Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Testing for COVID-19 during an outbreak within a large UK prison: an evaluation of mass testing to inform outbreak control

Claire Blackmore , Maciej Czachorowski , Elizabeth Farrington , Éamonn O'Moore , Emma Plugge

PII: S1201-9712(22)00556-2
DOI: https://doi.org/10.1016/j.ijid.2022.10.018
Reference: IJID 6455

To appear in: *International Journal of Infectious Diseases*

Received date: 24 April 2022
Revised date: 11 October 2022
Accepted date: 12 October 2022

Please cite this article as: Claire Blackmore , Maciej Czachorowski , Elizabeth Farrington , Éamonn O'Moore , Emma Plugge , Testing for COVID-19 during an outbreak within a large UK prison: an evaluation of mass testing to inform outbreak control, *International Journal of Infectious Diseases* (2022), doi: https://doi.org/10.1016/j.ijid.2022.10.018

Testing for COVID-19 during an outbreak within a large UK prison: an evaluation of mass testing to inform outbreak control

Claire Blackmore (corresponding author) [a, b] Claire.blackmore@nhs.net

Maciej Czachorowski [b]

Elizabeth Farrington [c]

Éamonn O'Moore [b]

Emma Plugge [b, d]

[a] Centre for Environmental Health and Sustainability, University of Leicester, University Road, Leicester, LE1 7LW, United Kingdom

[b] UK Health Security Agency, Wellington House, 133 - 155 Waterloo Road, London, SE1 8UG, United Kingdom

[c] NHS England and NHS Improvement, Regatta Place, Summers Road, Brunswick Business Park, Liverpool, Merseyside, L3 4BL, United Kingdom

[d] Primary Care, Population Sciences and Medical Education, University of Southampton, University Road, Highfield, Southampton, SO17 1BJ, United Kingdom

Highlights

- Systematic mass testing in closed settings provides information on infection rates
- Test positivity was 11.6% with only one-quarter reporting symptoms
- The prison wing handling new admissions reported the second-lowest positivity rate
- Testing uptake was higher in residents than in staff members
- Mass testing is a valuable tool to bring outbreaks under control quickly

Abstract

Objectives

The aim of this paper was to describe the results of mass asymptomatic testing for COVID-19 in a male prison in England following the declaration of an outbreak. It provides novel data on implementation of a mass testing regime within a prison during the pandemic.

Methods

The paper is an observational evaluation of the mass testing conducted for six months following declaration of a COVID-19 outbreak within a prison. It investigated the incidence of positive cases in both staff and residents using polymerase chain reaction (PCR) testing.

Results

Data from October 2020 until March 2021 was included. 2,170 tests were performed by 851 residents and 182 staff members; uptake was 48.3% for people living in prison and 30.4% for staff. Overall test positivity was 11.6% (14.3% for residents, 3.0% for staff), with around one-quarter of these reporting symptoms. The prison wing handling new admissions reported the second-lowest positivity rate (9.4%) of the eight wings.

Conclusion

Mass testing for COVID-19 over a short space of time can lead to rapid identification of additional cases, particularly asymptomatic cases. Testing that relies on residents and staff reporting symptoms will underestimate the true extent of transmission and will likely lead to a prolonged outbreak.

Keywords: COVID-19, prisons, infectious disease, outbreak investigation

Introduction

COVID-19 and prisons

Since the first cases were identified in 2019, COVID-19 has caused a global pandemic which has disrupted economies and caused significant morbidity and mortality. With COVID-19 predominantly spread through aerosols, and those in close contact at highest risk, concern was voiced that institutions such as prisons would be at risk of large outbreaks (Burki, 2020), exacerbated by overcrowding and poor health of imprisoned people (Davies et al., 2020, Fazel et al., 2001). Coupled with difficulties implementing basic infection prevention and control measures because of limited access to handwashing points, crowded conditions, little control over social distancing, and movement of both staff and people, it was expected that prisons would become a hotspot for COVID-19 outbreaks (Burki, 2020). In England, an estimated 2,700 deaths of people living in prison were projected if no regime changes were introduced (O'Moore and Farrar, 2020).

Infection prevention and control in prisons in England during the pandemic

Despite the development of a World Health Organization COVID-19 Prisons Checklist to help prisons prepare for potential outbreaks from the early months of the pandemic (Organization, 2020), and countries holding pandemic preparedness exercises (such as Operation Cygnus in the UK (Loveday and Wilson, 2021)), many COVID-19 outbreaks were observed in prisons and places of detention (Ryckman et al., 2021). These led to further restrictions often being enforced (Committee, 2020) including limiting contact with not only peers, but also visitors and staff, and stopping of all education, training and employment activities (except for essential workers). Access was restricted to gym, religious association

and general association, with residents allowed out of cells to shower and exercise once per day, with limits placed on numbers unlocked and in exercise yards to enable social distancing. Mask wearing was mandatory for staff and residents.

