Infection Prevention in Practice 6 (2024) 100325

Available online at www.sciencedirect.com

Infection Prevention in Practice

journal homepage: www.elsevier.com/locate/ipip

Short Report

Evaluating the dynamics of hospital COVID-19 contacts and subsequent conversion to SARS-CoV-2 infection: a multi-centre retrospective cohort study

Nneoma Okeke [a,*], Luke B. Snell [a], Balram Rathish [a], Amal Hussein [a], William Newsholme [a], Damien Mack [b], Aodhan Breathnach [c], Jonathan A. Otter [a,d]

[a] *Directorate of Infection, Guy's and St. Thomas NHS Foundation Trust, St. Thomas' Hospital, Lambeth Palace Road, London, SE1 7EH, UK*
[b] *Department of Microbiology, Royal Free Hospital, Royal Free London NHS Foundation Trust, Pond Street NW3 2QG, UK*
[c] *Department of Infection, St George's University Hospitals NHS Foundation Trust, Tooting, London SW17 0QT, UK*
[d] *National Institute for Healthcare Research Health Protection Research Unit (NIHR HPRU) in HCAI and AMR, Imperial College London & Public Health England, Hammersmith Hospital, Du Cane Road, W12 0HS, UK*

ARTICLE INFO

Article history:
Received 24 July 2023
Accepted 12 October 2023
Available online 10 November 2023

SUMMARY

We investigated the dynamics of COVID-19 contacts subsequent conversion to SARS-CoV-2 infection in an inpatient setting across three National Health Service (NHS) Trusts. 9.2% (476/5,156) COVID-19 contacts met inclusion criteria, were typable and tested positive for COVID-19. There was no significant difference between Omicron and non-Omicron contacts overall conversion proportions. Omicron contacts converted faster than non-Omicron contacts (median 3 days vs 4 days, P=0.03), and had significantly greater proportions of early conversions at day 3, 5, and 7 timepoints.

Introduction

Several SARS-CoV-2 variants have emerged since 2019 [1], with Omicron currently the dominant variant globally. The majority of SARS-CoV-2 infections are detected within five days of contact with an index case [2], and there is evidence that the Omicron variant has a shorter incubation period than its predecessors [3] based on community health data. These findings show the nature of COVID-19 is changing with time, but there is limited data on the dynamics of contact conversion over time in healthcare settings.

Policies for managing inpatient COVID-19 contacts have had implications for patient flow [4]. Evidence to support these policies is limited. This study aims to evaluate the relationship between COVID-19 patients and individuals with known exposure to them (contacts), in inpatient settings, and conversion dynamics over time.

Methods

Study design and participants

Three National Health Service (NHS) hospital groups collaborated to populate the dataset used for this retrospective cohort study: Guy's and St Thomas' NHS Foundation

* Corresponding author.
E-mail address: Nneoma.okeke@gstt.nhs.uk (N. Okeke).

https://doi.org/10.1016/j.infpip.2023.100325

Trust (GSTT), Royal Free London NHS Foundation Trust (RFL), and St George's University Hospitals NHS Foundation Trust (STG).

For the purpose of creating a standardised and reliable dataset, data was included using dates in which robust data was available. GSTT data spanned from September 2020 to August 2022, RFL from January 2020 to December 2022, and STG from January 2021 to December 2021, consisting of inpatients who were tagged as a contact with a confirmed case of COVID-19 (referred to hereafter as 'contact') on electronic health records. Contacts were considered a positive case if they tested polymerase chain reaction (PCR) positive within 14 days of identification, but excluded those positive on the day of contact tagging (day 0), as these patients were assumed to have a prior exposure. In line with data protection policies, all data was completely devoid of any personal identifiable information. This work was considered a service evaluation, and ethics approval was waived.

There were 6,327 contacts. The index case for 5,156/6,327 (81.5%) were typable, and categorised as Omicron or non-Omicron variants for analysis: The index case for 1,171/6,327 (18.5%) contacts were not typable. 571/5,156 (11.1%) contacts tested positive within 14 days, and the majority were typable (476/571, 83.4%).

