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ORIGINAL RESEARCH

SARS-CoV-2 testing and outcomes in the first 30 days after the first case of COVID-19 at an Australian children's hospital

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Abstract

Objective: International studies describing COVID-19 in children have shown low proportions of paediatric cases and generally a mild clinical course. We aimed to present early data on children tested for SARS-CoV-2 at a large Australian tertiary children's hospital according to the state health department guidelines, which varied over time.

Methods: We conducted a retrospective cohort study at The Royal Children's Hospital, Melbourne, Australia. It included all paediatric patients (aged 0–18 years) who presented to the ED or the Respiratory Infection Clinic (RIC) and were tested for SARS-CoV-2. The 30-day study period commenced after the first confirmed positive case was detected at the hospital on 21 March 2020, until 19 April 2020. We recorded epidemiological and clinical data.

Results: There were 433 patients in whom SARS-CoV-2 testing was performed in ED (331 [76%]) or RIC (102 [24%]). There were four (0.9%) who had positive SARS-CoV-2 detected, none of whom were admitted to hospital or developed severe disease. Of these SARS-CoV-2 positive patients, 1/4 (25%) had a comorbidity, which was asthma. Of the SARS-CoV-2 negative patients, 196/429 (46%) had comorbidities. Risk factors for COVID-19 were identified in 4/4 SARS-CoV-2 positive patients and 47/429 (11%) SARS-CoV-2 negative patients.

Conclusion: Our study identified a very low rate of SARS-CoV-2 positive cases in children presenting to a tertiary ED or RIC, none of whom were admitted to hospital. A high proportion of patients who were SARS-CoV-2 negative had comorbidities.

Key findings

- Our study of COVID-19 at a large Australian tertiary paediatric centre identified a very low number of SARS-CoV-2 positive cases in children.
- None of the children who tested positive for SARS-CoV-2 were admitted to hospital.
- A high proportion of patients who were SARS-CoV-2 negative had comorbidities.

Key words: *Australia, children, COVID-19, novel coronavirus, SARS-CoV-2.*

Introduction

A global pandemic was declared by the World Health Organization on 11 March 2020, after the first case of COVID-19 was identified in December 2019. By 19 April, numbers had reached 2 241 778 individual cases and 152 551 deaths worldwide.[1] Australia's first case of COVID-19 was diagnosed on 25 January and case numbers reached a peak on 20 March 2020. By 19 April, there had been 6606 notifications and 69 deaths.[2] Nationally, children aged less than 10 years have made up 1% of reported cases, and 10–19 year olds, 3%.[2]

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International studies describing COVID-19 in children have consistently noted that paediatric cases account for a small proportion of all cases.[3–5] Deaths have been rare.[6] Paediatric infection from SARS-CoV-2 typically results in a milder clinical course, less chance of hospitalisation, and fewer intensive care admissions than in adults.[7–11] SARS-CoV-2 infected children with comorbidities are suspected to be at higher risk of severe disease,[12] although there is limited evidence for this. This suspicion is partly based on how other coronaviruses have affected younger children (<3 years), and those with comorbidities.[13,14]

Screening for SARS-CoV-2 in Victoria, Australia, is performed according to Department of Health and Human Services (DHHS) guidelines.[15] Epidemiological and clinical criteria for screening have changed over time. In the early stages of the pandemic, testing was restricted to symptomatic overseas returned travellers and known contacts of COVID-19 patients. On 14 April, guidelines were broadened to include all patients with fever or respiratory tract infection symptoms, regardless of epidemiological features. As of 12 April, Victoria had reported a total of 1322 COVID-19 cases from approximately 82 000 tests (1.62%).[2]

We aimed to present early data on children tested for COVID-19 at a large tertiary children's hospital in Victoria in order to investigate the epidemiology of all tested and those who were positive for SARS-CoV-2 in the first month of the pandemic at the hospital.