England introduced measures including specific cohort units for protective isolation, shielding units and reverse cohorting (Coleman et al., 2022, O'Moore and Farrar, 2020), as well as compartmentalisation: significantly reducing transfers between prisons (Park et al., 2021) and limiting to single-cell accommodation within prison where possible, coupled with calls for early release or fewer custodial sentences (Henry, 2021, Reinhart and Chen, 2020).

Outbreaks in prisons can be rapidly contained with effective outbreak management (Wilburn et al., 2021) and testing asymptomatic people to contain outbreaks and reduce further spread (Lambert and Wilkinson, 2021, Malloy et al., 2021). Mass asymptomatic testing has been implemented in particular contexts and settings, including in China (Zhou et al., 2021) and in establishments with a high risk of transmission such as hospitals (Reid et al., 2020) and schools (Torjesen, 2021). However, mass asymptomatic testing was not available until months after the start of the pandemic, and must consider frequency, the test used, and the accompanying public health measures, as well as balancing these with the disruption to the prison regime, the risk of harm from false negative and positive results, and the financial cost (Lambert and Wilkinson, 2021).

Mass testing for COVID-19 in prisons in England

In outbreak situations from autumn 2020 until March 2022, testing guidance from Ministry of Justice and Public Health England (now the UK Health Security Agency) was for both lateral flow tests (LFT) and polymerase chain reaction (PCR) testing to be used (Justice,

2021), with all consenting residents tested regardless of whether or not symptomatic. PCR samples were processed by the local Lighthouse Laboratory using ThermoFisher TaqPath™ COVID-19 test for detection of SARS-CoV-2 (Gravagnuolo et al., 2021). The interval for this 'mass testing' was advised as follows:

- At day 0 (the first day mass testing is available)
- Between days 5 and 7
- At day 28 after the last confirmed or suspected case. This was changed to 14 days in January 2022.

Regular staff testing was also recommended to prevent incursion of infection. Staff were encouraged to test twice weekly with lateral flow tests (LFTs) and once a week with a PCR test.

This paper describes the results of a mass testing regime implemented in a male prison in the north-west of England following the identification of a COVID-19 outbreak using the testing regime recommended above. It was implemented within a wider routine testing programme for symptomatic residents, which is also reported here. This paper provides novel data on the operational implementation of a testing regime within an English prison during the COVID-19 pandemic.

Methods

Setting

This paper describes a COVID-19 outbreak in a local Category B (second-highest level of security) closed male prison in the north-west of England with a capacity of 750 residents, holding people on remand and sentenced who have been admitted from the community via the courts or transferred in from other prisons. It is a Victorian radial designed prison, organised into seven accommodation wings subdivided into spurs.

Participants

Eligible participants were all residents within the establishment, and all staff members working at the facility. In addition to residents already held within the establishment at the start of the outbreak, this also included new arrivals from court, and those transferred from other prisons.

Staff members included prison officers and those who worked in allied areas such as education, temporary staff employed by agencies, and those employed by external healthcare providers. Symptomatic staff were advised not to come to work and had the opportunity to undergo testing in the community outside of prison testing.

Those who had previously tested positive for COVID-19 in the 90 days prior to testing did not receive a further PCR test, in line with national guidance (Justice, 2021).

Design

This service evaluation investigated the incidence of positive cases during a COVID-19 outbreak in an English prison, following the recommended asymptomatic national testing regime for prisons at that time (Justice, 2021).

Materials

Following the declaration of an outbreak by the outbreak control team on 21st October 2020, mass testing capacity was mobilised as soon as was feasible and began on 7th November 2020. PCR testing was conducted using a nose and throat swab test in asymptomatic staff and residents.

PCR test results were linked to existing datasets: Prison National Offender Management Information System (p-NOMIS) for residents and human resources records for staff. These datasets held information on demographics and role within the prison (for staff). Presence of COVID-19 symptoms was also recorded. The national COVID-19 case definition was used (Agency, 2020).

Data analysis

In addition to the mass testing of residents, data were also collected from the wider, routine symptomatic testing programme occurring concurrently, and the asymptomatic staff testing programme conducted from 7th November . Symptomatology and laboratory results were reported into a central system linked to demographic data and exported to Excel. Data on residents were held within the p-NOMIS records system, and data on staff were held by the prison management system. Data were shared for analysis using a secure, encrypted method and stored on a secure server at Public Health England. Descriptive epidemiology and statistical tests were conducted using Excel. Chi-square test was used as independence of participants at each round of testing was assumed due to the rapid turnover of people living in the prison. Clopper-Pearson exact test was used to calculate 95% confidence intervals of testing positivity. Uptake of testing used the number of residents and the total

number of staff in the establishment at the midpoint of the mass testing period as the denominators.

Ethics

Participation in the testing programme was voluntary and there were no repercussions for those who opted not to be tested. No ethical approval was required as this was a service evaluation which collected data to monitor the outbreak.

Results

The first positive test was recorded on 13th October 2020, with analyses including data from 12th October 2020 until 20th March 2021. This includes routine testing conducted on symptomatic prison residents and tests on asymptomatic prison staff who were participating in the routine staff testing programme, in addition to the mass testing implemented following the outbreak declaration. A total of 2,170 unique tests were performed, consisting of 1,639 tests performed by 851 residents and 531 by 182 staff members. Results from the wider routine testing programme for symptomatic residents are reported first, including the scheduled mass testing programme, followed by the results of the mass testing programme alone.

