

## RAPID REVIEW

**(ARCHIVED)** COVID-19 incubation period and considerations for travellers' quarantine duration

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**Key Findings**

- Systematic reviews and meta-analyses report that the mean incubation period of Coronavirus Disease 2019 (COVID-19) ranges from 4.2 to 6.7 days.
- In two systematic reviews and meta-analyses, 95% of individuals show symptoms by 11.2 to 11.7 days after exposure. However, the evidence for the incubation period at the tail end of the distribution (97.5<sup>th</sup> percentile or higher) is limited with a high degree of uncertainty.
- Currently, there is no empirical evidence examining different quarantine or self-isolation periods for asymptomatic returning travellers (with or without testing); however, limited modelling studies suggest that shorter quarantine periods with testing may be comparable (in terms of disease detection and prevention of transmission) to 14-day quarantine periods without testing for preventing infectious individuals entering the community.

**Scope**

- The incubation period is the time from pathogen exposure to symptom-onset, and public health officials use the tail end of the incubation period range to determine the quarantine period for communicable diseases. The scope of this document is a rapid review of the incubation period in relation to the duration of quarantine for travelers returning to Ontario from outside of the country.
- We derived the information in this briefing note from Public Health Ontario's (PHO) upcoming document: *COVID-19 Epidemiological Parameters – What We Know So Far*.

## Background

- The mandatory quarantine or self-isolation period for most asymptomatic travellers (i.e., those without an exemption) returning from outside of Canada is 14 days.<sup>1</sup>
- In addition, there is a 14-day quarantine period for cases and close contacts of cases, outside of the returning traveller context.
- As of November 2, 2020, the Government of Canada and Government of Alberta have started the *Alberta COVID-19 Border Testing Pilot Program*.<sup>2</sup> Eligible international travellers entering Alberta receive a test at entry and another test six or seven days later (if the first was negative).

## Methods

- In considering feasibility, scope, and a need for responsiveness, we chose a rapid review as an appropriate approach to examining the incubation period of COVID-19. A rapid review is a knowledge synthesis where certain steps of the systematic review process are compromised in order to be timely.<sup>3</sup>
- On November 4, 2020, Public Health Ontario (PHO) Library Services developed and conducted a primary literature search in MEDLINE and National Institutes of Health (NIH) COVID-19 Portfolio (Preprints) (Appendix A).
- English-language peer-reviewed and non-peer-reviewed records that described incubation period and information on optimal quarantine periods were included. We restricted the search to 2020 publications.
- In addition, we searched PubMed and Google Scholar on November 18, 2020 for articles of interest (including non-English articles). We reviewed citations from included studies to identify additional research.
- Prior to posting, PHO subject-matter experts review all Rapid Reviews.
- As the COVID-19 outbreak continues to evolve and the scientific evidence rapidly expands, the information provided in this document is only current as of the date of posting.

