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Post-COVID-19 "New Normal" for Molecular Imaging Departments: A United Kingdom Perspective

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Abstract

Coronavirus Disease 2019 (COVID-19) has changed the way the world is navigated and has had a massive impact on healthcare. Depending on where you are in the world the guidance on dealing with potential infected patients is varied. With the high risk of a second wave, it is important to learn from initial responses to plan for the future. With proper preparation, it is possible to minimize exposure and risk of contamination to individuals attending Molecular Imaging Departments. This will facilitate departments to operate at full capacity. From the widespread nature of this pandemic, global perspective can be a useful tool, what follows is the United Kingdom's (UK) perspective.

COVID-19 Impact

The UK is comprised of England, Scotland, Wales, and Northern Ireland. According to United Nations (UN) data, the mid-year population of the UK is estimated to be 68,886,000. For reference, the United States (US) has a current mid-year population of approximately 331,000,000 (UN data). The US is around 40 times larger in land mass than all of the UK.

The UK has approximately 304,500 cases and 42,600 deaths due to COVID-19 as of June 20, 2020 (*1, 2*). This country was one of the slowest acting to implement restrictions, lockdowns, and social distancing rules. There has been some debate on whether the delay was due to the government initially looking to create 'herd immunity,' then backtracking on their comments (*3, 4*). Herd immunity is when a large portion of the population are resistant to a disease, through vaccination or recovery from previous infection, lowering the risk to those

who are vulnerable. Good examples of herd immunity are seen in polio and measles disease studies (*5*).

Once lockdown was implemented, on March 23, 2020, to help reduce infection rates, people in the UK were generally compliant. The advice directly from the government was to stay at home, visit shops infrequently and only for essentials. Exercise once daily alone, or with members of the same household was encouraged, as well as social distancing - keeping two meters apart from members of other households. Only essential travel was permitted with proof required. All shops that were non-essential, such as electronics, clothing, or department stores, shut for the duration of the lockdown. All gatherings were banned, and fines were implemented for those breaking any of these rules (*6*).

Nightingale, the name that was given to a series of COVID-19 specific field hospitals were built. This was completed in the matter of a week in different areas of England to ease the burden from the National Health Service (NHS) (*7*). In England the private sector opened their facilities to the NHS to alleviate the overwhelming need for; hospital beds, ventilators, and clinical staff (*8*). Face masks were eventually made compulsory in England on public transport as of June 13, 2020, this included ride sharing services such as Uber, Bolt, and Kapten. Fines were imposed on those travelling without a face covering. In Scotland and Wales, face masks were advised and in Northern Ireland they were encouraged in places where social distancing was not possible (*9*).

Acute Impact on Practice

When lockdown was initially imposed, greater consideration for imaging referrals was taken to include infection risk factors as well as radiation exposure, with particular reference to

vulnerable groups. Vulnerable groups are identified as those over 70 years of age and those with co-morbidities such as lung, renal, and heart disease. It was advised that non-urgent, out-patient appointments be postponed until lockdown measures were relaxed. Only those patients whose course of treatment would be negatively impacted without imaging could attend. A traffic light system was devised and adopted by many facilities (see Figure 1) (*10, 11*).

Staffing recommendations were set up to minimize exposure to other staff as well as patients. For example, some sites went to extended shifts which allowed for a 3 or 4 day working week to rotate staff, and many staff were encouraged to use up annual leave. Some facilities provided scrubs to be worn on shift, to be changed onsite and laundered by the facility, preventing staff from bringing home contaminated laundry. Personal Protective Equipment (PPE) including the use of masks, gloves, aprons, and eye shielding was provided for patient facing staff who would be within two meters of the patient. Radiologists who were previously attending sites to report studies, were set up to work from home, to help minimize any exposure to staff and patients (*10, 11*).

Infection reduction techniques were put into effect immediately in departments including screening all staff and patients at building entrances with a questionnaire (see Table 1) and enforced handwashing on arrival, with either soap or sanitizer. Depending on how the patient answered, a contingency plan was suggested and followed (see Figure 2) (*11*). Where possible, screens were placed at reception to protect employees and patients. Patients were given a mask to be worn for the duration of their visit and adaptations were made to waiting areas reducing capacity but allowing for social distancing (*10, 11*).

