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Short report

SARS-CoV-2 RT-PCR test results across symptomatic

COVID-19 cases in Auckland, New Zealand, February–June 2020

Kevin Howe, Michael Hale, Gary Edwin Reynolds

Abstract

During the first wave of COVID-19 transmission in New Zealand, a review of RT-PCR testing in all symptomatic cases reported in the Auckland Region found 74% of test results to have been positive. Detection rate was superior for nasopharyngeal swabs than for oropharyngeal samples, and highest one week after symptom onset. Certain symptom presentations may associate with these cases returning negative results, with dyspnoea reported by a greater proportion of cases who tested negative.

Keywords: coronavirus disease 2019; COVID-19; severe acute respiratory syndrome-related coronavirus-2; SARS-CoV-2

Introduction

Since its emergence, coronavirus disease 2019 (COVID-19) rapidly became a global pandemic.¹ In New Zealand, where an elimination approach was adopted, the number of community cases in its first wave totalled 1,579. This was achieved through an elimination strategy very similar to the ‘aggressive suppression’ strategy used in Australia,² using a combination of lockdowns, contact tracing, and widespread testing to remove community transmission. In particular, the extent of testing is evidenced in positivity rates below 1% in both nations.^{3,4}

The predominant modality of testing for severe acute respiratory syndrome-related coronavirus-2 (SARS-CoV-2) is detection of viral RNA from upper-respiratory swabs using reverse transcription polymerase chain reaction (RT-PCR).⁵ However, the reliability of such tests is not well characterised in the literature,⁶ which has also been largely focused on hospitalised patients despite a wide spectrum of presentation ranging from asymptomatic infection⁷ to severe disease.⁸

Methods

To evaluate the local RT-PCR test sensitivity, we reviewed test results and routine clinical data (including demographics, symptoms, and outcomes) from all confirmed and probable cases of COVID-19ⁱ within the metropolitan area of Auckland, New Zealand reported in its first wave, between notification of the first case on 26 February 2020 and recovery of the last case of the initial outbreak on 7 June 2020. Tests performed on confirmed cases, while symptomatic, were included in this study; probable cases who underwent testing were also included, with individual tests from probable cases included if they met criteria of:

1. Close contact of identified confirmed case(s) within the 14 days preceding symptom onset; and
2. Exhibition of at least two of the following symptoms over course of illness: cough; sore throat; dyspnoea; coryza; anosmia; or fever.

i Confirmed cases were all who had positive laboratory findings for SARS-CoV-2; probable cases were either not tested or tested negative, but classified by medical officers based on a combination of epidemiological exposure, acute respiratory illness, and a timeline of symptoms consistent with infection by the identified exposure.

Analysis was performed to compare characteristics between cases with and without negative test results, in order to look for contributing factors for cases testing falsely negative. Data from individual tests were also analysed by site and by timing in relation to symptom onset. This study received institutional ethics approval from the Auckland District Health Board Research Office as a public health investigation.

Results

In total, 528 tests from 472 cases were included, comprising 427 tests from 388 confirmed cases and 101 tests from 84 probable cases. Test samples were made up of nasopharyngeal (NP) and oropharyngeal (OP) swabs. Most were taken in community/primary-care settings ($n = 502$), with a small number ($n = 26$) from hospitals.

Of the included cases, the median age was 37 years; 269/472 cases (57%) were female. Fewer than 10% of cases had clinical outcomes of hospitalisation, intensive care unit (ICU) admission, and/or death. Cough was the most common symptom, reported by 342 cases (73%). Between cases with negative result and cases without negative result, no differences in demographic features or clinical outcomes were statistically significant, although some significant differences were observed in symptom presentation. Fever and anosmia were reported by a significantly higher proportion of cases without negative result. Dyspnoea was significantly higher in cases with negative result (Table 1).

Across all cases, 74% of tests returned positive results (Table 2). Sub-group analysis of only tests from confirmed cases found 91% of tests positive, with all negative tests in this group preceding at least one positive result. Nasopharyngeal swabs showed 77% of tests positive, compared with 48% for oropharyngeal swabs, an absolute difference of 29%.ⁱⁱ

ii The 95% confidence interval (95% CI) for this measure was 11–46%, with $p < 0.001$.