Methods

Study design and participants

We conducted a retrospective cohort study at The Royal Children's Hospital (RCH) Melbourne, a large tertiary paediatric hospital in Melbourne, Australia. It has 360 beds with approximately 90 000 ED presentations per year. We included all paediatric patients (aged 0–18 years) who presented to the ED or the newly established Respiratory Infection Clinic (RIC) who were tested for SARS-CoV-2 from the day of the first positive confirmed case at RCH, which was 21 March 2020, for 30 days to 19 April 2020. The RIC was a dedicated clinic for the initial assessment of possible COVID-19 patients operating during the pandemic for 8 to 10 h per day. Outside RIC operating hours patients with possible COVID-19 were seen in ED only. Ethics approval was obtained from the institutional Human Research and Ethics Committee (QA/62062/RCHM-2020).

Procedures

At the RCH since early March, any patient presenting to the ED or RIC underwent COVID-19 screening questions according to Victorian DHHS guidelines.[15] The screening information was documented prospectively in the patient's electronic medical record. From 25 March to 14 April, an additional random test of every fifth patient with respiratory symptoms who did not meet epidemiological criteria was completed in accordance with a DHHS directive. The decision to admit or discharge a patient was made clinically, prior to the return of SARS-CoV-2 test results.

Respiratory sampling was done as per local guidelines using a single flocked swab of first the oropharynx followed by nasopharynx and then transported to the RCH Molecular Microbiology lab (with or without viral transport medium). SARS-CoV-2 nucleic acid detection was performed at RCH using the LightMix Modular SARS-CoV and Wuhan CoV *E*-gene assay (TIB Molbiol, Berlin, Germany) and the results were sent to the Victorian Infectious Disease Reference Laboratory for confirmation.

Data were obtained retrospectively from the electronic medical record system for all patients presenting to the ED or RIC, tested for SARS-CoV-2 during the study period. Individual electronic medical records were reviewed by two specialist paediatricians (LFI and ST). Data retrieved were entered into a REDCap (Research Electronic Data Capture hosted at the Murdoch Children's Research Institute) database.[16] Information retrieved included demographics, presenting symptoms and history, risk factors, clinical comorbidities, laboratory testing and outcomes. A comparison of epidemiological and clinical features of COVID-19 positive patients to COVID-19 negative patients was performed.

Statistical analysis

We presented continuous variables as mean (standard deviation [SD]) and categorical variables as number (%). Data was descriptive with means and risk differences presented with 95% confidence intervals. All data analyses were done with Stata IC version 15.1 (StataCorp, College Station, TX, USA).

Results

Over a 30-day period from 21 March 2020 to 19 April 2020, there were 433 patients who presented to the ED and RIC in whom SARS-CoV-2 testing was performed (Fig. 1). Of these, 331 (76%) were assessed in the ED, and 102 (24%) in the RIC (Table 1). There were four (0.9%) SARS-CoV-2 positive patients overall. Stratified by age, 1/360 (0.3%) tested positive in the group aged less than 10 years, and 3/73 (4%) in the group aged 10 years and older. Overall, 231 (53%) patients were admitted from ED/RIC to the hospital, while the remainder were not admitted. None of the COVID-19 patients were admitted and all recovered in the community.

Most patients screened met DHHS criteria. There were 238 (55%) symptomatic patients who were screened due to the following reasons: admission to hospital, imaging in the radiology department or requiring a procedure in theatre. There were 20 (5%) symptomatic patients who did not meet epidemiological criteria but were screened as per a DHHS directive. The top three diagnoses, accounting for 365 (86%) patients, were respiratory or fever related and included viral illness, asthma and febrile neutropenia.