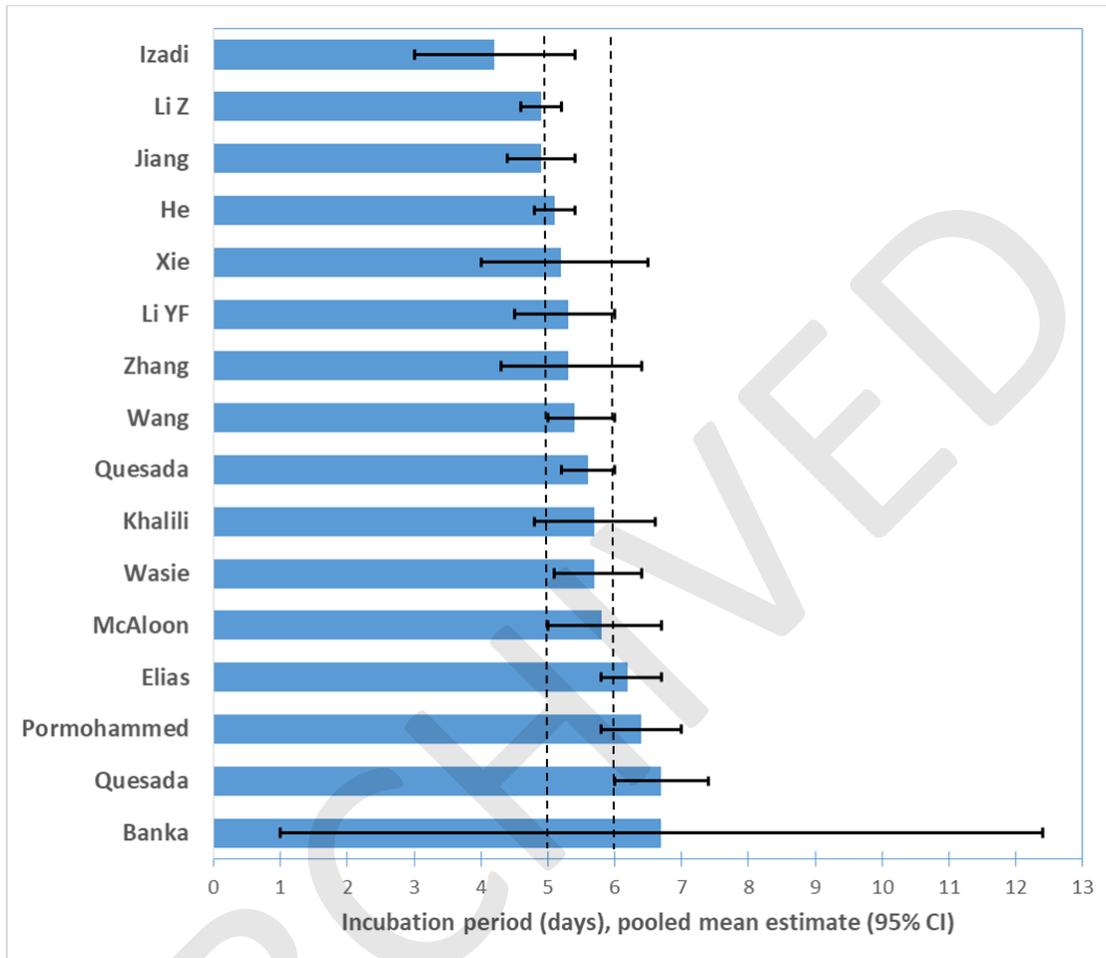
## Results

### Incubation Period

#### MEAN ESTIMATES

- Systematic reviews and meta-analyses estimated the mean incubation period ranged from 4.2 to 6.7 days (Figure 1).<sup>4-18</sup>
- The Banka and Comiskey mean estimate was the highest and had the highest uncertainty (6.4 days; 95% confidence interval [CI]: 1.0–12.4).<sup>12</sup> Only four of the included studies in this meta-analysis included variance measures, creating the high uncertainty.

**Figure 1. The pooled mean estimates of incubation period for COVID-19, from 16 meta-analyses (n=15 studies) that provided mean estimates. Dashed lines represent pooled means of 5.0–6.0 days.**



### TAIL-END DISTRIBUTION ESTIMATES

- Two of four systematic reviews and meta-analyses found that 95% of cases experienced symptoms within a median of 11.2 to 11.7 days of exposure; two of four systematic reviews and meta-analyses demonstrated that 97.5% of patients experienced symptoms within a median of 11.5 to 16.5 days of exposure.<sup>4,7,10,19</sup> There was greater uncertainty for the incubation period at the tail end (97.5<sup>th</sup> percentile or higher) of the distribution.
- From the four systematic reviews and meta-analyses, the pooled estimates for the 50<sup>th</sup> to 97.5<sup>th</sup> percentile of the median incubation period are as follows:
  - **50<sup>th</sup> percentile: 5.1 days** (95% CI: 4.5–5.8) to **5.4 days** (95% CI: 5.0–5.7)
  - **75<sup>th</sup> percentile: 6.7 days** (95% CI: 5.7–7.9) to **8.5 days** (95% CI: 7.9–9.1)
  - **90<sup>th</sup> percentile: 9.7 days** (95% CI: 8.1–11.6)
  - **95<sup>th</sup> percentile: 11.2 days** (95% CI: 10.7–11.8) to **11.7 days** (95% CI: 9.7–14.2)

- **97.5<sup>th</sup> percentile: 11.5 days** (95% CI: 8.2–15.6) to **16.5 days** (95% CI: 14.8–18.3)