New partnerships were founded between the NHS and private hospitals. In adherence to this some departments temporarily relocated specific services to private hospitals to reduce visits to high-risk NHS sites, dealing with the COVID-19 outbreak. An example of this is Sentinel Node breast injection services, where a breast is injected with radioisotope to help localize the sentinel node prior to lymphectomy. Some sites authorized to perform breast surgery with radioactive labelled patients were given temporary permission to inject patients on-site, either in pre-surgical holding bays or in theatre. This was in lieu of the usual practice of injecting in the Nuclear medicine department within NHS hospitals and then transferring to private clinics for surgery. This was facilitated by government legislation and accelerated approval pathways so as to not delay vital surgery or patient outcomes. A potential drawback to this scheme was no imaging capability at sites that did not have mobile gamma cameras, therefore careful screening was paramount to ensure imaging was not necessary (*12*).

Another area that was affected immediately was research. Most institutions suspended their projects at the onset of the pandemic (*11*). However, due to video conferencing technology such as Zoom, education & non-contact research has blossomed. Physicists and Technologists have been working on radiation monitoring projects using patient records to establish new guidance and base levels that have been neglected in the past. Education has continued remotely through online webinars such as the UKIO conference (*13*). This adaptation holds promise for the future making training more accessible to the community with the bonus of reduced time off and expenditure that often prevents attendance for those with less supportive work placements (*14, 15*).

Post COVID-19 Practice

Once the lockdown restrictions have been relaxed, Molecular Imaging Departments need to examine business practices to help avoid exposure to everyone until COVID-19 is eradicated. Measures implemented during the first wave are likely to become the norm. The British Society of Nuclear Medicine published COVID-19 Recovery Phase guidelines which alongside the aforementioned practices have guided departments back into recommencing non-urgent imaging and non-imaging procedures (*16*). A recently released video from HCA Healthcare UK, a private hospital system in the UK, highlights what patients can expect when attending one of their facilities (*17, 18*).

1. **Triage**. Patients on the waiting list from the time of the pandemic should be given priority for appointments. If following the traffic light system (see Figure 1), patients in the red should be prioritized followed by amber and then green. On booking it is best to ensure that patients do not have any active symptoms of COVID-19 or that they are not self-isolating (staying at home due to suspected exposure to COVID 19). Under these circumstances, it is best practice to reschedule appointments. Dependent upon the facility, it may be best to advise patients to not bring guests with them unless medically necessary. If patients require an aerosol-based test (e.g. Ventilation Lung scan) a different level of PPE may be required. Public Health England published a PPE guidance chart (see Figure 3 and Figure 4).
2. **Waiting Room**. There needs to be an area, at or near the entrance, for anyone entering to clean their hands, with either soap or sanitizer. Upon arrival all persons should be greeted and then instructed to clean their hands immediately. Each

person entering should have their temperature taken by a trained individual, wearing appropriate PPE. These temperatures should be recorded along with the screening questions (see Table 1). Patients and essential carers, should be given a mask to wear for the duration of their visit. If possible, screens or perspex shields should be placed at reception to protect staff and patients. Clear signage should be visible for handwashing, temperature checking stations, and adaptations made to the site for COVID-19. There should be lines of demarcation or stickers to signify two-meter distancing and where guests of the facility should stand, including in lifts.

Waiting areas may need rearranging to facilitate social distancing, this may include; chair removal to ensure two-meter distancing is maintained, but should be adaptable for accompanying persons where necessary. Special layouts may need to be taken into account for individuals in extenuating circumstances, such as prisoners being accompanied by wardens. If other waiting areas are available, once risk assessed, they could be utilized for patients pre and post injection.

If paper systems are still in use pens should be cleaned for each patient. Any paperwork not necessary for staff to handle should be shown through the perspex shield, where possible. Waiting areas should be cleaned with increased frequency to reduce cross contamination in accordance with local facilities or housekeeping policies. Clinical staff should endeavor to attend patients as quickly as possible to minimize their time in the waiting area. Some facilities have enforced restrictions on entrance times prior to appointments to reduce patient interaction.

3. **Staffing**. Staffing levels may return to normal, but with the possibility of extended hours to incorporate the backlog of patients. All staff should be educated on updated infection control measures. Time, distance, and shielding, concepts the technologists should be quite familiar with, will come in handy during times of pandemic and recovery, as similar rules apply. Where possible, staff should work two meters apart and wear a mask at all times. Staff should also decontaminate their hands whenever entering and leaving a room, prior to and after handling food, in addition to before and after patient contact. Staff in vulnerable groups may need further adjustments which should be discussed with management on a case by case basis.