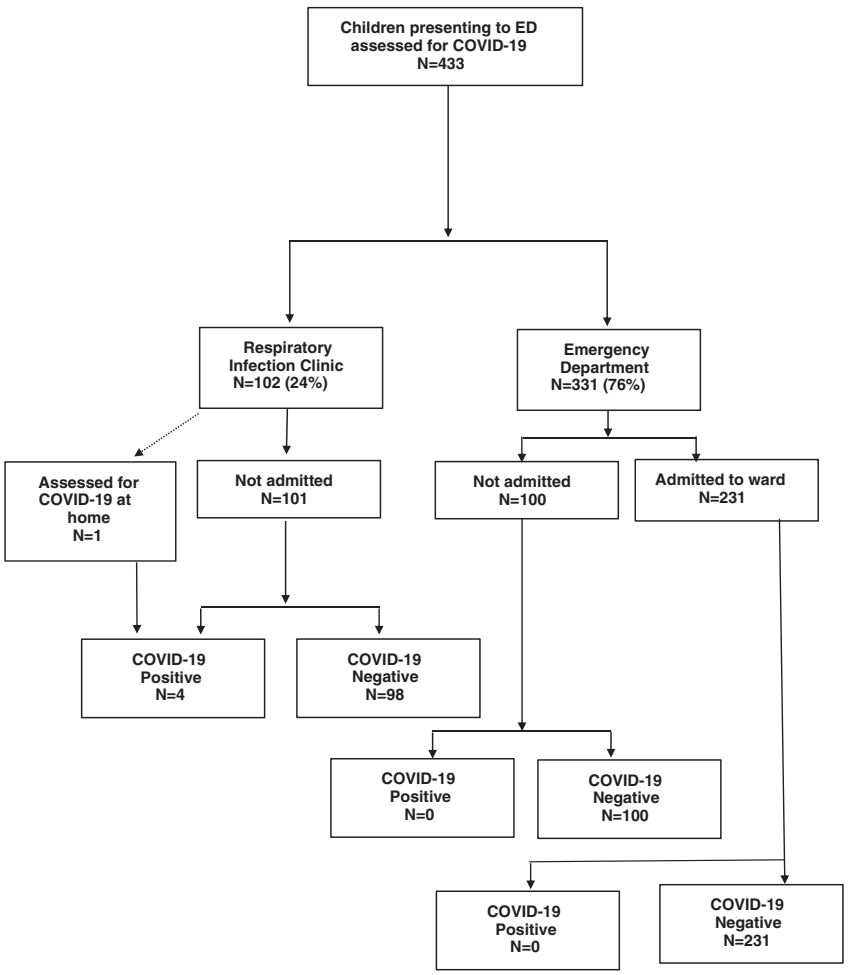

Figure 1. *Patients presenting to The Royal Children's Hospital ED and Respiratory Infection Clinic who were tested for SARS-CoV-2.*

Patients admitted to hospital

In the 231 patients admitted to hospital, the mean age was 5 years (SD 4.8) ranging from 2 weeks to 18 years old. None of the admitted patients tested positive for SARS-CoV-2. Twenty-four (6%) of these patients were admitted to the ICU during their admission. Of the 267 swabs taken, 200 (86%) were in patients who were only tested once, 32 (14%) patients were tested twice, and one (0.4%) patient was tested three times. Of the patients admitted to hospital, 125/231 (54%) had comorbidities.

Patients not admitted to hospital

There were 202 patients assessed and not admitted to hospital: 100 (50%) in ED and 102 (50%) in RIC. The mean age was 6 years (SD 4.7) ranging from 2 months to 17 years. There were 4/202 (1.9%) patients who tested positive for SARS-CoV-2 (Table 2). Three of these COVID-19 positive patients were assessed in the RIC and one patient was assessed at home. The patient assessed at home was a sibling of an earlier confirmed case assessed at the RIC. This patient was assessed by the RCH Hospital-In-The-Home service that assesses and manages acutely unwell patients directly from ED, clinic and the wards. A single patient had an inconclusive result and after discussion with the parents, a decision was made to not proceed with repeat testing but for the patient to isolate for 14 days. Of the patients who were not admitted to hospital, 72/202 (36%) had comorbidities.