## Quarantine and Testing Strategies

### EPIDEMIOLOGICAL STUDIES

- We are only aware of two epidemiological studies that investigated strategies for quarantine and testing in returning travellers. Among 328 people repatriated from Wuhan, China to France, Lagier et al. reported no cases were released into the community after a 14-day quarantine (with testing upon arrival and on day 5).<sup>20</sup> Among 4,347 travellers returning to Macao, China, Lio et al. reported no cases were released into the community after a 14-day quarantine (with testing upon arrival and on day 13; 43 cases detected at time of entry and quarantined successfully).<sup>21</sup>

### MODELLING STUDIES

- Clifford et al. modelled the optimal quarantine strategies for travellers entering the United Kingdom.<sup>22</sup> A 7-day quarantine and polymerase chain reaction (PCR) test on day 7 (release on day 8, with negative test result) led to a median 94% reduction of infectious people entering the community (compared to no quarantine and no testing). A 7-day quarantine (with testing) was similar to a 14-day quarantine period (with no testing), which led to a median 99% reduction in infectious people entering the community. A 5-day quarantine with a test on day 5 (release on day 6) led to a median 80% reduction in infectious people released into the community.
- Dickens et al. performed simulations to determine the optimal quarantine and testing strategies for returning travellers.<sup>23</sup> Compared to no quarantine and no testing on arrival, there was a 91.7% reduction in importation-associated cases entering the community with immediate testing on arrival and case isolation for 14 days. Using a similar strategy but case isolation for 7 days, the reduction was 90.2%. There was a 91.2% reduction in imported cases entering the community when all travellers were quarantined for 14 days from arrival (no testing).
- Wells et al., using a mathematical model, investigated the probability of post-quarantine transmission with varying quarantine periods and testing strategies.<sup>24</sup> Three strategies produced similar reductions in post-quarantine transmission compared to a 14-day quarantine with no testing: 1) 13-day quarantine + testing on entry, 2) 7-day quarantine + testing on exit and 3) 7-day quarantine + testing on entry + testing on exit.
- Steyn et al., using a branching process model for COVID-19 transmission, investigated the risk of community outbreaks seeded at the border.<sup>25</sup> Under a scenario of moderate transmission at a quarantine facility, there was a 98% reduction in the release of infectious people from a 14-day quarantine, with testing at day 3 and day 12. Similarly, if using a 14-day quarantine with no testing, there was a 96% reduction in release of infectious individuals. Using a 5-day quarantine with testing on day 3 led to a 75% reduction in release of infectious individuals.
- All four of these studies were modelled based on a one-day turnaround time for a test result to inform release from quarantine with a negative result.

## Conclusion

- Options for returning international traveler quarantine periods will depend on situational risk tolerance. For example, returning travellers from jurisdictions with relatively higher transmission than Ontario represent a greater risk than those returning from lower transmission jurisdictions; therefore, longer quarantine periods may be more justified for travellers from areas at higher-risk.
- There is no empirical evidence examining the optimal quarantine period or testing strategy for returning travellers; however, a limited number of modelling studies suggest a shorter quarantine period with testing (at the beginning or end of quarantine) may be comparable to 14-day quarantine without testing.
- It is expected that including testing for returning travellers will have implications for limited testing resources across all indications for testing. While out of scope for this document, the implications on the COVID-19 testing system are important to consider.
- It is also expected that the implications of missing undetected cases and their risk for forward transmission after entering the community will also depend on their individual-level adherence with public health measures and the societal prevention measures in place for preventing community transmission.

# Appendix A. Search Strategy and Results

## Search Results Reporting

### DATABASES SEARCHED

Database	Date searched	Remaining
MEDLINE	11/04/2020	283
NIH COVID-19 Portfolio (Preprints)	11/04/2020	63

### RECORDS TOTALS

Records source	Records
Records identified through database searching	346
Duplicates removed by bibliographic management software	10
Total records after duplicates removed	336

