Testing for asymptomatic COVID-19

A rapid systematic review and jurisdictional/ healthcare organizational scan

Date: 6/2/2020

Disclaimer:

This *Rapid Review* was published on June 02, 2020. The purpose was to provide decision-makers evidence in a timely fashion. As the evidence cycle is accelerated during this pandemic, some of the references may become out-of-date, retracted, or otherwise considered to be factually incorrect or superseded by newer evidence/ recommendations. Further, to expedite the review process, we have had to streamline several parts of the traditional systematic review process and forgo some of the safety checks and critical appraisal steps formally associated with evidence synthesis.

We caution readers to keep apprised of the latest recommendations from their local, provincial and federal authorities.

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Suggested citation: Ahmed M. Abou-Setta, George Okoli, Otto Lam, Viraj Kasireddy, Nicole Askin, Lauren MacKenzie, Joanne Langley, Sharon E. Straus, Andrea C. Tricco. Testing for asymptomatic COVID-19: A rapid systematic review and jurisdictional/ healthcare organizational scan.

Acknowledgements

The SPOR Evidence Alliance is supported by the Canadian Institutes of Health Research (CIHR) under the Strategy for Patient-Oriented Research (SPOR) Initiative. Special thanks to Naveeta Ramkissoon and Chantal Williams (AMSTAR Quality Assessment).

Funding Statement

This rapid systematic review was conducted through the Strategy for Patient Oriented-Research (SPOR) Evidence Alliance. The authors alone are responsible for the views expressed in this article and they do not necessarily represent the decisions, policy or views of the requester.

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Question:

What are the **benefits and harms** for testing asymptomatic individuals for COVID-19 in healthcare and non-healthcare settings (e.g. universities, colleges, retail, office settings)?

What are the **current policies** for testing asymptomatic individuals for COVID-19 in Canada and internationally?

Summary of findings:

Prevalence of asymptomatic cases

- COVID-19 cases who are asymptomatic at the time of testing may be pre-symptomatic (symptoms develop later), will remain asymptomatic throughout the course of the disease (asymptomatic infection) or recovered but still shedding dead viruses (post-infection shedding or detection of virus). As such a single negative test is not indicative of lack of infection, nor is a single positive test confirmation of a transmissible infection. Out of an abundance of caution, and irrespective of symptoms, individuals who tested positive are considered infective to others.
- There is a lot of uncertainty regarding the true prevalence of asymptomatic cases. One study from China noted that almost 80% of cases of COVID-19 may be asymptomatic, while others have estimated that the true prevalence is closer to 20% (or even less than 10%). The US Centers for Disease Control and Prevention (CDC) has recently estimated that the proportion of infections that are asymptomatic ranges from 20% - 50%; with 35% being the current best estimate.
- In healthcare settings, the proportion of asymptomatic healthcare workers and patients was variable; similar to the general population.

Potential benefits of testing

- Mathematical models have demonstrated that testing of asymptomatic individuals may be an important step in combatting the current pandemic; especially in populations at increased risk of COVID-19 exposure (e.g. healthcare workers), individuals who work in crowded settings (e.g. long-term care facilities, emergency shelters, correctional facilities, etc.).
- Evidence from testing international arrivals, individuals who were on cruise ships (e.g. Diamond Princess) and persons evacuated from Wuhan, China show that

COVID-19 cases may show no, or few symptoms, at the time of testing. Early identification allowed isolation, close observation and contact tracing.

Potential harms of testing

- Real-world (e.g. point of care) diagnostic accuracy differs from testing accuracy in a controlled environment. That is, testing results can be impacted by factors such as the adequacy of sample collection and time since exposure to COVID-19. This can lead to both false positive and false negative testing results.
- Currently, the potential harms to individuals (e.g. anxiety of false diagnosis), organizations (e.g. procedural changes) or society (e.g. added cost of mass testing, prophylaxis) are not fully established. Further, novel therapies being administered to manage COVID-19 may carry more harms than benefits.

Current testing policies (Canadian Provinces and Territories)

- Alberta, Manitoba, Ontario and Saskatchewan have expanded testing to include asymptomatic persons who request a test or are referred for testing by a physician.
- British Columbia and Northwest Territories are not recommending testing asymptomatic persons with some exceptions.
- Policies for testing asymptomatic persons in New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Quebec, Yukon and Nunavut were not identified. Policies are publicly available for symptomatic individuals and contact tracing.

Current testing policies (International)

- Review of policies from 28 countries demonstrates that testing asymptomatic persons is variable and depends on region, risk-level and work setting. Most allow testing for contact tracing and as indicated by a physician.

Background

In humans, coronaviruses may cause respiratory infections ranging from the common cold to severe diseases such as the Severe Acute Respiratory Syndrome (SARS) and the Middle Eastern Respiratory Syndrome (MERS) that were of epidemic proportions in 2003 and 2012, respectively. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is a rapidly emerging pandemic virus causing coronavirus disease 2019 (COVID-19).

For COVID-19, the average time that it takes for a secondary symptomatic case to arise directly from exposure to a primary symptomatic infected person (mean serial interval) has been estimated to be 4.0 days; ranging from 3.1 days to 4.9 days.[1] This is considerably shorter than the mean serial interval calculated for SARS (8.4 days) or MERS (14.6 days).[2] In addition, the mean reproductive number (R_0), which represents the speed of spread or transmissibility of SARS-CoV-2, in the absence of preventive measures, has been estimated to be around 3.28,[3] which is higher than that for SARS (1.7–1.9) and MERS (<1)[4].

Evidence from primary studies regarding the incubation period, the time between exposure and symptom onset, of SARS-CoV-2 has so far been variable. Some individuals may not develop symptoms for days or even weeks following infection (pre-symptomatic), while others may have mild respiratory symptoms, atypical symptoms (e.g. gastrointestinal symptoms),[5] or remain asymptomatic. Some studies have demonstrated high viral loads (by RT-PCR) in pre-symptomatic, mildly symptomatic and asymptomatic persons; thus, making transmission from such persons a highly plausible concern.[6,7] Even so, in these studies, it was not verified whether patients were in the communicability period as virus viability was not assessed.

Whereas symptomatic persons have generally been the focus of SARS-CoV-2 testing so far during this pandemic, it is now being suggested that testing of asymptomatic persons for the virus may reduce transmission of infection from these individuals.[8,9] In theory, screening more individuals increases the likelihood of identifying cases early and interrupting the spread of the disease. However, it would be necessary to determine if such true positive cases were in a communicable state.

There are barriers to implementing a universal testing strategy. Swabbing for PCR samples is invasive, may cause local discomfort and is not readily available in all locations. Additionally, it takes time and trained staff to swab properly. While the benefits and harms of testing individuals for infectious diseases like HIV and tuberculosis are well established,[10-14] it is still unclear if the benefits of testing

asymptomatic individuals outweighs the potential harms to individuals (e.g. anxiety of false positive diagnosis; false reassurance by false negative test), organizations (e.g. policy changes), public health (e.g. increased burden of contact tracing efforts for false positives; limited laboratory testing capacity) or society (e.g. added cost of mass testing). Further, novel therapies being administered to manage COVID-19 may carry more harms than benefits.

