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# A COVID-19 superspreading event involving two variants during sociotherapy activities in a French mental health centre

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## SUMMARY

**Background/Purpose:** Investigation of a COVID-19 super-spreading event involving both beta and delta variants of SARS-CoV-2, following a choir in a mental health centre.

**Methods:** An epidemiological and biological (RT-PCR, mutations screening and sequencing) investigation was carried out to identify the chains of transmission. A morbidity and mortality review was performed using ALARM root causes analysis to understand how this superspreading event could have taken place.

**Results:** On May 25 and 26, 2021, all 13 choir participants were screened. Of these, eight were positive. None of them was vaccinated. Biological results suggested seven cases of delta variants (three confirmed by sequencing) and one case of beta variant. The screening of 141 contact individuals identified 21 subsequent cases with a suspected delta variant and two cases of suspected beta variant. Since the two index cases had similar Ct during the choir, this suggests different spreading abilities. The contributing factors were multiple, including underestimation of infectious risks by the social therapy team in relation to low individual and collective perceived vulnerability

**Conclusion:** HCPs involved in sociotherapy must be aware of, and trained to mitigate, the risk of superspreading event. Conventional distancing and good natural ventilation appear to not be enough to prevent spread of more transmissible variants of SARS-CoV-2.

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## Introduction

Targeted and rapidly implemented interventions to prevent and mitigate COVID-19 super-spreading events (event in which a disproportionately large number of secondary cases relative to R0 occurs) are critical for early interruption of transmission during the containment phase of severe acute respiratory syndrome coronavirus (SARS-CoV-2) variants [1]. Sociotherapy, frequently implemented in mental health settings, involves the

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use of social exchanges, to improve well-being of individuals [2]. Choirs, commonly part of sociotherapy programmes, have been identified as high-risk situations for the transmission of SARS-CoV-2 [3]. At the end of May 2021, during the declining third wave of COVID-19 and the emergence of delta variant in France [4], we investigated a COVID-19 super-spreading event involving both beta and delta variants of SARS-CoV-2, related to a choir in a mental health centre.

## Methods

The super-spreading event occurred in a 170-bed mental health centre in western France. An epidemiological and biological investigation was carried out to identify the chains of transmission. All individuals involved in the incident were tested for SARS-CoV-2 by reverse transcription polymerase chain reaction (RT-PCR) nasopharyngeal swabs. Positive samples were further characterized for specific mutations, as described in the Results section, and finally by amplicon-based whole-genome sequencing using the Qiaseq SARS CoV-2 kit (Qiagen) and Miseq sequencing (Illumina). To understand how this superspreading event could have taken place, a morbidity and mortality review was performed using ALARM root causes analysis.

## Results

On 21<sup>st</sup> May 2021, a choir was organized by the local sociotherapy team, involving eight patients, four sociotherapists from the institution and one external professional. None of the participants was vaccinated. On 24<sup>th</sup> May 2021, a patient, who did not participate in the choir, was transferred to another hospital and tested positive for SARS-CoV-2, although since the beginning of May 2021, no patient or healthcare professional (HCP) had reported infection with SARS-CoV-2 in the institution. On the same day, five choir participants developed COVID-19 symptoms (Supplementary data; Figure 1). Of the 13 participants in the choir, five HCPs and three patients were infected with SARS-CoV-2; one patient subsequently died from COVID-19. The attack rate among choir participants was 61.5%. Among the seven symptomatic cases, the average period between the choir session and symptom-onset was 3.3 (3–4) days.

The eight positive samples were then tested by specific RT-PCR targeting the N501Y and E484K mutations. Seven were N501 and E484 wild type. One had an E484K mutation and was suspected to be a beta variant. On 4<sup>th</sup> June 2021, the result of whole-genome sequencing of the 24<sup>th</sup> May sample of the transferred case showed a 20A/S.452R variant (B.1.167.2), which led to a reanalysis of the seven N501 and E484 wild type samples. Among those seven samples, four could be subsequently tested by specific RT-PCR targeting the E484K, E484Q and L452R mutations. Those four samples had an L452R mutation but only three could be sequenced (Supplementary data). Whole-genome sequencing confirmed the presence of the delta variant in those three samples. In the epidemiological context, the four non-sequenced samples were deductively considered infected with the delta variant.

