**Supplementary Information (SI)**

Model variables are defined in table S1 below.

Model parameters are defined in table S2 below.

**Table S1: Model variables**

|  |  |  |
| --- | --- | --- |
| Variable description | Symbol | Notes |
| Susceptible hospitalised patients | *SH* | Initial value: 999. (equal to one less than the total number of patients in the hospital, which is assumed not to vary) |
| Latently infected hospitalised patients | *E1H, E2H* | Initial value:0. Includes patients infected in the hospital and those infected in the community admitted for reasons other than COVID-19. Use of two compartments corresponds to an assumption of an Erlang-distributed latent period. |
| Infected and infectious hospitalised patients | *I1H, I2H* | Initial value: 0.  Combines infectious patients who have become infected while in hospital and infectious patients admitted from the community for reasons other than COVID-19. Use of two compartments corresponds to an assumption of an Erlang-distributed infectious period. |
| Infected and infectious hospitalised patients with severe infections | *I’H* | Initial value: 1.  These patients are all assumed to be known to have COVID-19 and to be appropriately isolated. |
| Immune hospitalised patients | *RH* | Initial value: 0. We assume only infection-derived sterilising immunity |
| Susceptible hospital healthcare workers (HCWs) | *SHCW* | Initial value: 4000. (corresponding to the entire population of HCWs which is assumed not to vary) |
| Latently infected HCWs | *E1HCW, E2HCW* | Initial value: 0. |
| Infected and infectious HCWs who have not yet isolated | *I1HCW, I2HCW* | Initial value:0. |
| Infected HCWs in isolation | *I’HCW* | Initial value: 0.  Infected patients who are isolated are assumed to no longer be able to infect hospitalised patients and other HCWs |
| Immune HCWs | *RHCW* | Initial value: 0. |
| Susceptible people in the community | *SC* | 499,990.  (corresponding to 10 fewer than the entire number of people in the community which is assumed not to vary) |
| Latently infected people in the community | *E1C, E2C* | Initial value: 0. |
| Infected and infectious people in the community | *I1C, I2C* | Initial values *I1C* : 10. *I2C*: 0. |
| Immune people in the community | *RC* | Initial value: 0. |