Methods

The primary research question was "What are the benefits and harms for testing asymptomatic individuals for COVID-19 in healthcare and non-healthcare settings (e.g. universities, colleges, retail, office settings)?" We included randomized trials, non-randomized trials and observational studies. The non-randomized and observational studies could be single arm or with a control group, including but not limited to prospective or retrospective cohort studies, case-controlled studies or case reports/ series. We excluded opinion papers, editorials, and trial registries. In addition, we excluded studies on seroconversion, seroprevalence, antibody testing and modes of screening (e.g. questionnaire, clinical assessment, CT scans). The outcomes of interest were rates of pre-symptomatic/ asymptomatic COVID-19 cases, benefits of testing asymptomatic individual (or a subset of them) and harms associated with testing of asymptomatic individuals.

Search strategy for identification of studies

We searched general health bibliographic databases [MEDLINE (Ovid), EMBASE (Ovid), CENTRAL (Cochrane Library – Wiley)] from November 01, 2019 to May 20, 2020. We also searched COVID-19 specific databases [LitCovid (https://www.ncbi.nlm.nih.gov/research/coronavirus/), Medrxiv (https://connect.Medrxiv.org/relate/content/181), WHO COVID-19 Global Research on Coronavirus Disease (https://search.bvsalud.org/global-research-on-novel-coronavirus-2019-ncov/), Cochrane Covid (https://covid-19.cochrane.org/) on May 20, 2020. Lastly, we conducted searches in general purpose databases (e.g. Google). Each database was searched using an individualized search strategy; example of Medline search is available in Appendix 1. Finally, the reference lists of relevant narrative and systematic reviews and included studies were hand-searched for relevant citations. We performed reference management in EndNote™ (version X9, Thomson Reuters, Carlsbad, CA, USA).

For the jurisdictional/ healthcare organizational scan, we searched organizational, provincial, federal and related government websites. In addition, we

searched news outlets and conducted general searches across the web for specific policies in place at the time of the search. Searches were conducted from May 25-28, 2020.

Study selection

We used a two-stage process for study screening and selection using standardized and piloted screening forms. One reviewer screened the titles and abstracts of search results to determine if a citation met the inclusion criteria. A senior researcher reviewed all the selected citations and a sample of the excluded citations against the predetermined inclusion and exclusion criteria. Full-texts (if available) of all the selected citations were examined by the reviewers and all decisions were reviewed by a senior researcher. Discrepancies between the two reviewers were resolved by a third reviewer, as required.

Data abstraction and management

One reviewer summarized the findings from included study reports, and a senior researcher reviewed the summaries for accuracy and completeness. Discrepancies between the two reviewers were resolved by a third reviewer. Data management was performed using Microsoft Excel™ 2010 (Excel version 14, Microsoft Corp., Redmond, WA, USA).

Assessment of methodological quality and potential risk of bias

Due to the expedited nature of this rapid systematic review, and that most of the evidence was expected to come from lower quality, single-arm observational and modelling studies, we did not assess the methodological quality or potential risk of bias of the included observational and modelling studies. If any randomized trials were identified then we would have assessed the risk of bias of those trials using the Cochrane Risk of Bias Tool. However, we did assess the quality of systematic reviews (as defined by Cochrane) using the AMSTAR 2 tool.

Results

From the 1,414 records identified through database searching and other sources, we selected 82 academic publications/ media articles/ guidance documents from professional societies that provided evidence for the key questions (Figure 1). The majority of the publications reported on evidence from observational studies quantifying the prevalence of asymptomatic cases (n = 46) and mathematical modeling of the prevalence and role of asymptomatic cases during this pandemic (n = 24). There was one report providing guidance for testing surgical candidates and 11 evidence syntheses: 6 systematic literature reviews (SLR), 3 meta-analyses (MA), 1 rapid review (RR) and 1 literature review (LR). The quality of the systematic literature review were generally critically low, with only one review adjudicated as being of moderate quality.

Prevalence of asymptomatic cases

- **Evidence syntheses of primary studies of prevalence**[15-24] are not consistent in their estimations; ranging from ~5% to ~80% (Table 1). The conflicting evidence may be due in part to differences in the inclusion criteria, population of interest and methods for summarizing the evidence and timing of COVID-19 outbreaks. Individuals who are asymptomatic at the time of testing may actually be pre-symptomatic with two studies noting that 40% to 70% of cases were pre-symptomatic at the time of testing. As such, and out of an abundance of caution, a single negative test is not indicative of lack of infection. Irrespective of symptoms, individuals who tested positive are considered infective to others.
- **Primary observational studies of prevalence**[6,25-58] and recent **news articles**[59,60] of the general population reveal great uncertainty regarding the true rates of asymptomatic cases (Table 2-3). One news article[59] from China noted that almost 80% of cases of COVID-19 may be asymptomatic, while others have estimated that the true value is closer to 20% (or even less than 10%).
- **Primary observational studies of prevalence**[61-70] in healthcare settings shows similar uncertainty regarding the true rates of asymptomatic cases (Table 4).
- **Mathematical modeling studies**[71-73] estimated the prevalence of asymptomatic persons to range from 18% to 50% (Table 5). The US CDC73 has recently estimated that 35% is the current best estimate.

Potential benefits of testing

- **Mathematical modeling studies**[74-94] (Table 6) have demonstrated that testing of asymptomatic individuals may be an important step in combatting the current pandemic; especially in high-risk professions (e.g. healthcare), individuals who work in crowded settings and in older adults and vulnerable populations (e.g. long term

care facilities, emergency shelters, correctional facilities). Even so, as all the variables and assumptions in a model are not always clear, evidence from models should be considered carefully prior to being used as part of policy decisions.
- Evidence from testing international arrivals, individuals who were on cruise ships (e.g. Diamond Princess) and persons evacuated from Wuhan, China show that asymptomatic COVID-19 cases were often pre-symptomatic or asymptomatic cases. Early identification allowed quarantine, close observation and contact tracing.
- **In healthcare settings**, a model[94] predicted that after 30 days, weekly testing of healthcare workers would reduce new infections (healthcare worker and patients) by 5.1%.

Potential harms of testing
- One **meta-analysis of primary studies of diagnostic accuracy of testing**[95] reported that false positive rates are estimated may be up to ~3.2%.
- Evidence on other potential harms to individuals (e.g. anxiety of false diagnosis), organizations (e.g. policy changes) or society (e.g. added cost of mass testing, prophylaxis) was not identified from our search. Possible potential harms to individuals include the psychological stress awaiting the test results. The consequences of a false positive diagnosis include psychological impacts of unnecessary self-quarantine; taking unneeded medications; or behavioral changes motivated by the false belief that immunity to COVID-19 has been achieved, which could lead to future infection with COVID-19. A false diagnosis of no infection (false negative) may lead to false reassurances, and lack of self-isolation and further spread of COVID-19 to others.