Variables of interest

For standardisation, and to account for the 476 cases without lab based variant typing information, positive contact cases, without reported variants, were assigned a variant based on the dominant strain at the time; 66.4 % (316/476) contacts identified did not have variant typing information. The assignments were based on genomic epidemiology determined by local sequencing records at GSTT. Dates included: Omicron (01/01/2022 − 01/01/2023), Delta (01/06/2021−01/12/2021), Alpha (27/12/2020 − 01/05/2021), and Wuhan (01/02/2020−31/10/2020). Any case without typing information that fell outside these dates were considered unclassified and were not included in analysis. Non-Omicron cases were grouped for analysis and included Wuhan, Alpha and Delta cases.

Statistical analysis

Chi-square analysis was used to compare overall proportion converted by group, and the proportion converted by day 3, 5, and 7 from exposure for each group. The Mann-Whitney U test was used to compare the median number of days to conversion. All statistical analysis was performed using RStudio 3.3.0+ [5].

Results

Descriptive analysis

5,156 contacts satisfied criteria to be assigned into a group; 9.4% of non-Omicron contacts converted (223/2,368) vs 9.1% Omicron contacts (253/2,788), very similar conversion proportions with no significant difference.

As seen in Table I, the days to conversion ranged from 1 to 14 days for all variants, with a visual representation of frequencies seen in Figure 1. All variants showed a positive skew when looking at the number of converted contacts by day, aside the Wuhan variant. Unlike Omicron cases, non-Omicron cases generally saw a slight uptick in case conversions after day 10, which may have been caused by secondary exposures.

Omicron variant had the lowest median conversion days (3), while Wuhan had the highest (7); This figure negatively correlated with the age of the variant, with Alpha variant medians being 4 and Delta being 3.5.

The distribution of the number of cases by day of conversion was positively skewed for both the Omicron and non-Omicron variant groups (Figure 1); The Mann-Whitney U test was used to determine if there was a significant difference between the median days to conversion between the groups.

The results showed the Omicron group had a significantly lower median days to conversion than the non-Omicron group (3 (IQR = 1 − 5) days vs 4 (IQR = 1.5 − 6.5) days, *P=0.03*).

Omicron contacts had significantly higher proportions of earlier conversions when compared to non-Omicron contacts; The proportion of contacts who had converted by day 3 were 55.3% and 45.3% ($\chi^2 = 4.4$, P=0.04), day 5 proportions were 73.9% and 65% ($\chi^2 = 4$, P=0.04), day 7 proportions were 86.2% and 77.6 ($\chi^2 = 5.4$, P=0.02) for Omicron and non-Omicron groups respectively. No mathematical correction was made for multiple comparisons.

Discussion

In this retrospective multicentre cohort study using hospital inpatients, we found that Omicron variant contacts converted more quickly than non-Omicron COVID-19 variant groups, suggesting a reduced incubation period for the Omicron COVID-19 variant.

In this dataset, we did not find a significant difference in the overall proportion that converted by variant. The basic reproduction rate (R_0) of Omicron is higher than previous variants [6], and we would expect to see a higher proportion of contacts convert, however, the introduction of vaccinations, and natural immunity following SARS-CoV-2 infection, are likely playing a role in reducing transmissions. This means that it is difficult to

Table I
Cohort summary

	All contacts	Converted cases	Conversion (%)	Median conversion days	Days to conversion range
Omicron variant	2,788	253	9.1%	3	1−14
Non-Omicron variants	2,368	223	9.4%	4	1−14
Delta variant	1,165	53	4.5%	3.5	1−14
Alpha variant	1,009	156	15.5%	4	1−14
Wuhan variant	195	14	7.2%	7	3−14