**Table S2: Model Parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter description | Symbol | Values considered | Notes |
| Patient-to-patient single admission reproduction number. Expected number of secondary cases amongst hospitalised patients directly infected by one hospitalised infected unisolated patient in the absence of immunity amongst hospitalised patients | *RH->H* | High hospital transmission scenario:  1.0  Intermediate hospital transmission scenario:  0.75  Low hospital transmission scenario:  0.50 |  |
| HCW-to-patient reproduction number. Expected number of secondary cases amongst hospitalised patients directly infected by one infected HCW in the absence of immunity amongst hospitalised patients | *RHCW->H* | High hospital transmission scenario:  0.2  Intermediate hospital transmission scenario:  0.15  Low hospital transmission scenario:  0.1 |  |
| Patient-to-HCW single admission reproduction number. Expected number of secondary cases amongst HCWs directly infected by one infected unisolated patient in the absence of immunity amongst HCWs patients during a single hospital admission | *RH->HCW* | High hospital transmission scenario:  0.8  Intermediate hospital transmission scenario:  0.6  Low hospital transmission scenario:  0.4 |  |
| Community-to-community reproduction number. Expected number of secondary cases in the community directly infected by one infected person in the community in the absence of immunity | *RC->C* | Before first lockdown:  3  After first lockdown:  0.6-1.2 |  |
| HCW-to-community reproduction number. Expected number of secondary cases in the community directly infected by one HCW in the absence of immunity | *RHCW->C* | 0.2 |  |
| HCW-to-HCW reproduction number. Expected number of secondary cases in HCWs directly infected by one HCW in the absence of immunity | *RHCW->HCW* | High hospital transmission scenario:  0.5  Intermediate hospital transmission scenario:  0.375  Low hospital transmission scenario:  0.25 |  |
| Community-to-HCW reproduction number. Expected number of secondary cases in HCWs directly infected by one infected person in the community in the absence of immunity | *RC->HCW* | 0.1 |  |
| Patient-to-patient transmission parameter | 𝜷H,H | *RH->H/DH* | *DH* is the mean duration of infectiousness while continuously hospitalised for a patient infected while in hospital and without severe infection. This is given by  (𝛾1/(𝛾1+𝝁))(𝛾2/(𝛾2+𝝁))x (1/(𝝁+𝜌1)(1+𝜌1/(𝝁+𝜌2) |
| Patient-to-patient transmission parameter for patients hospitalised due to Covid-19 | 𝜷H’,H | 0 | We assume patients known to have COVID-19 are effectively isolated form non-COVID patients and not able to transmit to them |
| Patient-to-HCW transmission parameter | 𝜷H,HCW | *RH->HCW*/*DH* | See above for definition of *DH* |
| HCW-to-patient transmission parameter | 𝜷HCW,H | *RHCW->H*/*DHCW* | *DHCW* is the mean duration an infected HCW remains infectious to the hospital population. This is given by 𝜌1. |
| HCW-to-community transmission parameter | 𝜷HCW,C | *RHCW->C*/*DC* | *DC* is the mean duration of infectiousness for someone in the community |
| Community-to-HCW transmission parameter | 𝜷C,HCW | *RC->HCW*/*DC* | See above for definition of *DC* |
| Community-to-community transmission parameter | 𝜷C,C | *RC->C*/*DC* | See above for definition of *DC* |
| Hospital discharge rate for patients not hospitalised due to COVID-19 | **𝝁** | 0.2 /day | Mean length of stay is given by 1/𝝁 |
| Hospital discharge rate for patients hospitalised due to COVID-19 | **𝝁’** | 0.05 /day |  |
| Rate of admission to hospital for reasons other than COVID-19 for patients infected with SARS-CoV-2 | *𝛂* | 0.001 /day |  |
| Rate of admission to hospital for patients with COVID-19 infection requiring hospital treatment | *𝛂’* | 0.5 /day |  |
| Progression rate from E1 states to E2 states | 𝛾1 | 0.5 | Corresponds to a latent period with an Erlang distribution with a mean of four days |
| Progression rate from E2 states to I1 states | 𝛾2 | 0.5 |
| Progression rate from I1 states to I2 states | 𝜌1 | 0.3 | Corresponds to an infectious period with an Erlang distribution with a mean of 6.67 days |
| Progression rate from I2 states to R states | 𝜌2 | 0.3 |
| Progression rate from I’ states to R states | 𝜌3 | 0.1 |  |
| Proportion of non-severe hospitalised infected patients who progress to severe infection | 𝜋H | 0.3 |  |
| Proportion of infected people in the community who progress to severe infection | 𝜋C | 0.1 |  |
| Proportion of infected HCWs who progress to severe infection | 𝜋HCW | 0.1 |  |

**1.3 Seroprevalence in healthcare-workers versus the community: international comparisons**

To provide international comparisons, PubMed, Google Scholar and medRxiv were searched for literature published before 16 May 2021 with the main theme on seroprevalence in HCWs during the COVID-19 pandemic. The search terms used were: seroprevalence/antibody, healthcare worker, and SARS-CoV-2/COVID-19. Title, abstract, and full texts of the search results were reviewed. Estimated seroprevalence in HCWs was extracted from the papers and plotted against seroprevalence in the community. The seroprevalence in the community was extracted from the papers directly whenever data were available. For papers not reporting seroprevalence in the community over the same period we searched the literature for the estimates of seroprevalence in the community in the same country and over the most closely matching time period. For seroprevalence of the community, the main source of data for the United Kingdom was<https://www.gov.uk/government/publications/national-covid-19-surveillance-reports/sero-surveillance-of-covid-19>; for the USA it was<https://covid.cdc.gov/covid-data-tracker/#national-lab> and for Italy it was<https://pubmed.ncbi.nlm.nih.gov/32867328/> and <https://www.nature.com/articles/s41467-021-24622-7>.

**2 Supplementary Results**

2.1 Quantifying the number of hospital-acquired infections: sensitivity analyses.

In the main analysis we used aggregate length-of-stay data from all acute trusts combined over a 12 month period. We performed two sensitivity analyses: i) using time-varying length-of-stay data (aggregated over 3 month intervals) and summing interval-specific estimates of hospital-acquired infections; ii) using trust-specific length-of-stay data in the estimation of the number of hospital-acquired infections in each trust. The use of time-varying length of stay data gave estimates (90% CrI) of 144,000 (125,000 , 170,000) hospital-acquired infections under the assumption of day 3 and day 6 screening, and 100,00 (96,000 , 105,00) under the assumption of weekly screening. Corresponding estimates with trust-specific length-of-stay data were 142,000 (123,000 , 168,000) and 99,000 (96,000 , 104,000). Trust-specific estimates excluded data from 8 trusts for which length-of-stay data were not available. These excluded trusts had a combined total of 180 “definite” healthcare-associated infections.