   The effects of the pandemic on staff mental health should also be considered. Experiences are varied with some staff having been furloughed, some having volunteered in field hospitals or in alternate areas of the hospital, and even for those continued working at their normal workplace. The stress of being in a pandemic alongside caring for patients can take its toll. Therefore, health and wellness teams should be made accessible for any staff that needs them.

   Staff should be trained to look for signs of COVID-19 on imaging where possible. Clear protocols for positive findings should be outlined and adhered to, with real time radiologist support in indeterminate cases.

   Some facilities have started testing patient facing staff for COVID-19 on a regular basis. This will help to identify infected persons, potentially before symptoms arise. Some sites are also able to offer Anti-body testing.

4. **Attending patients**. It is best to have a plan with colleagues on how patients are attended. It is important to minimize exposure to multiple colleagues by having only one person deal with the patient where possible. If the facility normally gets patients changed, it may be a good idea to rethink that policy to minimize their exposure to lockers and other communal areas. If changing is a must, gowns and linens should not be placed in a changing room prior to the patient entering, but instead handed to the patient as they enter to minimize cross contamination with others. Lockers, chairs, and benches in changing rooms must be cleaned after each patient. Handling of patient's belongings by anyone other than the patient should be kept to a bare minimum, where possible. Attending staff should be wearing PPE in accordance with local policy and ensure that they wash their hands at all necessary intervals. The technologist should have all supplies ready to cannulate the patient, with extra available, so that they aren't compromising stores or leaving the room for additional items. When taking the patient's history, social distancing should be adhered to where possible. It is important to keep in mind that some patients may be hearing impaired, therefore they may have trouble understanding anyone wearing a mask due to voices being muffled and the inability to lip read. Instructions should be spoken slowly and clearly for all patients to ensure that they understand and consent to the procedure.

   When it is time to leave the room for any reason, ensure proper doffing procedures are followed. It may be necessary to perform mock scenarios to ensure policies are appropriate and understood by all staff.

5. **Emergency Response Planning.** COVID-19 Kits have become part of the emergency trolleys and are checked on a daily basis. These kits include a higher level of PPE to be utilized by those attending the emergency (see Figure 3 and Figure 4) and may be different depending on facility. Basic life support has also changed in the time of COVID-19. The resus council has updated their guidance to incorporate risk reduction techniques related to the pandemic. Highlights include assuming everyone has COVID-19 and no Cardio Pulmonary Resuscitation (CPR) until the correct PPE is worn. This is facilitated by the addition of a 'gatekeeper' at the door of the emergency. This person should not let anyone enter the emergency area who has not donned the proper PPE (*19*). The assumption that every person has COVID-19 is excellent advice applicable to every situation regardless of whether or not it is an emergency.

Conclusion

A new normal for Molecular Imaging Departments has been created. Molecular imaging technologists are adept at changing whilst still providing excellent care. Technologists have trained on new cameras, new software, and are given new isotopes and protocols frequently. While adjustments should be easily adopted by technologists, it is important to remember to comfort the patient throughout. They are the ones potentially vulnerable and scared. Technologists must reassure them that they are doing everything possible to minimize any exposure to COVID-19. The patient's peace of mind is important and should be looked after.

The aforementioned steps have facilitated Molecular Imaging Departments in the UK to remain open throughout the pandemic without compromising patient care. The authors of this

article appreciate that as the world changes, so will the guidance on how to deal with COVID-19 and adaptations will continue to be made.

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Figure 1

Stop light system recommended guidance by the British Society of Nuclear Medicine created during COVID-19 Pandemic. Green can be deferred, Amber must be discussed with clinician prior to moving forward, and Red is deemed essential and should not be cancelled or rescheduled (unless under extreme circumstances) (10).

