DELVE Scoping report on hospital and health care acquisition of COVID-19 and its control

# Executive summary

* The focus of this report is on SARS-CoV-2 infection acquired in hospital. It is timed to inform decisions about the opening up of hospitals and other healthcare settings for non-COVID-19 activities and NHS plans for winter and future waves of COVID-19.
* Transmission of COVID-19 in hospitals and social care settings in patients, residents and staff has been recognised as an important feature of the COVID-19 epidemic throughout the world; efforts to prevent infections have had varying success. Transmissions early in the epidemic reflected evolving understanding of the disease (e.g., the risk of asymptomatic infection and role of masks in source control) and limited access to testing and personal protective equipment.
* Infections in hospital have important implications for infection outcomes (hospitalised patients and some staff are at higher risk), workforce planning (healthcare workers being unable to work during peak pressure periods), and amplification of community transmission (through discharge of infectious patients and transmission to families and other contacts from healthcare workers and patients).
* Using publicly available data we estimate that at least 9% (95% confidence interval: 4-14%) of all COVID-19 infections in England were among patient-facing healthcare workers and resident-facing social care workers during the period from 26th April to 7th June 2020. An estimated further 1% of infections in this period were acquired by inpatients in hospital, with additional infections among care home residents (2-16% of all infections). This does not consider secondary cases arising from hospital acquired infections elsewhere.
* Although surveillance systems and large-scale hospital-based studies have recently been set up, there remain gaps in availability of surveillance data on hospital-acquired infections, particularly of healthcare workers (including agency staff) and in nursing homes; important questions remain unanswered, including about the impact on Black, Asian and minority ethnic (BAME) health and social care workers.
* At present, there is no single organisation with clear oversight of hospital-related infection surveillance, monitoring and response. Data obtained from surveillance, monitoring and outbreak investigations need to feed into epidemiological and modelling research, including to evaluate interventions.There remain significant opportunities to link epidemiological and phylogenetic datasets to improve the ability to identify and respond to changing epidemic dynamics.
* In recent weeks, there have been significant improvements reported in data collection and prevention of hospital acquired infection, but the data are not yet publicly available to assess the impact of changes and these are urgently needed.
* The report considers what further actions are needed to build comprehensive surveillance and infection control systems, with awareness that this would require further resources and expert support to the hospital, public health and care sectors. It sets out a suggested framework for effective centralised surveillance and monitoring of hospital acquired infections, linked to rapid infection control responses with sharing of best practice, coordinated through local teams. In the medium-term, we envisage an ambitious and comprehensive approach to prevention of infection transmitted through respiratory droplets and aerosol routes in hospitals, of the breadth and scale successfully implemented for methicillin-resistant *Staphylococcus aureus* (MRSA).

This paper has drawn on evidence available up to 28 June 2020. Further evidence on this topic is constantly published and DELVE may return to this topic in the future. This independent overview of the science has been provided in good faith by subject experts. DELVE and the Royal Society accept no legal liability for decisions made based on this evidence. Cite as: DELVE Initiative (2020) DELVE Scoping report on hospital and health care acquisition of COVID-19 and its control. Report No. 3. Published 6 July 2020.

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# Problem statement

Despite recent declines in COVID-19 cases there remains a significant risk of future epidemic waves, which may overlap with other pressures on the NHS and care system (particularly influenza, but also other infections) over the winter. There is an urgent need to safely open up hospitals to provide non-COVID-19 inpatient and outpatient care. There has been substantial heterogeneity in hospital acquired infection rates, in trust-level infection control responses and in policies across the devolved national administrations. Systematic data collection over the course of the epidemic thus far has been insufficient to identify the extent, sources and risks for hospital acquired transmission and to allow effective targeted outbreak response and infection control. Substantial recent investments have, however, been made to improve surveillance and control, but comprehensive, accessible national data are currently limited. For example, the absolute number of healthcare workers affected is unknown, as is the time and place of acquisition of infection. This lack of information is of particular importance in the case of Black, Asian and minority ethnic (BAME) healthcare workers amid widespread concerns that their mortality from COVID-19 exceeds their representation in the work force. Similarly, there has been only limited exploration of the extent to which hospital acquired transmission amplifies wider community spread, including to and from institutional settings such as care homes, especially when there was a lack of testing capacity within the NHS and social care.

This report provides an outline of the considerations in building a robust surveillance and response system to prevent future hospital acquired COVID-19 outbreaks. It will:

1. consider key areas to address in the hospital response;
2. highlight evidence gaps in understanding hospital-related transmission;
3. identify broad areas for systematic interventions.

# Background

Hospitals are high-risk sites for COVID-19 transmission because:

1. physical distancing is not always possible, leading to unavoidable close contacts between healthcare workers and patients, and contact between health workers on wards, non-patient and rest areas;
2. they can be sites of inadvertent mixing of COVID-19-infected and uninfected patients, for example, due to asymptomatic cases that are unrecognised as infectious;
3. many hospitalised patients and some staff are more vulnerable to COVID-19 infection and its complications – due to higher prevalence of both comorbid conditions and other risk factors (e.g., socioeconomic status, ethnicity);
4. healthcare workers and patients may transmit the infection into the community, including to their families, contacts and to highly vulnerable populations in care homes.

Prevention of hospital-acquired infections – among both staff and patients – could substantially impact epidemic transmission and help limit resurgence. Healthcare worker infections are important both because of the impact on their personal health, the risk of transmission to patients, and because they lead to loss of key healthcare providers for prolonged periods, both when infected and when required to quarantine, often at the time of maximum strain on the workforce. Hospital-acquired patient infections pose a greater clinical concern than community-acquired ones because complication rates for those hospitalised for other reasons are higher than in the wider population. Since hospitals connect a wide range of households and institutions within their communities, hospital-acquired infections can seed infections in care homes and other residential institutions, their surrounding communities and within the hospital itself (see Figure 1).

The primary focus of this report will be on transmission occurring within the hospital setting (acknowledging that identifying such transmissions has challenges). We recognise that these transmissions can have wider impact, due to the movement of individuals between hospitals and care homes, shared staff housing and other community settings. While we will not cover policies for these extra-hospital movements (and related infections) in detail, we will consider hospital practices that might amplify wider community transmission.

Despite the absence of systematic data on hospital-acquired infections, there is little doubt that they have been substantial. A recent modelling study estimated that 20% of inpatient infections, and up to 89% of healthcare worker infections, were hospital acquired.[[1]](#footnote-1) In a major London teaching hospital, 15% of inpatients with COVID-19 from 2nd March to 12th April 2020 had a hospital-acquired infection, with a case fatality rate of 36%.[[2]](#footnote-2) The Dynamic COVID-19 Clinical Information Network (CO-CIN) report to SAGE and NERVTAG, which captures data on those testing positive within healthcare settings, estimated that at the end of March, 10% of inpatients with COVID-19 had acquired their infection in hospital.[[3]](#footnote-3)

Comprehensive data on the scale of healthcare worker infections are limited. However, healthcare worker COVID-19 prevalence was estimated to be nearly six times higher than in the general population in England based on PCR testing (1.87% (1.07%-3.02%) tested positive compared to 0.32% (0.25%-0.44%) in the general population).[[4]](#footnote-4) In one London hospital, over a one-month period during the peak of the epidemic in March and April 2020, 45% of tested clinical staff were antibody-positive and 21% nucleic acid test positive at some point; most had no symptoms [5]. Such asymptomatic or mildly symptomatic healthcare workers are particularly concerning because both groups may pose an unrecognised transmission risk to others in the hospital and in the community. Two surveys in UK hospitals have found 57% (17/30, 95%CI: 37-75%) and 81% (34/42, 95%CI: 66-91%) of PCR-positive workers to have few or no symptoms.[[5]](#footnote-5) [[6]](#footnote-6) Mildly symptomatic healthcare workers may continue working for the first few days of illness; at one Seattle hospital 61% of infected healthcare workers with mild symptoms continued to work.[[7]](#footnote-7) Limiting infection control precautions to those with identified compatible symptoms will therefore be insufficient.

Using publicly available data, we estimate that at least 10% (95% CI: 4-15%) of all COVID-19 infections in England between 26th April and 7th June were among patient-facing healthcare workers and resident-facing social care workers (Annex 1). However, we emphasise that we cannot determine from the ONS data source the proportion of infections that were occupationally acquired. During the same period, we estimate that at least 1% of all COVID-19 infections were inpatients who acquired their infection in hospital, and that 6% (95% CI: 4-8%) of all COVID-19 infections were care home residents. The wide range of confidence intervals presented partly reflect the limited publicly available data. All our calculations are based on plausible, conservative estimates. They do not consider the unknown fraction of secondary cases arising from healthcare-acquired infections or the associated mortality, which has been concentrated in hospital and care home cases (Figure 2).

Hospital outbreaks (two or more linked infections) remain ongoing even as the number of cases is dropping nationwide; 31 were reported in England between June 1st and 7th and 21 in the following week.[[8]](#footnote-8) [[9]](#footnote-9) Data from CO-CIN highlight that the absolute number of patients with definite hospital-acquired infection (symptoms arose ≥14 days after admission) began to rise from mid-March, peaking around 1st April. However, the proportion of all patients with COVID-19 who had hospital-acquired infection did not peak until 1st May (Figure 3). Large clusters of infections have been publicly reported in three acute care hospitals (Addenbrookes, Western General, Weston General); the Addenbrookes outbreak involved multiple clusters of infection, including both patients and healthcare workers, although the mechanisms and directions of transmissions are not yet well understood.[[10]](#footnote-10) This combination of larger and smaller outbreaks highlights the heterogeneity in COVID-19 hospital-acquired infections and may reflect differences in infection prevention and control measures implemented by trusts. However, it is clear that most hospital-acquired COVID-19, both of patients and healthcare workers, can be prevented if optimal infection prevention and control practices are followed, as exemplified by both international and domestic experiences, even in the more difficult to control care home setting.[[11]](#footnote-11) [[12]](#footnote-12) [[13]](#footnote-13) [[14]](#footnote-14) [[15]](#footnote-15) [[16]](#footnote-16) [[17]](#footnote-17)

Figure 1. Schematic of the flow of individuals and possible routes of infection in and around hospital settings

