could not guarantee a minimum distance of 2 meters between persons (26). These measures contributed to a sharp decline in COVID-19 incidence. In the canton of Zurich, the incidence of COVID-19 decreased after March 23, 2020, ≈1 week after the lockdown began in Switzerland. This study started on April 1, 2020, ≈2 weeks after the beginning of lockdown.

Because of the successful control measures for COVID-19 and the low prevalence of influenza and other respiratory viruses, <20% of the study population had signs or symptoms of COVID-19. Among all persons with SARS-CoV-2 infection, the most frequent symptoms were cough (58.8%) and fever (55.9%), consistent with other reports (9,11).

We conducted this study because of reports of a large proportion of persons with asymptomatic SARS-CoV-2 infection (18,19,27). In this study, only 0.4% of persons without signs or symptoms of COVID-19 tested positive for SARS-CoV-2 infection. More than 88% of SARS-CoV-2–positive persons had ≥1 sign or symptom of COVID-19. Our findings are in contrast to Sutton et al. (28), who found that 33 (15.4%) of 214 pregnant women tested positive for SARS-CoV-2 infection at time of hospitalization for delivery. Only 4 of those women had COVID-19 symptoms at admission; symptoms developed in 3 more women in the following days. During the study period in New York, NY, USA, from March 22–April 4, a median of 4,958 persons (59 cases/100,000 inhabitants) tested positive for SARS-CoV-2 infection at time of hospitalization for delivery. Only 4 of those women had COVID-19 symptoms at admission; symptoms developed in 3 more women in the following days. During the study period in New York, NY, USA, from March 22–April 4, a median of 4,958 persons (59 cases/100,000 inhabitants) tested positive for SARS-CoV-2 infection at time of hospitalization for delivery. Only 4 of those women had COVID-19 symptoms at admission; symptoms developed in 3 more women in the following days.
et al. (31) reported that 23 (30.3%) of 76 residents in a skilled nursing home tested positive for SARS-CoV-2 infection during a local COVID-19 outbreak. At the time of testing, 13 (56.5%) SARS-CoV-2–positive persons were asymptomatic or had stable, chronic symptoms; COVID-19 symptoms developed in 10 of these 13 previously asymptomatic persons during the 7 days after testing (31). The delayed development of symptoms probably indicates that the cases were diagnosed during a presymptomatic period. Another recent study tested for SARS-CoV-2 infection among different subsets of the population in Iceland (32). In an open invitation sample of residents of Iceland with no or mild respiratory symptoms (32), 87 (0.8%) tested positive for SARS-CoV-2 infection; 36 (41.4%) of these persons were asymptomatic. Researchers also tested a random sample of 2,283 persons living in Iceland, of whom 13 (0.6%) tested positive for SARS-CoV-2 infection; 7 (53.8%) of these persons were asymptomatic. Both sample populations had a 0.3% proportion of persons with asymptomatic SARS-CoV-2 infections (36/10,797 persons in the open invitation sample and 7/2,283 persons in the random sample) (32), which is similar to the proportions in our findings (8/2,807 persons; 0.3%). The difference in the proportions of asymptomatic persons among those with SARS-CoV-2 infection (11.8% in this study vs. 41.4% in the open invitation and 53.8% in the random samples from Iceland) (32) might have been caused by an overrepresentation of symptomatic persons in our study because COVID-19–compatible symptoms are probably more common among admitted hospital patients.

Identifying and isolating persons with SARS-CoV-2 infection is critical to containing COVID-19. Because of limited testing capacity, healthcare providers must use resources strategically (33). Our findings indicate that screening on the basis of COVID-19 symptoms, regardless of clinical suspicion, can identify nearly all SARS-CoV-2–infected persons in the studied epidemiologic setting. Because COVID-19 has a broad spectrum of clinical manifestations, healthcare providers should screen patients for symptoms at admission. By only testing symptomatic patients, healthcare providers can use >80% fewer tests; however, this strategy would not identify 0.4% of SARS-CoV-2 infections. For every ≈285 persons without symptoms whom we tested, we identified 1 asymptomatic SARS-CoV-2 infection. Whether asymptomatic persons are as infectious as symptomatic persons is unknown. At the time of this study, no quantitative SARS-CoV-2 reporting existed; this lack of data hindered a comparison of viral replication between asymptomatic and symptomatic persons. Additional studies on this topic are urgently needed.

