A multiple site community outbreak of COVID-19 in Sydney, Australia

Adam Capon,[1,2] Dima Ousta,[1] Mark Ferson,[1,3] Andrew Ingleton,[4] Vicky Sheppeard[1,2]

Abstract:

Objective: To investigate an outbreak of COVID-19 in Sydney, Australia.

Methods: Epidemiological linking and analysis of cases of COVID-19 across multiple outbreak sites.

Results: Fifteen cases of COVID-19 and 41 contacts were identified and linked in a cluster that included one workplace and five households. The mean incubation period in the cases ranged from 4.6 to 6.4 days, while the median incubation period was shorter, ranging from 3 to 5 days. The overall range of incubation periods was 2 to 12 days. Differential attack rates were found within households (86% adults vs. 9% children) and workplace (32%) settings.

Conclusions and implications for public health: Our investigation links cases between multiple households and a workplace. When exploring these links using a rapid workplace assessment, real-time cluster data along with objective measurements of exposure, such as with the Australian Government COVIDSafe app, may have allowed these links to be identified more readily and potentially reduced further spread of COVID-19. We found age as a factor for infection, with children being less likely to both acquire SARS-CoV-2 infection and to develop symptoms. This finding aids in our understanding of how the virus affects children and cautiously supports face-to-face classroom teaching.

Key words: COVID-19, infectious disease, cluster investigation, public health

On 31 December 2019, a cluster of pneumonia cases of unknown aetiology, subsequently identified as coronavirus disease 2019 (COVID-19), was reported in Wuhan, China.[1] By 13 January 2020, one of the first Australian cases of COVID-19, a traveller from the Wuhan region of China, had developed symptoms.[2] As of 31 August 2020, 25,746 cases have been identified in Australia and more than 20 million cases worldwide.

Outbreaks of COVID-19 are now commonplace throughout the world, with every inhabitable continent reporting cases. Current literature on clusters has focused on proving human-to-human transmission in a number of settings while emphasising the importance of contact tracing and social distancing measures. Transmission was identified during the pre-symptomatic and symptomatic phases of infection along with possible asymptomatic transmission.[3-5] To understand the transmission of COVID-19, all cases and their contacts require identification and follow-up to determine their outcomes.

The incubation period for COVID-19 has been estimated at between 1 to 14 days with a mean of 5–6 days,[6] and Australian guidelines consider that a case can be infectious up to 48 hours before developing symptoms.[7] Estimates of transmissibility indicate that two to three people are likely to acquire the infection from each case.[8]

Australia had initial success in controlling COVID-19 by employing traditional public health control measures (case identification, isolation, contact tracing and quarantine). Physical distancing measures, border closures, increased testing capacity, testing people with mild symptoms and population-wide requirements to stay at home except for essential work or health care have all aided in this control.[9] As there is a need to balance the easing of public health measures against the risk of further outbreaks, it is crucial to understand the transmission risk in different settings and age groups.

On 8 April 2020, a Sydney metropolitan public health unit was notified of a potential cluster of cases in a workplace. This paper describes the investigation of the initial cluster together with the backward and forward tracing of cases that led to the discovery of infection in five other households.

Methods

Cases and close contacts were identified according to Australian guidelines applicable at the time of notification. In Australia, a confirmed case is defined as a person who tests positive on a validated specific Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) nucleic acid test or has the virus identified by electron microscopy or viral culture. At the time of the investigation, routine testing of asymptomatic close contacts was not recommended in Australia.[7] Further, a close contact was defined as a person who had face-to-face contact in any setting with a case for greater than 15 minutes or shared a closed space with a

1. *South Eastern Sydney Local Health District, South Eastern Sydney Public Health Unit, New South Wales*
2. *University of Sydney, School of Public Health, New South Wales*
3. *University of New South Wales, School of Public Health and Community Medicine, New South Wales*
4. *Sydney Local Health District, Sydney Public Health Unit, New South Wales*

Correspondence to: Dr Adam Capon, South Eastern Sydney Local Health District, South Eastern Sydney Public Health Unit, NSW; e-mail: adam.capon@health.nsw.gov.au

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case for a prolonged period (e.g. more than 2 hours) in the period extending from 24 hours before the onset of symptoms in the case. From 17 April 2020, the close contact definition was broadened to include the 48 hours prior to the onset of symptoms, with 15 minutes now cumulative over the course of a week – this definition was applied to the retrospective analysis.[7]

COVID-19 is a notifiable condition in Australia, and by law, all cases of COVID-19 must be reported to the relevant state or territory health department. In New South Wales (NSW), COVID-19 notification will trigger an interview by an NSW Health case manager who will initiate public health control measures and seek information on potential exposures, health and lifestyle factors, living arrangements and details of close contacts. This information is stored in the NSW Notifiable Conditions Information Management System (NCIMS) database.