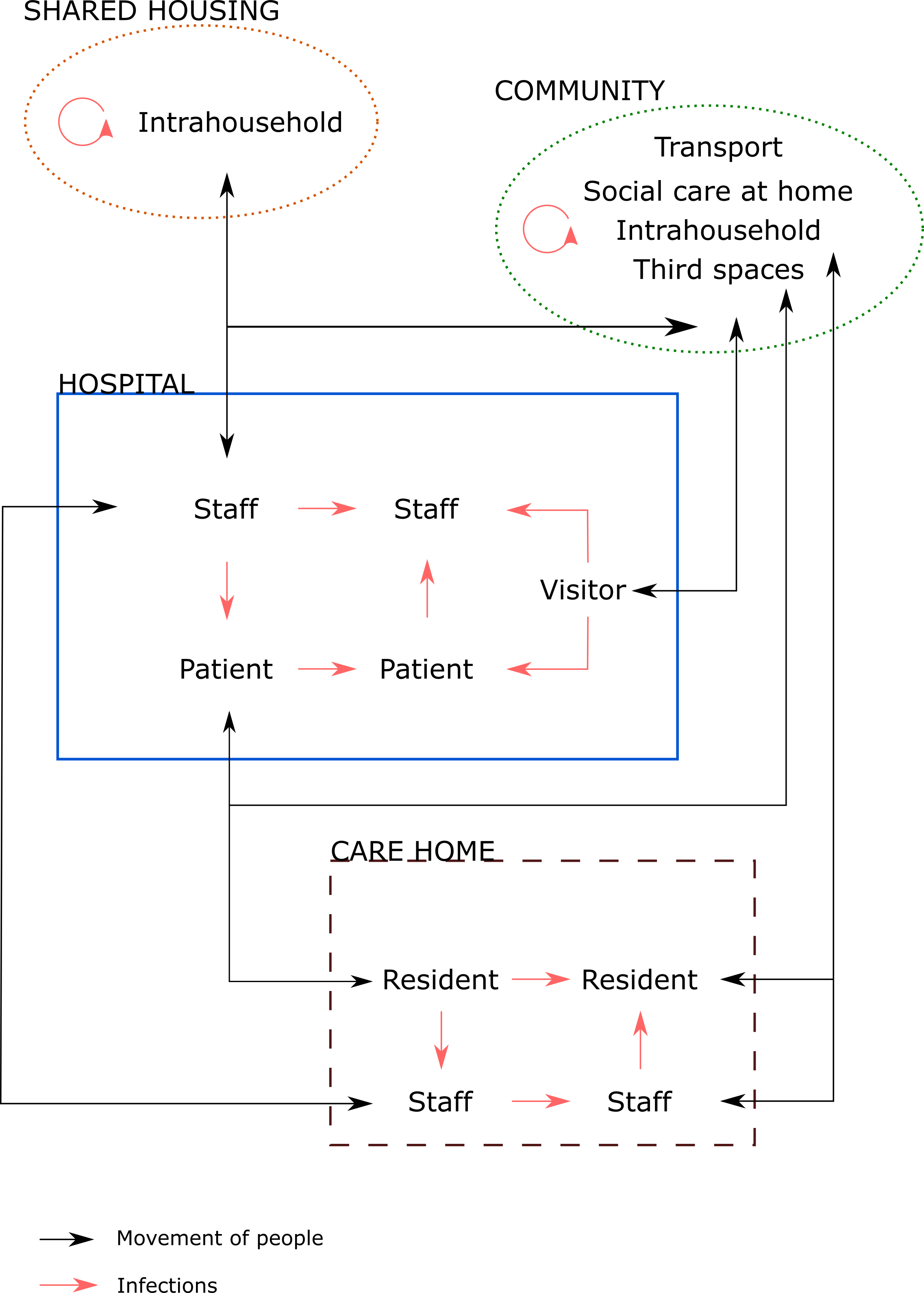
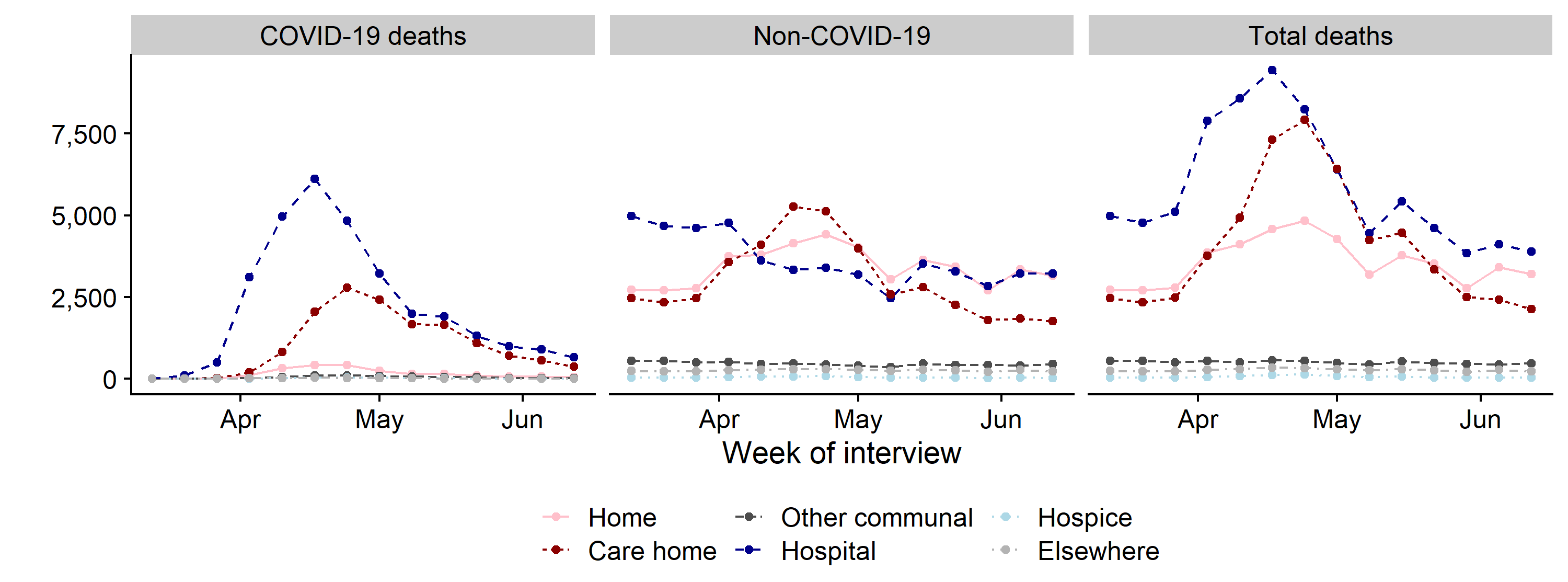
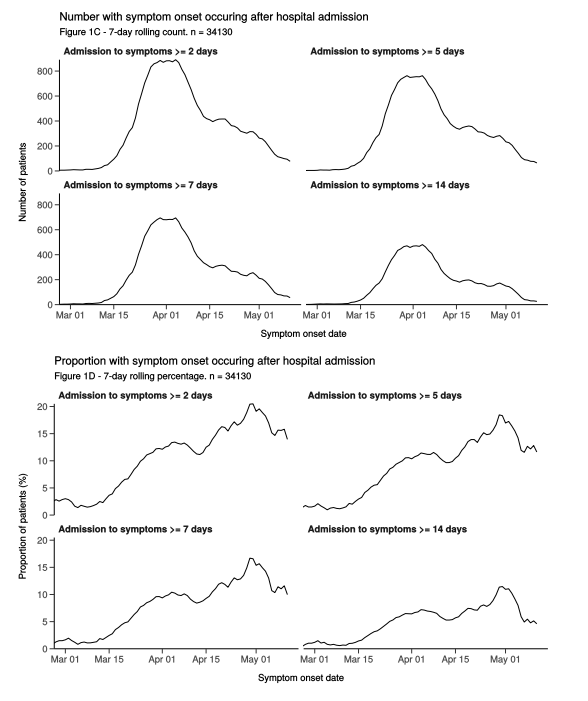


Figure 2. Weekly mortality in England and Wales by place of occurrence



Source: Adapted from *Deaths registered weekly in England and Wales, provisional*.[[18]](#footnote-18)

Figure 3. Number and proportion of patients with COVID-19 with symptom onset after hospital admission

  
Source: *Dynamic CO-CIN report to SAGE and NERVTAG, 21 May 2020[[19]](#footnote-19)*

# Current sources and gaps in understanding of hospital-related COVID-19 transmission

In order to address and minimise the risks of hospital transmission, there is a need for better evidence on how it arises (key transmission routes), who it affects (time, person and place), and how it is propagated onwards (transmission mechanism). We recognise that important steps have been taken during the epidemic to date and the challenges of updating systems in the midst of a pandemic. Initial problems with PPE supply and limited test availability, which restricted PCR testing for staff, have been resolved. Steps have included a review of approaches to understanding how COVID-19 spreads in hospitals early in the epidemic.[[20]](#footnote-20) Recommendations for changes to environmental procedures in hospitals were made to the Scientific Advisory Group for Emergencies (SAGE) in mid-May,[[21]](#footnote-21) masks in healthcare settings were mandated from 15 June 2020,[[22]](#footnote-22) and a recent letter to all Trusts from NHS England highlighted best practice for infection reporting, and outbreak management.[[23]](#footnote-23) A great deal of information on COVID-19 in hospitals has also been collected, including several nationwide efforts. These include:

1. *COVID-19 Clinical Information Network (CO-CIN)*.[[24]](#footnote-24) This network captures around half of all hospitalisations with COVID-19, adding hand-collected demographics and hospital episode data to positive COVID-19 test results. This is resource intensive and misses some cases but generates a rich dataset. CO-CIN has been reporting to SAGE regularly since 1st April.[[25]](#footnote-25)
2. *SIREN study*. Public Health England (PHE) is conducting a study to evaluate the level of antibodies in 100,000 healthcare workers and determine the level of protective immunity past infection may offer (Susan Hopkins, personal communication). While longitudinal in design, SIREN uses a convenience sample and thus will be subject to selection bias.
3. *NHS Situation Reports*. Since late May, the NHS has been compiling a weekly national SitRep on the COVID-19 situation; these are not currently publicly available.
4. *PHE dashboard*. PHE is developing a dashboard that links several routine datasets to estimate the number and proportion of hospital acquired COVID-19 infections at NHS Trust level (Susan Hopkins, personal communication). These datasets include Pillar 1 COVID-19 laboratory test results (Second Generation Surveillance System (SGSS)), hospital episodes statistics (HES) and Emergency Care discharge summaries. This project uses existing routinely available datasets. However, data processing and identification of hospital-acquired cases requires careful assumptions and there are points where information can be lost. The dashboard does not include detailed epidemiological data and is unable to capture healthcare worker infections.
5. *Office for National Statistics (ONS) survey*.[[26]](#footnote-26) The ONS has been conducting regular population-based surveys since late May, including capturing information on whether participants are healthcare workers. Non-response for these surveys is substantial (over 60% for the pilot study), which may lead to bias even after weighting procedures, and information on hospital acquisition is not available. However, this dataset provides regular, well-powered evidence on trends in prevalence.
6. *COVID Symptom Study smartphone application*. Developed by a private company (ZOE) and researchers at Kings College London, this app allows users to track their symptoms and pool information for analysis. While this produces a non-random sample of participants, data from this study has been used to estimate that healthcare workers in the UK and US had over 11 times the hazard of having tested positive for COVID-19, and 3.4 time the hazard after adjusting for likelihood of having tested.[[27]](#footnote-27)
7. *COVID-19 in care homes (VIVALDI) study*.[[28]](#footnote-28) This cohort study aims to observe what proportion of 11,500 care home staff and residents have been previously infected with SARS-CoV-2 at baseline, and through serial antibody and PCR testing and data linkage with NHS and other sources, estimate how many become infected and the duration of the antibody response. Initial high-level results were published on 3rd July.[[29]](#footnote-29)