## Search Strategies

### MEDLINE

Ovid MEDLINE(R) ALL <1946 to November 02, 2020>

#	Searches	Results
1	("COVID-19" or "severe acute respiratory syndrome coronavirus 2" or "SARS-CoV-2").nm,ps,px,rs,rx.	33475
2	Pandemics/ and Coronavirus Infections/	33019
3	("2019 corona virus" or "2019 coronavirus" or "2019 ncov" or "corona virus 19" or "corona virus 2019" or "corona virus 2019" or "corona virus disease 19" or "corona virus disease 2019" or "corona virus epidemic*" or "corona virus outbreak*" or "corona virus pandemic*" or "coronavirus 19" or "coronavirus 2019" or "coronavirus 2019" or "coronavirus disease 19" or "coronavirus disease 2019" or "coronavirus epidemic*" or "coronavirus outbreak*" or "coronavirus pandemic*" or "covid 19" or "covid 2019" or "new corona virus" or "new coronavirus" or "novel corona virus" or "novel coronavirus" or "novel human coronavirus" or "sars coronavirus 2" or "sars cov 2" or "sars cov2" or "sars like coronavirus" or "severe acute respiratory syndrome corona virus 2" or "severe acute respiratory syndrome coronavirus 2" or "severe specific contagious pneumonia" or "wuhan corona virus" or "wuhan coronavirus" or 2019ncov or covid19 or covid2019 or ncov or sarscov2 or "coronavirus response" or "corona virus response").ab,kf,kw,ti.	69089

#	Searches	Results
4	((pandemic* or novel or wuhan) adj3 (coronavirus* or "corona virus*" or betacoronavirus* or "beta coronavirus*" or "beta corona virus*" or pneumonia* or SARS or "severe acute respiratory syndrome")).ab,kf,kw,ti.	11838
5	(pneumonia adj3 (coronavirus* or "corona virus*" or betacoronavirus* or "beta coronavirus*" or "beta corona virus*" or SARS or "severe acute respiratory syndrome")).ab,kf,kw,ti.	1334
6	1 or 2 or 3 or 4 or 5	71171
7	Infectious Disease Incubation Period/ or Carrier State/	22010
8	Time Factors/ and (Disease Transmission, Infectious/ or Environmental Exposure/ or Inhalation Exposure/ or "Signs and Symptoms"/ or "Signs and Symptoms, Respiratory"/)	6336
9	incubat*.ab,kf,kw,ti.	318866
10	("exposure period*" or "symptom onset*" or carrier* or "serial time*" or "serial interval*" or "transmission interval*").ab,kf,kw,ti.	232177
11	((time or timing or duration or interval* or period* or hour or hours or day or days or week or weeks) adj5 (after or "from?" or between) adj5 (expos* or "in? contact" or "contact with?" or infection or infected or contract*)).ab,kf,kw,ti.	66463
12	((((time or timing or duration or interval* or period* or hour or hours or day or days or week or weeks) adj3 (before or "to?" or between or until) adj3 (onset or symptom* or disease* or transmi* or diagnos* or infectious* or infectivity)) and (expos* or "in? contact" or "contact with?" or infection or infected or contract*)).ab,kf,kw,ti.	11026
13	((time or timing or duration or interval* or period* or hour or hours or day or days or week or weeks) and (before or after or "to?" or "from?" or between or until) and (onset or symptom* or disease* or transmi* or diagnos* or infectious* or infectivity or expos* or "in? contact" or "contact with?" or infection or infected or contract*)).kf,kw,ti.	23170
14	("epidemiologic* dynamic*" or "epidemiologic* parameter*" or "epidemiologic* characteristic*" or "epidemiologic* feature*" or "transmission dynamic*" or "transmission parameter*" or "transmission characteristic*" or "transmission feature*" or transmissibility).kf,kw,ti.	5380
15	((asymptomatic* or presymptom* or pre-symptom* or "before symptom*" or "clinical characteristic*") and (transmi* or spread* or carrier*)).kf,kw,ti.	1493
16	7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15	660124
17	6 and 16	2176
18	(Review or "Systematic Review" or "Meta Analysis").pt.	2799071
19	Systematic Reviews as Topic/ or Meta-Analysis as Topic/ or Review Literature as Topic/	27902
20	review.ti.	498241