For residents receiving testing, the median age was 33 years (range 18-89 years, IQR 26-42). For staff, the average age was 46 years (range 21-70 years, IQR 37-54).

The number of tests conducted, response rate and test positivity, by resident or staff, is shown in Table 1. The total number of positive tests was 252, giving an overall test positivity of 11.6%. Response rates are calculated from the average number of tests conducted

monthly and use the monthly population statistics for residents (679) and staff members (349) from the mid-point of evaluation.

[Insert Table 1 here]

Positive tests performed by residents and staff are shown in Figure 1. Grey arrows indicate the dates of the start of the scheduled mass testing as per the testing schedule, and denote when testing was scheduled to take place.

[Insert Figure 1 here]

Resident testing

Location details were available for 1,205 (97.0%) tests carried out by residents (Table 2). The highest test positivity was seen on G Wing (24.6%), followed by B Wing (20.9%) and D Wing (16.9%). No positive tests were returned by residents on H Wing.

[Insert Table 2 here]

Positive tests performed by residents, by location and over time are shown in Figure 2. Although the majority of positive tests were initially from different wings, there was a clear peak on D Wing around Day 26 (the first day of mass testing as per the schedule), followed by a large number of positive tests from A Wing on Day 27. After this, the majority of infections appeared to be contained within B Wing until the end of the asymptomatic mass testing, whereby it remained at a low level on C Wing until the end of the period of evaluation. Two spurs of C Wing were used as the reverse cohorting unit.

[Insert Figure 2 here]

From 235 cases within residents, 63 (26.8%) of these were symptomatic. For staff, four staff members from 16 cases (25%) were symptomatic.

Staff testing

Data from staff testing by role (Table 3) shows the highest test positivity was in prison officers (6.3%), followed by staff working in healthcare (2.7%). No positive tests were returned by those working for external agencies. Symptomatic staff would have been eligible for testing in the community as per national guidance.

[Insert Table 3 here]

The timing of staff tests is shown in Figure 3. The number of tests was greatest following the start of the asymptomatic mass testing, but remained relatively constant from around Day 40 onwards. Positive tests were returned at all stages of the evaluation, with no obvious peaks. It should be noted that staff testing did not start until Day 29 of the outbreak, three days after the asymptomatic mass testing for residents.

[Insert Figure 3 here]

The positive tests by day of testing and divided into resident or staff (Figure 1) show a steady number of positive tests, albeit a low number, until Day 26. At this point there was a sharp increase. Cases then dropped quickly, with a smaller peak on Day 39 and a large number on Day 59. The majority of cases were seen in residents.

Test positivity by testing round

As described previously, mass testing was also conducted in line with government recommendations, using Days 0, 7 and 28. In this testing schedule, Day 0 was set as 7th November 2020, Day 7 as 14th November 2020, and Day 28 as 5th December 2020, although there were some delays: up to four days to conduct mass testing for Day 0 tests, up to five days for Day 7 tests, and up to 13 days for Day 28 tests. The number of tests conducted by day, and result, is detailed in Table 4, which is a subset of the larger dataset described above. All test results reported here are in residents and no staff were included.

[Insert Table 4 here]

The test positivity was highest on the first round of testing (22.8%), but this dropped sharply in the second round to 3.8%, and was 4.2% in the final round. Significant differences were found using Chi-square test of independence between the proportion of positive tests on Day 0 and Day 7 ($X^2 = 54.10$, $p<0.0001$), and between the proportion of positive tests on Day 0 and Day 28 ($X^2 = 61.41$, $p<0.0001$), but there was no significant difference observed between positive tests on Day 7 and Day 28 ($X^2 = 0.18$, $p<0.670$).

Discussion

The pattern of COVID-19 cases is in keeping with a propagated outbreak, as seen in other custodial establishments (Wilburn et al., 2021). The increase in cases between days 26 and 30 correspond to the first round of the mass testing scheduled as per the national guidance. This spike in cases shows how mass testing can lead to rapid identification of additional

cases, particularly asymptomatic cases. The usual reproduction number of SARS-CoV-2 is just under three (Billah et al., 2020), but the Diamond Princess cruise ship outbreak reported a reproductive number of 14.8 (Rocklöv et al., 2020), and the relatively closed environment of prison can be seen to have some similarities to those on a cruise ship. Implementation of IPC measures should prevent these scenarios (O'Moore and Farrar, 2020) but situations may arise when these are not possible. In the case of this prison, it may have been exacerbated by layout and environment, making IPC measures and good ventilation difficult.

Only about one in four cases had reported symptoms. This demonstrates that relying on residents and staff reporting symptoms will underestimate the true extent of the outbreak lead to further transmission and a prolonged outbreak, meaning that stricter IPC measures must be enforced for a longer time. This is likely to have a negative impact on the mental wellbeing of prison residents (Johnson et al., 2021).