While these various sources provide substantial data, each of them has limitations, and triangulation between them has not been systematically conducted to date. Moreover, data from these systems are not normally publicly available, although some (e.g., ONS, CO-CIN) are available on request through a governed process. As a result, there are a number of key information gaps that limit our ability to understand and tackle hospital acquired infections:

1. *Patient infections*. While the identities (and thus socio-demographics and comorbidities) of individuals testing positive are often captured, the time and place of onset (and thus possible transmission source) is not documented in a consistent or coordinated manner. This information, in conjunction with systematic surveillance data from residential care settings (which is currently also lacking) can help determine where improved infection prevention and control measures are required. A short standardised reporting system for each positive result (similar to systems previously used for methicillin-resistant *Staphylococcus aureus* and *Clostridioides difficile*) could help with this along with root-cause analysis, as recently requested by NHS England;[[30]](#footnote-30) Trust-level reporting of probable and definite healthcare-associated COVID-19 infections, is required since COVID-19 is a notifiable disease; however these data are not yet publicly available.
2. *Healthcare worker infections*. Although SIREN, a large-scale healthcare worker survey to measure prevalence and incidence has been established recently, data on healthcare worker acquisition have been substantially more limited than on patients. Comprehensive information will be needed including time of onset, time and place (hospital setting, other institution, home) of possible acquisition, relevant exposures, role/occupation, risk factors, comorbidities and socio-demographics. Addressing concerns about excess morbidity and mortality in BAME healthcare workers requires data such as these. While testing of healthcare worker and social care staff is being conducted, alongside widespread PCR and antibody testing (Pillars 1,2 and 4[[31]](#footnote-31)), comprehensive data sampling frames, analyses and results are not currently available.
3. *Population-level staffing*. Agency and other mobile staff may have been implicated in several institutional COVID-19 outbreaks, however, very little is known about how outbreaks relate to staff absences and the use of temporary staff (which itself may facilitate transmission between healthcare settings). Comprehensive data on staff sickness and other absences, and temporary staff arrival and mobility, would allow identification of patterns predictive of outbreak risk and targeted prevention interventions, and enable better workplace planning.
4. *Hospital outbreak investigations*. Effective interventions to stop transmission within hospitals require systematic investigations directly linked to recommendations for infection prevention and control changes. Such investigations are the responsibility of Trust Directors of Infection Prevention and Control (DIPC) and guidance has recently been strengthened.[[32]](#footnote-32) These changes could be monitored using local or regional assistance and peer learning from hospitals that have successfully eliminated outbreaks. While greater involvement of local PHE Health Protection Teams (led by consultants in communicable disease control (CCDC)) and Local Authority Directors of Public Health (DsPH) has commenced, there is no comprehensive national database on the nature or outcomes of these investigations. Such a database would allow an evidence base to be built, from which learning and interventions can be optimised.
5. *Data linkage*. Effective interpretation and use of all the above information rely on joined-up data. This includes linkages between: i) hospitals and their local community, including related care institutions; and ii) epidemiological and phylogenetic data to understand the characteristics of individuals with linked infections and make valid inferences about likely transmission events.
6. *Systematic PHE involvement.* The current situation, where PHE and local public health specialists can only investigate hospital acquired outbreaks when invited to do so by the local hospital trust is not conducive to full understanding of the national situation.

In establishing the Joint Biosecurity Centre (JBC), several of these gaps may be addressed by bringing together new and existing initiatives, including Test and Trace and outbreak investigations, into a comprehensive, centralised surveillance system capturing all infections acquired by patients and healthcare workers and any onward transmission. Data collected in the areas listed above will be synergistic in providing benefits. The availability of the above data will enable key questions to be answered, either directly or via modelling based on these parameters as inputs. Key questions include, but are not limited to:

1. Does patient acquisition/outcome differ by occupation, clinical setting, ethnicity and social deprivation?
2. What are the relative contributions of transmission pathways (patient to patient, patient to staff, staff to staff, etc (see Figure 1))?
3. What are the relative contributions of transmission locations (wards, theatres, bathrooms, shared staff spaces) and modes (direct droplet, aerosol, fomites)?
4. How does staff movement between hospital wards in the same hospital, or between hospitals, outpatient clinics and care homes amplify disease spread?
5. What is the national, regional and local fraction of healthcare worker infection that can be attributed to transmission at work (from patients or other healthcare workers), as opposed to community-acquisition, and does this fraction change with levels of infection in the community or other risk factors (e.g., ethnicity)?
6. What fraction of community-acquired cases are likely seeded from: (1) healthcare workers; (2) patients discharged to care facilities; (3) patients discharged home?
7. Where do hospital interventions need to be focused to minimise the risk of outbreaks?
8. What specific interventions work to bring hospital acquired outbreaks under control?
9. How well are hospitals able to implement recommendations and what additional support do they need to achieve them?
10. Are there differences in how the devolved nations of the UK and other countries have experienced and responded to hospital transmission that would inform future policy?

Determining the answers to these questions will require a clear mandate and resources. It will be challenging because of the need to distinguish between the potential explanations for apparent transmission chains linked to hospitals. The route of transmission for healthcare workers and patients can be difficult to ascertain with certainty because of the variable incubation period and clinical course of the disease, and because it is difficult to discriminate between exposure to hospital and community environments as the source, making it difficult to ascertain transmission dynamics. Molecular strain typing may be useful to help answer these (noting important caveats about inferring transmission and its direction), but its utility is predicated on timely linkage to epidemiology data (time, person, place), which is not currently widely available. It is likely that some of these questions, and data collection and modelling for them, will need to be prioritised, but the ordering of such priorities is likely to shift as the epidemic progresses.

# Epidemiological evidence of hospital acquired transmission

Internationally, hospital-acquired COVID-19 has been linked to a number of inadequate infection prevention and control practices:

* Failure to use personal protective equipment (PPE) appropriate for personal encounters, such as face masks, eye protection, gowns and gloves, either because of the lack of availability of appropriate equipment or lack of recognition of an infected patient or healthcare worker;
* Inadequate hand washing and respiratory hygiene;
* Failure to properly disinfect surfaces and maintain overall environmental hygiene and ventilation;
* Failure to eliminate the potential for fomites to transmit infection within or carry infection into or out of hospitals;
* Lack of escalation of infection prevention and control practices during patient encounters involving aerosol generation or exposure to mucosal surfaces and fluids;
* Lack of appropriate physical distancing;
* Failure to separate infected from non-infected patients;
* Rotation of staff between infected and uninfected patient locations or between hospitals;
* Inadequate testing and tracing capacity.

Much of the evidence for these modes of transmission is inferred from reports of hospital acquired transmission and one well-documented transmission in a care home earlier in the pandemic.

* Nine separate clusters of infection involving 35 healthcare workers and family members were reported from one Wuhan hospital when COVID-19 infections were occurring but unrecognised; they were attributed to lack of use of PPE in the hospital and large staff gatherings.[[33]](#footnote-33)
* Hospital acquired infection of 80 healthcare workers and 39 patients in one South African hospital was attributed to lack of the use of isolation and droplet and contact precautions, insufficient hand washing, delayed recognition of a COVID-19-infected patient, transferring infected patients between different wards and inadequate surface disinfection.[[34]](#footnote-34)
* From neurosurgery departments in 107 hospitals in Hubei province, 120 doctors and nurses were infected.[[35]](#footnote-35) The source of infection was reported to be a work colleague (38% of infections), an infected patient (29%), an infected family member (4%) or unknown (29%). Transmission was attributed to inadequate PPE and unrecognised contagious patients or colleagues.
* In a Bavarian maternity centre, 36 staff members were infected.[[36]](#footnote-36) The initial source was found to be a midwife who had recently returned from a ski trip. She became ill with a respiratory illness, later shown to be COVID-19 with several transmission chains following. The midwife attended a staff meeting at the clinic on the day that she became ill. The transmission chain was attributed to a failure to recognise a case of COVID-19 infection, staff meetings and eating in a canteen. Social distancing in break rooms and the staff canteen, and universal mask use were put in place with no further outbreaks at the clinic.
* A febrile healthcare worker reported to work at a paediatric dialysis unit in Germany, resulting in the infection of 28 healthcare workers, 13 patients and 7 patient companions.[[37]](#footnote-37) The outbreak was attributed to work attendance of a symptomatic infected worker, lack of physical distancing and lack of use of appropriate PPE.
* In the geriatric unit of a French hospital, a patient admitted with fever and respiratory symptoms that was not recognised to be COVID-19 led to 4 other patients and a healthcare worker on the same unit becoming infected.[[38]](#footnote-38) The outbreak was attributed to a super spreader event enabled by the lack of droplet and contact precautions, lack of universal use of enhanced infection prevention and control measures for all patients, and lack of timely COVID-19 diagnosis or suspicion.
* In a Seattle care home, a symptomatic worker introduced COVID-19 into the facility.[[39]](#footnote-39) The nursing home began using enhanced infection prevention and control practices two days after the introduction of the infection, but before its recognition. Staff were screened for symptoms and symptomatic residents were cared for using COVID-19-appropriate PPE. However, there was a high rate of presymptomatic disease, allowing spread of infection to several facility wings. A total of 57 residents (64% of all residents) and 26 staff (18% of all staff) were infected. Infected staff included nurses, as well as physical therapists, food delivery staff and janitorial staff, many of whom worked in multiple facility wings. Eleven of the infected residents were hospitalised and 15 died. The lack of recognition of presymptomatic spread of infection, and the assumption that asymptomatic persons were not contagious, was the main factor that was linked to spread of infection in the facility. Universal infection prevention and control measures regardless of symptoms aborted the outbreak.
* In an acute hospital in London, a review of 435 inpatient cases of COVID-19 between 2nd March and 12th April 2020 found that 66 (15%) were probably or definitely hospital acquired.[[40]](#footnote-40) There was evidence of patient-to-patient transmission between cases in the same bay, but the likely source could not be identified for most cases and might have been staff members, other patients or visitors with unrecognised infection. A comprehensive infection prevention and control (IPC) response was mounted, which included expansion of PPE use and cohorting of suspected cases; the number and proportion of hospital acquired cases subsequently fell. There was also evidence of high infection rates in healthcare workers in the same hospital: a cohort of 181 healthcare workers enrolled in late March and early April found 45% were antibody positive by one-month follow-up.[[41]](#footnote-41)

These reports documenting hospital acquired transmission highlight that infection control practices that may be in place to prevent transmission of non-respiratory pathogens like hepatitis B, methicillin-resistant *Staphylococcus aureus (*MRSA) and enteric infections will be insufficient to prevent SARS-CoV-2 which appears to transmit predominantly through the respiratory droplet route.