Cases were extracted from the NCIMS and subsequently linked according to the most plausible pathways of transmission. The pathways of transmission were developed based on the case managers' notes describing where cases had been and with whom they had been in contact during their incubation and infectious periods; they were demonstrated graphically by aligning incubation and infectious periods between cases (Figure 1). The incubation period was defined as the 14 days prior to symptom onset. The infectious period started 48 hours prior to symptom onset and ended at the earliest of either the date of case isolation or 10 days after symptom onset.

Descriptive analysis was undertaken for demographics and risk factors. Demographics included age, gender and Indigenous status. Risk factors included pre-existing medical conditions, current smoking, alcohol consumption and pregnancy for female cases.

The incubation period was determined as the difference between exposure date and symptom onset date (or test date if the case was asymptomatic). Where multiple dates of exposure were possible, the first exposure date and the last exposure date were used to calculate a range of possible incubation periods for the case. These were then used to determine the overall range of mean and median incubation period values.

Attack rates were calculated based on the number of cases divided by total cases and close contacts identified.

Results

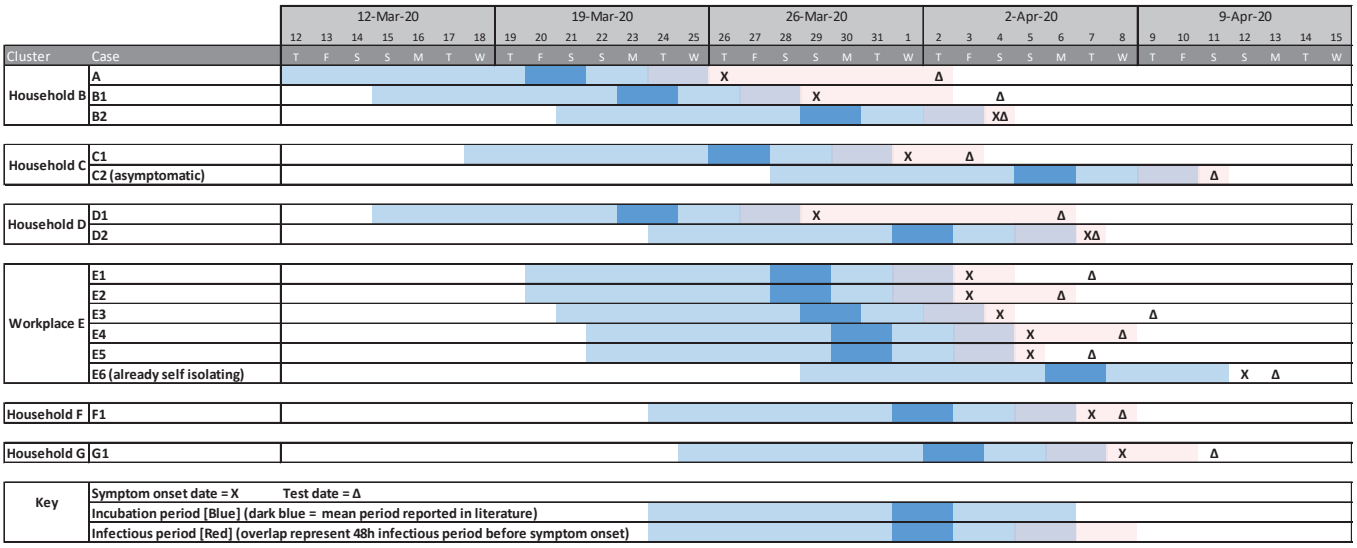
We identified a total of 15 cases and 41 close contacts in this cluster that occurred over a period of 18 days with symptom onsets between 26 March and 12 April 2020. Among the 15 cases, the mean age was 35 years (range: 4–72 years), ten cases (67%) were male and none identified as Indigenous. Only two (13%) had a pre-existing medical condition or currently smoked. Five (33%) cases drank alcohol and none of the female cases were pregnant.

The examination of case notes and symptom onset combined with possible incubation period (Figure 1) led to the discovery of the putative pathways of transmission (Figure 2).

On 22 March 2020, the index case, (A) returned to Sydney from overseas and by 26 March 2020 had become symptomatic with cough, fatigue, chills, headache and malaise. On 1 April, Case A was tested and subsequently found positive for SARS-CoV-2. This was reported to the local public health unit on April 3, and public health containment measures were implemented immediately. Case A shared a house with two adults and four young children and reported no other close contacts during their infectious period.

