

ISUOG Safety Committee Position Statement on use of personal protective equipment and hazard mitigation in relation to SARS-CoV-2 for practitioners undertaking obstetric and gynecological ultrasound

Endorsed by the Australasian Society for Ultrasound in Medicine (ASUM), the British Medical Ultrasound Society (BMUS), the Society and College of Radiographers (SCoR) and Società Italiana di Ecografia Ostetrica e Ginecologica e Metodologie Biofisiche (SIEOG)

In view of the challenges of the current coronavirus (SARS-CoV-2) pandemic, the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) has compiled the following expert-opinion-based guidance on safe use of personal protective equipment (PPE) and how to reduce the hazard of SARS-CoV-2 infection for clinicians undertaking ultrasound examinations (physicians, sonographers and allied professionals). The European Centre for Disease Prevention and Control (ECDC) has released a technical report for wearing and removing PPE in healthcare settings managing patients with suspected or confirmed coronavirus disease 2019 (COVID-19)¹, as have the Centres for Disease Control and Prevention (CDC)², World Health Organization (WHO)³ and, in the UK, Public Health England (PHE)⁴. At the time of writing, none of these recommendations has addressed the safe use of PPE when performing ultrasound examinations specifically. As guidance in relation to PPE differs from country to country and region to region, we recommend that local guidance is followed when this is available; if no guidance specific to ultrasound examinations exists, this document may be referenced.

This guidance describes steps that may be taken to minimize the risk of SARS-CoV-2 transmission between the patient and the practitioner during ultrasound examinations. It is important to note that many of the measures discussed in this document are supported by limited research-based evidence. This may explain why advice varies widely between different parts of the world (Appendix 1). Nevertheless, the authors, several of whom work in some of the areas first affected by the virus, including China (Appendix 2), Singapore, Hong Kong and Italy, have been able to synthesize what are believed to be the most effective interventions for reducing the transmission of SARS-CoV-2 between patients and healthcare providers.

BACKGROUND: RISK OF INFECTION DURING ULTRASOUND ASSESSMENT

An ultrasound examination has several unique attributes that are likely to increase the risk of transmission between patients and ultrasound operators (and potentially vice versa). These include, but are not limited to, the following:

- Physical proximity to the patient is less than 2 meters or 6 feet, and may be as little as 30–50 cm;

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- The ultrasound room or enclosed area is typically small;
- The ultrasound rooms often have restricted ventilation, as the air-conditioning systems are in some cases closed loop and/or there are no windows;
- The examination time may last between 10 and 60 min;
- Invasive or transvaginal procedures may need to be carried out;
- The woman may be asked to inhale or exhale deeply, and hold her breath;
- Therapeutic and interventional procedures may increase the risk of exposure to bodily fluids;
- There is a risk of the patient coughing, sneezing or exhaling heavily;
- The surfaces of the ultrasound machine, especially the keyboard, touch screen and trackball, are touched frequently.

These attributes have not been formally studied in relation to the risk of transmission of viral infection during ultrasound examination. A recent study on the ability of an exhaled turbulent gas cloud to carry respiratory pathogens a long distance, suggests that appropriate PPE should be considered for all healthcare workers, even if they remain further than 2 meters away from a symptomatic patient⁵.

NON-PPE RISK MITIGATION

Given that the undertaking of an ultrasound examination inevitably prevents distancing and requires that a doctor or sonographer remains in close contact with a patient for a long period of time, mitigation measures should be considered to reduce the risk of SARS-CoV-2 transmission.

Triage ultrasound scans

During the COVID-19 pandemic, depending on local disease prevalence and staff shortage, high-risk patients should be prioritized for ultrasound assessment, while prioritization by type of scan should be considered, with the second-trimester anatomy scan taking precedence over the first-trimester scan and growth scans performed based on coexisting and emerging comorbidities. Further details are provided in the ISUOG Consensus Statement on organization of routine and specialist obstetric ultrasound services in the context of COVID-19⁶.

Ventilation of ultrasound room

Very few studies have assessed environmental contamination as a route of transmission of SARS-CoV-2 in the healthcare setting⁷. Infection control advice is based on the reasonable assumption that the transmission characteristics of COVID-19 are similar to those of the 2003 SARS-CoV outbreak.

Adequate ventilation is the main way to reduce air environmental contamination and exposure to COVID-19 infection. The WHO divides environmental ventilation methods into three types: mechanical, natural and mixed-mode⁸. Good ventilation of rooms to clear aerosols is recommended by several organizations⁹⁻¹¹. Although most guidelines refer to conditions in which aerosol-generating procedures (AGP) are performed, AGPs are rare in routine ultrasound practice. The rate of clearance of aerosols in an enclosed space depends on the number of air changes per hour. A single air change is estimated to remove 63% of airborne contaminants and after five air changes less than 1% of airborne contamination is thought to remain⁹. After an AGP, a minimum of 20 min of ventilation is considered pragmatic, which can be reduced to 5 min if ultraclean ventilation is used (e.g. in some operating theaters). This situation is very unlikely to pertain to obstetric and gynecological ultrasound.