Most tests were performed in the first few days after symptom onset: 278 tests (52% of total) were taken 0–4 days post onset. Days 1 and 2 together accounted for 25% of total tests done, and the number of tests performed on subsequent days gradually declined. Proportion of test results positive increased gradually from day of symptom onset (56%; 95% CI: 39–72%) to 7–8 days after (89%; 95% CI: 80–98%), then remained largely unchanged before dropping sharply on days 13–14 (44%; 95% CI: 19–68%) (Figure 1).

Discussion

Our results are consistent with previous findings from hospitalised patients, with initial detection rates for swabs ranging from 32% to 80% depending on sample type and timing of tests.^{9,10} Swab site also impacted detection rate, with nasopharyngeal swabs superior to oropharyngeal samples. This is supported by prior studies finding both higher detection rates⁹ and viral loads¹¹ for nasal swabs than for throat swabs, indicating NP swabs should be preferred for RT-PCR testing.

Our data also indicated changes in detection rate relative to test timing post symptom onset. Although a decrease is expected in the infection's later stages, we found the proportion of tests positive to peak several days later than was observed in a previous study,¹⁰ while studies on viral loads indicate these to be highest either at day of onset¹² or immediately following.^{11,13} This difference may be due to differences in patient characteristics: our study was comprised predominantly of mild cases, while prior studies have largely consisted of hospitalised patients likely exhibiting moderate to severe disease.

Certain factors in cases' clinical presentations may also be associated with greater likelihood of testing negative. While our results did not show false-negative results to be associated with greater or lesser symptomology overall, they do suggest that patterns of symptom presentation may be associated with testing falsely negative.

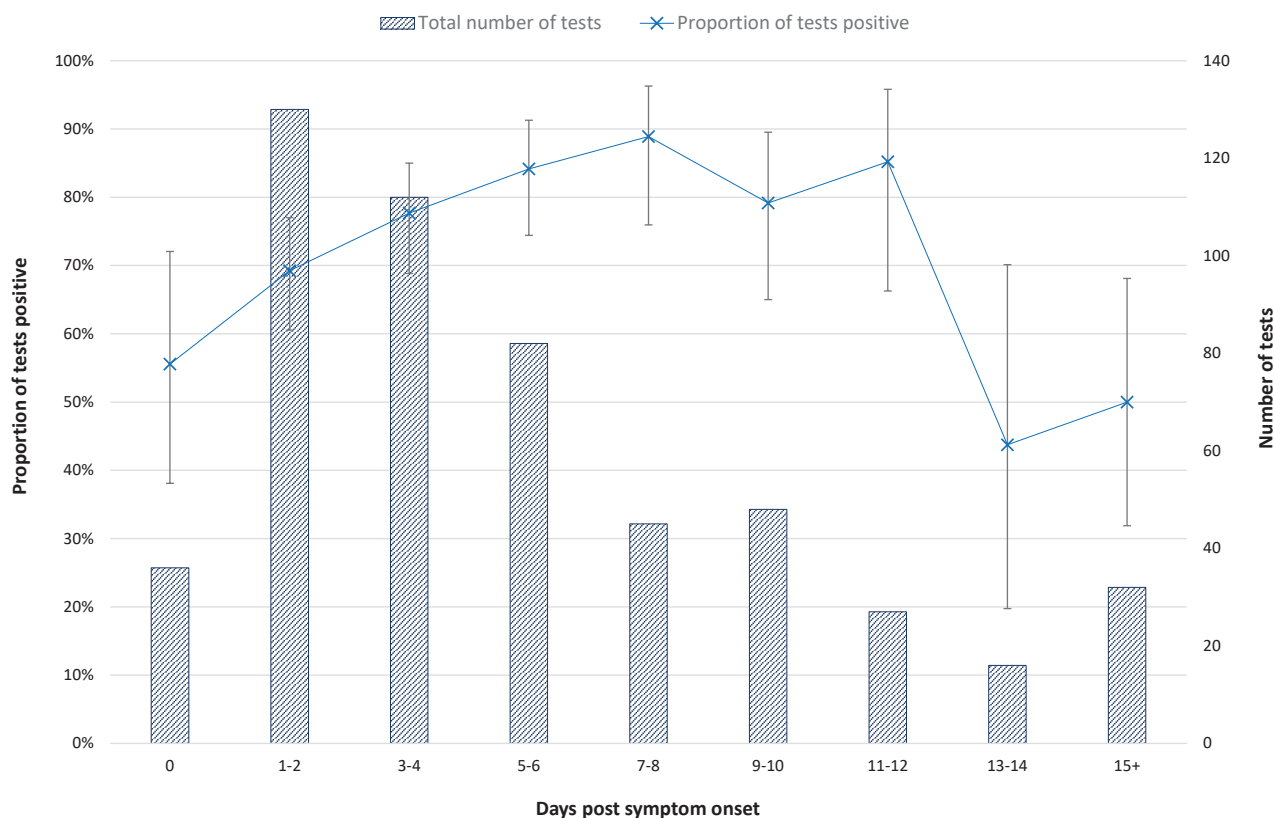
Table 1: Demographic & clinical characteristics of included cases, Auckland, New Zealand, February–June 2020