From 25<sup>th</sup> May to 3<sup>rd</sup> June 2021, 141 individuals (37 patients, 36 HCPs and 68 individuals from the community) experienced a 'risk of transmission' contact (defined as significant contact without adequate personal protective equipment, e.g., any period of face-to-face contact or at least 15 min within 2 m). All

were screened for SARS-CoV-2, identifying 21 subsequent cases with a suspected delta variant and two cases of suspected beta variant (Figure 1). We analysed the activity schedule of positive cases during the 14 days preceding the choir. The delta variant HCP1 was the only case who had contacts with all known delta variant suspect cases (outside and inside the institution) between 23<sup>rd</sup> May 2021 and 25<sup>th</sup> May 2021 at the beginning of the epidemic, suggesting they were the primary case of the delta variant. The investigation of the two secondary cases of beta variant did not allow us to build the transmission chain. We assumed the first identified case to be the primary case (Figure 1). These suspected index cases of delta and beta variants had similar cycle threshold ( $C_t$ ) values on 25<sup>th</sup> May 2021 (date of their first RT-PCR), respectively, 25 and 23.

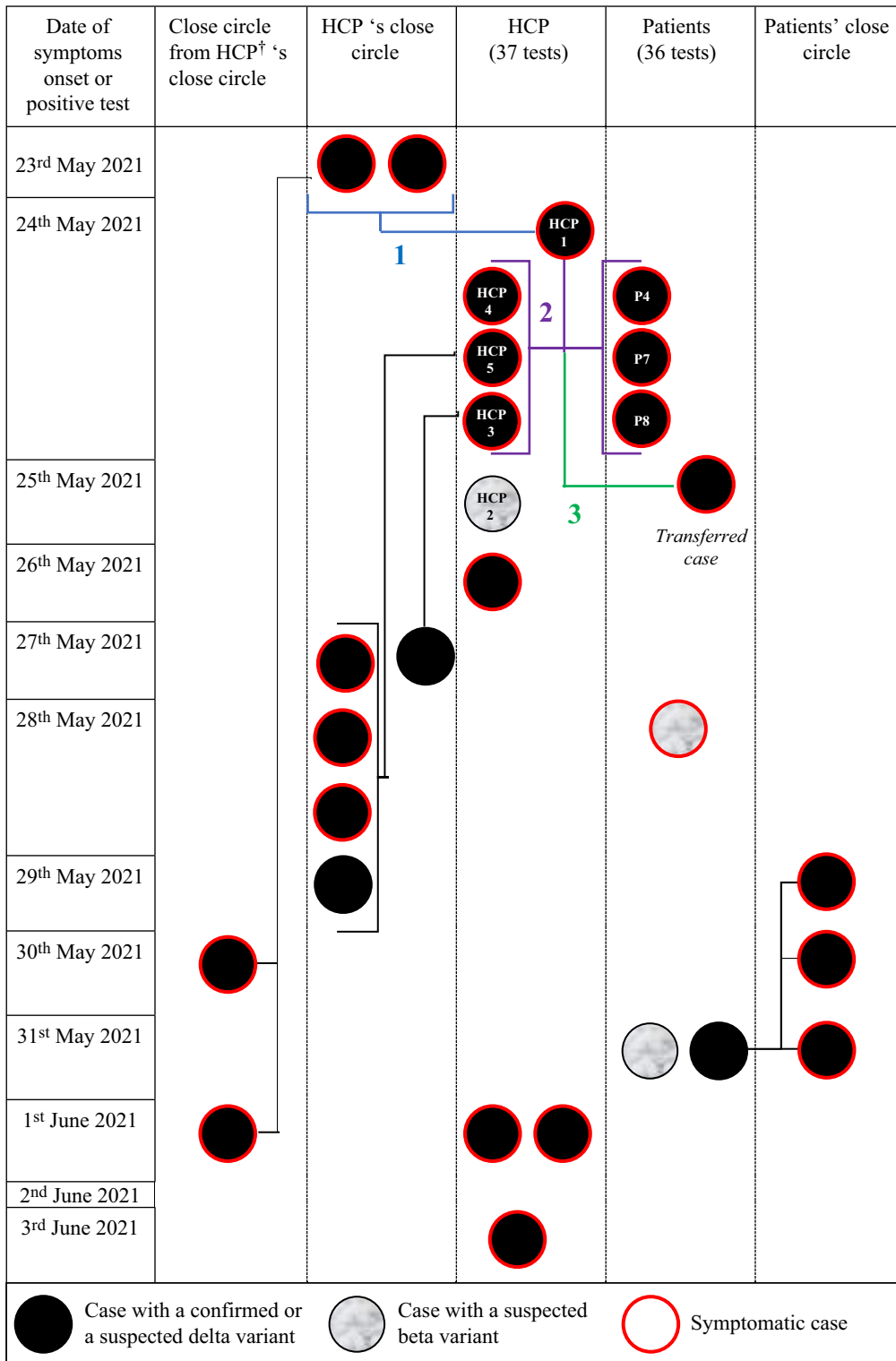
The choir activity was reconstructed on 30<sup>th</sup> June 2021 with the local team who participated. This activity occurred indoor for 2 h, in a 697-m<sup>3</sup> room naturally ventilated by six opened doors. Participants sat on 13 chairs forming an oval and separated by 1.5 m. (Supplementary data). Participants entered the room wearing facemasks (except one patient) and cleaned their hands. All participants removed their facemasks at the beginning of the singing activity for convenience and remained unmasked during the session. The HCPs (HCP1, HCP3 HCP4 and HCP5) moved from patient to patient to conduct the activity while other participants stayed in front of their chair except patient P4 who wandered round. None of the participants had COVID-19 symptoms during the activity.