Red	Amber	Green
Do not cancel or rebook unless patient at risk **Book all new referrals**	**Discuss with clinician if there is a need to cancel/rebook. New referrals to be discussed**	**Rebook without need for discussion with a clinician** **Do not book new appointments**
F-18 FDG new cancer	F-18 FDG follow up	2 phase bones and non-oncology Whole body bone
F-18 FDG sepsis	Ga-68 DOTATATE follow up	Amyloid DPD
Ga or F-18 PSMA/F-18 Choline new cancer	Ga or F18 PSMA/F-18 Choline follow up	Benign I131 thyroid therapy
Ga-68 DOTATATE (staging / therapy decision)	Ga-68 PSMA follow up	C13 UBT
GFR	Lung VQ	Colonic Transit
GI bleed	Mag3	CSF studies
In-111 Pentetreotide (Octreoscan)	MIBG pheochromocytoma	Dacroscintigraphy
Lu-177 DOTATATE	MPS routine (SOB)	DMSA
Lung perfusion	MUGA - cardiac	Gastric Emptying
Meckels	Parathyroid (bear in mind cessation of drug therapy in lead up)	HIDA
MPS acute chest pain	Platelet	I-123 Ioflupane (DaTSCAN)
MUGA Oncology	Thyroid Tc-99m/ I-123 (paeds)	Lymphoscintigraphy
Oncology Bones	White cell (also consider FDG)	MIBG heart
Radium-223		Morphine HIDA
SLN		Platelets
99mTc-EDDA/HYNIC-TOC (Tektrotyd)		Proctoscintigraphy
Y90-SIRT		Red Cell Mass
		Salivary
		Se-75 /Tauroselcholic acid (SeHCAT)
		Small bowel transit
		Thyroid Tc-99m/ I-123 (adults)
		Tl-201 hibernation

Figure 2

Contingency plan for Molecular Imaging Departments (11). Originally Adapted from: Song Y, Lan X. Key protection management of nuclear medicine imaging during the outbreak of COVID-19. Amazon Web Services website. https://s3.amazonaws.com/rdcms-snmmi/files/production/public/ACNM/ACNM%20COVID19%20-%20Wuhan%20NucMed%20Experience.pdf. Accessed April 20, 2020.