In the main analysis we used as input the number of “definite” healthcare associated infections (those with onset 15 or more days after hospital admission) as input data and estimated the number of hospital-acquired infections by multiplying this by the reciprocal of the probability of hospital-acquired infection being both detected and meeting the 15-day criterion (making use of the length-of-stay distribution, the incubation period distribution, the PCR sensitivity profile and the assumed testing policy in place). As an additional sensitivity analysis we repeated this analysis using instead, as input data, the number of “probable and definite” healthcare associated infections (those with onset 8 or more days after hospital admission) and multiplied this by the inverse of the probability of a hospital-acquired infection being detected and meeting this criterion. With a policy of testing on symptom onset and at 7 day intervals after admission the estimated number of hospital acquired infections (90% CrI) was 122,000 (120,000 , 123,000) while with a policy of testing symptomatic infections and on days 3 and 6 post-admission the corresponding estimate was 189,000 (183,000, 196,000).

2.2 Full results from analysis with negative binomial auto-regressive models

**Outcome 1: Indeterminate, probable and definite healthcare associated infections.**

**Table S3: Model P1.1.1**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 0.07 0.00 0.07 0.00 0.02 0.05 0.10 0.27 18514 1

d (community-acquired) 0.02 0.00 0.01 0.01 0.02 0.02 0.03 0.04 6880 1

b (hospital-acquired) 0.33 0.00 0.03 0.28 0.31 0.33 0.35 0.39 4795 1

c (HCW) 0.03 0.00 0.01 0.02 0.03 0.03 0.03 0.04 6251 1

q (single rooms) -0.09 0.00 0.04 -0.17 -0.12 -0.09 -0.07 -0.02 5439 1

u (heated volume) -0.13 0.00 0.04 -0.22 -0.16 -0.13 -0.10 -0.05 5610 1

s (occupancy) 0.00 0.00 0.03 -0.06 -0.02 0.00 0.02 0.06 5807 1

r (trust size) 0.12 0.00 0.02 0.07 0.10 0.11 0.13 0.16 5287 1

t (trust age) -0.05 0.00 0.03 -0.10 -0.07 -0.05 -0.03 0.01 5352 1

v (vaccine) -2.25 0.01 0.63 -3.50 -2.67 -2.25 -1.83 -1.05 13932 1

nv0 0.48 0.00 0.06 0.37 0.44 0.47 0.51 0.59 7239 1

sigmasq\_a 5.94 0.01 0.94 4.18 5.30 5.91 6.55 7.88 4202 1

sigmasq\_k 0.09 0.00 0.03 0.02 0.07 0.09 0.12 0.16 2515 1

phi0 0.27 0.00 0.03 0.21 0.24 0.26 0.29 0.34 10249 1

k0 0.10 0.00 0.02 0.06 0.09 0.10 0.11 0.15 2473 1

Leave-one-out information criterion: 10587.3

**Table S4: Model P1.1.0**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 0.09 0.00 0.10 0.00 0.03 0.06 0.13 0.36 8515 1

d (community-acquired) 0.06 0.00 0.01 0.05 0.06 0.06 0.07 0.08 12021 1

b (hospital-acquired) 0.54 0.00 0.02 0.49 0.52 0.54 0.55 0.58 10291 1

c (HCW) 0.03 0.00 0.01 0.02 0.03 0.03 0.04 0.04 4709 1

q (single rooms) -0.11 0.00 0.03 -0.16 -0.13 -0.11 -0.09 -0.06 12190 1

u (heated volume) -0.14 0.00 0.03 -0.20 -0.16 -0.14 -0.12 -0.08 11944 1

s (occupancy) 0.00 0.00 0.02 -0.04 -0.01 0.00 0.02 0.04 12423 1

r (trust size) 0.06 0.00 0.02 0.02 0.04 0.06 0.07 0.09 5720 1

t (trust age) -0.06 0.00 0.02 -0.10 -0.07 -0.06 -0.04 -0.02 15728 1

sigmasq\_a 1.19 0.01 0.70 0.08 0.65 1.13 1.64 2.72 2495 1

sigmasq\_k 0.09 0.00 0.03 0.03 0.07 0.09 0.10 0.14 3249 1

phi0 0.39 0.00 0.05 0.30 0.36 0.38 0.42 0.48 13168 1

k0 0.07 0.00 0.02 0.04 0.06 0.07 0.08 0.11 3069 1

Leave-one-out information criterion:10591.7

**Table S5: Model P1.0.0**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 0.06 0.00 0.07 0.00 0.02 0.04 0.08 0.25 7155 1