If infections were introduced by new entrants, the highest rate of infection would have been seen on C Wing, specifically spurs C1 and C2 which were used as the reverse cohorting unit where many imprisoned people would spend their first nights in the prison. However, the rate of infection on this wing was lower than all but one of the wings, suggesting asymptomatic infection within the establishment was unlikely to have been introduced by the new entrants to the prison. Staff are the most likely source of infection, with one study using sequencing information showing multiple introductions of the virus into the prison from the community (Czachorowski et al., 2022). Although the positivity rate was slightly higher on C1 than other spurs on the same wing, C2 had a lower positivity rate in testing than another spur that was not used for reverse cohorting.

The national recommendations when this service evaluation took place stated that mass testing should take place as soon as an outbreak is declared ('Day 0'), seven days later ('Day 7') and 28 days after the putative last case (this was later changed to 14 days after the last case). It can be difficult to adhere strictly to testing schedules, particularly where there are large numbers of people to test and short intervals between cycles. It is a huge logistical challenge to mobilise testing at short notice, particularly in a large, national prison system and when there is competition for mass testing procedures. Furthermore, when there are nearly 1,000 people to be tested, and particularly where there are restrictions on movement, this can be difficult to undertake in a single day. However, it is a valuable tool in providing a systematic method of testing to identify cases where testing of symptomatic people or contacts will miss a large proportion of cases. In a prison environment, it may be more pragmatic to treat individual wings as separate environments, with each wing having its own schedule. However, data from this evaluation suggests that if one wing is affected, it is likely that there will be infected individuals across the whole prison.

Key challenges have been highlighted in the literature for mass testing in prisons: assumed participation of consent, test administration, and technological barriers (Lambert and Wilkinson, 2021). With the implementation of national guidelines and increasing testing capacity within the UK, technological barriers had minimal impact, but test administration is likely to have been a significant challenge to the testing schedule and may explain testing needing to be implemented over several days. In England, UKHSA have worked with Her Majesty's Prison and Probation Service, NHS England and NHS Improvement to enable the rapid mobilisation of mass testing units to help the local services in conducting the necessary testing.

Another issue is that of uptake: our evaluation showed poor response rate to testing. It should be noted that the figure reported for residents (48.3%) was likely to have been affected by the transient population of the prison. This would not have affected staff members, whose uptake was even lower (30.4%). This is a key issue for both prevention of infection incursion and outbreak control; measures such as reverse cohorting can mitigate the risk of introducing infection from incoming residents, but staff are likely to introduce infection from the community and can introduce infection to several areas of the prison estate (Kinner et al., 2020). The numbers of staff entering and leaving the prison into the community is also much greater than the number of residents entering and leaving the prison. Infection rates in prison staff have been found to more closely mirror that of the prison they work in than their local community (Nowotny et al., 2021), and so asymptomatic testing needs much higher uptake and coverage of staff members to be effective. It is not surprising that this outbreak occurred at a time when the prevalence of COVID was highest in the north-west of England (Statistics, 2020), and also covers the period where the alpha variant became the dominant variant throughout England which may have exacerbated the outbreak further, though cases in the prison do not mirror the regional trend in North West England at this time (see Figure 4). This may suggest that establishments such as prisons may amplify spread of viruses even before marked peaks in community transmission are observed, as has been described in other prison outbreaks (Duarte et al., 2022, Henry, 2021, Vicente-Alcalde et al., 2022), with prisons being described as “epicentres of transmission to the community” in some circumstances(Henry, 2021).

[Insert Figure 4 here]

Strengths and limitations

This paper is the first in the published literature to evaluate the recommendation of testing on days 0, 7 and 28 to provide a structured testing regimen during a COVID-19 outbreak in prison. It has shown that despite logistical challenges to implementation, particularly in larger establishments with transient populations, it is possible to implement a testing protocol to detect asymptomatic cases in a methodical manner, and implement control measures.

The dataset had a good level of completeness, allowing robust evaluation of testing. The only exception was relating to symptomatology. There is a risk that residents would under-report the presence of symptoms as this may lead to greater restrictions on their movement and more time in isolation. For staff, there may be a perceived lack of incentive to report symptoms (or participate in testing) as they would be unable to work extra hours and earn overtime, or there may be repercussions for the staff member's household contacts who may have to isolate in line with the guidance at that time.

Additional questions would have been useful, particularly to identify reasons for those who opted out of testing, as this would allow concerns to be addressed and could increase uptake of testing. This information would also be valuable in investigating any possible selection bias as it was not possible to say whether uptake was higher amongst particular groups. Likewise, in those being tested, additional questions around hand washing and respiratory etiquette, and the number of daily contacts, would have been useful to examine whether certain behaviours are linked to asymptomatic cases, and if additional measures could be put in place to reduce the risk of onward transmission. This would also need to take into account the prison regime.