Current testing policies (Canadian Provinces and Territories)

At the time of searching, four Canadian Provinces were testing asymptomatic individuals (Table 7). Other provinces and territories were either not recommending testing (with some exceptions) or did not mention testing asymptomatic persons while recommending testing for symptomatic individuals and contact tracing:
- Alberta, Manitoba, Ontario and Saskatchewan have expanded testing to include asymptomatic persons.
- British Columbia and Northwest Territories are not recommending testing asymptomatic persons with some exceptions.
- Policies for testing asymptomatic persons in New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Quebec, Yukon and Nunavut were not identified. Policies are available for testing symptomatic individuals and for contact tracing.

Current testing policies (International)

- Policies from 28 countries demonstrate that policies for testing asymptomatic persons are variable and depend on region, risk-level, and work setting. Most allow testing for contact tracing and as indicated by a physician (Table 8).

General guidance

- Guidance form the Surgical Infection Society[96] is to consider all surgical candidates as infected (irrespective of symptoms).

Limitations

- The pursuit of asymptomatic testing is necessarily limited by several factors. First, by the availability of swabs, transport media, testing reagents, laboratory equipment and laboratory human resources. Second, each laboratory has a maximum capacity for tests that can be processed per day. Increased testing for asymptomatic individuals decreases the number of tests that can be processed for symptomatic individuals, and can in turn delay test result turnaround time. This laboratory capacity limit also means that if the incidence of COVID-19 cases begins to rise, testing must be triaged, with symptomatic cases prioritized over asymptomatic cases. Finally, the diagnostic accuracy of testing is impacted by disease prevalence. In situations where diseases prevalence is low, the number of expected false positives may outnumber the number of true positives, making asymptomatic testing unhelpful.

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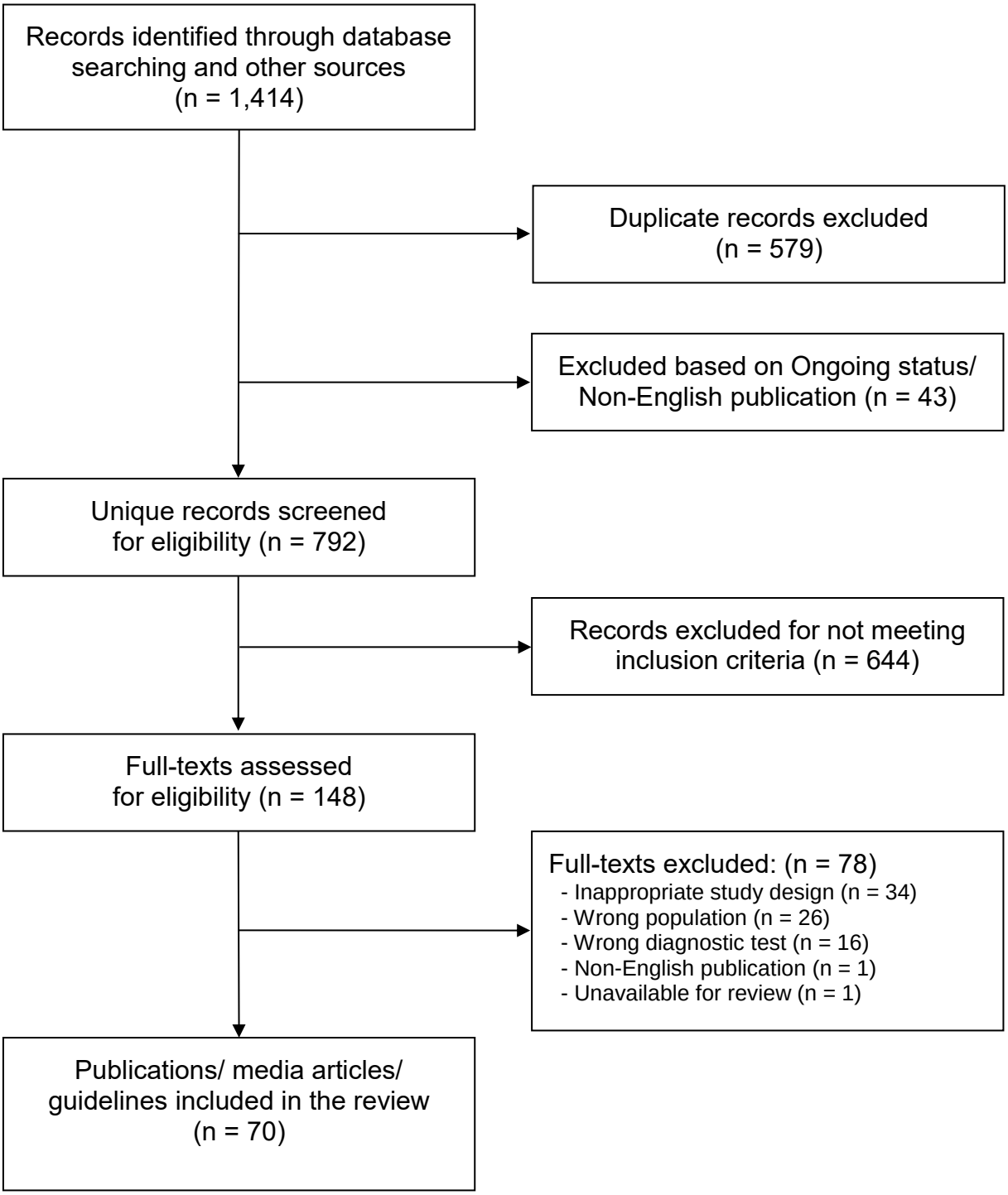
Figure 1. Modified PRISMA flow-chart*



*Note: Policies for testing asymptomatic persons from Canada and other countries is not counted in Figure 1.

Table 1. Evidence syntheses of primary studies of prevalence.

Study	Description
Buitrago-Garcia, Medrxiv, 2020[15] AMSTAR: Moderate quality	**Systematic literature review:** Authors searched a living evidence database (University of Bern Institute of Social and Preventive Medicine), which includes evidence from Medline/ PubMed, Embase, bioRxiv and Medrxiv. Search was last conducted on **04/20/2020**. Based on 8 studies, proportion of asymptomatic infections can be as high as 29% (95% CI 23 to 37%). In modelling studies, 40-60% of cases were attributed to transmission from pre-symptomatic individuals (with a smaller contribution from asymptomatic individuals).
Byambasuren, Medrxiv, 2020[16] AMSTAR: Critically-low quality	**Systematic literature review:** Authors searched PubMed, Embase, Cochrane COVID-19 trials, European PMC and Medrxiv. Search was last conducted on **04/08/2020**. Five low risk-of-bias studies tested 9,242 at-risk people; 413 were PCR-positive and among these, 65 were asymptomatic. Proportion of asymptomatic cases was 16% (95% CI: 12% - 20%) overall. Asymptomatic cases were more prevalent in non-aged care 19% (15% - 24%) compared to long-term aged care 8% (4% - 14%). Evidence of transmission of the infection by asymptomatic cases was demonstrated in two studies; this occurred at a lower rate compared to symptomatic cases.
de Souza, Medrxiv, 2020[17] AMSTAR: Critically-low quality	**Systematic literature review:** Authors searched Medline database only. Search was last conducted on **04/07/ 2020**. From 38 studies (n = 1,124 infected children), 14.2% were asymptomatic.
Laura, Medrxiv, 2020[18] AMSTAR: Critically-low quality	**Systematic literature review**: Authors searched OVID Medline, PubMed and Google Scholar. The date of last search is **not reported**. Estimates suggest <80% of infected people are asymptomatic. Evidence from naval ship infections and Japanese evacuees (most of which were adults from Wuhan) shows that the range of asymptomatic cases were 18 to 33% of cases, while reports from the US Naval Ship, the Theodore Roosevelt, the percentage of asymptomatic individuals was much higher ~60% at the time of testing.
Mullins, Medrxiv, 2020[19] AMSTAR: Critically-low quality	**Rapid Review:** Authors searched PubMed and Medrxiv. The date of last search is **not reported**. From 19 pregnant infected women, 3 (16%) were asymptomatic.