d (community-acquired) 0.07 0.00 0.01 0.05 0.06 0.07 0.08 0.09 12690 1

b (hospital-acquired) 0.60 0.00 0.02 0.55 0.58 0.60 0.61 0.64 9730 1

c (HCW) 0.03 0.00 0.01 0.02 0.02 0.03 0.03 0.04 3679 1

sigmasq\_a 1.29 0.02 0.75 0.08 0.72 1.26 1.80 2.86 1896 1

sigmasq\_k 0.09 0.00 0.03 0.04 0.07 0.09 0.11 0.14 2752 1

phi0 0.38 0.00 0.04 0.30 0.35 0.37 0.40 0.47 12115 1

k0 0.07 0.00 0.02 0.04 0.06 0.07 0.08 0.10 2484 1

Leave-one-out information criterion: 10607.6

**Outcome 2: Probable and definite healthcare associated infections.**

Probable and definite healthcare associated infections are those with onset/detection eight or more days after the day of hospital admission.

**Table S6: Model P1.1.1**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 0.08 0.00 0.08 0.00 0.02 0.06 0.11 0.30 13074 1

d (community-acquired) 0.02 0.00 0.01 0.01 0.02 0.02 0.03 0.03 5645 1

b (hospital-acquired) 1.07 0.00 0.07 0.93 1.02 1.07 1.11 1.19 5523 1

c (HCW) 0.03 0.00 0.00 0.02 0.02 0.03 0.03 0.04 4199 1

q (single rooms) -0.09 0.00 0.03 -0.14 -0.11 -0.09 -0.07 -0.03 10190 1

u (heated volume) -0.10 0.00 0.03 -0.17 -0.12 -0.10 -0.07 -0.03 9945 1

s (occupancy) 0.01 0.00 0.02 -0.04 -0.01 0.01 0.02 0.05 13533 1

r (trust size) 0.04 0.00 0.02 0.01 0.03 0.04 0.05 0.08 3758 1

t (trust age) -0.04 0.00 0.02 -0.08 -0.05 -0.04 -0.03 0.00 13427 1

v (vaccine) -2.00 0.01 0.59 -3.16 -2.40 -1.99 -1.59 -0.85 11032 1

w (alpha variant) 0.18 0.00 0.06 0.07 0.14 0.18 0.22 0.30 5604 1

sigmasq\_a 0.40 0.01 0.44 0.01 0.10 0.26 0.56 1.64 1621 1

sigmasq\_k 0.12 0.00 0.04 0.03 0.09 0.12 0.14 0.20 1993 1

phi0 0.28 0.00 0.04 0.22 0.26 0.28 0.31 0.36 9354 1

k0 0.11 0.00 0.03 0.06 0.09 0.11 0.13 0.17 1909 1

Leave-one-out information criterion: 8884.7

**Table S7: Model P1.1.0**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 0.08 0 0.07 0.00 0.02 0.05 0.11 0.27 11513 1