# Successful infection control practices for COVID-19

There is much publicly available guidance on specific infection prevention and control practices. There is also evidence that hospital acquired infection has been controlled in some cases.[[42]](#footnote-42) [[43]](#footnote-43) Guided by our analysis of this literature, and evidence of infection prevention and control practices used in the UK and elsewhere ([[44]](#footnote-44) [[45]](#footnote-45) [[46]](#footnote-46) [[47]](#footnote-47) [[48]](#footnote-48) [[49]](#footnote-49) [[50]](#footnote-50) [[51]](#footnote-51) [[52]](#footnote-52) and Annex 2), we summarise the following important measures that have been reported to reduce hospital-acquired transmission, organised according to transmission routes shown in Figure 1.

1. Minimise risk of importation into hospitals
   1. Consistent and reasonable limits on visitors (varying by local epidemic state)
   2. Minimise agency/multi-site staffing and staff movements between sites (including hospitals, care homes and other institutions) as practical
   3. Entry screening, or self-certification, of staff, patients and visitors for signs and symptoms of COVID-19 infection[[53]](#footnote-53)
   4. Maximise use of telemedicine and remote consultations
2. Minimise risk of transmission within hospitals
   1. Aerosol/droplet transmission
      1. Requirements to wear surgical/cloth masking by staff, visitors and patients wherever feasible, for source control; in addition to staff masking for wearer-protection in specific high-risk settings[[54]](#footnote-54)
      2. Organise hospitals into COVID-19 stratified “hot” and “cold” zones, or entire hospitals into “hot” and “cold” hospitals if feasible
      3. Cohort staff to limit physical overlap and movement between zones if possible, i.e., “bubbling”
      4. Limits on communal activities for healthcare workers (break rooms, cafeteria) and maintenance of physical distancing
      5. Move Multidisciplinary Team and other meetings online as much as possible
      6. Maximise use of remote consultations for outpatients
      7. Maintain effective airflow handling systems (acknowledging building infrastructure limits)
      8. Physical distancing, especially in likely hotspots (e.g., waiting rooms, triage locations, A&E, corridors, lifts, staff lounges, canteens or cafeterias)
   2. Contact transmission
      1. Repeated frequent handwashing for everyone present in facility
      2. Ensuring access to appropriate personal protective equipment for all staff
      3. Training on donning and doffing personal protective equipment (e.g., masks, gowns, gloves, visors), and mandating staff use as appropriate
      4. Reduced sharing of equipment (e.g., computer keyboards)
      5. Expanded and improved environmental cleaning procedures (including exploring novel methods such as UV light, antiviral surfaces, optimum surfaces)
3. Minimise risk of outbreak occurrence and expansion within hospital
   1. Active clinical surveillance of patients for the development of COVID-19 infection
   2. Prompt isolation, testing, investigation and contact tracing of infected healthcare workers
   3. Prompt quarantine of healthcare workers and patients with significant exposure to known cases, and self-monitoring for those with lesser exposure
   4. Rapid and standardised outbreak investigations and reporting, including root-cause analysis
   5. Provision of sick leave without penalty or prejudice based on symptoms (including contract staff)
4. Minimise risk of exportation from hospitals
   1. Testing/quarantining of patients being discharged to own home or institutional care

The simultaneous use of overlapping infection control measures has made it difficult to evaluate the importance of each measure individually. However, multiple coordinated precautions are likely to be required, reinforced by comprehensive staff training linked to continuous professional development. Strong leadership is needed at a high level across the healthcare service to ensure that these are applied and monitored effectively and consistently to minimise hospital acquired infection and prevent onward transmission to the community and thus further pressures on hospitals.

# Summary considerations

To minimise and control hospital-acquired COVID-19 infections, we recommend continuing and enhanced investment in standardised, timely, nationwide hospital surveillance systems to track and analyse trends and undertake rapid, locally led, outbreak control. Many of the ideas below are being developed within the COVID-19 response by the JBC and PHE among others; our aim is to highlight the urgent need for their systematic and joint implementation, and transparent rapid access to data. We envisage an ambitious and comprehensive approach to prevention of infection transmitted through respiratory droplets and aerosols in hospitals, of the kind successfully implemented for MRSA.[[55]](#footnote-55)

1. *Rapid identification of COVID-19 cases within hospitals*. Establish a standardised risk-based protocol for testing individuals within hospitals, both for COVID-19 and other key respiratory pathogens such as influenza, including consistent intensity, breadth of coverage and speed of results turnaround. This protocol would need to reach beyond existing systems for testing patients to cover hospital employees (including staff without patient-facing roles), students and volunteers.
2. *Centralised surveillance and monitoring of COVID-19 infections acquired within hospitals*. Building on existing reporting systems, standardised COVID-19 case reporting would allow the rapid identification of hospitals with certain or probable outbreaks and cases linked to them, with the potential for external oversight (e.g. the Care Quality Commission). Direct surveillance might be supported by using routinely available data, such as on staff absences which can also inform workforce planning decisions, and processed results such as phylogenetic data. Reports should be publicly available, and include case numbers and reductions over time, as part of hospital performance metrics.
3. *Connected COVID-19 data systems across community, care institutions and hospitals*. Information on local community incidence and links to institutional settings, including long-term care facilities, may empower hospitals to assess the risk of importing and exporting cases, and take appropriate preventative measures.
4. *Standardised, tiered infection prevention and control guidelines*. These guidelines should vary by risk level, based on closely monitored infection levels; much of this already exists, but requires integration with the other considerations in this section.
5. *Regional or local outbreak investigations for COVID-19*. A minimum standard for outbreak investigations should be set centrally, with external oversight (e.g., the JBC, PHE) and a standardised reporting structure. While the preferred approach to outbreak management should be through empowerment of Trust or hospital-level structures (e.g., Directors of Infection Prevention and Control), but may require central resources. Outbreak investigations should include support from successful local/regional peer institutions, including PHE and Directors of Public Health. Report findings should lead to enforceable, externally monitored recommendations of interventions to reduce hospital transmission, with mandated executive-level responsibility for implementation. All hospital-acquired infections should be linked to existing Test and Trace systems.
6. *Research platform*. Data obtained from surveillance, monitoring and outbreak investigations should feed into epidemiological and modelling research and evaluation. This research is needed to evaluate which interventions are cost-effective and feasible in preventing hospital and social care transmission in the long-term.

# Annex 1. Technical Document. Estimates concerning COVID-19 infections of patient-facing healthcare workers and resident-facing social care workers in England, and nosocomial COVID-19 infections in England, between 26th April and 7th June

Prepared for the DELVE Initiative by David Ellis

Please see attached document.

# Annex 2. Management of nosocomial (hospital-acquired\_ infections of SARS-CoV2: A scoping review of UK government guidelines and practice and international approaches

Prepared for the DELVE Initiative by Genevie Fernandes

## Background

The risk of nosocomial transmission of SARS-CoV 2 has made health workers around the world extremely vulnerable to infection and mortality. While there are no formal estimates of nosocomial transmission of SARS-CoV-2, high infection rates among health-care workers (HCWs) highlights just how widespread this problem is globally as well as in the UK. Based on data from 30 countries from national nursing associations, government figures and media reports, the International Council of Nurses has reported that at least 90,000 health-care workers worldwide are believed to have been infected with SARS-CoV 2.[[56]](#footnote-56) In early May, UK government figures[[57]](#footnote-57) reported an infection rate of 4.8% among health, social care and essential workers and their households. However, Henegan and colleagues estimated that 30.5% of all infected cases on the 16th of April were related to healthcare workers, and also discussing the difficulty in gaining accurate estimates of infection rates among health workers alone.[[58]](#footnote-58) As of April 22, Cook and colleagues reported that a total of 116 NHS staff had died from SARS-CoV 2; and 63% of the cases were of the BAME communities.[[59]](#footnote-59)

Figures from China’s National Health Commission show that more than 3300 health-care workers (4% of the 81,285 reported infections) have been infected as of early March.[[60]](#footnote-60) Other reports from China have reported an infection rate of 2.09-29% among healthcare workers.[[61]](#footnote-61)[[62]](#footnote-62)[[63]](#footnote-63) In May, the European Centre for Disease Prevention and Control reported that 20% of SARS-CoV 2 cases in Spain are healthcare workers, compared with 10% in Italy as a whole (in the hard-hit region of Lombardy the percentage rises to 20%). In Germany, as of May 16, 11,780 cases with a SARS-CoV-2 infection have been notified among staff working in medical facilities (6.7% of total cases i.e. 173,772).[[64]](#footnote-64) In the United States, infected healthcare workers represent 11% of total cases.[[65]](#footnote-65)

The nosocomial route of transmission amplifies infections among health workers as well as patients coming to hospital settings for other medical reasons, thus making infection control and management practices a critical component of a government’s response for containing SARS-CoV 2. This report provides a scoping review of how countries have prevented and managed nosocomial SARS-CoV 2 infections. This review covered 11 countries including the UK, South Korea, Singapore, New Zealand, Ireland, Australia, Germany, Italy, Denmark, Sweden, and Norway, and relied on guidelines from government websites, peer-reviewed articles and news media reports.