The results presented in this service evaluation are purely those from the symptomatic testing programme delivered from 12th October 2020 and the asymptomatic mass testing from 7th November 2020. During this time, different results systems were in place to record test results depending on the testing method: any staff member who was symptomatic would have had the opportunity to undertake PCR testing in the community, and any residents who were transferred to hospital would have received tests in secondary care. Due to this, not all cases are necessarily captured in this dataset.

Implications of the paper

This evaluation has shown that it is possible to conduct a mass testing programme within a wider programme of testing for infectious diseases in custodial environments as part of outbreak management. While there can be operational constraints to administering mass testing over a large population, mass testing at set intervals can provide valuable information about the presence of infection within a closed setting and attempt to bring it under control quicker. Given the high proportion of asymptomatic infection in this population, mass testing of the whole prison is recommended to ensure that all cases are identified. Without the identification of such cases and the institution of appropriate IPC measures, the outbreak is likely to be prolonged, with asymptomatic cases acting as a reservoir for spread across the prison and potentially into the community through transmission to prison staff.

Author contributions

EP, MC and CB were responsible for design and ongoing development. CB handled the data and drafted the manuscript. MC provided guidance on data management and feedback on initial drafts of the manuscript. EP and EF provided feedback on the manuscript, with EP and EM responsible for final review.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding

This service evaluation did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Ethical approval statement

This paper reports a service evaluation and as such, it is exempt from ethical approval.

References

Agency UHS. COVID-19: investigation and initial clinical management of possible cases; 2020. Available from: https://www.gov.uk/government/publications/wuhan-novel-coronavirus-initial-investigation-of-possible-cases.

Billah MA, Miah MM, Khan MN. Reproductive number of coronavirus: A systematic review and meta-analysis based on global level evidence. PloS one 2020;15(11):e0242128.

Burki T. Prisons are “in no way equipped” to deal with COVID-19. The Lancet 2020;395(10234):1411-2.
Coleman PC, Pailing A, Roy A, O’Moore É, Chandan JS, Lumby V, et al. Implementation of novel and conventional outbreak control measures in managing COVID-19 outbreaks in a large UK prison. BMC Public Health 2022;22(1):677.
Committee HoCJ. Coronavirus (Covid-19): The impact on prisons: Government Response to the Committee’s Fourth Report of Session 2019–21. 2020.
Czachorowski M, Bashton M, O'Moore É, McGrath N, Smith D, Gutridge K, et al. Repeated mass testing of staff and residents in prison outbreaks of Covid-19: an enhanced outbreak investigation in two adult prisons in England, 2021. medRxiv 2022.
Davies M, Rolewicz L, Schlepper L, Fagunwa F. Locked out? prisoners' use of hospital care. Research summary Nuffield Trust Retrieved from: https://www nuffieldtrust org uk/research/locked-out-prisoners-use-of-hospital-care 2020.
Duarte C, Cameron DB, Kwan AT, Bertozzi SM, Williams BA, McCoy SI. COVID-19 outbreak in a state prison: a case study on the implementation of key public health recommendations for containment and prevention. BMC Public Health 2022;22(1):1-12.
Fazel S, Hope T, O'Donnell I, Piper M, Jacoby R. Health of elderly male prisoners: worse than the general population, worse than younger prisoners. Age and ageing 2001;30(5):403-7.
Gravagnuolo AM, Faqih L, Cronshaw C, Wynn J, Klapper P, Wigglesworth M. High throughput diagnostics and dynamic risk assessment of SARS-CoV-2 variants of concern. EBioMedicine 2021;70:103540.
Henry BF. Reducing COVID-19 outbreaks in prisons through public health-centred policies. The Lancet Public Health 2021;6(10):e701-e2.
Johnson L, Gutridge K, Parkes J, Roy A, Plugge E. Scoping review of mental health in prisons through the COVID-19 pandemic. BMJ open 2021;11(5):e046547.
Justice UHSAaMo. Preventing and controlling outbreaks of COVID-19 in prisons and places of detention; 2021. Available from: https://www.gov.uk/government/publications/covid-19-prisons-and-other-prescribed-places-of-detention-guidance.
Kinner SA, Young JT, Snow K, Southalan L, Lopez-Acuña D, Ferreira-Borges C, et al. Prisons and custodial settings are part of a comprehensive response to COVID-19. The Lancet Public Health 2020;5(4):e188.
Lambert S, Wilkinson D. Trust, efficacy and ethicacy when testing prisoners for COVID-19. International Journal of Prisoner Health 2021.
Loveday H, Wilson J. Pandemic preparedness and the role of infection prevention and control–how do we learn? : SAGE Publications Sage UK: London, England; 2021. p. 55-7.
Malloy GS, Puglisi L, Brandeau ML, Harvey TD, Wang EA. Effectiveness of interventions to reduce COVID-19 transmission in a large urban jail: a model-based analysis. BMJ open 2021;11(2):e042898.
Nowotny KM, Seide K, Brinkley-Rubinstein L. Risk of COVID-19 infection among prison staff in the United States. BMC public health 2021;21(1):1-8.
O’Moore E, Farrar J. Briefing paper-interim assessment of impact of various population management strategies in prisons in response to COVID-19 pandemic in England. Public Health England 2020:2021-12.
Organization WH. Checklist to evaluate preparedness, prevention and control of COVID-19 in prisons and other places of detention. World Health Organization. Regional Office for Europe; 2020.
Park K, Blakinger K, Lauer C. A Half-Million People Got COVID-19 in Prison. Are Officials Ready for the Next Pandemic?; 2021. Available from: https://www.themarshallproject.org/2021/06/30/a-half-million-people-got-covid-19-in-prison-are-officials-ready-for-the-next-pandemic.
Reid RJ, Rosella L, Milijasevic N, Small LN. Mass testing for asymptomatic COVID-19 infection among health care workers at a large Canadian hospital. Official Journal of the Association of Medical Microbiology and Infectious Disease Canada 2020;5(4):245-50.