d (community-acquired) 0.03 0 0.01 0.02 0.03 0.03 0.04 0.04 11151 1

b (hospital-acquired) 0.60 0 0.03 0.55 0.58 0.60 0.62 0.65 12953 1

c (HCW) 0.02 0 0.00 0.01 0.02 0.02 0.02 0.03 5790 1

q (single rooms) -0.10 0 0.03 -0.16 -0.12 -0.10 -0.08 -0.04 13043 1

u (heated volume) -0.10 0 0.03 -0.17 -0.13 -0.10 -0.08 -0.04 11074 1

s (occupancy) 0.01 0 0.02 -0.03 0.00 0.01 0.03 0.06 14400 1

r (trust size) 0.04 0 0.02 0.01 0.03 0.04 0.05 0.07 7975 1

t (trust age) -0.04 0 0.02 -0.08 -0.06 -0.04 -0.03 0.00 14289 1

sigmasq\_a 0.33 0 0.28 0.01 0.11 0.25 0.46 1.05 3674 1

sigmasq\_k 0.11 0 0.04 0.03 0.09 0.12 0.14 0.19 2235 1

phi0 0.33 0 0.04 0.26 0.30 0.33 0.36 0.42 13389 1

k0 0.10 0 0.03 0.06 0.08 0.10 0.12 0.16 2074 1

Leave-one-out information criterion: 9196.4

**Table S8: Model P1.0.0**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 0.06 0.00 0.06 0.00 0.02 0.04 0.08 0.23 10293 1

d (community-acquired) 0.04 0.00 0.01 0.02 0.03 0.04 0.04 0.05 15490 1

b (hospital-acquired) 0.66 0.00 0.03 0.61 0.64 0.66 0.68 0.71 15446 1

c (HCW) 0.02 0.00 0.00 0.01 0.02 0.02 0.02 0.03 5272 1

sigmasq\_a 0.41 0.01 0.33 0.01 0.15 0.34 0.61 1.20 3448 1

sigmasq\_k 0.12 0.00 0.04 0.03 0.09 0.12 0.14 0.19 2292 1

phi0 0.32 0.00 0.04 0.25 0.29 0.32 0.34 0.40 14926 1

k0 0.10 0.00 0.03 0.06 0.08 0.10 0.11 0.16 2020 1

Leave-one-out information criterion: 9207.9

**Outcome 3: Definite healthcare associated infections.**

Definite healthcare associated infections are those with onset/detection 15 or more days after the day of hospital admission.

**Table S9: Model P1.1.1**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 0.04 0.00 0.04 0.00 0.01 0.03 0.06 0.15 13701 1

d (community-acquired) 0.01 0.00 0.00 0.01 0.01 0.01 0.02 0.02 7688 1

b (hospital-acquired) 0.56 0.00 0.04 0.49 0.54 0.56 0.58 0.63 8462 1

c (HCW) 0.01 0.00 0.00 0.01 0.01 0.01 0.02 0.02 4488 1

q (single rooms) -0.10 0.00 0.03 -0.16 -0.12 -0.10 -0.07 -0.03 9970 1

u (heated volume) -0.06 0.00 0.04 -0.14 -0.09 -0.06 -0.04 0.02 9598 1

s (occupancy) 0.02 0.00 0.03 -0.04 0.00 0.02 0.04 0.08 11123 1

r (trust size) 0.03 0.00 0.02 -0.01 0.01 0.03 0.04 0.07 6889 1

t (trust age) -0.04 0.00 0.02 -0.09 -0.05 -0.04 -0.02 0.01 12478 1

v (vaccine) -1.64 0.01 0.63 -2.89 -2.06 -1.63 -1.21 -0.43 10917 1

w (alpha variant) 0.08 0.00 0.07 -0.05 0.03 0.08 0.12 0.22 7235 1

sigmasq\_a 0.13 0.00 0.13 0.00 0.03 0.09 0.18 0.47 3272 1

sigmasq\_k 0.35 0.00 0.07 0.21 0.30 0.34 0.39 0.50 3992 1

phi0 0.34 0.00 0.04 0.26 0.31 0.33 0.36 0.43 10230 1

k0 0.07 0.00 0.03 0.02 0.05 0.07 0.09 0.15 2608 1

Leave-one-out information criterion: 7380.5

**Table S10: Model P1.1.0**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 0.04 0 0.04 0.00 0.01 0.03 0.06 0.15 12237 1