A morbidity and mortality review performed using ALARM root causes analysis, identified contributing factors from all the seven categories [5] (Table 1). In addition to risky behaviours of psychiatric patients, the nature of the activity and facemask removal for convenience exacerbated transmission. Individual, team, and organizational factors contributed to the underestimation of the infectious risk by the sociotherapists. This analysis reveals that professionals have not been vaccinated because they did not perceive themselves at risk of getting COVID-19 or transmitting the virus. They perceived a sense of security working in a hospital not previously affected by COVID-19, and where all admissions were screened for SARS-CoV-2.

## Discussion

This outbreak of SARS-CoV-2 delta variant highlights the risk of COVID-19 superspreading events associated with choir activities as part of sociotherapy in a mental health centre. Exposure to the risk of COVID-19 was due to a combination of scanty infection control awareness from professionals and poor understanding of the risks and measures by psychiatric patients.

The sociotherapy at the interface between the hospital and the community setting relies on therapeutic techniques that turn contact with others into a social rehabilitation. Singing in a musical choir can assist in achieving a common goal of improved self-esteem. Since summer 2020, indoor choir practices were flagged as situations at high risk for the transmission of the virus from asymptomatic cases. Despite this evidence, and 16 months and three waves into the COVID-19 pandemic in France, measures to prevent the transmission of COVID-19 appeared muddled to sociotherapists and more widely in the institution [6]. The relaxation of some control measures in France at this period potentially contributed to this confusion. The absence of COVID-19 in the hospital, which is located in a



**Figure 1.** Hypothesis of transmission pathways among SARS-CoV-2 cases according to spatio-temporal information identified during the outbreak that followed the choir. Numbers 1 to 3 identify the likely transmission events: 1 in blue: contact in a private context the evening of 20<sup>th</sup> May 2021; 2 in purple: contact during a sociotherapy activity: choir of 21<sup>st</sup> May 2021 10:00 to 12:00; 3 in green: contact during a sociotherapy activity: minibus excursion of 21<sup>st</sup> May 2021 14:00 to 16:00 h.

**Table I**

Contributing factors of the COVID-19 super-spreading event identified in the ALARM roots causes analysis