## Summary

### What are the guidelines and practices in the UK? (See table 1 for detailed guidelines and references)

* **Point of entry:** Symptomatic individuals or those suspected with SARS-CoV-2 symptoms must contact the NHS via a helpline or online for advice on hospital admission. At the point of entry, patients must be identified as asymptomatic, symptomatic for COVID-19 or COVID+. All patients should be tested on emergency admission.
* **Separation among zones of risk:** Guidelines state that patients with suspected/possible COVID-19 need to be segregated, especially in admission/waiting and non-COVID areas. Confirmed/suspected cases must be isolated in separate room or a COVID+ cohorted area. Several NHS hospitals have divided their facility into two zones: (i) SARS-CoV-2 (positive and suspected cases) and (ii) Non-SARS-CoV-2.
* **Use of masks:** Guidelines state that symptomatic patients may wear masks, but this is not mandated. From 2 April, all healthcare facilities were recommended to wear masks for all contact with all patients and symptomatic patients were recommended to wear masks if able to do so. As of 15 June, all healthcare workers will have to wear surgical masks in all areas of the hospital while visitors will have to wear face coverings at all times.
* **Personal protective equipment (PPE):** HCWs are recommended to wear PPE including gloves, disposable apron or gown (based on risk assessment), surgical masks or fluid resistant mask or filtering face piece respirator (based on risk of procedure i.e. aerosol generating procedures) and face and eye protection. It is important to note, that when providing care to any individuals in the extremely vulnerable group undergoing shielding, HCWs have to wear gloves, disposable plastic apron and surgical mask.
* **Teams:** It is recommended that when there are sufficient levels of staff, a dedicated team of staff should be assigned to care for patients in isolation/cohort rooms/areas and there should be efforts to reduce staff movement between pathways for SARS-CoV-2 and non-SARS-CoV-2.
* **Testing for HCWs:** Symptomatic HCWs need to inform their employer and can get tested within the first three days of the onset of symptoms. If test result is negative, staff can resume patient care. On a positive test result, staff can resume patient care after 7 days if symptoms have resolved. While guidelines recommend the testing of asymptomatic staff based on available capacity, NHS hospitals[[66]](#footnote-66) (Newcastle Upon Tyne, Sheffield, Cambridge, Imperial and Barts Health NHS Trust London) have started testing asymptomatic staff, part of pilot studies.
* **Testing for patients:** Between 17th March and 15th April, around 25,000 people were discharged from hospitals into care homes. Due to government policy at the time, not all patients were tested for COVID-19 before discharge, with priority given to patients with symptoms.[[67]](#footnote-67) [[68]](#footnote-68) On 15 April, the policy was changed to test all those being discharged into care homes and all elective admissions.
* **Visitors:** Visiting may be suspended if considered appropriate depending on local circumstances and risk assessment. Also, visitors with symptoms cannot enter the hospital.
* **Non-SARS-CoV-2 services:** All opportunities for remote, multi-professional virtual consultations must be maximised. On 27 April, the government announced that the “restoration of other NHS services” will start from 28 April on a “hospital-by-hospital” basis. As of 14 May, NHS England stated that ‘over the coming weeks patients who need important planned procedures – including surgery – will begin to be scheduled for that care, with specialists prioritising those with the most urgent clinical need.

### What are the approaches followed by other countries? (See tables 2 & 3 for detailed guidelines and references)

Countries use an ecosystem of measures to prevent and manage SARS-CoV 2 infections among patients and healthcare workers in the hospital setting. All patients are screened at the point of entry and then suspected cases with respiratory symptoms are allocated to separate wards and clinics, in separate locations, with separate teams. In countries such as South Korea, Singapore, Denmark, and recently Italy, individuals are screened through community based testing and primary healthcare staff (GPs) and only then sent to hospitals if presenting with severe symptoms, thereby reducing the burden on staff for initial triage at the point of entry. In Ireland, symptomatic patients are screened in a triage tent at the entrance of the emergency department. Patients have to wear surgical masks, and health-care workers have to wear personal protective equipment based on the risk level of patient interaction. Disinfecting areas for reducing environmental transmission and physical distancing measures are observed. Visitors and caregivers are restricted entry to hospitals in most countries. Finally, health staff are encouraged to shift to virtual channels like telephone or video consultations for other non-COVID-19 services as much as possible.

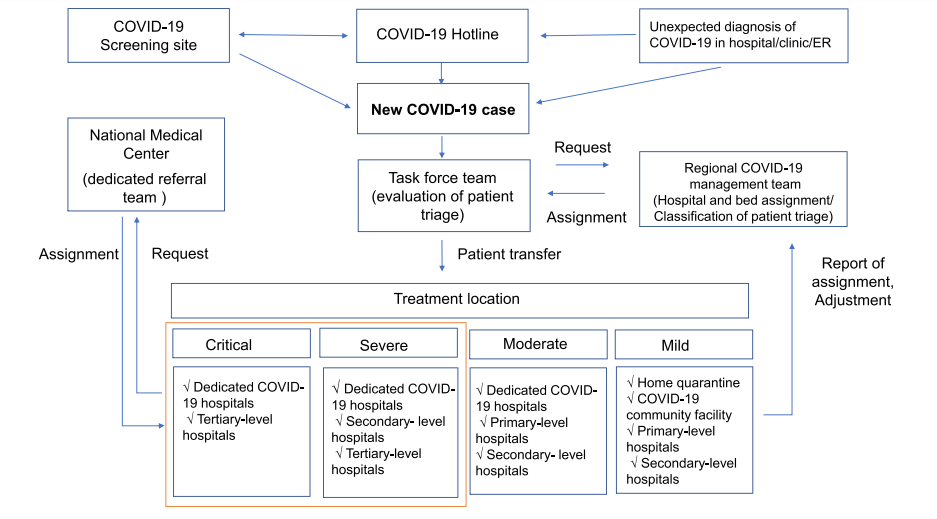
Countries have adopted several measures to reduce the risk of infection among HCW.

* Personal protective equipment (PPE): PPE is commonly recommended across all the reviewed countries. All HCWs have to wear surgical masks during patient interactions, and then based on the risk level of the task around patient care (i.e. routine care or aerosol generating procedures), they have to put on a lower or higher level of PPE. While donning appropriate levels of PPE is a universally recommended measure, reports from Italy and Spain,[[69]](#footnote-69) highlighted the shortages in PPE which has affected healthcare workers.
* Organisational practices: Some countries follow organisational practices such as allocating designated and small teams for treating COVID-19 and non COVID-19 patients. This practice prevents cross-integration of staff between clean and infected wards, and with small dedicated teams it also becomes easy to do contact tracing if members get infected. In South Korea’s Samsung Medical Centre,[[70]](#footnote-70) COVID-19 units are staffed by only dedicated core clinical teams with special training who live in hospital accommodations during two-week shifts and then are quarantined for one week and only allowed to return to the care of non COVID-19 patients after a negative COVID-19 test.
* Testing: All the countries provided testing for HCWs on presentation of SARS-CoV2 symptoms. For HCWs in Singapore, temperature is monitored twice every day and with any increase in temperature, HCWs are evaluated for testing. While Italy and Norway require HCWs to present with severe symptoms for testing, other countries tested even with mild symptoms. Testing alone is not enough. It is also important to ensure that HCWs are quarantined or allowed to rest well before they resume patient care. Countries follow different strategies after a HCW tests positive. In Singapore,[[71]](#footnote-71) when someone (health-care worker, staff or patient) in the hospital tests positive, response teams trace every contact and then quarantine only those who had close contact with the infected person, and close contact is defined as spending 30 minutes at a distance of less than six feet and without the use of a surgical mask. If the exposure is shorter than the prescribed limit but within six feet for more than two minutes, workers can stay on the job if they wear a surgical mask and have twice-daily temperature checks. People who have had brief, incidental contact are just asked to monitor themselves for symptoms. In Germany,[[72]](#footnote-72) if HCWs have SARS-CoV2, they cannot care for patients and can resume work only after 48 hours of being free from symptoms and after negative PCR from 2 simultaneous oro- and nasopharyngeal swabs. As of mid-May, Vietnam,[[73]](#footnote-73) has started conducting weekly testing for all its HCWs in the hospital setting.

Support mechanisms: Singapore and Denmark have set up peer support networks and psychological interventions for its HCW to address the physical fatigue and psychological stress of donning PPE and working in COVID-19 shifts. ‌

While all the countries have infection control and management guidelines in place, the key differentiating factor between countries that have successfully managed to prevent and control nosocomial infections (such as South Korea and Singapore) and those that have had high rates of infections in HCWs (such as Italy) is the early response in testing and stratifying patients thereby reducing the burden at the hospital level. South Korea[[74]](#footnote-74) conducts widespread testing in the community regardless of presentation of symptoms, thereby identifying asymptomatic, mild and moderate cases. COVID-19 management teams then stratify confirmed cases based on the level of their symptoms, with mild cases asked to self-isolate at home along with daily monitoring of symptoms, and other mild cases directed to community facilities, and severe and critical patients sent to hospitals (see figure 1). With such an organised response, hospital staff are well prepared for the incoming cases. While early testing and contact tracing reduces the burden of patients in the hospital, measures such as providing telehealth consultations for other medical areas and restricting visitors prevents overcrowding and enables effective management in this setting.

Figure 1: Stratification of hospital/room assignments for SARS-CoV2 in South Korea[[75]](#footnote-75)



Overall, a major lesson that emerges is that while infection control guidelines have to be followed in hospital settings, other response measures are equally important to enable the effective implementation of these guidelines. These measures include (i) the need for preparedness (hospitals in Singapore and South Korea conduct pandemic drills and ensure that staff are well trained for such eventualities), (ii) financing public healthcare systems (investments in infrastructure and workforce), (iii) a coordinated response between federal and provincial governments (especially for procurement, stockpiling and ensuring timely PPE, ventilators and other materials), (iv) protection of HCWs (through training, PPE, testing, PPE, and support), (v) community surveillance through early and widespread testing and contact tracing, and (vi) use of virtual channels to provided non COVID-19 services during the outbreak.