d (community-acquired) 0.02 0 0.00 0.01 0.02 0.02 0.02 0.03 9555 1

b (hospital-acquired) 1.02 0 0.05 0.91 0.98 1.02 1.05 1.12 12117 1

c (HCW) 0.01 0 0.00 0.01 0.01 0.01 0.01 0.02 4661 1

q (single rooms) -0.11 0 0.04 -0.18 -0.14 -0.11 -0.09 -0.05 11102 1

u (heated volume) -0.08 0 0.04 -0.16 -0.11 -0.08 -0.05 0.00 10383 1

s (occupancy) 0.02 0 0.03 -0.03 0.00 0.02 0.04 0.08 12640 1

r (trust size) 0.04 0 0.02 0.00 0.02 0.04 0.05 0.08 7417 1

t (trust age) -0.05 0 0.03 -0.10 -0.06 -0.05 -0.03 0.00 14738 1

sigmasq\_a 0.16 0 0.16 0.00 0.04 0.11 0.22 0.57 2838 1

sigmasq\_k 0.32 0 0.07 0.19 0.28 0.32 0.37 0.47 4855 1

phi0 0.37 0 0.04 0.29 0.34 0.37 0.40 0.46 13262 1

k0 0.07 0 0.03 0.02 0.05 0.07 0.09 0.14 3477 1

Leave-one-out information criterion: 7396.1

**Table S11: Model P1.0.0**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 0.03 0 0.03 0.00 0.01 0.02 0.04 0.13 9101 1

d (community-acquired) 0.02 0 0.00 0.01 0.02 0.02 0.02 0.03 11485 1

b (hospital-acquired) 0.63 0 0.03 0.58 0.61 0.63 0.65 0.69 13361 1

c (HCW) 0.01 0 0.00 0.00 0.01 0.01 0.01 0.01 3871 1

sigmasq\_a 0.29 0 0.18 0.01 0.14 0.27 0.40 0.67 3020 1

sigmasq\_k 0.35 0 0.07 0.22 0.30 0.35 0.40 0.49 6169 1

phi0 0.35 0 0.04 0.28 0.32 0.35 0.38 0.45 9178 1

k0 0.06 0 0.03 0.01 0.04 0.06 0.08 0.13 3820 1

Leave-one-out information criterion: 7390.5

**Outcome 4: HCW infections.**

HCW infections are imputed from trust data on the number of HCWs absent due to COVID-19 on each day, assuming that each absence lasts for a period of 10 days.

**Table S12: Model P1.1.1**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 9.36 0.01 0.95 7.47 8.71 9.36 10.01 11.24 9942 1

d (community-acquired) 0.08 0.00 0.01 0.06 0.07 0.08 0.09 0.11 22430 1

b (hospital-acquired) 0.89 0.00 0.11 0.67 0.81 0.89 0.96 1.11 24263 1

c (HCW) 0.07 0.00 0.01 0.05 0.06 0.07 0.07 0.08 22559 1

q (single rooms) 0.06 0.00 0.04 -0.01 0.04 0.06 0.09 0.13 7433 1

u (heated volume) -0.01 0.00 0.04 -0.09 -0.03 0.00 0.03 0.08 7482 1

s (occupancy) 0.03 0.00 0.03 -0.04 0.00 0.03 0.05 0.10 7262 1

r (trust size) 0.39 0.00 0.03 0.34 0.37 0.39 0.41 0.45 6482 1

t (trust age) 0.01 0.00 0.03 -0.05 -0.01 0.01 0.03 0.07 7345 1

v (vaccine) -0.30 0.00 0.19 -0.67 -0.43 -0.30 -0.18 0.07 16531 1

w (alpha variant) 0.89 0.00 0.06 0.78 0.85 0.89 0.93 1.00 14827 1

sigmasq\_a 18.45 0.00 0.65 17.16 18.01 18.45 18.89 19.71 17039 1

sigmasq\_k 0.02 0.00 0.00 0.02 0.02 0.02 0.02 0.03 9670 1

phi0 0.99 0.00 0.08 0.84 0.94 0.99 1.04 1.14 11187 1

k0 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 26116 1

Leave-one-out information criterion: 17804.3

**Table S13: Model P1.1.0**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 9.39 0.01 1.00 7.44 8.71 9.39 10.06 11.35 10288 1