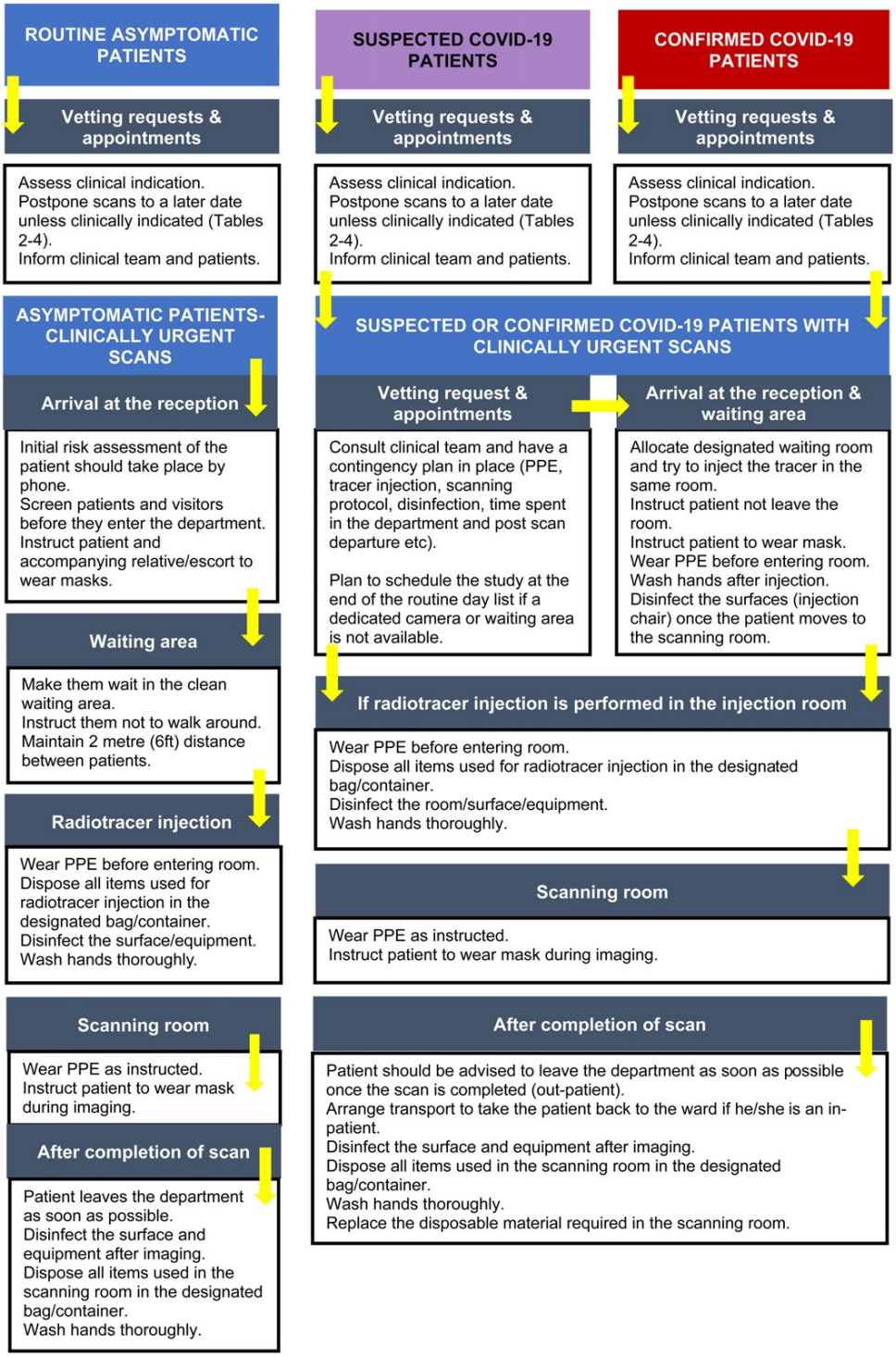
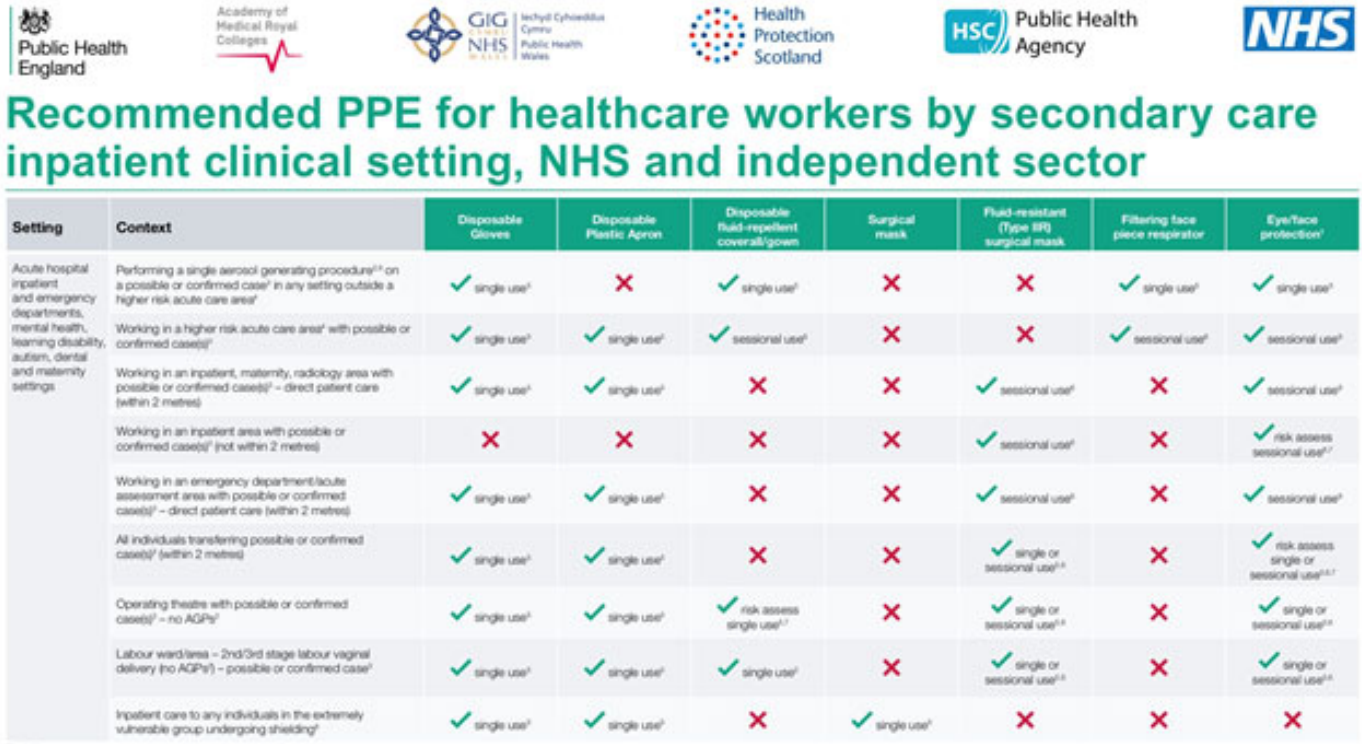


Figure 3: Reprinted from gov.uk (*20*).



