A large outbreak of the Kappa mutation of COVID-19 in Cork, Ireland, April–May 2021

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Abstract

Background In May 2021, the B.1.617 variant of SARS-CoV-2 emerged in Ireland, and both Delta and Kappa sub-lineages were initially deemed variants of concern (VOCs) on a precautionary basis. We describe a large outbreak of SARS-CoV-2 B.1.617.1 (Kappa mutation) linked to a private gathering among third level students in Cork, Ireland.

Methods Surveillance data were available from the Health Service Executive COVID Care Tracker. The epidemiological sequence of infection for each new case in this outbreak was tracked and whole genome sequencing was requested on all linked cases. Enhanced public health control measures were implemented by the Department of Public Health HSE-South to contain onward spread of VOCs, including retrospective contact tracing, lengthy isolation and quarantine periods for cases and close contacts. Extensive surveillance efforts were used to describe and control onward transmission.

Results There were 146 confirmed SARS-CoV-2 cases linked to the outbreak. All sequenced cases (53/146; 36%) confirmed Kappa mutation. The median age was 21 years (range 17–65). The majority (88%) had symptoms of SARS-CoV-2 infection. There were 407 close contacts; the median was 3 per case (range 0–14). There were no known hospitalisations, ICU admissions or deaths. Vaccination data was unavailable, but the outbreak pre-dated routine availability of COVID-19 vaccines among younger adults in Ireland.

Conclusion Enhanced public health control measures for new and emerging variants of SARS-CoV-2 may be burdensome for cases and close contacts. The overall public health benefit of enhanced controls may only become apparent when evidence on disease transmissibility and severity becomes more complete.

Keywords Contact tracing · Kappa mutation · SARS-CoV-2 · Surveillance · Variants of concern · Whole genome sequencing

Background

Since the emergence of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection in late 2019, new variants have evolved with differing consequences around the world. In May 2021, the B.1.617 variant emerged in Ireland, and its impact on transmissibility and disease severity was initially uncertain. This variant had three sub-lineages with different mutations: B.1.617.1 (Kappa), B.1.617.2 (Delta) and B.1.617.3. Initially, all three mutations were classified as variants of concern (VOCs) by the World Health Organization, and by Irish public health authorities, on a precautionary basis [1]. Delta evolved to become the dominant strain of circulating SARS-CoV-2 globally for a period of several months [2]. However, much less is known about the Kappa variant, and about its public health impact.
In May 2021, the Department of Public Health in Cork and Kerry (south of Ireland) was notified of the first confirmed case of the Kappa mutation of COVID-19 in our region. At the time, Ireland was pursuing a containment strategy for any new cases of SARS-CoV-2 infection, and intensive control measures were required for any confirmed VOC cases. This first notified case in our region was linked to an outbreak which had arisen from a private gathering among third level students in Cork 3 weeks previously. Initial outbreak control measures had already been undertaken before B.1.617 was notified. However, there had been no specific reason to suspect a VOC, and the extent of onward transmission in the community was uncertain.

Here we describe the findings of an extensive public health investigation into a large outbreak of the Kappa mutation of COVID-19, including retrospective contact tracing and extensive surveillance data were compiled for confirmed cases and these were reported by regional Departments of Public Health via the national Computerised Infectious Disease Reporting (CIDR) system. Any confirmed case who was under investigation as a VOC was required to self-isolate fully for 14 days (rather than restricting movements for 14 days for close contacts of non-VOC cases) and attend testing as soon as possible, and again 10 days after the date of last exposure to a confirmed case.

Data sources and the national cyber-attack

Positive SARS-CoV-2 test results are uploaded to the Health Service Executive’s (HSE) Contact Management Programme (CMP) by a network of laboratories in real time. CMP is a centralised national programme which is used to gather information on confirmed cases, identify their close contacts, issue testing appointments to close contacts and provide tailored public health advice to both cases and close contacts. At the time of this outbreak, enhanced surveillance data were compiled for confirmed cases and these were reported by regional Departments of Public Health. This led to significant disruption to public health investigation and control efforts, as there was no outbreak reporting tool available to link individual cases of COVID-19 together. An extensive retrospective manual investigation was required to track any onward transmission of the Kappa mutation from the first notified case. Enhanced control measures were required for any suspected, probable or confirmed VOC cases where they were possible to identify, as well as their close contacts.