Study	Description
Prakash, Medrxiv, 2020[20]	**Meta-analysis:** Results suggest that 68.4% (95% CI: 67.0-69.7%) of individuals are pre-symptomatic (later developing symptoms) at time of testing.
Zhen-Dong, Journal of Infection, 2020[21] AMSTAR: Critically-low quality	**Systematic literature review:** Authors searched cnki.net, cqvip.com, wanfangdata.com.cn, PubMed and other databases. Search was last conducted on **04/03/2020**. From 37 studies (n = 406 children), 406 cases of which 77 (19%) were asymptomatic.
Zhu, Family Medicine & Community Health, 2020[22]	**Meta-analysis:** From 10 studies (n = 878 patients), 5.4% of patients were asymptomatic (95% CI 3.1% -8.4%).
Zhu, Journal of Medical Virology, 2020[23] AMSTAR: Low quality	**Systematic literature review:** Authors searched seven databases. The date of last search was **02/28/2020**. No other date mentioned. From 38 studies (n = 3,062 cases), 11.9% were asymptomatic.
Zimmermann, Pediatric Infectious Disease Journal, 2020[24]	**Literature review:** Authors identified 11 case series (n = 333 children) with confirmed SARS-CoV-2 infections. Up to 35% of children were reported as asymptomatic.

Table 2. Primary observational studies of prevalence.

Study	Description
Children (<18 years of age)	
Du, Infection, 2020[42]	From 14 infected children, 8 (57.1%) were asymptomatic.
Peng, Medrxiv, 2020[25]	From 39 infected children, 16 (41%) were asymptomatic.
Qiu, The Lancet Infectious Diseases, 2020[26]	From 36 infected children, 10 (28%) were asymptomatic.
Xu, Medrxiv, 2020[27]	From 32 infected children, 11 (34%) were asymptomatic.
Pregnant women	

Study	Description
Breslin, AJOG, 2020[28]	From 43 pregnant, infected women, 14 (32.6%) were asymptomatic. Mean maternal age was 26.9 ± 5.9 years (range: 20-39 years).
Mayor, BMJ, 2020[29]	From 33 pregnant, infected women, 29 (87.9%) were asymptomatic. Maternal Age not reported.
Wu, International Journal of Gynaecology & Obstetrics, 2020[30]	From 19 pregnant, infected women, 9 (47.4%) were asymptomatic. Mean maternal age was 29 years (range: 21-36 years).
Evacuees from Diamond Princess Cruise Ship	
Emery, Medrxiv, 2020[31]	The proportion and infectiousness of asymptomatic coronavirus infections was characterized; majority (74%, 70-78%) of infections proceeded asymptomatically (i.e., a 1:3.8 case-to infection ratio). Over half (53%, 51-56%) of the infections remained undetected, despite intense testing. Asymptomatic individuals were the source for 69% of all infections. Median age was 65 (IQR: 45, 75).
Yamahata, JMIR Public Health and Surveillance, 2020[32]	Tests performed for all 3711 people (2666 passengers and 1045 crew); 59% of infected cases were asymptomatic. 10% of asymptomatic individuals later developed symptoms during the next 6-hours (pre-symptomatic). Age of patients not reported.
Evacuees from Wuhan, China	
Arima, Emerging Infectious Diseases, 2020[33]	From 566 Japanese nationals repatriated from Wuhan, 503 were asymptomatic/subclinical subjects and 5 (1.0%) were PCR-positive. During quarantine, 2 more developed symptoms and became PCR-positive, while 1 subject who remained asymptomatic had a positive result on exit screening. Age of patients ranged from 30-69 years.
Lagier, Travel Medicine & Infectious Disease, 2020[34]	Of 337 evacuated, all passengers were tested twice whether they were symptomatic or asymptomatic. Mean age was 31 years (range: 0-75 years).
General population	
AlShami, medrix, 2020[36]	Sixty-nine of 128 (54%) laboratory-confirmed COVID-19 travelers returning to Saudi Arabia was asymptomatic. The remaining 59 individuals (46%) had only mild symptoms. False-negative and false positive test results occurred in 18.8% and 3% of the individuals, respectively. The prevalence of asymptomatic carriers was considered high. Testing and isolation of travelers and contacts of laboratory-confirmed cases, regardless of symptoms, were very effective in identifying and containing the virus. Mean age was 41.1 ± 17.6 years.

Study	Description
Arons, New England Journal of Medicine, 2020[37]	From 48 cases, 27 (56%) were asymptomatic. Mean age among all positive cases 78.6 ± 9.5 years.
Ben-Ami, Medrxiv, 2020[38]	A pooling strategy was used to test asymptomatic populations. Six (0.11%) PCR-positive patients were detected among 5,464 individuals. Age of patients not reported.
Chang, Emerging Infectious Diseases, 2020[39]	Out of 7,425 blood donations, 4 asymptomatic donors were identified. Mean age was years 38.3 years (range: 21-42).
Chantal, medrix, 2020[40]	Five participants were PCR-positive among a representative sample (n = 1862) of the Luxembourg population. Four of the infected participants were oligo-symptomatic and one was asymptomatic. Ages ranged from 30 to 79 years.
Chau, Medrxiv, 2020[41]	Among 14,000 quarantined individuals, 49 were PCR-positive. Of the 30 PCR-positive individuals who participated in this study, 13 (43%) never had symptoms and 17 (57%) were symptomatic. Asymptomatic SARS-CoV-2 infection was suggested to be common, and able to transmit the virus to others. Median age was 29 years (range: 16-60 years).
Ji, Clinical Infectious Diseases, 2020[43]	From 1015 cases, 50 (4.9%) were asymptomatic. Age groups are present for all individuals, irrespective of symptoms.
Kim, Clinical Microbiology & Infection, 2020[44]	From 213 cases, 41 were asymptomatic (19.2%, 95% CI 14.5%-25.1%). Median age was 26 years (IQR 22, 47 years).
Kim, International Journal of Infectious Diseases, 2020[45]	From 71 cases, 10 (14%) were asymptomatic. Ages ranged from 8 to 79 years.
Kimball, Morbidity & Mortality Weekly Report, 2020[6]	Of 23 positive cases, 13 (56.5%) were asymptomatic. Mean age was 80.7 (8.4 years).
Lavezzo, Medrxiv, 2020[46]	Mass community testing at two time points showed positive tests were reported in 2.6% and 1.2% of individuals, respectively. Just under half (43.2%) of cases were asymptomatic across. Age of patients not reported.