d (community-acquired) 0.15 0.00 0.01 0.13 0.14 0.15 0.16 0.17 15782 1

b (hospital-acquired) 0.71 0.00 0.06 0.60 0.67 0.71 0.75 0.83 16005 1

c (HCW) 0.09 0.00 0.01 0.07 0.08 0.09 0.09 0.10 14377 1

q (single rooms) 0.03 0.00 0.03 -0.04 0.01 0.03 0.05 0.10 5070 1

u (heated volume) -0.01 0.00 0.04 -0.10 -0.04 -0.01 0.02 0.07 5131 1

s (occupancy) 0.10 0.00 0.04 0.03 0.07 0.09 0.12 0.16 5319 1

r (trust size) 0.39 0.00 0.03 0.34 0.37 0.39 0.42 0.46 3864 1

t (trust age) 0.00 0.00 0.03 -0.06 -0.02 0.00 0.02 0.06 5867 1

sigmasq\_a 20.84 0.01 0.66 19.57 20.40 20.84 21.28 22.13 12798 1

sigmasq\_k 0.02 0.00 0.00 0.02 0.02 0.02 0.02 0.03 7808 1

phi0 0.93 0.00 0.07 0.80 0.88 0.93 0.97 1.06 10680 1

k0 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 25752 1

Leave-one-out information criterion: 17867.3

**Table S14: Model P1.0.0**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 9.27 0.01 0.95 7.42 8.61 9.28 9.91 11.11 9802 1

d (community-acquired) 0.16 0.00 0.01 0.14 0.15 0.16 0.17 0.19 22771 1

b (hospital-acquired) 0.78 0.00 0.06 0.67 0.74 0.78 0.82 0.90 21310 1

c (HCW) 0.10 0.00 0.01 0.09 0.10 0.10 0.11 0.12 18849 1

sigmasq\_a 20.79 0.01 0.69 19.43 20.32 20.79 21.25 22.14 16335 1

sigmasq\_k 0.02 0.00 0.00 0.01 0.02 0.02 0.02 0.02 9573 1

phi0 0.94 0.00 0.07 0.81 0.90 0.94 0.99 1.08 10377 1

k0 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 25615 1

Leave-one-out information criterion: 18090.4

**Outcome 5: Negative control outcome - admissions of patients with confirmed community-acquired Covid-19 infections.**

Results below give output from auto-regression models where the dependent variable is a negative control given by the weekly number of confirmed community-acquired COVID-19 admissions to each trust. This is a negative control in the sense that many factors that might be supposed to causally affect the rate of hospital transmission in a trust (such as factors related to the hospital buildings) would not, in general, be expected to have a large impact on the admissions of community-acquired cases. For such covariates associations of similar magnitude and in the same direction for both the outcome of interest and for the negative control outcome can therefore provide evidence against there being a direct causal effect.