The CMP was still accessible during the national cyber-attack, and thus case details were retrospectively retrieved using these records. This allowed each confirmed case and their close contacts to be manually tracked. CMP does not routinely collect information on disease severity or hospitalisation of cases after the date of first positive PCR sample, and this information was not readily available for all cases. Any remaining hand-written notes from the original

Methods

Case definitions

In Ireland, all confirmed cases of COVID-19 must be notified to the Medical Officer of Health based in the relevant regional Departments of Public Health. Confirmed cases are defined as those who test positive for COVID-19 on any clinical specimen, typically a nasopharyngeal polymerase chain reaction (PCR) swab. Close contacts were typically defined as those who spent more than 15 min within close proximity (< 2 m face to face) of a confirmed case. For any suspected, probable or confirmed VOC, more conservative infection control measures were applied than to non-VOC cases. Any confirmed case who was under investigation as a VOC was required to self-isolate fully for 14 days (rather than 10 days, as applied to non-VOC cases) until asymptomatic and at least 5 days fever-free. Anyone who was deemed a close contact was also required to fully self-isolate from others for 14 days (rather than restricting movements for 14 days for close contacts of non-VOC cases) and attend testing as soon as possible, and again 10 days after the date of last exposure to a confirmed case.
outbreak investigation (3 weeks prior), which were held by the Department of Public Health staff, the regional Contact Tracing Centre or the third level partners (including university-based Student Health Departments), were sought and retrieved to investigate the potential sequence of onward spread of the Kappa mutation. Lists of cases which had been previously notified to the HSE Health Protection Surveillance Centre (HPSC) were also requested and retrieved. A new, anonymised database of cases and close contacts was set up in Microsoft Excel for surveillance purposes using identified records from the CMP.

For any confirmed cases of COVID-19 linked to this outbreak who were diagnosed more than 14 days prior to 13th May (the date of first notification of confirmed Kappa mutation), their records were manually checked to identify if they had any linked close contacts who might still be within the incubation period (14 days) to develop SARS-CoV-2 infection. The records of all those close contacts were also individually reviewed within CMP to identify if they had subsequently tested positive for COVID-19, and if so, whether they had generated any additional close contacts who might still be within the 14-day incubation period.

Whole genome sequencing

WGS is not routinely undertaken on all confirmed cases of COVID-19 in Ireland. Any positive cases who were linked to the outbreak were flagged to the National Virus Reference Laboratory in Dublin to request WGS. This could only be done retrospectively for samples which were still retained by the initial receiving laboratory, and where the samples had a high viral load, typically characterised by a cycle threshold value < 25. Thus, WGS results were not available for all positive cases. WGS was also proactively requested on any linked cases on or after 13th May 2021, when the first confirmed case of Kappa mutation was notified.

Analysis

Descriptive analyses of surveillance data were performed using Microsoft Excel. The epidemiological sequence of infection for each case was manually tracked within CMP. It was possible to estimate the total number of close contacts and the median number (and range) of close contacts per case. The data from this outbreak were subsequently compared with publicly available national surveillance data on VOCs and variants of interest in Ireland, as reported by the HPSC. In doing so, it was possible to estimate the overall impact this investigation had on the epidemiological profile of the Kappa mutation in Ireland during the pandemic to date.

Ethical statement

This work was undertaken in accordance with the Infectious Disease Regulations (1981) and did not require independent ethical review.

Results

Outbreak in Cork and Kerry

In total, 146 confirmed cases were linked to this outbreak. Of these, 54/146 (37%) cases had attended the private gathering on 24 April 2021. The epidemic curve, including the sequence of main events, is shown in Fig. 1. Of the close contacts initially identified from the gathering, 33/87 (38%) remained COVID-negative after attending for at least one PCR test.

The median age of all confirmed cases was 21 years (range 17–65 years) with 85% of cases occurring in those aged under 25 years. The majority of confirmed cases (88%) had symptoms of SARS-CoV-2 infection (Table 1). WGS results were available for 53/146 samples (36%) which were all positive for the Kappa mutation.

