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High rates of SARS-CoV-2 seropositivity in nursing home residents

Nursing home residents have high morbidity and mortality due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection.[1] Spread of the virus within nursing homes has been estimated in point prevalence surveys using real time reverse transcriptase polymerase-chain reaction (RT-PCR) and naso/oropharyngeal swabs. These surveys have revealed high rates of SARS-CoV-2 infection in residents, which is frequently asymptomatic or presents with atypical symptoms.[2,3] However, the true incidence of infection and the extent of possible future protection from re-infection in this group is unclear.

During March-April 2020 we investigated outbreaks in four UK nursing homes where 40% of 394 residents tested positive on RT-PCR, of whom 43% had no identifiable symptoms in the preceding two week period.[3] The first COVID-19 case was confirmed on 25 March, with the final new case on 17 April. Part of the initial control strategy was to implement RT-PCR testing for all residents, with re-testing one week later in those testing negative; this was completed on 23 April. Ongoing infection prevention and control included strict training and adherence to personal protective equipment (PPE) wearing, and weekly resident RT-PCR testing from mid-May. Testing was carried out with the aim of detecting new infections in staff or residents early, so that they could be immediately isolated for 14 days.

The sensitivity of RT-PCR is imperfect and ascertainment is highly dependent on the timing of testing in relation to the onset of infection. This limits the development of appropriate strategies for preventing further outbreaks. Serological assessment provides additional retrospective information to assess the extent of a COVID-19 outbreak in institutional settings.

Here we report SARS-CoV-2 seroprevalence in the same four nursing homes using assays for IgG antibodies.[4] Testing was performed as part of an outbreak investigation with Public Health England and verbal consent obtained from residents (or their relative/friend as appropriate) who had a RT-PCR result available. Serum samples were collected in June 2020 and analysed using the Abbott Architect nucleocapsid IgG assay. Samples with binding ratios near to the cut-off were confirmed on an in-house receptor binding domain double antigen bridging assay to determine final status.

Seventy two percent of nursing home residents (95% CI 66 – 77) were anti-SARS-CoV-2 IgG antibody positive, representing 173 of 241 residents available and consenting to testing. Of residents who had previously tested positive by RT-PCR, 93% had developed antibodies (95% CI 85 – 96; 87 of 94) and 59% of those who were previously RT-PCR negative were antibody positive (95% CI 50 – 66, 86 of 147; see Table 1). 35% of antibody positive residents (95% CI 29 – 43, 62 of 173) had been asymptomatic in the two-week ascertainment window prior to PCR testing during the outbreak. Seropositivity was not associated with the presence of comorbidities ($\chi 2$ P=0.81).

These results demonstrate that COVID-19 infection was considerably more widespread within the nursing homes studied (72% of residents) than estimated by serial point prevalence surveys using oropharyngeal and nasal swabs during the acute outbreak (40%). The estimate is also far in excess of data from the UK Office for National Statistics, who have estimated a 20% infection rate in care homes with at least one COVID-19 case, albeit based on RT-PCR testing results.[5] In contrast, the 72% figure is comparable to that found in a PHE investigation in a mixed group of residential and nursing homes (the 'Easter Six'). This work, pending peer-reviewed publication, found 151 of 186 (81.2%) care home residents were seropositive and that these antibodies were neutralising in 89% of cases.[6]

The discrepancy between RT-PCR and serological results likely reflects the delay in initiating point prevalence RT-PCR surveys at the start of the outbreaks we studied. Clinicians first suspected an outbreak on 13 March but widespread RT-PCR testing was not available until mid-April 2020. Given the high rates of atypical or asymptomatic infection in this population, it is likely that a substantial proportion of patients had already been infected and lost PCR-positivity prior to our first RT-PCR survey. In addition, the sensitivity of RT-PCR testing in nursing homes may be limited as some patients have difficulty co-operating with the swabbing procedure.

A key question is whether the presence of SARS-CoV-2 antibodies directed at neucleoprotein are indicative of protection against re-infection. Early evidence suggests that this may be the case. Of the Easter six care home residents 89% with IgG seropositivity to neucloeoprotein antigen also had neutralising antibodies,[6] and a preprint from Addetia et al. suggests that neutralizing antibodies correlate with protection from SARS-1 CoV-2 in humans during a fishing vessel outbreak with high attack rate.[7] With this caveat, our findings of high antibody prevalence are reassuring. Residents and staff who were previously exposed and antibody positive may be protected against re-infection and contribute to herd immunity, protecting antibody-negative residents through a reduction in virus introduction or transmission.

In summary, we provide the first description of SARS-CoV-2 antibody prevalence in a large, high-dependency nursing home population which experienced a COVID-19 outbreak during the peak of the epidemic in April 2020. The results indicate that spread within the home was more extensive than previously estimated using a combination of classic symptoms and positive PCR tests. In advance of possible further waves of infection, there is an urgent need to determine whether seropositivity to the nucleocapsid or alternative viral antigen is an indicator of clinically meaningful protection from reinfection in the nursing home population.

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Table 1
Rt-PCR status during COVID-19 outbreak and subsequent SARS-CoV-2 IgG serology

	RT-PCR status		
	Positive	Negative	***Total***
Antibody status			
Positive, N (%)	87 (92.6%)	86 (58.5%)	***173 (71.8%)***
Negative , N (%)	7 (7.44%)	61 (41.5%)	***68 (28.2%)***
Total , N (%)	***94 (100%)***	***147 (100%)***	***241 (100%)***

Table 1. SARS-CoV-2 RT PCR results in nursing home residents taken using oro/naso-pharngeal swabbing during outbreaks in April 2020, and SARS-CoV-2 nucleocapsid IgG serology in these individuals in June 2020.

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Graham NSN
UK Dementia Research Institute Care Research & Technology Centre, based at Imperial College London and the University of Surrey Department of Brain Sciences, Imperial College London, London W12 0NN

Junghans C
Department of Primary Care and Public Health, Imperial College London SW7 2AZ

McLaren R
Park Medical Centre, Hammersmith, London W6 0QG

Randell P
North West London Pathology, Charing Cross Hospital, London W6 8RF

Lang N
Department of Public Health, Hammersmith & Fulham Council, London W6 9JU

Ladhani SN
Immunisation and Countermeasures Division, Public Health England, 61 Colindale Avenue, London NW9 5EQ

Sharp DJ*
UK Dementia Research Institute Care Research & Technology Centre, based at Imperial College London and the University of Surrey Department of Brain Sciences, Imperial College London, London W12 0NN

Sanderson F
Department of Infection, Imperial College Healthcare NHS Trust, Charing Cross Hospital, London W6 8RF

*Corresponding author. Professor David Sharp,
E-mail address: david.sharp@imperial.ac.uk (S. DJ)