Comparison of COVID-19 positive patients to COVID-19 negative patients

Patients with COVID-19 were older than those without (mean age difference −8.2 (−12.9 to −3.6), ranging from 6 to 18 years old. One of the four COVID-19 positive patients had a comorbidity, which was asthma. In contrast, 196/429 (46%) non-COVID-19 patients had comorbidities. The three most common comorbidities were asthma in 46 (11%), immunosuppression in 38 (9%) and prematurity in 33 (8%) patients.

Risk factors for COVID-19 compared to non-COVID-19 patients were history of overseas travel (3/4 (75%) *versus* 19/429 (4%)) and contact with confirmed cases (4/4 (100%) *versus* 23/429 (5%)). There were two distinguishing clinical features which were headache and sore throat. Headache was present in 3/4 (75%) COVID-19 patients and 22/429 (5%) of non-COVID-19 patients. Sore throat was present in 3/4 (75%) COVID-19 patients and 67/429 (16%) of non-COVID-19 patients. Fever was a presenting feature for only 1/4 COVID-19 patients compared to 255/429 (60%) of non-COVID-19 patients. A respiratory viral panel test was performed on 40/429 (1%) non-COVID-19 patients. Of these, 27/40 patients tested positive for other viruses including influenza (n = 1), parainfluenza (n = 6), respiratory syncytial virus (n = 5), enterovirus (n = 3), and rhinovirus (n = 12).

Discussion

In this initial paediatric study of COVID-19 to emerge from Australia, the proportion of positive cases among those tested since our first positive case was low at 4/433 (0.9%). Broken down by age, 1/360 (0.3%) tested positive in the age group less than 10 years, and 3/73 (4%) in the group aged 10–18 years. Our findings are consistent with the Australian Communicable Diseases

Table 1 *Epidemiological and clinical features of children stratified by COVID-19 status*†

	Total, *n* (%)	Tested and positive for COVID-19, *n* (%)	Tested and negative for COVID-19, *n* (%)	Risk or mean difference (95% confidence interval)
Demographics				
Total patients	433	4 (1)	429 (99)	
Female	179 (41)	3 (75)	176 (41)	0.31 (−0.09 to 0.77)
Age, years: mean ± SD	5.0 ± 4.8	13.1 ± 5.1	4.9 ± 4.7	−8.2 (−12.9 to −3.6)
Age less than 10 years	360 (83)	1 (25)	359 (84)	−0.59 (−1.01 to −0.16)
Presenting location				
ED	331 (76)	0	331 (77)	
Respiratory infection clinic	101 (23)	3 (4)	98 (23)	
Home visit	1 (0.2)	1 (25)	0	
Admitted to hospital	231 (53)	0	231 (54)	
ICU admission	24 (6)	0	24 (6)	
Comorbidities				
Any comorbidity	197 (45)	1 (25)	196 (46)	−0.21 (−0.63 to 0.22)
Asthma	47 (11)	1 (25)	46 (11)	0.14 (−0.28 to 0.57)
Immunosuppression	38 (9)	0	38 (9)	
Prematurity	33 (8)	0	33 (8)	
Cerebral palsy/developmental delay	25 (6)	0	25 (6)	
Heart disease	16 (4)	0	16 (4)	
Chronic lung disease	11 (3)	0	11 (3)	
Renal disease	9 (2)	0	9 (2)	
Diabetes	2 (0.5)	0	2 (0.5)	
Others	16 (8)	0	16 (8)	
Allergies	71 (16)	1 (25)	70 (16)	
Risk factors and reason for swab				
Risk factors				
Any risk factors	51 (12)	4 (100)	47 (11)	0.89 (0.86 to 0.92)
Overseas travel in last 14 days	22 (5)	3 (75)	19 (4)	0.71 (0.28 to 1.13)
Contact with positive case	26 (6)	4 (100)	23 (5)	0.94 (0.93 to 0.97)
Reasons for testing				
Require admission or procedure in theatre/ radiology and symptomatic	238 (55)	0	238 (55)	
As of 14th April – anyone with fever and/or respiratory symptom	99 (23)	0	99 (23)	
Travel history plus symptoms	20 (5)	3 (75)	17 (4)	
Confirmed contact plus symptoms	20 (5)	4 (100)	16 (4)	
Did not meet any criteria and symptomatic – swabbed as per DHHS directive	20 (5)	0	20 (5)	
Aboriginal or Torres Strait Islander and symptomatic	11 (3)	0	11 (3)	