Overall, there were 69 secondary infections which were not linked to the private gathering, and 22 confirmed tertiary infections. These cases arose among other third level students, household contacts (from student accommodation or private families), social/community contacts and a small number of school-going classmates of siblings (n < 5).

In total, there were 407 close contacts identified for the confirmed cases. The median number of close contacts was 3 (range 0–14). Thirty close contacts (7% of all close contacts) had testing appointments scheduled but did not attend their appointment. It is unknown whether they became symptomatic, or if they contributed to onward transmission of COVID-19 in other settings.

Vaccination data were unavailable for the cases involved in this outbreak. However, widespread vaccination of adults

Fig. 1 Epidemic curve of confirmed cases of SARS-CoV-2 B.1.617.1, Cork, Ireland, April–May, 2021 (n = 146)
under 50 only commenced in Ireland from late May 2021 onwards, except for healthcare workers and clinically vulnerable groups [8]. Thus, it is likely that the large majority of cases linked to this outbreak were unvaccinated at the time of exposure. Similarly, data on disease outcomes were not routinely available, but there were no identifiable hospitalisations, ICU admissions or deaths linked to this outbreak based on available regional surveillance information in Cork and Kerry.

Impact on national epidemiology

By the end of November 2021, there had been 210 cases of Kappa mutation identified in Ireland, accounting for <1% of all sequenced cases of COVID-19 in the country. Of these, 142 cases (68%) were residents of Cork and Kerry, although the region only accounts for 14% of the national population [9]. The majority of confirmed cases of the Kappa mutation in Cork and Kerry (111/142; 78%) were aged 18–23 years. This suggests that over half of all confirmed cases of the Kappa mutation in Ireland (111/210, 53%) were accounted for by young adults in Cork and Kerry.

Outbreak response

The first confirmed case of Kappa mutation had attended the large private gathering of third level students in Cork City during their infectious period. However, during initial outbreak control efforts, it was unknown that they had B.1.617.1 infection. Three OCT meetings had been convened between 29 April and 6 May 2021, before it became evident that a VOC had been circulating.

After the first OCT meeting, an email alert was issued by the third level institutions to warn and inform students of a possible outbreak of COVID-19 and to advise them to come forward for testing if they thought they had been exposed to SARS-CoV-2, or if they had developed any new symptoms. All students were informed of the ongoing risks associated with COVID-19 and they were encouraged to contact either their Student Health Department or their own respective general practitioners if they required a test for COVID-19.

When the outbreak was identified, the Department of Public Health initially undertook contact tracing efforts to identify all students who had attended the private gathering. This required multiple phone calls to individual cases and to fellow students, family members or others with whom they had shared accommodation. Where details of close contacts were initially disclosed to public health staff, this information was then entered in the CMP and close contacts were sent routine automated messages advising them to restrict their movements and to avail of COVID-19 testing. Public health staff monitored the household addresses where cases had been notified, including student accommodation complexes and private family homes. This information was tracked using Excel files specific to the initial, routine outbreak investigation, before the Kappa mutation was reported via WGS.

A pop-up testing centre was also considered as part of initial outbreak control measures. However, this did not proceed for a number of reasons. Firstly, previous pop-up testing sites at third level institutions in our region had yielded very low positivity rates among the student population, even during recognised outbreaks. Confirmed cases were already widely dispersed around the region by the time this outbreak was identified because many had left their third level accommodation and returned to their family homes to prepare for upcoming examinations; this would likely have adversely impacted on attendance rates. Moreover, it was not possible to facilitate walk-in testing due to logistical constraints at the time, and the requirement to pre-book a testing appointment may have deterred students from attending.