Study	Description
Le, Emerging Infectious Diseases, 2020[47]	Out of 12 positive cases, 1 (8.3%) was asymptomatic. Mean age was 27.7 years (range: 25-30 years).
Ling, European Journal of Radiology, 2020[48]	Of 295 patients, 4 (1.4%) were asymptomatic. Age of patients not reported.
Liu, Journal of Infection and Public Health, 2020[49]	From 24 cases, 3 (12.5%) were asymptomatic. Mean age was 43 (range: 12-84 year). One patient was less than 18 years, 14 were between 18-60 years and 9 were above 60 years.
Park, Emerging Infectious Diseases, 2020[50]	Of 1,143 persons at an outbreak at a call center, 97 (8.5%) were positive. Only 4 (1.9%) cases remained asymptomatic within 14 days of quarantine. Mean age was 38 years (range 20–80 years).
Pham, Medrxiv, 2020[51]	Asymptomatic carriage was identified in 43% (89/208) of individuals. Median age was 30 (IQR: 24, 49).
Qasim, Medrxiv, 2020[52]	Out of 1192 confirmed cases, 9.39% were symptomatic and asymptomatic. Age of patients not reported.
Roxby, Morbidity & Mortality Weekly Report, 2020[53]	From 142 residents and staff at a senior independent and assisted living community, 4 infected residents were asymptomatic. Resident's age ranged from 75-92 years; staff age is 24 and 51.
Streeck, Medrxiv, 2020[54]	This study was conducted in a German town, which was exposed to a super-spreading event (carnival festivities), followed by social distancing measures. 15.5% of 919 individuals with evaluable infection status (out of 1,007; 405 households) were infected. Under a quarter (22.2%) of all infected individuals were asymptomatic. Age of patients not reported.
Wong, Journal of Travel Medicine, 2020[55]	From 138 cases, 12% were asymptomatic and 30% were pre-symptomatic. Age of patients not reported.
Xiong, Journal of the American Society of Nephrology, 2020[56]	From 131 cases, 28 (21.4%) were asymptomatic. Mean age was 63.2 years (range: 31-92 years).
Yang, Medrxiv, 2020[57]	Among 10 cases, two (20%) were asymptomatic. Age of patients not reported.
Zhou, Clinical Microbiology & Infection, 2020[58]	From 328 patients, 13 (4%) were asymptomatic. Mean age was 51.8 years (range: 25-80 years).

Table 3. News articles on prevalence.

Study	Description
Day, BMJ, 2020[59]	**News:** Reported that on April 1st, majority of new infections 130 of 166 (78%) identified were asymptomatic.
Day, BMJ, 2020[60]	**News:** Majority of people infected (50-75%) with COVID-19 were asymptomatic.

Table 4. Primary observational studies of prevalence in healthcare settings.

Study	Description
Brandstetter, Pediatric Allergy & Immunology, 2020[61]	**Observational study:** Of 201 hospital staff after an outbreak, 31 were confirmed cases; of which 30 (96.8%) had symptoms.
Garcia-Basteiro, medrix, 2020[62]	**Observational study:** Of a total of 578 healthcare workers, 39 (6.7%) had been previously diagnosed with COVID-19; 14 (2.4%) were positive at recruitment, and 54 (9.3%) were seropositive for IgM and/or IgG and/or IgA. Of the seropositive healthcare workers, 40.0% had not been previously diagnosed with COVID-19, and 23.1% were asymptomatic. Thus, a large proportion of infected individuals may have either mild or no symptoms.
Lombardi, medrix, 2020[63]	**Observational study:** Nasopharyngeal swabs were positive in 138 of 1,573 (8.8%) healthcare workers; this was significantly greater in symptomatic (20.2%) compared to asymptomatic (3.7%) subjects. Although the relative frequency of positive tests among asymptomatic subjects was low, the number was high in absolute terms (~one third of all infected subjects).
Mandic-Rajcevic, Medrxiv, 2020[64]	**Observational study:** Among a total of 5,700 healthcare workers, 143 were positive. The first (index) case caused a cluster of 7 positive healthcare workers, identified through contact tracing and testing of 250 asymptomatic healthcare workers; these infected individuals rarely reported symptoms of a respiratory infection, and up to 90% were asymptomatic (or with mild symptoms) at the time of the NF swab. Healthcare workers are the primary source of infection in healthcare institutions, with 90% being asymptomatic (or with symptoms not typical of respiratory infection).

Study	Description
Mays, Medrxiv, 2020[65]	**Observational study:** All asymptomatic patients were screened prior to needed surgeries and aerosolizing procedures (n=350); 3 of 350 patients (0.9%) were positive. This strategy was later expanded to screening all patients prior to hospital admission (n=349); 3 of 349 patients (0.9%) were positive and 2 of 349 (0.6%) were inconclusive.
Olalla, Medrxiv, 2020[66]	**Observational study:** Among 498 healthcare workers, 2 (0.4%) were PCR-positive. Both were asymptomatic on the day of sampling, with one being a true asymptomatic carrier (0.2%). The prevalence of asymptomatic carriers among healthcare workers was considered very low.
Pongpirul, Emerging Infectious Diseases, 2020[67]	**Observational study:** Among 11 cases, one patient remained asymptomatic throughout hospitalization.
Schwierzeck, Clinical Infectious Diseases, 2020[68]	**Observational study:** From 12 cases, six (50%) were asymptomatic.
Shields, Medrxiv, 2020[69]	**Observational study:** Nasopharnygeal swabs for viral RNA were positive in 2.39% (n=13/544) of healthcare workers who were at work and asymptomatic.
Treibel, Lancet, 2020[70]	**Observational study:** Asymptoamtic Infetion curve among HCW's showed a peak of 7.1% and fell six-fold over the next 4 weeks. The number of cases every consecutive week from March 23 onwards showed a sharp decline from 28 of 396 HCW(7·1%; 95% CI 4·9–10·0) in week 1 to three cases of 269 HCW's (1·1%, 0·4–3·2) in week 5.

Table 5. Prevalence modeling studies.

Study	Description
Mizumoto, European Communicable Disease Bulletin, 2020[71]	**Cruise Ship - Diamond Princess:** Out of 634 cases, 17.9% (15.5% - 20.2%) were estimated to be asymptomatic.
Nishiura, International Journal of Infectious Diseases, 2020[72]	**Evacuation:** Based on the modelling from chartered evacuations from Wuhan, China, the estimated ratio of asymptomatic passengers was 30.8% (95% CI, 7.7–53.8%).

Study	Description
US Centers for Disease Control[73]	Percent of infections that are asymptomatic (from preliminary COVID-19 estimates, ASPR and CDC) range from 20% - 50% with 35% being the current best estimate.

Table 6. Modeling of benefit of testing asymptomatic persons.