**Table S15: Model P1.1.1**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

adm\_coeff 0.29 0.00 0.02 0.25 0.27 0.29 0.30 0.32 749 1

b (hospital-acquired) 0.04 0.00 0.02 0.01 0.03 0.04 0.06 0.08 779 1

c (HCW) 0.01 0.00 0.00 0.00 0.01 0.01 0.01 0.02 186 1

q (single rooms) 0.03 0.00 0.04 -0.05 0.00 0.03 0.05 0.09 266 1

u (heated volume) -0.09 0.00 0.05 -0.18 -0.12 -0.09 -0.06 0.02 286 1

s (occupancy) 0.06 0.00 0.04 -0.02 0.03 0.06 0.09 0.14 182 1

r (trust size) 0.11 0.00 0.02 0.06 0.09 0.11 0.12 0.15 341 1

t (trust age) 0.02 0.00 0.03 -0.04 0.00 0.02 0.04 0.08 361 1

v (vaccine) -1.42 0.03 0.73 -2.85 -1.92 -1.43 -0.91 -0.03 522 1

w (alpha variant) 0.86 0.00 0.05 0.77 0.83 0.85 0.89 0.95 721 1

sigmasq\_k 0.54 0.00 0.09 0.37 0.48 0.54 0.60 0.72 518 1

phi0 0.11 0.00 0.02 0.07 0.09 0.11 0.12 0.16 463 1

k0 0.07 0.00 0.03 0.02 0.05 0.06 0.08 0.12 237 1

Leave-one-out information criterion: 7838.9

**Table S16: Model P1.1.0**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

adm\_coeff 0.41 0 0.03 0.36 0.39 0.41 0.43 0.46 342 1.01

b (hospital-acquired) 0.15 0 0.03 0.09 0.13 0.15 0.17 0.21 441 1.00

c (HCW) 0.02 0 0.00 0.01 0.01 0.02 0.02 0.02 302 1.00

q (single rooms) -0.10 0 0.04 -0.19 -0.13 -0.10 -0.08 -0.02 223 1.00

u (heated volume) -0.05 0 0.06 -0.17 -0.09 -0.05 -0.01 0.06 207 1.00

s(occupancy) 0.17 0 0.04 0.08 0.14 0.17 0.19 0.25 175 1.00

r (trust size) 0.12 0 0.02 0.08 0.11 0.12 0.14 0.17 331 1.00

t (trust age) 0.02 0 0.04 -0.07 0.00 0.02 0.05 0.10 166 1.00

sigmasq\_k 0.41 0 0.06 0.31 0.37 0.41 0.45 0.54 363 1.00

phi0 0.11 0 0.02 0.07 0.09 0.10 0.12 0.14 723 1.00

k0 0.03 0 0.01 0.01 0.02 0.03 0.04 0.06 233 1.02

Leave-one-out information criterion: 8165.4

**Table S17: Model P1.0.0**

mean se\_mean sd 2.5% 25% 50% 75% 97.5% n\_eff Rhat

a0 (intercept) 0.11 0.00 0.11 0.00 0.03 0.08 0.15 0.42 1568 1

adm\_coeff 0.42 0.00 0.03 0.37 0.41 0.42 0.44 0.48 955 1

b (hospital-acquired) 0.19 0.00 0.03 0.13 0.17 0.19 0.21 0.25 1198 1

c (HCW) 0.02 0.00 0.00 0.01 0.02 0.02 0.03 0.03 719 1

sigmasq\_a 13.60 0.09 1.91 10.39 12.22 13.43 14.88 17.55 485 1

sigmasq\_k 0.44 0.00 0.06 0.33 0.40 0.43 0.47 0.56 617 1

phi0 0.10 0.00 0.02 0.07 0.09 0.10 0.11 0.14 1536 1

k0 0.01 0.00 0.01 0.00 0.01 0.01 0.02 0.03 237 1

Leave-one-out information criterion: 8194.5

**2.3 Generation and analysis of synthetic data**

Synthetic data were generated using three steps:

1. Fully observed daily infection data were generated for the number of infected HCWs and the number of hospital-acquired infections. This was done by, for each infected individual of type *x* (where *x* may be a patient infected in the community (*C*), a patient infected in hospital (*P*), or a HCW (*H*)) : i) generating a number of secondary cases sampled from a negative binomial distribution with mean + and dispersion parameter 0.5, where and represent the expected number of secondary cases in patients and, respectively, HCWs, generated by one infected individual of type *x*; ii) assigning these new infections to patients and HCWs by sampling from binomial distributions where the number of trials was equal to the number of secondary cases generated in i) and the probability the infection was in a patient was given by ; iii) choosing the day of new infections by sampling generation intervals from a Weibull distribution with shape 2.83 and scale 5.67 [30](https://paperpile.com/c/VM68rO/jaCik).
2. Sampling the number of observed infections of each type for each day from binomial distributions where the number of trials was equal to the number of infections of each type and each day (generated in step 1) and the probability of “success” was the probability of observing (and correctly classifying) each type of infection (which was varied in the simulations).
3. Weekly aggregated data for each trust were created by summing the number of observed infections generated in step 2 over seven day intervals within each trust.

The above procedure was used to generate synthetic data for each trust, taking as input the daily number of observed community-acquired infections for each trust, and generating as output the weekly number of observed hospital-acquired infections in patients and HCWs. Simulated data thus generated were then analysed with negative binomial regression models with an identity link function where the dependent variable was either the simulated number of observed hospital-acquired infections or the simulated number of infections in HCWs observed for trust *i* in week *j* and where the independent variables were the numbers of observed HCW infections, hospital-acquired patient infections and admitted patients with community-acquired infections in trust *i* and week *j-1*.

**2.4 Seroprevalence in HCWs versus the community: international comparisons**

A total of 195 relevant studies and 1 systematic review paper were found. Of the 195 studies, 110 were done in Europe (of which 23 were done in the United Kingdom), 40 papers reported seroprevalence among HCWs in North America, 31 studies were in Asian countries, 8 studies were in African countries, 2 studies were in Turkey, 1 study was from Russia, 1 study was from South America, 1 study was from Australia, and 1 was a multinational study (Figure S9). The studies varied in sample size from 24 to 61,910 HCWs. The type of antibody detected in the seroprevalence studies included IgA, IgM and IgG, and some used in-house antibiotic tests, while others used commercial point of care tests. Overall, the seroprevalence in HCWs ranged from 0% to 81%, and that in the general community ranged from 0.1% to 73%.