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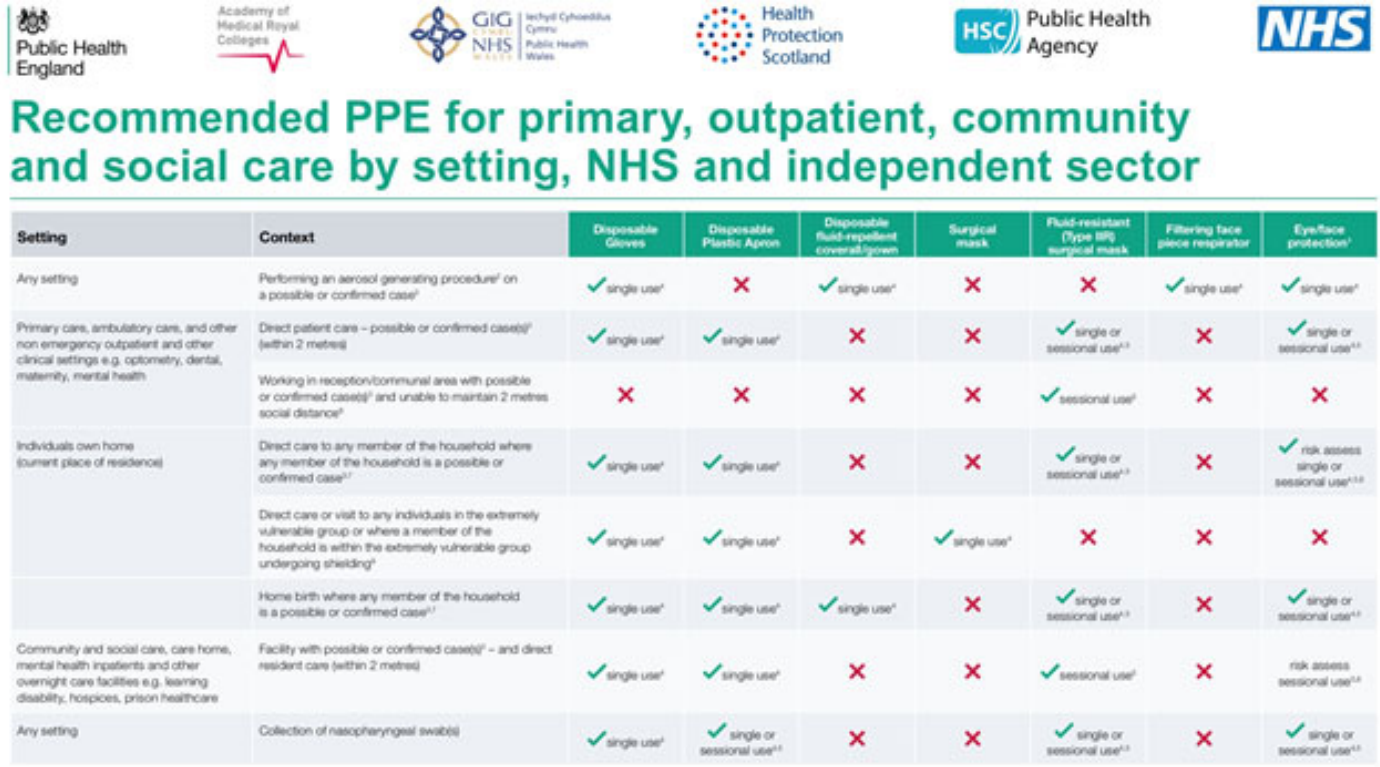
Recommended PPE for healthcare workers by secondary care inpatient clinical setting, NHS and independent sector