Reinhart E, Chen DL. Incarceration And Its Disseminations: COVID-19 Pandemic Lessons From Chicago's Cook County Jail: Study examines how arrest and pre-trial detention practices may be contributing to the spread of COVID-19. Health Affairs 2020;39(8):1412-8.
Rocklöv J, Sjödin H, Wilder-Smith A. COVID-19 outbreak on the Diamond Princess cruise ship: estimating the epidemic potential and effectiveness of public health countermeasures. Journal of travel medicine 2020;27(3):taaa030.
Ryckman T, Chin ET, Prince L, Leidner D, Long E, Studdert DM, et al. Outbreaks of COVID-19 variants in US prisons: a mathematical modelling analysis of vaccination and reopening policies. The Lancet Public Health 2021;6(10):e760-e70.
Statistics OfN. Coronavirus (COVID-19) Infection Survey: England; 2020. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/datasets/coronaviruscovid19infectionsurveydata/2020.
Torjesen I. What do we know about lateral flow tests and mass testing in schools? bmj 2021;372.
Vicente-Alcalde N, Ruescas-Escolano E, Franco-Paredes C, Tuells J. Control of a COVID-19 Outbreak in a Spanish Prison: Lessons Learned in Outbreak Control. Frontiers in Medicine 2022;9.
Wilburn J, Blakey E, Trindall A, Burr H, Tanti V, Doolan S, et al. COVID-19 within a large UK prison with a high number of vulnerable adults, march to june 2020: an outbreak investigation and screening event. International Journal of Infectious Diseases 2021;104:349-53.
Zhou Y, Jiang H, Wang Q, Yang M, Chen Y, Jiang Q. Use of contact tracing, isolation, and mass testing to control transmission of covid-19 in China. bmj 2021;375.