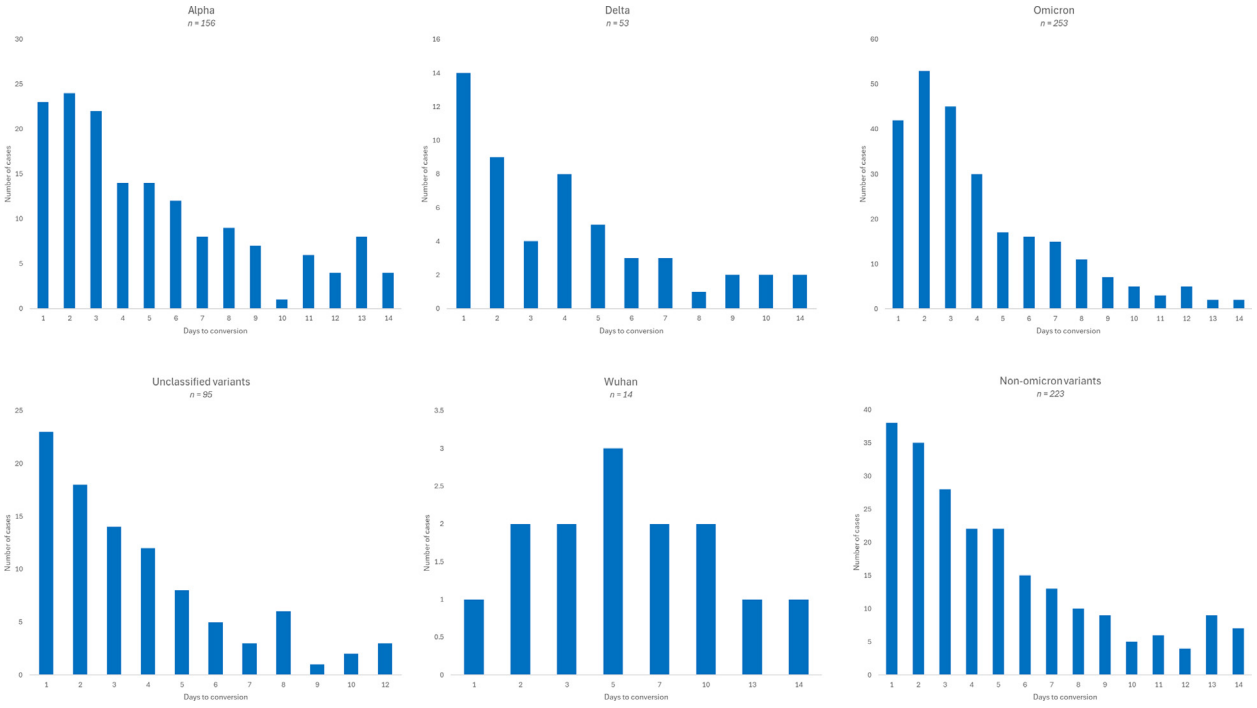

Figure 1. Distribution of the number of cases per conversion day by variant*. *Non-Omicron variants consist of those identified as either Alpha, Delta or Wuhan variants — unclassified variants were excluded from this group.

comment on whether changes in IPC practices that occurred over the duration of this study (including variations with the approach to masking, testing, and patient isolation) influenced the overall proportion of COVID-19 contacts that converted. For example, from May 2022, asymptomatic testing of all admissions ceased and since asymptomatic patients can still transmit the infection [7], this could have resulted in more inpatient spread of SARS-CoV-2. We did not measure trends in the number of COVID-19 contacts that were generated, which may have been influenced by changes in IPC practice.

We analysed the contact conversion proportion by day from exposure. Omicron variants converted faster overall with a median 3 days to conversion compared with 4 for non-Omicron variants, and also had significantly higher conversion proportions by day 3, 5 and 7. These findings show that SARS-CoV-2 dynamics are changing as variants evolve, with almost three quarters of all contacts converting by day 5 in the most recent, Omicron, variant.

Our findings have important policy implications. One of the most challenging aspects of the pandemic from a hospital IPC viewpoint was the need to isolate or cohort together similarly exposed contacts. This resulted in a high degree of inaccessible beds and reduction in patient flow through the hospital. Any reduction in the isolation duration of COVID-19 contacts would have major benefits in improving patient flow during COVID-19 waves. Public health bodies have changed the recommendation for isolation periods for exposed inpatients over the course of the pandemic [8]; with the initial period being 14 days, and the most recent being 10 days, with local flexibility for less [9]. Our findings suggest that in the Omicron era a duration of 7 days for exposed inpatient contacts would mean that close to 90% of contacts would have converted, and provide evidence to support reducing the duration of isolation for COVID-19 contacts.

Limitations of the paper

The process by which contacts were identified was not standardised across any of the hospital group's sites, meaning that many contacts may have been missed from this analysis.

Due to the nature of the COVID-19 pandemic, the majority of cases were tested for SARS-CoV-2 on admission. Those who tested positive before the date they were identified as a contact were excluded from the analysis as temporality dictates they acquired the infection elsewhere. However, it is still an assumption to say the index case definitely caused the subsequent infection in the contact as we did not have typing information for a large majority of these cases. Therefore, we cannot rule out secondary exposure from another source influencing these results — especially in non-Omicron cases.