Topic	Contributing factors	Improvement area
Patients	<ul style="list-style-type: none"> <li>- Lack of awareness of the infectious risk</li> <li>- Difficulties in complying with infection control measures</li> <li>- Unvaccinated</li> </ul>	<ul style="list-style-type: none"> <li>- Promotion of the COVID-19 vaccination</li> <li>- Specific protocols, support at the organizational level regarding preventive measures</li> </ul>
Individual (staff)	<ul style="list-style-type: none"> <li>- Lack of infection control training; underestimation of the infectious risk, facemask not worn</li> <li>- Unvaccinated (did not perceived the collective benefit of vaccination)</li> </ul>	<ul style="list-style-type: none"> <li>- Promotion of the COVID-19 vaccination</li> </ul>
Team	<ul style="list-style-type: none"> <li>- Feeling of greater freedom due to step down in community constraints</li> <li>- Navigated from patient to patient during activities to help them</li> <li>- No one questioned the holding of this singing activity although it was posted throughout the hospital</li> <li>- Lack of consideration of psychiatric disease as a risk factor of getting a SARS-CoV-2 infection.</li> </ul>	<ul style="list-style-type: none"> <li>- Educate and remind about preventive measures against COVID-19 in wards</li> <li>- Develop benefit–risk thinking</li> <li>- Remind the barrier measures against COVID-19 in wards and in crisis units</li> </ul>
Task and technology	<ul style="list-style-type: none"> <li>- Singing generates aerosols</li> <li>- Facemasks not convenient for singing</li> <li>- Choir gathers patients and HCPs from different hospital units, multiplying contamination sources</li> <li>- Choir is appealing (two patients came without being registered)</li> </ul>	<ul style="list-style-type: none"> <li>- Search for facemasks compatible with singing or others sociotherapy activities</li> </ul>
Work environmental	<ul style="list-style-type: none"> <li>- Choir is performed indoors</li> <li>- Frequent choir sessions</li> <li>- No hand hygiene at the end of the choir activity</li> </ul>	<ul style="list-style-type: none"> <li>- Protocol or checklist including hand hygiene using alcohol hand rubs at the end of sociotherapy activities</li> </ul>
Organizational/management	<ul style="list-style-type: none"> <li>- Change in decision-making – setting up of a crisis unit</li> <li>- Poor safety culture (no catching up by professionals having seen the activity poster)</li> <li>- Low vaccination rate among professionals</li> <li>- Continuity plan not regularly updated</li> <li>- Communication problems</li> </ul>	<ul style="list-style-type: none"> <li>- Acculturate professionals to risk and safety in care</li> <li>- Send the schedules of sociotherapy activities by the management to the crisis unit for validation</li> </ul>
Institutional context	<ul style="list-style-type: none"> <li>- First COVID-19 cluster in the institution, no COVID-19 culture, risk little identified by the institution’s professionals</li> <li>- Difficulty in supplying vaccines to patients with psychiatric disorders in hospital</li> </ul>	<ul style="list-style-type: none"> <li>- Create a “cluster” pack to be efficient at the level of the risk quality department</li> <li>- Develop the co-ordination between the infection control team and the hospital</li> </ul>

HCP, healthcare professional.

rural area, likely also contributed by leading to individual and collective underestimation of the infectious risk. The indoor choir meeting without facemasks, which gathered HCPs and patients from various areas in the hospital, likely contributed to the spread of the delta variant in the community in western France.

Despite a similar viral load estimated through  $C_t$  value at day 4 from the choir, the index case of delta variant provided six secondary cases, whereas no secondary case was identified around the primary case of beta variant. This finding suggests that the delta variant was more contagious than the beta variant in a non-vaccinated population [7]; the immobility of the beta variant participant may also have limited its transmission. The absence of facemasks and the high force of exhalation during singing potentially increased the contaminant load with long distance transmission [8]. The median of 3.3 (3–4) days from exposure to symptom onset, was shorter than the five days commonly found in previous studies [9]. The distances between infected participants varying from 2 to 10 m suggest potential airborne transmission in absence of face coverage. Likewise, an outbreak among church attendees after an infectious chorister sang showed transmissions up to 15 m from the primary case-patient [3,10]. There were no other activities, where large-scale direct person-person contact could have occurred between patients; however, HCPs could have infected each other during team breaks. In contrast to previous opinion, in the absence of facemasks during high exhalation activities such as singing, natural ventilation is not sufficient to prevent the spread of COVID-19 among non-vaccinated individuals [3]. Our results are limited by the declarative aspect of some information and the absence of whole-genome sequencing to complete the epidemiological relatedness of cases. Despite these limitations, the spatio-temporal characteristics described above suggest the choir activity to be the only transmission route of this super spreading event.

In conclusion, choir therapy in mental health settings can expose the entire facility to super-spreading events. HCPs involved in sociotherapy must be aware of, and trained to mitigate, this risk. Conventional distancing and good natural ventilation appear to not be enough to prevent spread of more transmissible variants of SARS-CoV-2.

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## Conflict of interest statement

None.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jhin.2022.05.008>.

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