When the first notified case of Kappa mutation was alerted, additional public health measures were instigated. All cases whose WGS result had confirmed B.1.617.1 were called to inform them of their result. Enhanced personalised advice was provided to all cases who were still in their infectious period. The Department of Public Health made individual calls to all linked close contacts who required further tailored advice for themselves and their household contacts, including enhanced isolation and testing requirements.

| Table 1 Characteristics of confirmed cases epidemiologically linked to outbreak of Kappa mutation of COVID-19, Cork, Ireland, April–May 2021 |
|-------------|---|---|
| **Cases** | **n** | (%) |
| **Age (years)** | | |
| < 20 | 19 | 13 |
| 20–25 | 108 | 73 |
| 25–29 | < 5 | 2 |
| 30–49 | < 5 | 2 |
| 50+ | 14 | 10 |
| **Symptoms** | | |
| Yes | 129 | 88 |
| No | 17 | 12 |
| **Sequence of infection** | | |
| Acquired at initial private gathering | 54 | 37 |
| Secondary infections | 69 | 47 |
| Tertiary infections | 22 | 15 |
| Sequence of infection unknown | < 5 | 1 |
| **Close contacts** | | |
| Total number close contacts | 407 | |
| Median number (range) | 3 (0–14) | |
Epidemiological links between cases were intensively investigated to ensure all possible cases were identified. Retrospective contact tracing was undertaken where possible, and cases were asked whether they had any history of international travel in the 14 days prior to symptom onset (or date of PCR test if asymptomatic).

**Discussion**

When a new variant of SARS-CoV-2 infection emerges, its impact on transmissibility and disease severity is uncertain. Efforts to contain its spread within a population may require extensive control and surveillance measures. For VOCs, public health controls may include enhanced contact tracing of cases, strict isolation or quarantine advice for suspect cases and contacts, increased testing opportunities and additional restrictions on movement for suspect cases, or for the wider community. In this outbreak, one private gathering ultimately resulted in 146 linked cases of COVID-19 and 407 close contacts who required individualised, retrospective follow-up and tailored advice in the context of an emerging VOC.

It is plausible that the enhanced public health control measures implemented during this outbreak helped to limit spread of the Kappa mutation in our region, and elsewhere in Ireland. National epidemiological data supports this possibility, given that more than two thirds of all confirmed cases in Ireland were confined to our region, and the majority of those were in young adults who may have been linked to this outbreak either directly or indirectly. However, the available surveillance data for this mutation may be skewed since we requested WGS on all cases with known links to this outbreak. It is possible that further transmission of the Kappa mutation was curtailed by the concurrent dominance of the Delta variant in Ireland. It is also possible that the timing of this outbreak helped to limit its onward spread. The initial private gathering described herein occurred 2 weeks before many third level students were due to take their end-of-semester exams. Students may have modified their own social behaviours while preparing for exams, particularly after receiving individualised advice during contact tracing calls, targeted automated text messages or via email alerts.

When further evidence becomes available on the severity and transmissibility of new SARS-CoV-2 variants, the public health response is tailored accordingly. In June 2021, the WHO re-categorised the Kappa sub-lineage as a variant of interest rather than a VOC due to its declining global prevalence [10]. In Ireland, this meant that close contacts of confirmed cases of the Kappa mutation no longer required enhanced control measures, and additional precautions were stood down. At present, this variant has been further de-escalated by the European Centre for Disease Prevention and Control because it is no longer detected, or only detected at extremely low levels, among community samples in Europe [11].

The Irish public health response to COVID-19 has often been guided by the precautionary principle, whereby political and public health leaders adopt precautionary measures when scientific evidence about a health hazard is uncertain, and when there is a high risk of human harm [12]. In retrospect, enhanced contact tracing and stricter control measures may have yielded limited public health benefit in this outbreak. However, such judgments are difficult to make in real time, when scientific evidence is incomplete or emerging. Public health teams face an ongoing challenge in determining the appropriate balance in implementing labour-intensive efforts to contain new variants of SARS-CoV-2 when they arise, given that the effectiveness of such efforts may not be immediately apparent. Enhanced control measures may be burdensome for individual cases and their close contacts, and may only help to contain onward spread if compliance with public health advice is high.

There has been relatively little research conducted on the implementation of enhanced public health controls for VOCs, and the experiences of public health practitioners have been seldom incorporated in the existing literature despite their integral role in this process. Our study may fill a gap in the literature in this regard. A scoping review of 37 studies relating to the public health implications of VOCs reported that most studies have focused on societal interventions, including lockdowns, travel restrictions or mass vaccination efforts, when VOCs have been identified. However, no studies had considered the implications of VOCs on contact tracing efforts, or on the feasibility of implementing enhanced or intensive contact tracing of individuals [13]. Continued pandemic preparedness requires an acknowledgement of the operational realities facing public health teams on the ground [14, 15], and the feasibility of implementing policy decisions relating to emerging threats.