However, our investigation revealed that prior to the implementation of public health control measures, transmission had already occurred with people outside Case A's immediate household. Case A had contact with households B, C and D on multiple days after symptom onset, prior to diagnosis and prior to isolation. On 29 March 2020, Case A's spouse (B1) and a relative who lived in another household (D1) became symptomatic (Figure 2). On 1 April 2020, a relative in a third household (C1) was also symptomatic. On 4 April, the other adult in Case A's household (B2) became symptomatic. While it was likely that A infected B2, it is also possible that B2 was infected by their other relatives (B1, C1 or D1). D1's spouse (D2) became symptomatic on 7 April 2020. C1's young asymptomatic child (C2) was diagnosed with SARS-CoV-2 infection on 11 April 2020. C2 was in home quarantine at the time and no childcare facility was affected. All these cases are represented in three family households that contain numerous children (Table 1).

Figure 1: Case chronology by location of transmission, showing incubation and effective infectious periods.



When interviewed, C1 reported attending work on 1 April 2020. However, a workplace investigation identified C1 also attended the workplace on 3 April 2020. In this workplace, there were 19 close contacts who shared a predominantly open-plan workspace. By 3 April 2020, two work colleagues (E1 and E2) became symptomatic, and in the next two days, another three colleagues (E3, E4 and E5) also become symptomatic and tested positive for SARS-CoV-2 (Figure 2). Cases then arose in the households of E4 and E5 (G1 and F1 respectively). A final workplace case (E6) developed symptoms on 12 April 2020 and subsequently tested positive for SARS-CoV-2, and while E6's exposure is attributed to C1, it is possible that E6's key exposure may have been E1, E2, E3, E4 or E5. We note that D2 was also a member of this workplace. While D2 most likely acquired the infection at home (from D1), as D2 was not in home quarantine, it is also possible that D2 acquired the infection at work (from C1, E1, E2, E3, E4 or E5).

The mean incubation period for the 14 subsequent cases (Cases B1 – G1) ranged from 4.6 to 6.4 days. The median incubation period was shorter, ranging from 3 to 5 days. The overall range of incubation periods was 2 to 12 days.

The attack rate varied depending on setting. The attack rate was analysed for the three interrelated families as a whole, the workplace and overall, stratified by age group (Table 2). The attack rate was lower among children than the adult population.

Figure 2: Pathways of transmission.

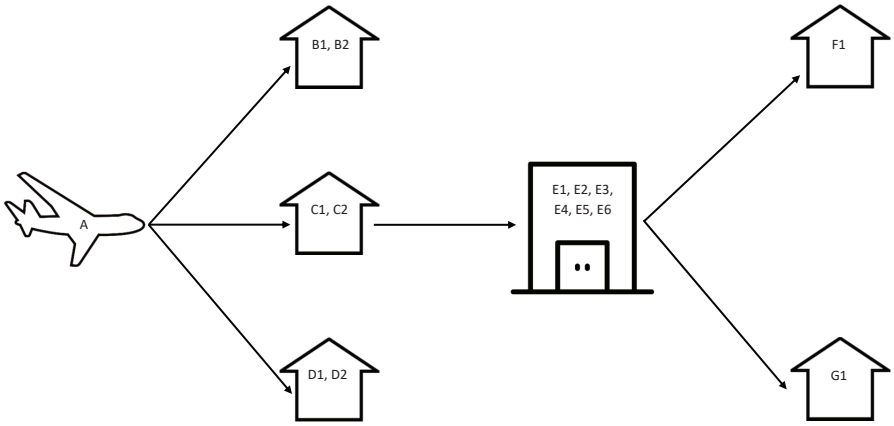


Table 1: Three household make up of infection.

Index case household	Other cases in household	Household non-cases
A	B1, B2	4 children (2-9 years old)
C1	C2[a]	1 Adult
		3 children (1 – 8 years old)
D1	D2	3 children (9 -14 years old)

Note:
a: Asymptomatic child

Table 2: Attack rate from interrelated family, workplace and overall, stratified by age.

	Total	Symptomatic or asymptomatic (n)		Tested for SARS CoV2	Confirmed case	Overall attack rate
Interrelated families (Households B,C&D)						
Adults	7	Symptomatic	6	6	6	86%
		Asymptomatic	1	1	0	
Children[a]	11	Symptomatic	0	0	0	9%
		Asymptomatic	11	4	1	
Workplace						
Adults	19	Symptomatic	7	7	6	32%
		Asymptomatic	12	8	0	
Overall						
Adults	43	Symptomatic	16	16	14	33%
		Asymptomatic	27	18	0	
Children[a]	13	Symptomatic	0	0	0	8%
		Asymptomatic	13	4	1	

Note:
a: A child is defined as under 15 years old

Discussion

This report describes a multiple site outbreak associated with a case of SARS-CoV-2 infection. The investigation tracks the spread of infection through three to four generations of spread across five households and one workplace.