Setting	Context	Disposable Gloves	Disposable Plastic Apron	Disposable fluid-repellent coverall/gown	Surgical mask	Fluid-resistant (Type IIR) surgical mask	Filtering face piece respirator	Eye/face protection[1]
Acute hospital inpatient and emergency departments, mental health, learning disability, autism, dental and maternity settings	Performing a single aerosol generating procedure[2,3] on a possible or confirmed case[3] in any setting outside a higher risk acute care area[4]	✓ single use[5]	✗	✓ single use[5]	✗	✗	✓ single use[5]	✓ single use[5]
	Working in a higher risk acute care area[4] with possible or confirmed case(s)[3]	✓ single use[5]	✓ single use[5]	✓ sessional use[6]	✗	✗	✓ sessional use[6]	✓ sessional use[6]
	Working in an inpatient, maternity, radiology area with possible or confirmed case(s)[3] – direct patient care (within 2 metres)	✓ single use[5]	✓ single use[5]	✗	✗	✓ sessional use[6]	✗	✓ sessional use[6]
	Working in an inpatient area with possible or confirmed case(s)[3] (not within 2 metres)	✗	✗	✗	✗	✓ sessional use[6]	✗	✓ risk assess sessional use[6,7]
	Working in an emergency department/acute assessment area with possible or confirmed case(s)[3] – direct patient care (within 2 metres)	✓ single use[5]	✓ single use[5]	✗	✗	✓ sessional use[6]	✗	✓ sessional use[6]
	All individuals transferring possible or confirmed case(s)[3] (within 2 metres)	✓ single use[5]	✓ single use[5]	✗	✗	✓ single or sessional use[6,8]	✗	✓ risk assess single or sessional use[6,8,7]
	Operating theatre with possible or confirmed case(s)[3] – no AGPs[2]	✓ single use[5]	✓ single use[5]	✓ risk assess single use[6,7]	✗	✓ single or sessional use[6,8]	✗	✓ single or sessional use[6,8]
	Labour ward/area – 2nd/3rd stage labour vaginal delivery (no AGPs[2]) – possible or confirmed case[3]	✓ single use[5]	✓ single use[5]	✓ single use[5]	✗	✓ single or sessional use[6,8]	✗	✓ single or sessional use[6,8]
	Inpatient care to any individuals in the extremely vulnerable group undergoing shielding[9]	✓ single use[5]	✓ single use[5]	✗	✓ single use[5]	✗	✗	✗

1. This may be single or reusable face/eye protection/full face visor or goggles.
2. The list of aerosol generating procedures (AGPs) is included in section 8.1 at: www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/covid-19-personal-protective-equipment-ppe. (Note APGs are undergoing a further review at present).
3. A case is any individual meeting case definition for a possible or confirmed case: https://www.gov.uk/government/publications/wuhan-novel-coronavirus-initial-investigation-of-possible-cases/investigation-and-initial-clinical-management-of-possible-cases-of-wuhan-novel- coronavirus-wn-cov-infection
4. 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.
5. Single use refers to disposal of PPE or decontamination of reusable items e.g. eye protection or respirator, after each patient and/or following completion of a procedure, task, or session; dispose or decontaminate reusable items after each patient contact as per Standard Infection Control Precautions (SICPs).
6. A session refers to a period of time where a healthcare worker is undertaking duties in a specific care setting/exposure environment e.g. on a ward round; providing ongoing care for inpatients. A session ends when the healthcare worker leaves the care setting/exposure environment. Sessional use should always be risk assessed and considered where there are high rates of hospital cases. PPE should be disposed of after each session or earlier if damaged, soiled, or uncomfortable.
7. Risk assessed use refers to utilizing PPE when there is an anticipated/likely risk of contamination with splashes, droplets of blood or body fluids.
8. For explanation of shielding and definition of extremely vulnerable groups see guidance: https://www.gov.uk/government/publications/guidance-on-shielding-and-protecting-extremely-vulnerable-persons-from-covid-19/ guidance-on-shielding-and-protecting-extremely-vulnerable-persons-from-covid-19
9. Ambulance staff conveying patients are not required to change or upgrade PPE for the purposes of patient handover.

Patient use of PPE: In cohort wards, communal waiting areas and during transportation, it is recommended that suspected or confirmed cases wear a surgical face mask if this can be tolerated. The aim of this is to minimise the dispersal of respiratory secretions, reduce both direct transmission risk and environmental contamination. A surgical face mask should not be worn by patients if there is potential for their clinical care to be compromised (e.g. when receiving oxygen therapy).

Figure 4 reprinted from gov.uk (*20*).