#	Searches	Results
21	("meta-analy*" or metaanaly* or "meta analy*" or metanaly* or (pooled adj3 study) or (pooled adj3 analysis) or ((literature or systematic or evidence or quantitative or qualitative or "mixed methods" or integrative or research or critical or studies or umbrella or scoping or realist or rapid or narrative) adj5 (synthesis or review or overview)) or "in this review" or "review of reviews" or "knowledge synthesis").ab,kf,kw,ti.	887950
22	"Cochrane Database Syst Rev".ja.	15056
23	18 or 19 or 20 or 21 or 22	3156510
24	17 and 23	299
25	limit 24 to yr="2019 -Current"	292
26	limit 25 to English	283

## NIH COVID-19 PORTFOLIO (PREPRINTS)

National Institutes of Health iSearch COVID-19 Portfolio (Preprints)

#	Searches	Results
1	(title:incubat* OR title:"exposure period*" OR title:"symptom onset*" OR title:carrier* OR title:"serial time*" OR title:"serial interval*" OR title:"transmission interval*" OR abstract:incubat* OR abstract:"exposure period*" OR abstract:"symptom onset*" OR abstract:carrier* OR abstract:"serial time*" OR abstract:"serial interval*" OR abstract:"transmission interval*") AND pubTypes:preprint AND (title:review OR title:"meta-analy*" OR title:metaanaly* OR title:"meta analy*" OR title:metanaly* OR title:"pooled study"~3 OR title:"pooled adj3 analysis"~3 OR title:"knowledge synthesis" OR abstract:"meta-analy*" OR abstract:metaanaly* OR abstract:"meta analy*" OR abstract:metanaly* OR abstract:"pooled study"~3 OR abstract:"pooled adj3 analysis"~3 OR abstract:"knowledge synthesis" OR title:"literature synthesis"~15 OR title:"systematic synthesis"~15 OR title:"evidence synthesis"~15 OR title:"quantitative synthesis"~15 OR title:"qualitative synthesis"~15 OR title:"integrative synthesis"~15 OR title:"research synthesis"~15 OR title:"critical synthesis"~15 OR title:"studies synthesis"~15 OR title:"umbrella synthesis"~15 OR title:"scoping synthesis"~15 OR title:"realist synthesis"~15 OR title:"rapid synthesis"~15 OR title:"narrative synthesis"~15 OR title:"literature overview"~15 OR title:"systematic overview"~15 OR title:"evidence overview"~15 OR title:"quantitative overview"~15 OR title:"qualitative overview"~15 OR title:"integrative overview"~15 OR title:"research overview"~15 OR title:"critical overview"~15 OR title:"studies overview"~15 OR title:"umbrella overview"~15 OR title:"scoping overview"~15 OR title:"realist overview"~15 OR title:"rapid overview"~15 OR title:"narrative overview"~15 OR abstract:"literature review"~5 OR abstract:"systematic review"~5 OR abstract:"evidence review"~5 OR abstract:"quantitative review"~5 OR abstract:"qualitative review"~5 OR abstract:"integrative review"~5 OR abstract:"research review"~5 OR abstract:"critical review"~5 OR abstract:"studies review"~5 OR abstract:"umbrella review"~5 OR abstract:"scoping review"~5 OR abstract:"realist review"~5 OR abstract:"rapid review"~5 OR abstract:"narrative review"~5 OR abstract:"literature synthesis"~5 OR abstract:"systematic synthesis"~5 OR abstract:"evidence synthesis"~5 OR abstract:"quantitative synthesis"~5 OR abstract:"qualitative synthesis"~5 OR abstract:"integrative synthesis"~5 OR	59