## Table 1: UK government’s COVID-19 Infection Prevention and Control Guidelines

**Point of entry**

Symptomatic individuals are advised to consult NHS Inform online and phone 111 as the first point of contact,[[76]](#footnote-76) not their GP.[[77]](#footnote-77) In the case of any emergency admissions in the hospital, patients must be immediately identified as either i) asymptomatic; ii) symptomatic for COVID-19; iii) COVID+.[[78]](#footnote-78)

**Use of face mask**

National guidelines recommend that symptomatic patients maywear a surgical face mask in clinical areas, common waiting areas or during transportation and where tolerable and appropriate.[[79]](#footnote-79) As of 15 June, all hospital staff in England will be expected to wear surgical masks, while all visitors and outpatients will be expected to wear face coverings at all times.[[80]](#footnote-80)

**Hand hygiene**

All staff, patients and visitors should decontaminate their hands with alcohol-based hand rub when entering and leaving areas where patient care is being delivered. Hand hygiene must be performed immediately before every episode of direct patientcare and after any activity/task or contact that potentially results in hands becoming contaminated, including the removal of PPE, equipment decontamination and waste handling.25

**Separation among zones of risk**

Patients with suspected/possible COVID-19 need to be segregated, especially in admission/waiting and non-COVID areas. Any patient who subsequently tests positive or shows symptoms can be immediately isolated or managed in a COVID+ cohorted area.26 Hospitals across the country have been divided into zones to separate patients most likely infected with COVID-19 from those with other health problems.

**Patient placement**

**Single rooms:** Wherever possible, patients with possible or confirmed COVID-19 should be placed in single rooms. Where single/isolation rooms are in short supply, and cohorting is not yet considered possible (patient(s) awaiting laboratory confirmation), patients who have excessive cough and sputum production should be prioritised for single/isolation room placement. Single rooms in COVID-19 segregated areas should, wherever possible, be reserved for performing aerosol generating procedures (AGPs).

**Cohorting:** If a single/isolation room is not available, cohort possible or confirmed respiratory infected patients with other patients with possible or confirmed COVID-19. Use privacy curtains between the beds to minimise opportunities for close contact. Where possible, a designated self-contained area or wing of the healthcare facility should be used for the treatment and care of patients with COVID-19.

**Negative pressure rooms:** Special environmental controls, such as negative pressure isolation rooms, are not necessary to prevent the transmission of COVID-19. However, in the early stages where capacity allows, and in high risk settings, patients with possible or confirmed COVID-19 may be isolated in negative pressure rooms. Patients with suspected/confirmed COVID-19 should not be placed in positive pressure rooms.

**Personal protective equipment (PPE)[[81]](#footnote-81)**

Conducting an aerosol generating procedure (AGP) on a possible/confirmed case outside a higher risk acute care area\*

* Single use gloves
* Single use disposable fluid-repellent coverall/gown
* Single use filtering face piece respirator
* Single use eye/face protection (visor/goggles)

Working with a possible/confirmed case in higher risk acute care area

* Single use gloves
* Single use disposable plastic apron (sessional use full gowns for OT and labour wards)
* Sessional use filtering face piece respirator
* Sessional use eye/face protection (visor/goggles)

Working with a possible/confirmed case in other inpatient areas (other than higher risk acute areas), operating theatres and labour wards (no AGPs) and transferring patients

* Single use
* Single use disposable plastic apron
* Single or sessional use fluid resistant surgical mask (risk assess)
* Single or sessional eye/face protection (visor/goggles) (risk assess)

Providing inpatient care to any individual in the extremely vulnerable group undergoing shielding

* Single use gloves
* Single use disposable plastic apron
* Single use surgical mask

\*Higher risk acute areas include ICU/HDUs; ED resuscitation areas; wards with non-invasive ventilation; operating theatres; endoscopy units for upper Respiratory, ENT or upper GI endoscopy; and other clinical areas where AGPs are regularly performed.

**Testing**

Staff

Symptomatic staff: If a member of staff develops symptoms of COVID-19 they should follow the stay at home guidance, and get tested as soon as possible. Staff should first tell their employer and then be tested in the first three days of the onset of symptoms - testing should not be undertaken after day five of symptoms. Those eligible for a test will be directed to the most appropriate place for testing including a local acute, mental health and community hospital trust/ local community venues/outreach testing centres.[[82]](#footnote-82) If the result is negative, the advice from Public Health England states that staff “can return to work when they are medically fit to do so, following discussion with their line manager and appropriate local risk assessment. Interpret negative results with caution together with clinical assessment.” If staff test positive for COVID-19, they can return to work after seven days, unless they still have symptoms other than a cough or loss of sense of smell/taste, in which case they must continue to self-isolate until they feel better.

Asymptomatic staff: Guidelines25 state that ‘additional available NHS testing capacity should be used to routinely and strategically test asymptomatic frontline staff as part of infection prevention and control measures. Local health systems should work together with their labs and regions to agree the use of available capacity.’

Patients

**Emergency admissions**: All patients should be tested on admission. For patients who test negative, a further single re-test should be conducted between 5-7 days after admission.

**Elective admissions (including day surgery):** Patients should isolate for 14 days prior to admission along with members of their household. As and when feasible, this should be supplemented with a pre-admission test (conducted a maximum of 72 hours in advance), allowing patients who test negative to be admitted with IPC and PPE requirements that are appropriate for someone who’s confirmed COVID status is negative.

**Inpatients:** Any inpatient who becomes symptomatic, who has not previously tested positive, should be immediately tested as per current practice.

**Other day interventions:** Testing and isolation to be determined locally, based on patient and procedural risk.

**Discharge:** All patients being discharged to a care home or a hospice should be tested up to 48 hours prior to discharge.

**Team composition26**

When there are sufficient levels of staff, a dedicated team of staff should be assigned to care for patients in isolation/cohort rooms/areas. Maintaining consistency in staff allocation where possible and reducing movement of staff between different pathways.

**Visitors26**

Visitors with COVID-19 symptoms must not enter the healthcare facility. Visitors who are symptomatic should be encouraged to leave and must not be permitted to enter areas where there are extremely vulnerable patients. Visiting may be suspended if considered appropriate depending on local circumstances and risk assessment. For e.g. Plymouth Hospitals Trust**.** has suspended visitors in its red and amber zones (suspected and confirmed cases of COVID-19). All visitors entering a segregated/cohort area must be instructed on hand hygiene. They must not visit any other care area. Limiting entry points to a facility will help manage local restrictions.

**Environmental decontamination**

The main patient isolation room should be cleaned at least twice daily. Body fluid spills should be decontaminated promptly. Patient isolation rooms, cohort areas and clinical rooms must be decontaminated at least daily. Clinical rooms should also be decontaminated after clinical sessions for patients with possible/known pandemic COVID-19. Rooms/areas where PPE is removed must be decontaminated, ideally timed to coincide with periods immediately after PPE removal by groups of staff (at least twice daily). The increased frequency of decontamination/cleaning should be incorporated into the environmental decontamination schedules for all areas, including where there may be higher environmental contamination rates. Opportunities for cleaning of frequently touched surfaces multiple times (more than twice a day wherever possible) should be taken.

**Non COVID-19 services**

On 27 April, the government announced that the “restoration of other NHS services” will start from 28 April on a “hospital-by-hospital” basis. As of 14 May, NHS England stated that ‘over the coming weeks patients who need important planned procedures – including surgery – will begin to be scheduled for that care, with specialists prioritising those with the most urgent clinical need.[[83]](#footnote-83)

In terms of planned and elective care, only patients who remain asymptomatic having isolated for 14 days prior to admission and, where feasible, tested negative prior to admission, should be admitted. In terms of outpatient services, only patients who are asymptomatic should attend these services, ensuring they can comply with normal social distancing requirements. Those requiring urgent and emergency care will continue to be tested on arrival and streamed accordingly, with services split to make the risk of picking up the virus in hospital as low as possible. Those attending emergency departments and other ‘walk-in’ services will be required to maintain social distancing, with trusts expected to make any adjustments necessary to allow this. Those requiring a long hospital stay will be continuously monitored for symptoms and re-tested between 5 and 7 days after admission, and those who are due to be discharged to a care home will be tested up to 48 hours before they are due to leave. Independent hospitals have been given the go-ahead to resume some private and elective surgery after NHS England triggered a ‘de-escalation’ clause in the historic contract signed with the sector in March to help tackle the COVID-19 pandemic.[[84]](#footnote-84) All opportunities for remote, multi-professional virtual consultations must be maximised. Most GP surgeries now offer online and video consultations.[[85]](#footnote-85)

## Table 2: SARS-CoV-2 Infection prevention and control measures in South Korea, Singapore, New Zealand, Ireland and Australia

### South Korea**[[86]](#footnote-86)**

**Point of entry**

Triage is strengthened at the first point of entry to the emergency room at the hospital entrance for early case detection through measures like checklists. Checklists for patients with febrile respiratory symptoms, travel history or contact status with confirmed COVID-19 cases are prepared and circulated among HCW.

**Patient placement**

Patients with febrile respiratory symptoms are immediately placed in an isolated, negative pressure room. Suspected patients with febrile respiratory symptoms are separated from other patients even in the absence of symptoms.

**Treatment response for suspected and confirmed patients**

Critical care physicians wearing PPE take detailed history of patients with febrile respiratory symptoms, including contact with COVID-19 cases or travel history.

**Treatment response for suspected and confirmed patients**

Individuals with negative results and no evidence of pneumonia are transferred from the emergency room to cohort wards if they were stable, or to the cohort area of the ICU if they were unstable. In the case of evidence of atypical pneumonia and negative PCR results, individuals are transferred from the emergency room to a negative-pressure isolation room, and PCR tests are performed repeatedly.

**Reducing the risk of infection among healthcare workers (HCW)**

PPE, testing and daily monitoring of temperature are the three major practices followed for reducing the risk of infection among HCWs. Staff in charge of high-suspect COVID-19 cases, wear PPE, which includes N95 masks, face shields or goggles, long-sleeved gowns and gloves, and those performing aerosol-generating procedures. HCWs are regularly checked for their temperature and respiratory symptoms, and have access to testing.

**Infrastructure**

The hospital is divided in three zones based on risk stratification. First, the main hospital is maintained as the clean zone. Second, a separate temporary building (the moderate risk zone) is used for suspected COVID-19 cases, such as individuals with febrile respiratory symptoms without an obvious epidemiological link. A third zone, a separate area in the emergency department (high-risk zone) is used for patients at high risk of COVID-19 infection, such as individuals with febrile respiratory syndromes and a history of contact with confirmed cases of COVID-19.

**Visitors and caregivers**

The number of patient visitors and caregivers restricted; and all are required to adhere to personal hand hygiene standards and are given surgical masks to wear when visiting patients or healthcare workers.

### Singapore[[87]](#footnote-87)

**Patient placement**

Patients with COVID-19 are nursed in cohort rooms with three patients to a room, spaced at least w2 m apart, and partitions were placed between patient beds.

**Reducing the risk of infection among healthcare workers (HCW)**

Healthcare teams are kept small and segregated by type of patients: (i) suspect and confirmed cases of COVID-19 (ii) other patients. Teams are also organised to ensure there are enough HCWs if the outbreak worsens, and that they get enough rest. Cross-institution coverage by HCWs is suspended.