	All cases ^a (n = 472)	Cases with negative result ^a (n = 117)	Cases without negative result ^a (n = 355)	p value ^b
Median age (years)	37	34	39	
Age range	0.8–99	0.8–89	10–99	0.091
Women	269 (57)	65 (56)	204 (57)	0.747
Clinical outcomes				
• Hospitalisation	38 (8.1)	15 (13)	23 (6.5)	0.048
• ICU admission	3 (0.6)	2 (1.7)	1 (0.3)	0.153
• Death	4 (0.8)	0 (0)	4 (1.1)	0.576
Symptoms				
• Cough	342 (73)	91 (78)	251 (71)	0.153
• Sore throat	230 (49)	71 (61)	159 (45)	0.004
• Fever	220 (47)	38 (32)	182 (51)	< 0.001
• Coryza	187 (40)	56 (48)	131 (37)	0.039
• Anosmia	89 (19)	11 (9.4)	78 (22)	0.0025
• Dyspnoea	32 (6.8)	23 (20)	9 (2.5)	< 0.0001

a Percentage shown in parentheses.

b Statistically significant p-values in bold. Testing for statistical significance performed using Fisher's exact tests for categorical data and Student's t-test for case ages. Correction for multiple comparisons was applied using the Benjamini-Hochberg procedure with false discovery rate set at 0.01.

Figure 1: Proportion of tests positive and number of tests performed in symptomatic COVID-19 patients,^a Auckland, New Zealand, February–June 2020



a 95% confidence intervals generated using the Clopper-Pearson method.

Table 2: Results for all included SARS-CoV-2 RT-PCR tests, Auckland, New Zealand, 26 February – 7 June 2020

	Number of tests	Positive test results		
		<i>n</i>	%	95% CI ^a
All tests	528	390	74	70–78
Confirmed cases only	427	390	91	88–94
Swab site				
• Nasopharynx	425	329	77	73–81
• Oropharynx	33	16	48	31–66
• Unknown	70	45	64	52–75

a 95% confidence intervals generated using the Clopper-Pearson method.

Despite low seasonal influenza activity during the study period,¹⁴ a major limitation of this report is lack of certainty in the diagnosis of COVID-19 for probable cases included in its analysis. Beyond potentially biasing the proportion of results positive in this study, this may also be a confounding factor in analysis of detection rate relative to symptom onset and the characteristics of patients receiving false-negative results. Despite implementing strict inclusion criteria to mitigate this, some misclassification of cases likely remains. However, addressing this by omitting probable cases would almost certainly result in an over-estimation of sensitivity, which could have adverse consequences for public health management of disease transmission if relied upon.

While changes since the early days of the pandemic—such as improved knowledge, test availability, and experience around swab technique—are likely to have resulted in increases in real-world detection rates, our study’s findings nonetheless bring into question the usefulness of individual negative RT-PCR results for ruling out infection in symptomatic patients. Further research is needed to better characterise changes in detection rate and viral load to determine optimal timing for initial testing or re-testing, as well as correlation with serological/antibody changes. Potential associations between patient factors and testing falsely negative also warrant further study.

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