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Recommended PPE for primary, outpatient, community and social care by setting, NHS and independent sector

Setting	Context	Disposable Gloves	Disposable Plastic Apron	Disposable fluid-repellent coverall/gown	Surgical mask	Fluid-resistant (Type IIR) surgical mask	Filtering face piece respirator	Eye/face protection[1]
Any setting	Performing an aerosol generating procedure[2] on a possible or confirmed case[3]	✓ single use[4]	✗	✓ single use[4]	✗	✗	✓ single use[4]	✓ single use[4]
Primary care, ambulatory care, and other non emergency outpatient and other clinical settings e.g. optometry, dental, maternity, mental health	Direct patient care – possible or confirmed case(s)[3] (within 2 metres)	✓ single use[4]	✓ single use[4]	✗	✗	✓ single or sessional use[4,5]	✗	✓ single or sessional use[4,5]
	Working in reception/communal area with possible or confirmed case(s)[3] and unable to maintain 2 metres social distance[6]	✗	✗	✗	✗	✓ sessional use[5]	✗	✗
Individuals own home (current place of residence)	Direct care to any member of the household where any member of the household is a possible or confirmed case[3,7]	✓ single use[4]	✓ single use[4]	✗	✗	✓ single or sessional use[4,5]	✗	✓ risk assess single or sessional use[4,5,8]
	Direct care or visit to any individuals in the extremely vulnerable group or where a member of the household is within the extremely vulnerable group undergoing shielding[9]	✓ single use[4]	✓ single use[4]	✗	✓ single use[4]	✗	✗	✗
	Home birth where any member of the household is a possible or confirmed case[3,7]	✓ single use[4]	✓ single use[4]	✓ single use[4]	✗	✓ single or sessional use[4,5]	✗	✓ single or sessional use[4,5]
Community and social care, care home, mental health inpatients and other overnight care facilities e.g. learning disability, hospices, prison healthcare	Facility with possible or confirmed case(s)[3] – and direct resident care (within 2 metres)	✓ single use[4]	✓ single use[4]	✗	✗	✓ sessional use[5]	✗	risk assess sessional use[5,8]
Any setting	Collection of nasopharyngeal swab(s)	✓ single use[4]	✓ single or sessional use[4,5]	✗	✗	✓ single or sessional use[4,5]	✗	✓ single or sessional use[4,5]

1. This may be single or reusable face/eye protection/full face visor or goggles.
2. The list of aerosol generating procedures (AGPs) is included in section 8.1 at: www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/covid-19-personal-protective-equipment-ppe. (Note APGs are undergoing a further review at present)
3. A case is any individual meeting case definition for a possible or confirmed case: https://www.gov.uk/government/publications/wuhan-novel-coronavirus-initial-investigation-of-possible-cases/investigation-and-initial-clinical-management-of-possible-cases-of-wuhan-novel-coronavirus-wn-cov-infection
4. Single use refers to disposal of PPE or decontamination of reusable items e.g. eye protection or respirator, after each patient and/or following completion of a procedure, task, or session; dispose or decontaminate reusable items after each patient contact as per Standard Infection Control Precautions (SICPs).
5. A single session refers to a period of time where a health care worker is undertaking duties in a specific care setting/exposure environment e.g. on a ward round; providing ongoing care for inpatients. A session ends when the health care worker leaves the care setting/exposure environment. Sessional use should always be risk assessed and considered where there are high rates of hospital cases. PPE should be disposed of after each session or earlier if damaged, soiled, or uncomfortable.
6. Non clinical staff should maintain 2m social distancing, through marking out a controlled distance; sessional use should always be risk assessed and considered where there are high rates of community cases.
7. Initial risk assessment should take place by phone prior to entering the premises or at 2 metres social distance on entering; where the health or social care worker assesses that an individual is symptomatic with suspected/confirmed cases appropriate PPE should be put on prior to providing care.
8. Risk assessed use refers to utilising PPE when there is an anticipated/likely risk of contamination with splashes, droplets or blood or body fluids.
9. For explanation of shielding and definition of extremely vulnerable groups see guidance: https://www.gov.uk/government/publications/guidance-on-shielding-and-protecting-extremely-vulnerable-persons-from-covid-19/guidance-on-shielding-and-protecting-extremely-vulnerable-persons-from-covid-19

Table 1

Example of questions asked when entering a facility.

1. Do you or someone in your household currently suffer from any of the below symptoms:
a high temperature
a new continuous cough
a loss of, or change in, your normal sense of taste or smell
2. Have you or someone in your household been told you have confirmed COVID- 19 in the last 14 days?
3. Have you been told you have been in contact with someone who has confirmed COVID-19 in the last 14 days?
4. Have you travelled outside the UK in the last 14 days?
5. Have you been advised to self-isolate?