Table 1. *Continued*

	Total, *n* (%)	Tested and positive for COVID-19, *n* (%)	Tested and negative for COVID-19, *n* (%)	Risk or mean difference (95% confidence interval)
Lives with public facing parent and symptomatic	5 (1)	0	5 (1)	
Patient in high risk setting and symptomatic (e.g. boarding school, cruise or reported case in school)	3 (2)	0	3 (2)	
Symptoms				
Fever (37.5°C or more)	256 (59)	1 (25)	255 (60)	−0.35 (−0.77 to 0.08)
Respiratory symptoms				
Cough	275 (64)	2 (50)	273 (64)	−0.14 (−0.63 to 0.35)
Rhinorrhoea/coryza	174 (40)	2 (50)	172 (40)	0.10 (−0.39 to 0.59)
Sore throat	70 (16)	3 (75)	67 (16)	0.59 (0.17 to 1.01)
Difficulty breathing or shortness of breath	116 (27)	0	116 (27)	−0.27 (−0.32 to −0.23)
Other symptoms				
Diarrhoea	41 (9)	1 (25)	40 (9)	0.16 (−0.27 to 0.58)
Headache/dizziness	25 (6)	3 (75)	22 (5)	0.70 (0.27 to 1.12)
Diagnosis				
Viral illness/viral screening		4 (100)	231 (54)	
Respiratory: asthma, wheeze, bronchiolitis, LRTI, pneumonia, croup			84 (20)	
Febrile illness: febrile neutropenia, pyrexia of unknown origin			50 (12)	
Gastrointestinal: abdominal pain, gastroenteritis, vomiting			15 (3)	
Trauma: injury, overdose			11 (3)	
Neurology: seizure disorders, headache			10 (2)	
Bone/soft tissue infection – cellulitis			9 (2)	
Surgical – appendicitis, bowel obstruction			4 (1)	
Musculoskeletal – limp, myositis, muscle			4 (1)	
Other infections – tonsillitis, urinary tract, meningitis, ascites			6 (1)	
Other diagnoses			6 (1)	

†Data are *n* (%) unless otherwise indicated. COVID-19, coronavirus disease 2019; DHHS, Department of Health and Human Services; LRTI, lower respiratory tract infection. Other comorbidities: short gut, ulcerative colitis, seizure disorders, metabolic, genetic disorders, hay fever. The cases swabbed in the category of 'Did not meet any criteria and symptomatic – swabbed as per DHHS directive' were tested as part of DHHS directive to test a proportion who did not meet criteria. Chronic lung disease: cystic fibrosis, oxygen dependent, tracheostomy dependent. Other diagnoses: aspiration, breath holding episodes, excessive infant crying, foreign body in respiratory tract, foreign body in digestive tract, newborn feeding problems.

Intelligence data which show nationally confirmed cases in children have been low: 1% of all COVID-19 cases in Australia have been aged less than 10 years and 3% aged 10–19 years.[2] A recently published Icelandic study reported a lower risk of COVID-19 infection in symptomatic children aged less than 10 years (6.7%) compared to those over 10 years old (13.7%).[17] A similar finding of <1% COVID-19 infection in children aged

Table 2 *Characteristics of COVID-19 positive patients*†

Case	Fever	Respiratory symptoms	Other symptoms	Risk factors	Comorbidity	Outcome
1	Fever, T = 38	Sore throat	Headache and diarrhoea	Travel overseas + contact with confirmed case	Nil	Full recovery at home with no treatment/admission
2	Nil	Nil	Headache	Travel overseas + contact with confirmed case	Hay fever	Full recovery at home with no treatment/admission
3	Nil	Sore throat, cough, coryza	Nil but reduced appetite	Travel overseas + contact with confirmed case	Nil	Full recovery at home with no treatment/admission
4	Nil	Sore throat, cough, coryza	Headache	Contact with confirmed case. No travel overseas.	Asthma	Full recovery at home with no treatment/admission