Study	Description
Allali, Medrxiv, 2020[74]	A stochastic epidemic model was used to explore solutions to handle the epidemic spread during the post-containment period. Using specific model parameters (simulation of the effects of social distancing, time delay R0 elapsed between the detection of a symptomatic individual and placement in quarantine, number of asymptomatic people tested positively and isolated), the optimal solutions were determined to be combinations of the following: social distancing, and testing to detect and isolate symptomatic and asymptomatic individuals.
Bej, Medrxiv, 2020[75]	A SIR-based, SUIR model demonstrated the effect of 'pro-active' testing (i.e., asymptomatic individuals) for the design of contact restriction measures. Early use of a pro-active testing approach, even without any lockdown, reduced the effect of the pandemic. Early implementation of lockdown and pro-active testing yielded the best outcome.
Chowell, Medrxiv, 2020[76]	A SEIR-type model, accounting for asymptomatic infectious individuals (40%), was used to evaluate how COVID-19 transmission may be impacted by different levels of testing and isolation. The results indicated that an "imperfect though sufficient combination" of testing, contact tracing, and protective measures can control the pandemic.
Einian, Medrxiv, 2020[77]	Based on an estimation of the number of identified and unidentified infected cases, a model was developed to assess the effectiveness of different policy responses to contain the COVID-19 pandemic. The results suggested that the number of unidentified cases, including asymptomatic cases, is likely to be much greater than that reported. Therefore, a social distancing policy may not be effective, unless a large portion of the population is confined for an extended period of time; this would be impractical and would be damaging to the economy. An alternative policy is required which combines social distancing with extensive testing (including asymptomatic individuals), and the isolation of identified cases.
Gorji, Medrxiv, 2020[78]	Complementary mitigation strategies, based on PCR testing, were evaluated for the detection and quarantine of both symptomatic and asymptomatic cases. Epidemic dynamics modeling showed that due to the lack of a sufficient number of tests, it would not be practical to stop the pandemic via mass testing. A smart-testing strategy which biases tests toward high risk individuals (with or without symptoms) with exceptionally high numbers of contacts, however, would only require a realistic number of tests. A mitigation strategy combining smart testing with contact counting and contact tracing (app-based) would reduce transmission. This may ease social distancing requirements.

Study	Description
Gupta, Medrxiv, 2020[79]	Through a modeling approach which accounted for asymptomatic individuals, the impact of lockdown relaxation and increased testing was evaluated. Asymptomatic individuals accounted for 60.7% of the confirmed COVID19 cases; the detection of a higher proportion of cases through testing significantly decreased the future number of total infections. The positive impact of testing was greater with higher transmission rates and the relaxation of restrictions. A combination of high testing and less social restrictions, or a combination of lower testing with intensive social distancing, achieved similar containment targets. Asymptomatic individuals have an important role in COVID19 transmission, and there should be a decreased dependence on the presence of symptoms to inform public health measures.
Hammoumi, Medrxiv, 2020[80]	A Susceptible-Asymptomatic-Infectious model was used to determine basic and control reproduction numbers and estimate model parameter values. Due to the high rate at which the epidemic spreads, even 90% containment would not lead to the elimination of COVID-19 until mid-summer 2020, resulting in significant social economic damage. Thus, in addition to containment, other measures such as mass testing are required to reduce the size of the asymptomatic population.
Hasan, Medrxiv, 2020[81]	The results of a SIR deviated model suggests that a predicted second outbreak in the coming winter will be attributed to a large number of asymptotic COVID-19 carriers in both temperate and tropical countries. Testing of the entire population of the world is recommended.
Lokuge, Medrxiv, 2020[82]	A surveillance strategy was developed to detect all remaining COVID-19 community transmissions through the exhaustive identification of every active transmission chain. Screening all symptomatic individuals, in combination with exhaustive contact tracing, would be sufficient to enable appropriate and early detection and elimination of community transmission. The only situation in which the testing of asymptomatic cases is required is upstream contact tracing, including widespread testing of asymptomatic low and high risk contacts of cases.
Mayorga, Medrxiv, 2020[83]	A compartmental model was developed in which the impact of detecting and isolating asymptomatic individuals was evaluated. The effective reproduction number, healthcare burden, and overall fatality was remarkably decreased by removing asymptomatic individuals from the infectious pool. With the assumption that 45% of asymptomatic individuals can be detected and isolated, quarantine would not be required. The key to overcoming this pandemic is the detection and isolation of all infected individuals, including asymptomatic individuals.

Study	Description
Miller, Medrxiv, 2020[84]	Stochastic simulations were used to assess the impacts of testing and PPE use. Without testing or PPE, the healthcare system is rapidly overwhelmed; the effective use of PPE by both healthcare workers and patients can prevent this situation. Testing alone is less effective.
Millioni, Medrxiv. 2020[85]	A two-step sequential pooling procedure was described, which could identify positive subjects, while saving costs and time. Simulation data were used to assess the efficiency of an approach based on an "informed" version of pooling. The pooling strategy comprised the following concepts: 1) a negative result will be given only if all samples within the pool are negative; and 2) a positive result will be given even if only one sample in the pool is positive; this would necessitate individual testing to identify true positives and false positives. This pre-screening approach is advantageous, given that the mass testing of asymptomatic subjects would require a significant amount of resources.
Okada, Acute Medicine Surgery, 2020[86]	This simulation study investigated the benefits of performing PCR testing for all asymptomatic patients under different conditions. The benefit of testing was found to depend on 1) prevalence, 2) diagnostic ability, and 3) threshold probability. The net-benefit had a linear relationship with the prevalence, regardless of diagnostic ability. Thus, a low prevalence (<1%) would mean that the net-benefit would approach zero. Therefore, it is necessary to first determine the COVID-19 prevalence in the asymptomatic population; this would inform testing policy.
Perez-Reche, Medrxiv, 2020[87]	Data from outbreaks were used to calibrate a mathematical model to evaluate the effect of (1) population-level interventions (social distancing, lockdown) and (2) local interventions (isolation of both tested and untested infectious individuals). Early and thorough testing, together with partially lifted lockdowns, can lead to the rapid isolation of symptomatic and asymptomatic cases; this can suppress a secondary COVID-19 wave. The identification of asymptomatic cases can be facilitated by contact tracing and early testing of contacts.
Prabhakaran, Medrxiv, 2020[88]	Majority of new infections are attributed to infected people who do not show symptoms. Contact tracing is required to identify these individuals.
Schwartz, Medrxiv, 2020[89]	A novel mathematical model was used to analyze the effect of removing non-pharmaceutical interventions on transmission, as a function of the rate of testing. It is critical for predictive models to account for asymptomatic carriers; this information should be obtained by testing. Not accounting for asymptomatic transmission can lead to large errors in the prediction of clinical caseload, and estimation of the risk of a second wave (based on the timing of terminated interventions).