There were a number of challenges encountered in the management of this outbreak. The first confirmed case of Kappa mutation coincided with a major ransomware attack on computer systems used within the public healthcare system in Ireland, including regional Departments of Public Health. Therefore, the outbreak could only be accurately tracked by retrospectively accessing individualised records of all cases and their close contacts. Some links were only possible to decipher through close collaborative working between the public health practitioners and clinical teams based in third level institutions. The available data on cases and their close contacts were incomplete, and it is unlikely that the full extent of onward transmission in the community was ascertained. The WHO has highlighted the need for robust electronic data capture tools to support efficient contact tracing and outbreak management on a large scale [16].
In Ireland, the Computerised Infectious Disease Reporting (CIDR) system is used as an information system to manage the surveillance of infectious disease notifications. However, it was developed in 2004, and it does not have an in-built outbreak management function. The test results of close contacts are not automatically linked to an initial index case, and manual data processing is required to track secondary, tertiary or quaternary transmission. The absence of an outbreak management tool for the health protection function in Ireland has been well documented. This may hamper the speed and effectiveness of outbreak response, as well as resilience of public health preparedness for future threats [6, 15].

Although the B.1.617 lineage of SARS-CoV-2 was first detected in India [1, 15], there were no linked cases in this outbreak with a known history of recent international travel, and the extent of community transmission was uncertain. Genomic surveillance is essential for effective recognition and containment of VOCs [17, 18] and the benefits of enhanced WGS capacity for outbreak control have been highlighted in previous outbreak reports during the pandemic to date [19, 20]. However, in this outbreak, there were delays in receiving WGS results due to limited laboratory sequencing capacity. The median time to confirmatory result in this outbreak was 23 days, thereby exceeding one full incubation period. When confirmatory WGS results only become available after a time delay, this limits the ability to detect VOCs in real-time. This adds complexity to the ensuing public health investigation of VOCs, which becomes largely retrospective, and it precludes many opportunities to prevent onward transmission. Crude early warning systems for VOCs may aid public health decision-making, based on the presence or absence of S-gene targets, and these have been used in Ireland with some success [1]. However, such systems do not superecede the need for expanded WGS capacity for early detection of emerging variants of SARS-CoV-2.

Conclusion

This large outbreak of the Kappa mutation of SARS-CoV-2 in the south of Ireland resulted in 146 confirmed cases and 407 linked close contacts. The public health investigation of emerging or suspected VOCs involves strict isolation and control measures for confirmed cases, and enhanced contact tracing processes for all linked close contacts. However, enhanced public health precautions are burdensome for cases and their close contacts, and they may only help to curtail the spread of new variants in the context of real-time WGS information, robust information systems and adequately resourced public health teams. Such control measures should be tailored appropriately as soon as practicable, once information on disease severity and transmissibility emerges.

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Author contribution Deirdre Murray chaired the initial outbreak control meetings and oversaw initial public health control measures with input from Michael Hanrahan and Sonya Keogh. Peter Barrett led the public health response to initial confirmed cases of Kappa mutation, and oversaw the enhanced public health advice provided to cases and close contacts of those who tested positive for Kappa mutation with input from Philippa White. Peter Barrett and Orla Bruton established a database of information on cases and close contacts with input from Aline Brennan and Sonya Keogh. Jonathan Dean led on the laboratory testing of SARS-CoV-2 samples in the National Virus Reference Laboratory. Peter Barrett, Orla Bruton and Ryan Chu analysed the surveillance data with input from Michael Hanrahan. Peter Barrett and Orla Bruton drafted the initial manuscript with contributions from Michael Hanrahan and Deirdre Murray. All authors reviewed the manuscript. Peter Barrett revised the final version. The manuscript was approved by all authors.

This work was undertaken in accordance with the Infectious Disease Regulations (1981) and thus did not require independent ethical review. No identifiable information is presented herein.

Declarations

Conflict of interest The authors declare no competing interests.

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