Knowledge is emerging that the peak viral excretion of SARS-CoV-2 occurs in the pre-symptomatic or early symptomatic phase of the infection.[10] Combined with a relatively short incubation period and mild early symptoms, this creates a challenge for public health control; as illustrated here, secondary and perhaps tertiary transmission had already occurred prior to the diagnosis of the index case.

Striking in this cluster is the low attack rate of 9% among child household contacts compared to 86% among their cohabiting adults (Table 2). It is unusual to see such a difference in attack rates of a respiratory transmitted infection between children and adults, with most respiratory infections thought to have a higher attack rate in children due to lower acquired immunity. This low attack rate among children has also been observed in a school setting.[11] A physiological explanation for this has been proposed regarding fewer ACE2 receptors in the lower respiratory tracts of children to attract the binding S proteins of SARS-CoV-2,[12] although this theory has been questioned in favour of the differing immune systems between adults and children.[13] However, exposures of contacts were not quantified in this investigation beyond meeting the close contact definition, and it is possible that differential exposures to the cases between adults and the children may have accounted for this observation. Further work in this area is required.

At the time of this outbreak, routine testing of asymptomatic close contacts was not recommended in Australia.[7] This is despite some studies that have estimated a large proportion of SARS-CoV-2 infections being asymptomatic.[14-16] While none of the 18 asymptomatic adults tested in this cohort was confirmed positive with SARS-CoV-2, an approach recently adopted in NSW of immediately testing all close contacts may have shortened the time to diagnosis of some secondary cases, resulting in more rapid isolation of their close contacts and curtailing the potential tertiary spread.[17] While one child out of the four tested was confirmed positive with SARS-CoV-2 despite being asymptomatic, there is no evidence of onward spread of infection from this child providing limited support to the idea of allowing children greater freedoms, such as returning to school.

Through this investigation, it became clear that there was differential recollection among those interviewed of timing and duration of contact. A workplace investigation and epidemiological linking revealed unreported family and workplace contact. These gaps in initial information provided to the public health team limited the ability to identify and quarantine close contacts in a timely manner, potentially resulting in further transmission. Rapid triangulation of information against workplace records or recollections of close contacts, along with a timely cluster investigation, can assist in identifying risk exposures and other close contacts who require quarantine.

A rapid workplace investigation should involve interviewing potentially exposed workers along with those responsible for human resources. A conceptual understanding of the work environment can be developed through workplace layout plans and photographs. The acquisition of timesheets, visitors' logs and closed-circuit camera television footage can assist in tracking movements of cases and contacts through the work environment. Understanding the processes and procedures in the workplace, such as cleaning practices and schedules along with whether the workplace has a specific COVID safe plan, will provide insight into the workplace risks.

Cluster investigation should occur in real-time and be undertaken by a team that is able to work across all groups responding to case notifications. Charting and cross-tabulating incubation periods, infectious periods and visited locations of all notified cases can aid in the source identification of unexplained cases.

The Australian Government has since launched the COVIDSafe app, a contact-tracing app for mobile phones, which may have helped overcome limitations of case and contact recollection. This app is designed to monitor close interaction of 15 minutes or more between people carrying a phone with the app and to provide that information for contact tracers to identify potential links between cases and their close contacts. Had this app been available to aid this investigation, a clearer picture could have been gained sooner and may have led to earlier containment of this outbreak.

Limitations

The initial investigation only identified close contacts of the case up to 24 hours prior to symptom onset. Australian guidelines now recommend 48 hours before symptom onset for the identification of close contacts, which may have led to the identification of additional cases and contacts.

Not all contacts were tested, limiting the ability to identify any further asymptomatic cases and leading to a potential under-reporting of the attack rate for both children and adult groups.

Genome sequencing of SARS-CoV-2 isolates was not used to confirm epidemiological links established in this investigation; however, the authors are aware that isolates from five cases (C2, D2, E2, E3 and E5) have been sequenced and were within two single nucleotide polymorphisms difference, considered a cluster in NSW.[18] Further, the low case rate in NSW at the time of this outbreak provides confidence that the correct source of infection was identified.

Conclusion

Our investigation drew together and defined the links between multiple households and a workplace outbreak site in Sydney. When exploring the links between cases undertaking a rapid workplace assessment, having real-time cluster data, along with objective measurements of exposure, such as through the Australian Government COVIDSafe app, would have allowed these links to be identified more readily and potentially reduced spread of COVID-19. We found age as a factor for infection, with children less likely to be symptomatic or to acquire COVID-19. This finding adds weight to the limited spread of infection among children and supports other research regarding the limited transmission risk posed by face-to-face childcare or schooling of young children.

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