Study	Description
Sinnott-Armstrong, Medrxiv, 2020[90]	A pooled testing strategy was developed to identify asymptomatic and mild cases. The proposed strategy may reduce the total number of tests up to four-fold. This approach can be used to supplement testing of asymptomatic individuals and individuals with mild symptoms; this would facilitate the adoption of behavioral changes and slow the spread of the pandemic. The disadvantages of this strategy are the high usage of consumables, and the fact that the existing clinical and logistical barriers to obtaining individual swabs for testing are not addressed.
Smith, Medrxiv, 2020[91]	An individual-based transmission model was used to simulate COVID-19 transmission in a LTCF setting. The ability of a range of surveillance strategies to detect simulated outbreaks was evaluated, assuming the limited availability of PCR tests. It was estimated that 7 individuals would be infected (but not yet show symptoms), 7 days after the new admission of an asymptomatic COVID-19-infected patient. A median of 11–21 days would be required to detect an outbreak if only symptomatic individuals are tested. Group testing of symptomatic patients and staff was the most effective. Including individuals with symptoms and newly admitted patients in group tests can reduce delays in outbreak detection.
Taipale, Medrxiv, 2020[92]	A SIR model was developed to evaluate an intervention based on repeatedly testing every individual and self-quarantine of infected individuals. By identifying and isolating the majority of infectious individuals (including asymptomatic individuals) resulted in the end of the epidemic. Unlike sampling-based tests, population-scale testing does not need to be very accurate. False positives can be almost arbitrarily high when a high proportion of the population is already effectively quarantined. False negative rates (<15%) can be tolerated if 80% of individuals comply with testing every 10 days. Such mass testing would be made possible by upscaling existing PCR-based methods or using field test kits at home. The described approach was also supported by an economic analysis.
Verdun, medrix, 2020[93]	Optimized group testing strategies were assessed and compared to individual testing, accounting for biochemically realistic scenarios in the context of sample dilution effects. Significant efficiency gaps were found between the different group testing strategies; thus, there is a need to inform decisions on the pooling protocol with the following variables: estimated prevalence, target specificity, and high- vs. low-risk population. A strategy to simultaneously test asymptomatic individuals and high-risk individuals (e.g., healthcare workers) is to combine them together in specific pool configurations.

R0 = Mathematical modeling term that indicates how contagious an infectious disease is; SEIR = Susceptible - Exposed - Infectious - Recovered model; SIR = Susceptible - Infectious - Recovered model; SUIR = Susceptible - Undiagnosed - Infectious - Recovered model

Table 7. Policies for testing asymptomatic persons in Canadian Provinces and Territories.

Provinces & Territories	Policies
Alberta [Testing]	• From May 25, 2020, testing expanded to include: ○ *asymptomatic close contacts* of confirmed COVID-19 cases ○ asymptomatic workers and residents at specific outbreak sites such as health care facilities ○ *asymptomatic workers and residents* at LTC and level 4 supportive living facilities
British Columbia (BC) [Not Testing]	• **BC Centre for Disease Control** – *Not testing asymptomatic persons* unless recommended by a medical health officer or a health care provider, even if they are a contact of a confirmed case or a returning traveler • **Fraser Health** – *Not testing asymptomatic persons* including patients in health care units • **Vancouver Island Health** – *Not testing asymptomatic persons* • **Vancouver Coastal Health** – *Not testing asymptomatic persons*
Manitoba [Testing]	• Testing expanded to: ○ *Asymptomatic persons* that visits an ER, Urgent Care or a community-testing site ○ *Asymptomatic persons* admitted to acute care or long term care facilities
Northwest Territories [Not Testing]	• *Not testing asymptomatic persons*
Ontario [Testing]	• **Eastern Ontario Health Unit** – Testing expanded to include *asymptomatic persons* • **KFL & A Public Health** – Testing expanded to include *asymptomatic high-risk health care workers, and workers in congregate* (e.g. LTC, retirement homes, correction institutions, shelters and group homes) • **Hamilton Health Services** – Testing expanded to include *asymptomatic persons* (e.g. newborns of positive mothers, pre-operative patients, some chronic care and long stay patients, patients admitted from LTC facilities, prior to bone marrow transplantation, some new admissions especially those from outbreak units, and upon request by receiving facility for transfer)

Provinces & Territories	Policies
	• **Lakeridge Health Services** – Testing expanded to include *asymptomatic staff* that work within LTC or retirement home facilities with exposure or outbreak sites or as directed by Public Health Unit • **Niagara Health Services** – Testing expanded to include *asymptomatic persons* & staff that work within LTC or retirement home facilities • **Simcoe Muskoka District Health Unit** – Testing expanded to include *asymptomatic persons* who are new/ re-admissions to LTC home or retirement home, transferred from a hospital to LTC home, living in the same room with a symptomatic resident or confirmed case in outbreak sites (e.g. LTC, retirement home)
Saskatchewan [Testing]	• From May 19, 2020, testing expanded to asymptomatic cancer patients receiving inpatient and/ or outpatient treatment

Note: Policies for New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Quebec, Yukon and Nunavut make no recommendations for testing asymptomatic persons (but did not clearly recommend against it either) except for contact tracing.

Table 8. Policies for testing asymptomatic persons from other countries.

Countries	Key findings
Australia [Variable Testing]	• **Australian Health Protection Principle Committee about COVID-19** – Testing expanded to include: ○ asymptomatic persons *at risk of exposure* who present with atypical symptoms, such as health care workers and residential aged care facility workers ○ *asymptomatic contacts of cases*, including upstream contacts of those without an epidemiological link ○ *asymptomatic vulnerable populations and settings* in which a single case or outbreak is identified (e.g. residential care settings, health care settings, remote Aboriginal and Torres Strait Islander communities, and workers in critical infrastructure) • **New South Wales** – *Not testing asymptomatic persons* • **Victoria** – *Not testing asymptomatic* persons except in special circumstances such as recovered cases wishing to return to work in a healthcare facility or aged care facility or where requested by the department as part of outbreak management or enhanced surveillance
Austria [Not Testing]	• *Not testing asymptomatic persons.*
Belgium [Variable Testing]	• *No mention of testing asymptomatic persons*; focus on symptomatic persons.
China [Testing]	• **Wuhan**: Mass testing of 10-11 million individuals occurred within 10 days (identified 300 new cases)
Czech Republic [Not Testing]	• *Not testing asymptomatic persons.*

Denmark [Variable Testing]	• From May 20, 2020, testing mainly *limited to symptomatic persons* or high-risk populations. *No recommendation for testing asymptomatic persons* from the average-risk, general population.
Finland [Not Testing]	• *Not testing asymptomatic persons.*
France [Variable Testing]	• From April 13, 2020, testing mainly *limited to symptomatic persons* or high-risk populations. *No recommendation for testing asymptomatic persons* from the average-risk, general population.
Germany [Variable Testing]	• *No mention of testing asymptomatic persons*; focus on symptomatic persons.
Hong Kong [Variable Testing]	• From April 22, 2020, testing expanded to include *asymptomatic inbound international travelers*
Iceland [Not Testing]	• *Not testing asymptomatic persons.*
India [Variable Testing]	• *Testing asymptomatic* direct and high-risk contacts of a confirmed case.
Italy [Variable Testing]	• Testing mainly *limited to symptomatic persons* or high-risk populations. *No recommendation for testing asymptomatic persons* from the average-risk, general population.
Japan [Variable Testing]	• *No mention of testing asymptomatic persons*; focus on symptomatic persons.
Netherlands [Variable Testing]	• From June 01, 2020, testing mainly *limited to symptomatic persons*. *No recommendation for testing asymptomatic persons* from the average-risk, general population.