Only 9.2% of all contacts identified satisfied the criteria for conversion in this study, however, not all contacts had evidence of COVID-19 testing throughout the 14-day period. This is likely related to the various changes seen in COVID-19 admission and contact testing practice changes over time. Testing may have been focused on symptomatic patients, particularly with the more recent cases. Studies have shown there are high proportions of COVID-19 patients that remain asymptomatic [10] meaning if this was the practice, there could be converted cases in this dataset. Also, we did not track patients who converted outside of hospital, and not all of the contacts remained as inpatients for the full 14-day duration.

Strengths of the paper

Investigating health data is important, especially when dealing with transmissible viruses with high mutation rates. The significant reduction in incubation periods between the

variants shows the importance of continuous monitoring when informing decisions.

Data standardisation is key in ensuring accuracy; it is important to communicate to clinical staff why certain parameters are being collected and how they should be recorded to ensure accurate analysis.

Conclusion

There was a significant difference in the median number of days to conversion, with Omicron variants converting quicker than its preceding variants. Similarly, there was a significant difference in the proportion of patients that converted before days 3,5 and 7 of being identified as a contact. It is important for the epidemiology of infections to be investigated thoroughly, especially in the case of those such as COVID-19 with high mutation rates, when it comes to healthcare management as changes such as those seen could help inform changes in policy to improve practice.

Conflict of interest statement

There are no relevant financial or non-financial competing interests to report.

Funding statement

L. B. S. has received grants from the Medical Research Council (MR/W025140/1). The remaining authors have no funding to declare from public, commercial, or not for profit sectors.

References

[1] Aleem A, Akbar Samad AB, Slenker AK. Emerging Variants of SARS-CoV-2 And Novel Therapeutics Against Coronavirus (COVID-19). In: StatPearls [Internet]. Treasure Island (FL); 2022 Oct 10. StatPearls Publishing; 2022 Jan—. PMID: 34033342.

[2] Hawkins LPA, Pallett SJC, Mazzella A, Anton-Vazquez V, Rosas L, Jawad SM, et al. Transmission Dynamics and associated mortality of nosocomial COVID-19 throughout 2021: A retrospective study at a large teaching hospital in London. J Hosp Infect 2023;133:62—9.

[3] Zeng K, Santhya S, Soong A, Malhotra N, Pushparajah D, Thoon K, et al. Serial Intervals and Incubation Periods of SARS-CoV-2 Omicron and Delta Variants, Singapore. Emerg Infect Dis 2023;29(4):814—7. https://doi.org/10.3201/eid2904.220854.

[4] Direct and indirect health impacts of covid-19 in England: emerging omicron impacts [Internet]. GOV.UK. 2022 [Cited: 20/03/2023]. Available from: https://www.gov.uk/government/publications/direct-and-indirect-health-impacts-of-covid-19-in-england-emerging-omicron-impacts/direct-and-indirect-health-impacts-of-covid-19-in-england-emerging-omicron-impacts#:~:text=The%20COVID%2D19%20pandemic%20has,contributed%20to%20declines%20in%20activity.

[5] Posit | R-Studio [Internet]. Posit. 2022 [Cited: 20/03/2023]. Available from: https://posit.co/products/open-source/rstudio/.

[6] Ying Liu MS, Rocklöv Joacim. The effective reproductive number of the Omicron variant of SARS-CoV-2 is several times relative to Delta. J Trav Med April 2022;29(Issue 3). https://doi.org/10.1093/jtm/taac037. taac037.

[7] Muller CP. Do asymptomatic carriers of SARS-COV-2 transmit the virus? The Lancet Regional Health - Europe 2021;4:100082.

[8] [withdrawn] infection prevention and control for seasonal respiratory infections in health and care settings (including SARS-COV-2) for winter 2021 to 2022 [Internet]. GOV.UK; 2022 [Cited: 20/03/2023]. Available from: https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/covid-19-guidance-for-maintaining-services-within-health-and-care-settings-infection-prevention-and-control-recommendations#infection-control-precautions-for-seasonal-respiratory-infections.

[9] Covid-19: information and advice for health and care professionals [Internet]. GOV.UK; 2022 [Cited: 20/03/2023]. Available from: https://www.gov.uk/guidance/covid-19-information-and-advice-for-health-and-care-professionals.

[10] Ma Q, Liu J, Liu Q, Kang L, Liu R, Jing W, et al. Global percentage of asymptomatic SARS-COV-2 infections among the tested population and individuals with confirmed covid-19 diagnosis. JAMA Netw Open 2021;4(12).