Tasks are stratified by risk of infection. Highest risk tasks (airway suctioning, intubation and bronchoscopy) warrant the donning of full PPE, including eye protection, disposable gown, gloves, and either an N95 mask or a powered air purifying respirator. Medium risk tasks, such as triaging Emergency Department patients at first presentation for fever and/or respiratory symptoms, requires a lower level of PPE.

Twice daily temperature monitoring of all HCWs is made mandatory. HCWs whose logged temperature readings are higher than 37.5 degree Celsius will be flagged up to the hospital's clinical epidemiology team for further evaluation including testing.

Mealtimes for healthcare workers are staggered. Peer support programmes address the physical fatigue and psychological stress from regular donning and doffing of full PPE.

**Physical distancing**

In the general ward, shared communal facilities are closed, and patients are limited to one visitor at any time. Common areas such as waiting areas, pharmacies, patients are directed to keep 1m apart from one another, using visual cues to guide waiting and queuing in both seated and standing areas.

**Visitors and caregivers**

All visitors and outpatients undergo a questionnaire survey of travel and contact history, as well as thermal scanning for fever before they are allowed into the hospital premises.

Each inpatient is restricted to only 2 specified visitors through the period of hospitalization. Similarly, each outpatient is only allowed 1 accompanying person when attending the specialist outpatient clinic. No visitors are allowed in the respiratory surveillance ward.

**Non-COVID-19 Medical Services**

Didactic teaching and departmental meetings are conducted using video conferencing. Medical students are withdrawn from clinical attachments.

### New Zealand**[[88]](#footnote-88)**

**Point of entry**

Screening measures are in place for patients coming through to Emergency Department to see if they are symptomatic; and if they are coming for a respiratory illness then they go through a different pathway. Hospitals have begun treating all respiratory infection as potential COVID-19 cases, and such patients are provided with a surgical mask upon entry to the facility.

**Patient placement**

All patients who meet the case definition criteria for COVID-19 have to wear a surgical mask and are encouraged to follow cough etiquette and respiratory and hand hygiene. Cases under investigation, and probable cases are accommodated in a single room. If confirmed, they can be cohorted with other confirmed cases.

**Treatment response for suspected and confirmed patients**

Infection prevention and control precautions should apply for all suspected and confirmed cases of COVID-19 and the patients should always wear a surgical mask and followed respiratory and hand hygiene.

In addition to standard precautions, contact and droplet precautions should be taken. When performing an aerosol generating procedure, apply airborne precautions including the use of an airborne infection isolation room (negative pressure room) where possible.

**Reducing the risk of infection among healthcare workers (HCW)**

HCWs must wear PPE for contact and droplet precautions. PPE includes long sleeve impervious gown, gloves, eye protection and surgical mask. PPE for contact and airborne precautions include long sleeve impervious gown, gloves, eye protection and particulate respirator (N95 mask).

General practitioners and healthcare workers with respiratory or influenza-like symptoms who are in close contact with patients (ie, less than 2 metres distance for more than 15 minutes) should be tested for COVID-19 and other potential causes of their illness.

**Infrastructure**

In response to staff fears, on May 8, the Waitakere Hospital instituted ward ‘bubbles’ segregating the hospital into different wards and promoting no cross-institutional coverage by HCW.

**Visitors and caregivers**

Family/Whānau (extended family) must wear a surgical mask and practice hand hygiene when supporting the patient during transfer to hospital and whilst being assessed in the emergency department.

Hospital visits are limited and restricted. Allowances of visits are determined by each district health board and are done so on a case-by-case basis. Screening of visitors will be done, and visitors may be refused entry. If approved, visits are done one-person at a time, are booked in advance, and require precautions such as hand hygiene and keeping a physical distance of 2 meters. When approved, visitors are required to wear PPE provided by the DHB.

**Non-COVID-19 Medical Services**

Elective surgeries may be postponed or rearranged. General practices are open, but appointments will be conducted online or by phone where possible.

### Ireland[[89]](#footnote-89)

**Patient placement**

Patients with COVID-19 should be cared for in single rooms with en suite facilities. They can also be cohorted together. Patients with suspected COVID-19 should not be cohorted with those confirmed positive.

**Treatment response for suspected and confirmed patients**

HCWs should perform aerosol generating procedures on confirmed patients in a negative pressure or neutral pressure room, ensuring that patients, visitors and other healthcare settings are not exposed.

**Reducing the risk of infection among healthcare workers (HCW)**

Designate small teams of HCWs caring for patients with possible or confirmed COVID-19 and review this allocation regularly to ensure that staff caring for COVID-19 patients do not care for patients without COVID-19 during the same shift.

Surgical masks should be worn by all HCWs for all encounters, of 15 minutes or more, with other HCW in the workplace where a distance of 2m cannot be maintained.

PPE for HCWs treating patients with COVID-19 include respiratory protection (surgical mask), Gloves, Long-sleeved gown (for high contact activities) /apron (for low contact activities), Eye protection as per risk assessment\* (face shield or goggles) \*where there is a risk of blood, body fluids, excretions or secretions (including respiratory secretions) splashing into the eyes. PPE for conducting aerosol generating procedures include PPE as above but an Filtering Face Piece 2 mask (rather than surgical mask) and long-sleeved gown.

At the start of each shift, all staff should be checked for symptoms of viral respiratory infections, such as cough, fever, shortness of breath or myalgia.If possible, designate extra catering support to staff working in cohort areas to minimise their need to travel in the facilities.

**Physical distancing**

Social interaction between HCWs who do not have to work together should be avoided.

**Visitors and caregivers**

Restrictions will be required on visitors, but allowance of specific scenarios such as compassionate and practical approach is required when making this assessment.

In labour wards, birth partners in whom there is no clinical suspicion of COVID-19 will be allowed to provide support to the mother in labour

When visiting patient's rooms, visitors are required to perform hand hygiene and wear appropriate PPE.

**Non-COVID-19 Medical Services**

HCWs should try whenever possible to deliver care as remotely as possible (sometimes through the use of mobile telephones).

### Australia[[90]](#footnote-90)

**Point of entry**

All patients go through risk assessment to determine the level of PPE required if any. Patients with acute respiratory symptoms should wear surgical mask upon presentation to hospital. Suspected, probable and confirmed cases need to wear surgical masks.

**Patient placement**

Patients with acute respiratory symptoms must be placed in a single room with door closed, or in a separated closed area designated for suspected COVID-19 cases. Once the patient is isolated in a single room, they do not need to continue wearing a mask.

**Treatment response for suspected and confirmed patients**

If aerosol generating procedures have to be performed, the patient should be placed in a negative pressure room. For aerosol generating procedures performed on patients who are NOT suspected or confirmed cases of COVID-19, P2 respirators are not necessary, i.e., a surgical mask is sufficient.

**Reducing the risk of infection among healthcare workers (HCW)**

Healthcare workers with influenza-like illness should not work while they are symptomatic. They should be tested for SARS-CoV-2 and undergo isolation pending results. Healthcare workers who are defined as close contacts should be treated as such.

When caring for patients (suspected and confirmed cases of COVID1-9), the PPE requirements for HCW depends on the task (i.e. routine care and aerosol generating procedures for patients with COVID-19) and setting (ICU, Wards outside the ICU, and the Emergency department).

In settings where the loss of the healthcare worker will have a significant impact on health services, an individual risk assessment should be conducted in collaboration with the Public Health Unit.

**Physical distancing**

Physical distancing measures in clinics, and wards between health workers and patients. Waiting room chairs are separated by greater than 1.5 meters. Direct communications between HCWs and patients conducted at a distance where practical, and if not, HWs wear appropriate PPE

**Visitors and caregivers**

Visitors to hospitals should be limited and restricted to essential circumstances. When entering hospitals, they should be trained and supervised when using PPE.

In the labour ward requirements, women’s partner or other support person may attend the delivery, but precautions are required to protect labour ward staff, such as performing hand hygiene and putting on a surgical mask when the individual is entering the hospital.

### Italy**[[91]](#footnote-91)** **[[92]](#footnote-92)** **[[93]](#footnote-93)**

**Point of entry**

The first evaluation is done by telephone or e-mail. In case of symptoms suggesting a possible COVID-19 infection, the patient is invited to stay home, isolated from the rest of the family. The GP monitors the evolution of the symptoms while avoiding as much direct contact as possible with these patients. In case of respiratory distress, a special hotline number has been set up to dispatch a team that can transfer the patient to the hospital. In the hospitals, separate areas for patients with COVID-19, are organised with a triage area equipped with mechanical ventilation equipment.

**Patient placement**

Dedicated patient transport and isolation pathways. Patients with respiratory symptoms, both suspected and confirmed cases tested and allocated to the appropriate cohort. Cohort ICUs set up for COVID-19 patients (areas separated from the rest of the ICU beds to minimise risk of in-hospital transmission).

**Treatment response for suspected and confirmed COVID-19 patients**

Isolated rooms with negative pressure to be identified for treatment of patients with COVID-19. However, reports from Italy found that critical care beds and negative pressure rooms ran out quickly in the first few weeks of the outbreak, since hospitals were overloaded by patients with acute respiratory failure, leading staff to use general wards with natural ventilation as a makeshift remedy.

**Hospital infrastructure**

Since the end of February, the hospitals in Northern Italy have been reorganised. Most of them have special areas for COVID-19 patients. Operating rooms turned into makeshift ICUs to create surge capacity. Hospitals have dedicated patient transport and isolation pathways.

**Reducing the risk of infection among healthcare workers (HCW)**

HCWs have to wear appropriate PPE based on routine case and other procedures for COVID-19 patients. One of the key safety restrictions is that of appropriate filtering face piece (FFP) masks. FFP2, N95 and FFP3 masks are recommended for the management of COVID‐19 patients, but the levels of protection for airway management in COVID‐19 patients adopted in most of hospitals in Italy are either second‐ or third‐level PPE, preferring the use of airborne‐level PPEs for critical care aerosol‐generating procedures, including tracheal intubation, bronchoscopy and ATI. So far, the outbreak‐related global PPE shortage has forced the use of lower‐protection PPEs for aerosol‐generating procedures.

Testing for HCWs is only available on display of severe symptoms.

**Social distancing**

Suspension of group activities and sharing of common spaces inside of the structure.

**Visitors**

For the entire duration of the emergency, visitors including family and acquaintances are prohibited from accessing the facility.