New Zealand [Variable Testing]	• **Southern Health** – Testing expanded to include asymptomatic healthcare and other workers, Maori and Pacific people, and those with a history of international travel • **Nelson Marlborough Health Services** – From May 04, 2020, targeted testing of asymptomatic persons from the following priority groups: returning international travelers, essential workers who have been in direct contact with a confirmed case, including hospital, primary care, ambulance, welfare support staff, community-based assessment centre staff and police, and staff at a supermarket and vineyard
Norway [Variable Testing]	• Testing mainly *limited to symptomatic persons* or high-risk populations. *No recommendation for testing asymptomatic persons* from the average-risk, general population.
Russia [Variable Testing]	• **Moscow** – *asymptomatic persons* may be tested based on physician's recommendations
Singapore [Variable Testing]	• *Asymptomatic persons* may be tested based on physician's recommendations
South Africa [Variable Testing]	• Testing mainly *limited to symptomatic persons* or high-risk populations. *No recommendation for testing asymptomatic persons* from the average-risk, general population.
South Korea [Variable Testing]	• *Asymptomatic persons* may be tested based on physician's recommendations
Spain [Variable Testing]	• Planning on testing asymptomatic persons working in essential services (healthcare workers, workers in senior residences, police, delivery workers, staff from the food supply chain) • **Catalonia**: not clearly stated that asymptomatic persons to be tested but as of April 07, and for six weeks, mass testing of the population to take effect
Sweden [Variable Testing]	• Testing mainly *limited to symptomatic persons* or high-risk populations. *No recommendation for testing asymptomatic persons* from the average-risk, general population.

Switzerland [Variable Testing]	• Testing mainly *limited to symptomatic persons* or high-risk populations. *No recommendation for testing asymptomatic persons* from the average-risk, general population.
Ukraine [Not Testing]	• Testing mainly *limited to symptomatic persons.*
United Arab Emirates [Variable Testing]	• *Asymptomatic testing allowed* but person pays out of pocket for test.
United Kingdom [Variable Testing]	• *Asymptomatic testing prioritized* for travelers returning from Wuhan (China), Iran, Daegu or Cheongdo (Republic of North Korea) or Northern Italy. • From May 3rd, *asymptomatic health and social care workers* being tested • From June 1st, *teachers, students and their families* will be eligible for testing. • **England** – Testing expanded to include *asymptomatic persons* in care homes (residents and workers) as well as National Health Services workers, and patients • **Ireland** – *asymptomatic persons* who are part of contact tracing • **Scotland** – Testing expanded to include *asymptomatic persons* in care home (residents and workers)
United States of America [Variable Testing]	• US Centers for Disease Control – Testing of *asymptomatic individuals* in the community is not currently a priority; given the limited availability of testing. Clinician judgment is needed for who should be tested. • **Alabama** – Testing *asymptomatic persons* in LTC facility in case of confirmed case or outbreak; asymptomatic persons who have underlying medical conditions or disability placing them at a higher risk of complications, residency in a congregate housing setting such as a homeless shelter or LTC facility, based on a case-by-case review and approval by the state health department or local health jurisdiction • **Alaska** – Testing asymptomatic patients upon admission to a health care facility, patients undergoing urgent/emergent procedures that put health care personnel at high exposure risk, asymptomatic contacts of confirmed COVID-19 patients, asymptomatic residents and health care

	workers in hospitals and congregate living settings, and people coming in to remote communities from areas where COVID-19 is circulating • **Arizona** – Does not test asymptomatic persons • **California** – Based on availability, asymptomatic persons will be tested in higher-risk populations (e.g. group living facilities) and essential jobs • **Colorado** – Does not test asymptomatic persons • **District of Columbia** – Testing asymptomatic patients who are greater than 65 years of age • **Georgia** – Testing is available to all who request it, including asymptomatic persons • **Illinois** – Testing asymptomatic persons who work in health care facility or provide home health services, correctional facilities, such as jails or prisons, first responders, such as paramedics, emergency medical technicians, law enforcement officers or firefighters, and those who support critical infrastructure, such as workers in grocery stores, pharmacies, restaurants, gas stations, public utilities, factories, childcare, eldercare and sanitation • **Massachusetts** – Testing of asymptomatic persons only on recommendation of their healthcare provider, a state agency, or an employer However, recommended persons are encouraged to confirm if their insurance will cover the cost • **Minnesota** – Does not test asymptomatic persons • **Mississippi** – Does not test asymptomatic persons • **Missouri** – Testing asymptomatic persons if they are registered residents of the state • **New Jersey** – Testing prioritized for health care workers, first responders, personnel in congregate living settings, and those who have been in contact with an individual who has tested positive for COVID-19 Other asymptomatic persons considered for testing if recommended by their health care provider • **New Mexico** – Testing asymptomatic people who are close contacts or household members of New Mexico residents who have already tested positive for the coronavirus, asymptomatic residents in nursing homes, and asymptomatic people in congregant settings such as homeless shelters, group homes, and detention centers

	• **North Carolina** – Testing of asymptomatic residents or staff in congregate living facilities with cases or outbreaks of COVID-19 but considered on a case-by-case basis in consultation with local and state public health if other testing options are not available • **Oklahoma** – Testing open to everyone including asymptomatic persons • **Rhodes Island** – Periodic voluntary of asymptomatic health/social care staff and staff of congregate and nursing home/LTC facilities • **Vermont** – Testing asymptomatic persons

Appendix 1. Medline search strategy.

Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to May 19, 2020>
Search Strategy:
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1. exp Betacoronavirus/ or exp coronavirus infections/ or coronaviridae infections/ or exp coronavirus/ (18540)
2. (COVID-19 or COVID-19 Diagnostic Testing or COVID-19 Drug Treatment or COVID-19 Serotherapy or COVID-19 Vaccine or Nidoviral Uridylate-Specific Endoribonuclease or Papain-Like Protease, Coronavirus or RNA-Dependent RNA Polymerase, Coronavirus or Severe Acute Respiratory Syndrome Coronavirus 2 or Spike Glycoprotein, COVID-19 Virus).nm. (104)
3. (2019nCoV or Betacoronavirus* or Corona Infect* or Corona Virus* or Coronavirus* or Corono Virus* or Coronovirus* or CoV or CoV2 or COVID or COVID19 or COVID-19 or HCoV-19 or nCoV or nCovor or SARS CoV 2 or SARS2 or SARSCoV* or SARS-CoV* or Severe Acute Respiratory Syndrome Coronavirus 2 or Severe Acute Respiratory Syndrome CoV*).af. (30570)
4. or/1-3 [COVID-19] (35808)
5. exp Asymptomatic Infections/ or exp Asymptomatic Diseases/ (7007)
6. (asymptomatic or preclinical or presymptomatic or pre-clinical or pre-symptomatic).tw,kf. (265886)
7. or/5-6 (268160)
8. 4 and 7 [Asymptomatic COVID-19] (802)
9. exp animals/ not humans.sh. (4699960)
10. 8 not 9 (730)
11. limit 10 to yr="2019 -Current" (524)
12. limit 11 to English (480)