Our study has limitations. First, all participants were tested only once for SARS-CoV-2 infection at admission; no routine follow-up tests were scheduled, regardless of patient signs or symptoms. The lack of follow-up testing might have missed some cases of SARS-CoV-2 infection. Second, we did not collect information on the patients’ potential exposures to SARS-CoV-2 or any other agents of respiratory illness. Third, different laboratories conducted the PCRs with different methods. However, we ensured the validity of results from different laboratories by retesting a subset of SARS-CoV-2–positive samples at another laboratory. Fourth, our findings must be considered in the epidemiologic context; they do not apply to high-prevalence settings with active outbreaks. Fifth, we did not collect information about patients’ COVID-19 symptoms during the previous 2 weeks. We also did not conduct follow-up evaluations of symptoms in patients who were asymptomatic at admission. Further studies should evaluate whether these asymptomatic patients might have been presymptomatic or recovering from COVID-19 at admission. Sixth, we did not collect information on ageusia and anosmia, which were later described as characteristic symptoms among mild and moderate cases of COVID-19 (34). Including these variables might have increased the number of symptomatic persons among SARS-CoV-2–infected patients.

This prospective study benefited from a multicenter design and the availability of data on regional incidence of COVID-19. We selected study sites that accounted for ≈44% of all patient discharges in the canton in 2018 and included the 3 largest hospitals (23) and were therefore representative of the canton of Zurich. In addition, no admitted patients refused to participate in the screening for SARS-CoV-2.

In conclusion, universal testing for SARS-CoV-2 of all patients at hospital admission in this region of Switzerland did not identify a substantial number of asymptomatic infections in a low-prevalence setting. Future studies are needed to delineate the role of asymptomatic SARS-CoV-2–infected persons as transmitters in the current pandemic.

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About the Author

Dr. Scheier is an infectious disease fellow at the University Hospital Zurich, Zurich. His research focuses on epidemiology of emerging infections.

References

EID Podcast
Plague in a Dog

Some might think the plague is a relic of the Middle Ages. But *Yersinia pestis* still lingers, and has even infected man’s best friend.

In this EID podcast, Dr. Joshua Daniels, a bacteriologist at Colorado State University’s Veterinary Diagnostic Laboratory, explains how doctors diagnosed this unusual infection.
Universal Admission Screening for SARS-CoV-2 Infection among Hospitalized Patients, Switzerland, 2020

Appendix

Appendix Table. PCRs used to detect SARS-CoV-2, Switzerland, 2020

<table>
<thead>
<tr>
<th>Hospital</th>
<th>PCR</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>GZO Wetzikon</td>
<td>In-house assay according to V.M. Corman et al. (1) or Roche cobas SARS-CoV-2 IVD test</td>
<td>open reading frame 1, envelope protein gene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>open reading frame 1, envelope protein gene</td>
</tr>
<tr>
<td>City Hospital Triemli†</td>
<td>CDC 2019-Novel Coronavirus (2019-nCoV) Real-Time RT-PCR Diagnostic Panel (2)</td>
<td>Viral nucleocapsids 1 and 2, RNase P</td>
</tr>
<tr>
<td>University Hospital of Zurich</td>
<td>In-house assay according to V.M. Corman et al. (1) or Roche cobas SARS-CoV-2 IVD test</td>
<td>open reading frame 1, envelope protein gene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>open reading frame 1, envelope protein gene</td>
</tr>
</tbody>
</table>

* A subset of SARS-CoV-2-positive samples was confirmed by identical PCR at GZO Wetzikon and University Hospital of Zurich. E, envelope protein; ORF, open reading frame; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.
† All SARS-CoV-2–positive samples were reanalyzed by the laboratory performing SARS-CoV-2 diagnostics for the University Hospital of Zurich and GZO Wetzikon with an in-house assay according to V.M. Corman et al. (1) or Roche cobas SARS-CoV-2 IVD test (Roche Diagnostics, https://diagnostics.roche.com).

References