**Other medical services**

Cessation of elective surgery, semi-elective procedures postponed, with only emergency, trauma and selected oncological surgery proceeding. Most of the outpatient clinics have been closed and non-urgent visits are postponed, to make resources available for the most severe cases. Telemedicine consultations are being used for non-COVID-19 services where possible.

### Germany**[[94]](#footnote-94)** **[[95]](#footnote-95)** **[[96]](#footnote-96)**

**Point of entry**

If possible, tests in the outpatient and pre-inpatient areas should be carried out separately and if possible before further patient care / treatment. The tests should preferably be carried out in designated facilities outside of medical practices or outpatient clinics, which ensure the separation of patients with respiratory symptoms and other patients in order to be able to maintain regular care structures.

**Patient placement**

Cases, contacts and suspected cases of COVID-19, as well as non-cases, should be treated in three spatially and personnel-separate areas: COVID-19 area, suspected case area, NON-COVID-19 area. Patients with COVID-19 should only be seen and cared for by dedicated personnel.

**Treatment response for suspected and confirmed COVID-19 patients**

Patients should preferably be treated in isolation rooms ideally with a functional anteroom for donning and doffing PPE. As the epidemic/pandemic progresses, isolation of patients in cohorts is reasonable.

If SARS-CoV-2 is detected in patients or staff in an area that is not intended for COVID-19 patients, immediate action must be taken. This includes relocation of the case in the COVID1-9 area, use of mouse and noise protection for staff, setting up of an outbreak team, determination and allocating contacts to separate areas. Germany

**Reducing the risk of infection among healthcare workers (HCW)**

General medical measures of wearing of medical mouth-nose protection by staff in all areas with possible patient contact and especially contact with patients with cold symptoms. In these situations, patients should also be treated with medical mouth-nose protection. All other basic hygiene measures must also be observed. Direct contact of all kinds should be reduced in medical facilities.

Separation of personnel with strict assignment to individual areas in which they should be allowed to treat either COVID-19 or non COVID-19 patients. Wherever possible, work should be carried out in permanent teams, so that in the event of a new infection, as few contacts as possible are available among the staff.

Testing and subsequent resuming of work for HCWs is based on whether there is a relevant shortage of staff. Germany

**Reducing the risk of infection among healthcare workers (HCW)**

In the first scenario, where there is no shortage, HCWs who have symptoms can stay away from patient care and resume work after being free from symptoms for 48 hours, with a test conducted if possible. In this scenario, if HCWs have SARS-CoV2, then they cannot attend to patients and can resume work only after 48 hours of being free from symptoms and after negative PCR from 2 simultaneous oro- and nasopharyngeal swabs. In the second scenario, where there is a shortage of staff, HCWs with symptoms can give patient care but have to wear mouth and nose protection at all times and test for SARS-CoV2. If the test results are positive, then they can resume care for non-COVID-19 patients after being symptom-free for at least 48 hours and negative PCR from 2 simultaneous oro- and nasopharyngeal swabs. The health status of the staff should be regularly monitored and, if necessary, a diagnostic clarification should be carried out. Employees with acute respiratory diseases should stay at home.

**Visitors**

Restrictions to visits by family and friends. If permitted, visits should be kept to a minimum and time limited. Protective measures are required by visitors including: maintaining a distance of at least 1.5 m from the patient, wearing protective gowns and close-fitting, multi-layer mouth and nose protection as well as using hand sanitizer when leaving the patient's room.

**Other medical services**

Even outside direct care of COVID-19 patients, the general wearing of PPE for all staff in direct contact to particularly vulnerable patients.

### Denmark**[[97]](#footnote-97)** **[[98]](#footnote-98)**

**Point of entry**

People with mild respiratory symptoms who may suspect COVID-19 are generally encouraged to stay home, as well as keep distance, and can additionally by phone contact the GP and test for SARS-CoV-2 as recommended.

When examining COVID-19 in a hospital, or in a special COVID-19 regional assessment unit ('Fever clinic'), a clinical assessment of the patient, including an assessment of symptoms, followed by testing as required.

**Patient placement**

Suspected COVID-19 patients are placed in a single room or behind room separation that is visited only by designated and necessary staff. Isolation can be done as cohort isolation, where patients with verified same infectious disease and micro-organism gene type

**Treatment response for suspected and confirmed COVID-19 patients**

In direct patient contact, personnel should wear protective equipment in the form of gloves, liquid-repellent, long-sleeved disposable coat, surgical mask and visor / goggles. FFP2 or FFP3 mask is used in high-risk procedures. Disposable equipment should be used as far as possible for patient care.

If intensive treatment is needed, including mechanical ventilation (respirator), this can be taken care of head of the team. Patients are hospitalised in isolation and managed according to droplet infection guidelines.

**Hospital infrastructure**

Separate COVID-19 cohort isolation wards have been set up using existing wards, and the available number of intensive care beds have been tripled.

**Reducing the risk of infection among healthcare workers (HCW)**

Healthy employees as well as employees with symptoms that are not compatible with COVID19 can go to work as normal. Upon presentation of SARS-CoV2 like symptoms, employees should get tested, leave the workplace immediately and cannot care for suspected or confirmed cases. Employees can be tested for mild symptoms and can resume work after negative test results. If employees test positive, then they can resume patient care after 48 hours of being symptom-free. For employees at high-risk, they must have been tested again 48 hours after symptom cessation, and if negative, reassessment should be performed after another 24 hours. If this test is also negative, the employee can resume work. Consideration should be given to whether the recovered employee can be relocated to a less sensitive work area, from becoming symptom-free for 48 hours and until there are 2 x negative tests available.

**Reducing the risk of infection among healthcare workers (HCW)**

If a situation arises, where the test capacity does not match the need for testing for SARS-CoV-2, testing must be prioritized to (i) patients with moderate to severe symptoms who are hospitalised or are already admitted in the hospital, (ii) employees who perform functions in healthcare, the elderly, efforts for particularly vulnerable groups in the social field, or in other very key functions in society, (iii) citizens and employees of care centers, residences, closed institutions and other settings where it can be difficult to ensure isolation, distance, hygiene (iv) particularly vulnerable individuals.

In Nordsjællands Hospital, a 600-bed facility situated north of Copenhagen, apart from PPE provision and creating new workflows, healthcare workers are offered a psychological intervention to address fear, anxiety and stress.

**Other medical services**

Hospital system will prioritise those who are critically ill – some treatments will need to be postponed, such as non-emergency operations and other major non-critical interventions. Fewer meetings in practices or clinics. At risk patients should be offered telephone or video consultations.

### Sweden**[[99]](#footnote-99)** **[[100]](#footnote-100)** **[[101]](#footnote-101)** **[[102]](#footnote-102)**

**Point of entry**

A triage tent is set up at the entrance of the hospital. Individuals with no COVID-19 symptoms are sent directly to the emergency room or home without entering the triage tent.

**Patient placement**

Suspected COVID-19 patients with no serious symptoms referred to isolation with instructions on self-care. While suspected COVID-19 patients - with general symptoms, where emergency visits and possibly in-patient care is necessary are allocated to a separate area in the hospital.

**Reducing the risk of infection among healthcare workers (HCW)**

The healthcare services in Sweden prioritise testing for hospitalised patients and health or elderly care personnel with suspected COVID-19.

Despite the policy on testing HCW only symptoms, the Linköping University hospital decided to test all staff in the department after having had some patients with COVID-19. It turned out half (50) of the staff tested positive for the coronavirus, and between five and ten of them did not have any symptoms at all, or only a little headache or a slight sniffle.

In the Karolinska University Hospital, HCWs have gone up to working 12.5 hours, splitting the day into two shifts instead of three.

**Visitors**

Visitors are restricted.

### Norway**[[103]](#footnote-103)** **[[104]](#footnote-104)**

**Point of entry**

Individuals with symptoms are encouraged to contact the GP as the first point of contact.

**Reducing the risk of infection among healthcare workers (HCW)**

The Norwegian Institute of Public Health recommends that tests for health-care workers should be performed for SARS-CoV-2 on showing acute respiratory tract infections with fever, cough or breathing difficulties.

**Visitors**

Restrictions on visitors to all the country's health institutions and the introduction of entry control.

**Other medical services**

E-consultation or video consultation options should be provided.

## CASES: Two hospitals that have prevented nosocomial SARS-CoV-2 infections among health workers and patients

**Samsung Medical Centre in South Korea[[105]](#footnote-105)**

Samsung Medical Center, a 2000-bed tertiary hospital in Seoul with 9,000 staff, has adopted a rigorous infection control strategy which has led to zero infections in staff and secondary infections in patients as of early May. All hospital visitors are thoroughly screened for risk of SARS-CoV-2 with questionnaires, scanned with thermal cameras, and required to wear masks prior to entering the building. Advanced screening of patients and use of telemedicine limit unnecessary patient encounters. Designated COVID-19 screening, treatment, and quarantine areas are separated from the rest of the hospital. COVID-19 units are staffed by only dedicated core clinical teams with special training who live in hospital accommodations during two-week shifts and then are quarantined for one week and only allowed to return to the care of non COVID-19 patients after a negative COVID-19 test. Health staff wear full body suits with powered air purifying respirators while caring for COVID-19 patients, particularly for critically ill patients requiring high-risk procedures. Strict social distancing is enforced throughout the hospital, in particular the cafeteria, which is considered a particularly high-risk area for disease transmission among staff. All staff are required to wear surgical masks in the hospital, and N95 masks are required when seeing any patient with respiratory symptoms and while performing high-risk procedures regardless of the patient’s COVID-19 status.

**Cotugno Hospital in Italy[[106]](#footnote-106)**

The Cotugno Hospital, a specialist infectious diseases facility in Naples, only treats COVID-19 patients, and has managed zero infections among health staff as of April. Staff protection at the hospital goes beyond standard WHO recommendations, as they wear thick waterproof suits and those inside the treatment rooms with patients communicate through a window to those outside. Medicines are passed through a compartment. The ICU is divided into two zones. The first zone is a sub-intensive unit with patients that are recovering or haven’t deteriorated, while the second zone houses the critical patients, and different care teams are allocated to these two zones. A red and white tape marks the line that cannot be crossed. Clean area nurses and doctors assist infected area staff across the line. They keep the two absolutely separate. Since this is a specialist hospital that has been dealing with infectious diseases, the staff are well trained and have the knowledge and experience of implementing infection control measures including how to separate areas and wear and remove PPE. It is important to note that since the COVID-19 outbreak first started in the north of Italy, this hospital had more time to prepare for the emergency, and had more technological tools, devices and trained staff that strictly followed protocols.

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