†Details of patients' age, country of travel and contact history are omitted to protect the privacy of patients. T, temperature (°C).

less than 9 years was reported in a Korean study.[18]

A cornerstone of the public health strategy in Victoria was to rapidly identify and contain those at higher risk of COVID-19. The screening criteria for COVID-19 changed over time, reflective of an evolving situation and response to new clinical and epidemiological information.[19] Direct comparison with other countries is difficult due to the variation in public health approach and screening guidelines. In Madrid, Spain, initially screening was limited to children with confirmed contact with COVID-19; however, as greater community transmission occurred, this approach changed, and only hospitalised children or those with comorbidities who were at higher risk of complications were tested.[9]

There has been concern in the early days of the pandemic about the risk to patients with comorbidities. Our data show that 46% of patients tested had a comorbidity. To date, the literature on children with comorbidities with COVID-19 is sparse. A liver transplant unit in Lombardy reported three children who had mild disease but no data on those who tested negative.[20] Another reported on five children with malignancy who had mild illness and eight children with inflammatory bowel disease on immunosuppression who were also mildly affected.[21,22] Our data add to these by showing that many children potentially exposed to COVID-19 had comorbidities and acute respiratory illnesses including asthma, croup and bronchiolitis.

There is concern of delayed presentations to hospital in children because of parental fears of contracting COVID-19.[23] Families of children with comorbidities or those with symptoms requiring evaluation need reassurance that the hospital is a safe place and that their children are not at higher risk when seeking medical attention. Our findings suggest that there is a very low risk of being exposed to SARS-CoV-2 in a tertiary paediatric hospital at this time.

Last, our data highlight the success of outpatient management for COVID-19 positive patients. In previous studies, children who did not require hospital level care for symptoms were admitted to hospital as a precaution.[24,25] Our positive patients were not admitted to hospital after clinical assessment, with the knowledge that the SARS-CoV-2 results may be positive. This was a clinical decision made prior to the SARS-CoV-2 results being returned. This process will require monitoring if our test turnaround times shorten. Clinicians may be more likely to admit patients for inpatient observations influenced by a confirmed COVID-19 status.

This is the first paediatric paper to encompass the whole presenting cohort of children who were tested, and the strength of this is in showing the large majority of patients with comorbidities and being admitted were non-COVID-19 patients. Our study has limitations, including that data were collected retrospectively. This was mitigated by following guidelines for high-quality medical record review in that the data abstractors were trained and study materials were piloted.[26] Another limitation is the inherent bias because of the different criteria for testing for the admitted cohort compared to the non-admitted cohort. The admitted cohort were required to be tested for SARS-CoV-2 because they were being admitted to hospital. This means that comparisons cannot easily be made between the groups. Due to small numbers of positive patients in Australia, these data are unlikely to be comparable to settings with a higher incidence of COVID-19.

Conclusion

Our study of COVID-19 at a large Australian tertiary paediatric centre identified a very low number of SARS-CoV-2 positive cases in children presenting to a tertiary ED or RIC, none of whom were admitted to hospital. A high proportion of patients who were SARS-CoV-2 negative had comorbidities.

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Author contributions

LFI and ST coordinated the study, acquired data, carried out the initial data analysis, drafted the initial manuscript and approved the final manuscript as submitted. SH contributed to study design, data acquisition, reviewed and revised the manuscript and approved the final draft. FEB and PAB were involved in the design of the study, data interpretation and analysis, reviewed and revised the manuscript and approved the final draft. SM, HJL, SL, AJD, NWC and ACS were involved in the data interpretation, reviewed and revised the manuscript and approved the final draft. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Competing interests

FEB is a section editor for *Emergency Medicine Australasia*.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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