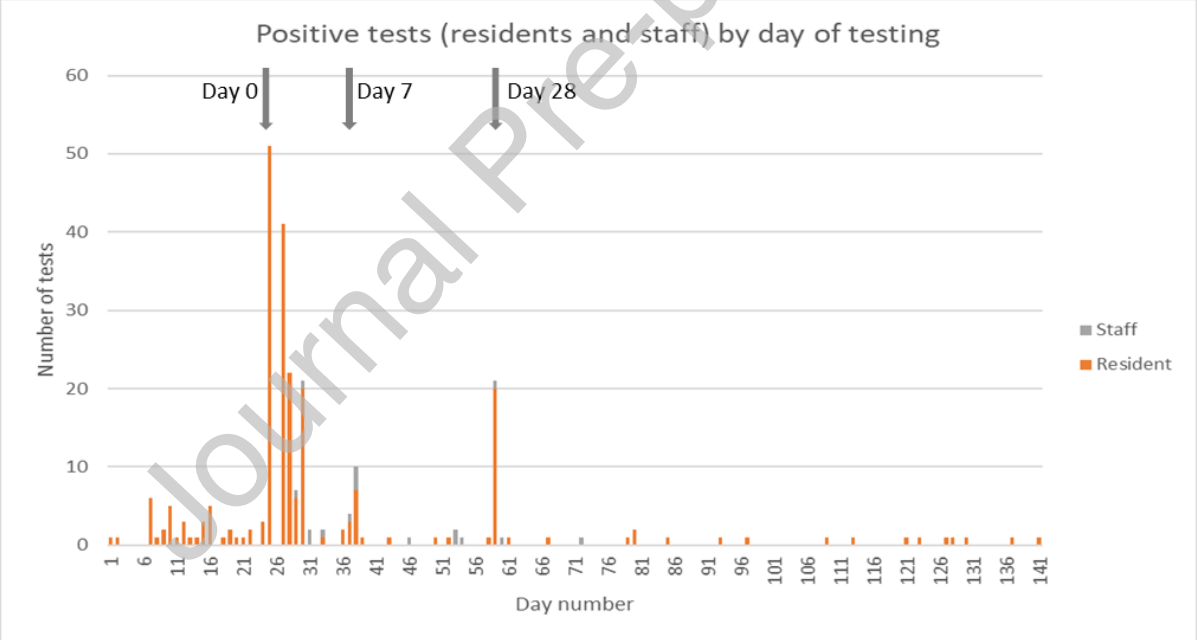

Figure 1: Positive tests performed by residents and staff

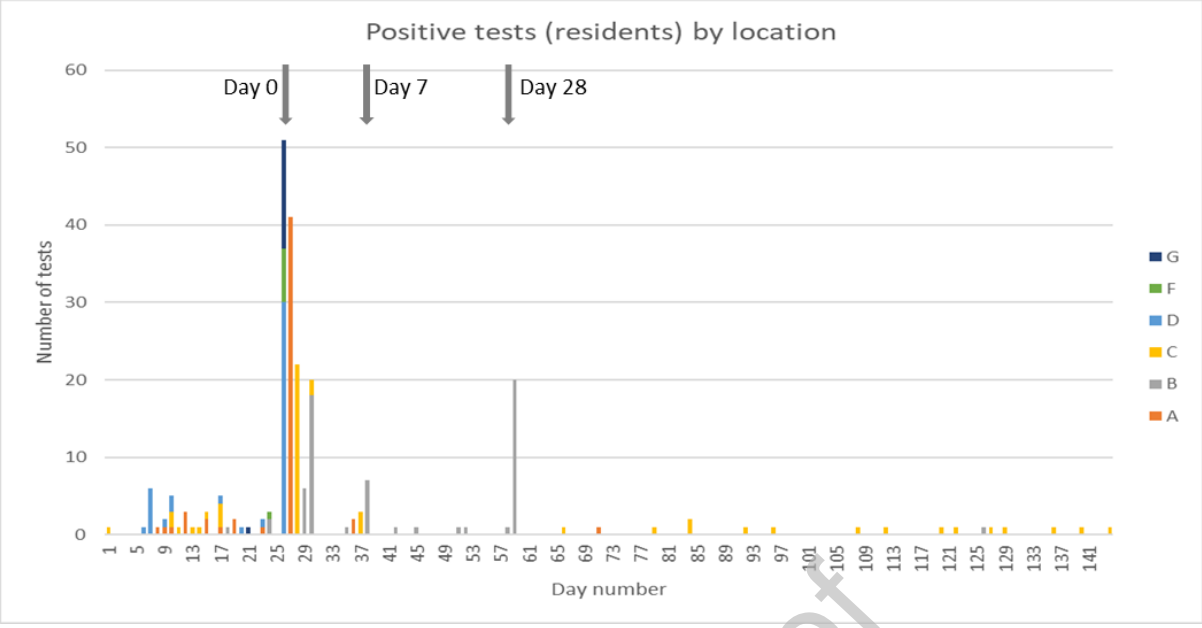

Figure 2: Positive tests, by day number and location, for people living in the establishment. Dates of additional testing are shown by grey arrows

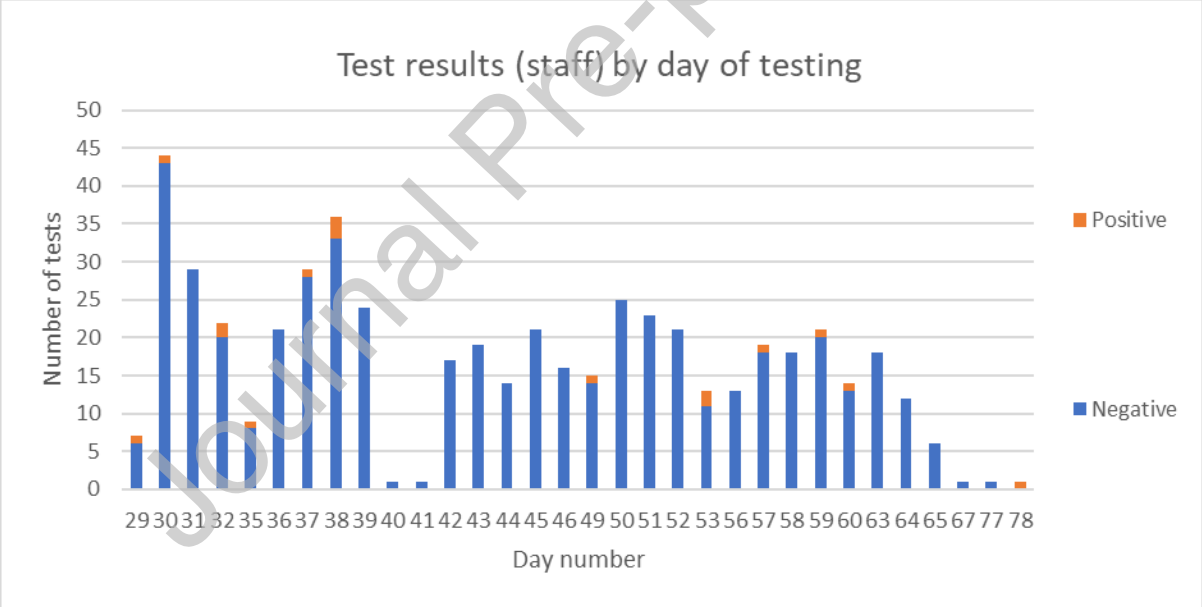

Figure 3: Test results (staff only), by day of testing (*note: testing for staff started on Day 29 of wider testing*)