#	Searches	Results
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2	<p>(title:time OR title:timing OR title:duration OR title:interval* OR title:period* OR title:hour OR title:hours OR title:day OR title:days OR title:week OR title:weeks) AND (title:before OR title:after OR title:"to" OR title:"from" OR title:between OR title:until) AND (title:onset OR title:symptom* OR title:transmi* OR title:infectious* OR title:infectivity OR title:expos* OR title:"in contact" OR title:"contact with" OR title:infection OR title:infected OR title:contract*) AND pubTypes:preprint AND (title:review OR title:"meta-analy*" OR title:metaanaly* OR title:"meta analy*" OR title:metanaly* OR title:"pooled study"~3 OR title:"pooled adj3 analysis"~3 OR title:"knowledge synthesis" OR abstract:"meta-analy*" OR abstract:metaanaly* OR abstract:"meta analy*" OR abstract:metanaly* OR abstract:"pooled study"~3 OR abstract:"pooled adj3 analysis"~3 OR abstract:"knowledge synthesis" OR title:"literature synthesis"~15 OR title:"systematic synthesis"~15 OR title:"evidence synthesis"~15 OR title:"quantitative synthesis"~15 OR title:"qualitative synthesis"~15 OR title:"integrative synthesis"~15 OR title:"research synthesis"~15 OR title:"critical synthesis"~15 OR title:"studies synthesis"~15 OR title:"umbrella synthesis"~15 OR title:"scoping synthesis"~15 OR title:"realist synthesis"~15 OR title:"rapid synthesis"~15 OR title:"narrative synthesis"~15 OR title:"literature overview"~15 OR title:"systematic overview"~15 OR title:"evidence overview"~15 OR title:"quantitative overview"~15 OR title:"qualitative overview"~15 OR title:"integrative overview"~15 OR title:"research overview"~15 OR title:"critical overview"~15 OR title:"studies overview"~15 OR title:"umbrella overview"~15 OR title:"scoping overview"~15 OR title:"realist overview"~15 OR title:"rapid overview"~15 OR title:"narrative overview"~15 OR abstract:"literature review"~5 OR abstract:"systematic review"~5 OR abstract:"evidence review"~5 OR abstract:"quantitative review"~5 OR abstract:"qualitative review"~5 OR abstract:"integrative review"~5 OR abstract:"research review"~5 OR abstract:"critical review"~5 OR abstract:"studies review"~5 OR abstract:"umbrella review"~5 OR abstract:"scoping review"~5 OR abstract:"realist review"~5 OR abstract:"rapid review"~5 OR abstract:"narrative review"~5 OR abstract:"literature synthesis"~5 OR abstract:"systematic synthesis"~5 OR abstract:"evidence synthesis"~5 OR abstract:"quantitative synthesis"~5 OR abstract:"qualitative synthesis"~5 OR abstract:"integrative synthesis"~5 OR abstract:"research synthesis"~5 OR abstract:"critical synthesis"~5 OR abstract:"studies synthesis"~5 OR abstract:"umbrella synthesis"~5 OR abstract:"scoping synthesis"~5 OR abstract:"realist synthesis"~5 OR abstract:"rapid synthesis"~5 OR abstract:"narrative synthesis"~5 OR abstract:"literature overview"~5 OR abstract:"systematic overview"~5 OR abstract:"evidence overview"~5 OR abstract:"quantitative overview"~5 OR abstract:"qualitative overview"~5 OR abstract:"integrative overview"~5 OR abstract:"research overview"~5 OR abstract:"critical overview"~5 OR abstract:"studies overview"~5 OR abstract:"umbrella overview"~5 OR abstract:"scoping overview"~5 OR abstract:"realist overview"~5 OR abstract:"rapid overview"~5 OR abstract:"narrative overview"~5)</p>	2

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4	<p>(title:asymptomatic* OR title:presymptom* OR title:"pre-symptom*" OR title:"before symptom*" OR title:"clinical characteristic*") AND (title:transmi* OR title:spread* OR title:carrier*) AND pubTypes:preprint AND (title:review OR title:"meta-analy*" OR title:metaanaly* OR title:"meta analy*" OR title:metanaly* OR title:"pooled study"~3 OR title:"pooled adj3 analysis"~3 OR title:"knowledge synthesis" OR abstract:"meta-analy*" OR abstract:metaanaly* OR abstract:"meta analy*" OR abstract:metanaly* OR abstract:"pooled study"~3 OR abstract:"pooled adj3 analysis"~3 OR abstract:"knowledge synthesis" OR title:"literature synthesis"~15 OR title:"systematic synthesis"~15 OR title:"evidence synthesis"~15 OR title:"quantitative synthesis"~15 OR title:"qualitative synthesis"~15 OR title:"integrative synthesis"~15 OR title:"research synthesis"~15 OR title:"critical synthesis"~15 OR title:"studies synthesis"~15 OR title:"umbrella synthesis"~15 OR</p>	9

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