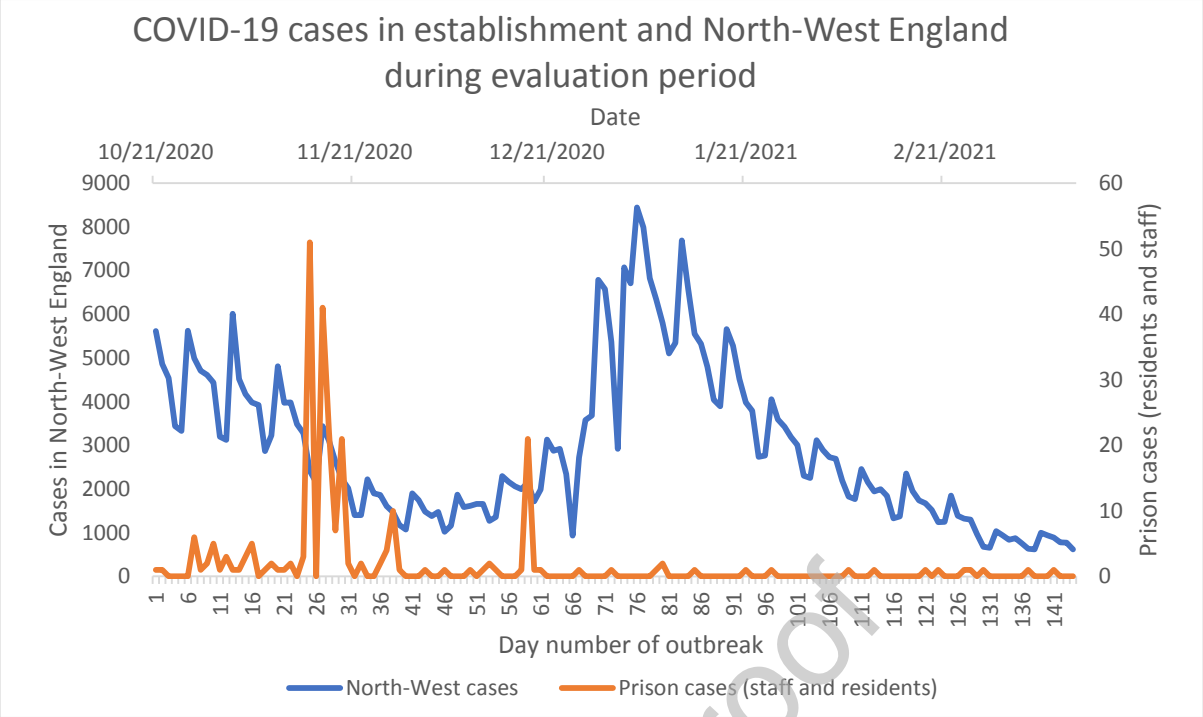

Figure 4: Positive tests performed by residents and staff in prison, and positive tests in North West England during the same period. Source for North West England data: UK Health Security Agency

Table 1: Test positivity by resident and staff member

Group	Tests (n)	Response rate (%)	Positive (n)	Negative (n)	Other (n)[a]	Test positivity (%)
Residents	1,639	48.3	236	1,384	19	14.4
Staff	531	30.4	16	515	0	3.0
TOTAL	2,170	42.2	252	1,899	19	11.6

[a] Test was inconclusive, unreadable or unknown (result not returned)

Table 2: Positive tests of residents, by location

Location	Positive (n)	Negative (n)	Other (n)	Total (n)	Test positivity
A Wing	56	287	3	346	16.2%
B Wing	62	235	0	297	20.9%
C Wing	52	491	13	556	9.4%
D Wing	43	210	2	255	16.9%
F Wing	8	46	1	55	14.5%
G Wing	15	46	0	61	24.6%
H Wing	0	32	0	32	0.0%
Other [a]	0	37	0	37	0.0%
TOTAL	236	1,384	19	1,639	14.4%

[a] No location given, or location given as "outside"

Table 3: Test results and test positivity by staff group

Staff group	Positive tests (n)	Negative tests (n)	Total	Test positivity
Health staff	2	72	74	2.7%
Agency staff	0	111	111	0.0%
Prison service staff (officer)	11	164	175	6.3%
Prison service staff (other)	3	168	171	1.8%
TOTAL	**16**	**515**	**531**	**3.0%**

Table 4: Scheduled mass testing results, reported by day and test result

Day of testing	Positive tests (n)	Negative tests (n)	Other results [a] (n)	Total tests (n)	Test positivity [b]	Lower 95% CI	Upper 95% CI

Day 0	119	403	13	535	22.8%	19.3%	26.6%
Day 7	12	305	9	326	3.8%	2.0%	6.5%
Day 28	17	389	9	415	4.2%	2.6%	6.9%
TOTAL	**148**	**1,097**	**31**	**1,276**	**12.9%**	**11.0%**	**15.0%**

[a] unknown (results not received), inconclusive or unable to read

[b] Test positivity was calculated using only valid (positive or negative) test results