Air-conditioning systems equipped with high-efficiency particulate air (HEPA) filters provide adequate protection especially if combined with the use of PPE and face masks. Most hospital systems are not equipped with HEPA filters, hence, turning off air conditioning and, where there are windows, opening them for good ventilation if an independent air supply is not feasible, has been recommended by WHO for rooms hosting patients with suspected SARS infection¹². As every ultrasound environment is different and there are no consistent regulations or advice regarding ventilation, we recommend that consideration is given to ventilation in ultrasound rooms in individual workplaces.

ADVICE TO PATIENTS

First point of contact: should temperature be taken and history of travel, occupation, contact and cluster (TOCC) be asked before or on arrival at the ultrasound department?

According to the Royal College of Obstetricians and Gynaecologists, maternity departments with direct entry for patients and the public should put in place a system for identification of potential cases of COVID-19 as soon as possible, to prevent potential transmission to other patients and staff¹³. This system should be set up at the first point of contact (either near the entrance or at reception) to ensure early recognition and infection control. This should be employed before a patient sits in the maternity waiting area¹³.

From an epidemiological point of view, the SARS-CoV-2 virus first emerged in the Hubei province in China. Therefore, in the early phase of the epidemic, history of travel to the Hubei province, as well as contact with people known to have been infected by SARS-CoV-2, obtained via TOCC assessment was advocated as the first measure to identify potential carriers of the SARS-CoV-2 virus^{14,15}. Nonetheless, the rapid spread of the disease across countries and continents, as well as the evidence of existence of asymptomatic carriers¹⁶, has led to circumstances in which all patients are to be considered at risk of infection and hence potential carriers of the SARS-CoV-2 virus.

On this basis, and following the available recommendations^{2,9,15}, in the most affected areas, such as northern Italy, several maternity units have implemented strict protocols for the triage of women accessing the unit. Such measures include the arrangement of 'check point' triage areas in which dedicated medical personnel equipped with PPE take the temperature and assess the medical history, in terms of symptoms and contact, of women attending the maternity units and the ultrasound departments.

Women should be advised that triage of their symptoms and contact represents the first-line assessment in order to allow the identification of contacts should they develop symptoms at a later stage. According to ISUOG's Interim Guidance, patients identified to be at risk for SARS-CoV-2 infection should delay their antenatal visit and routine ultrasound assessment by 14 days¹⁵. We recommend that this advice is considered on a local basis after taking into account the potential implications of a delayed ultrasound examination in the context of local/national regulations. This advice applies only to routine ultrasound examinations; clearly, pregnancies requiring time-critical examinations should be considered on a case-by-case basis.

Should the patient wear a mask?

Surgical masks, also referred to as medical masks, face masks or simply masks, provide only a barrier protection against droplets, including large respiratory particles, while they do not effectively filter small particles from the air and do not prevent leakage around the edge of the mask when the user inhales².

The rationale for the use of surgical masks is two-fold: to protect the wearer from sources of infection, such as splashing or spraying of blood, hand-to-face contact and large droplets and sprays, and to protect others from the wearer in case they are a source of infection¹⁷. If no mask is used, the mucosal surfaces of the nose and mouth are exposed, providing an easy route of entry to the body for pathogenic microorganisms. There is no standard definition of a surgical mask, and there is a wide variation in the design and quality of the masks currently in use. In terms of the design, it is recommended that masks should fully cover the nose and mouth of the wearer. Two randomized controlled trials support the use of surgical masks in a community setting^{18,19} and the use of masks is recommended in cases of suspected or confirmed SARS-CoV-2 carriers in order to prevent spread of the infection^{1-3,20}.

N95 and FFP2 respirators filter out particles, including bacteria and viruses². Statements from leading health organizations (ECDC, WHO and CDC)¹⁻³ provide different recommendations for the use of respirators in a healthcare setting. However, respirators are recommended for use only by healthcare professionals requiring protection from both airborne and fluid hazards (e.g. splashes, sprays), while no indication exists outside of the healthcare setting². There is little or no evidence supporting the use of N95 or FFP2 masks by patients.

The rapid increase of the epidemic curve of the SARS-CoV-2 virus, together with evidence that carriers of the disease can be asymptomatic¹⁶, has led to a situation in which all individuals, including the medical staff and patients, represent potential carriers of the infection. On this basis, and despite the lack of evidence as to whether asymptomatic carriers contribute to the spread of the SARS-CoV-2 virus, in certain countries both the healthcare staff and patients, as well as other hospital attendants, have been advised to don surgical masks in a healthcare setting in order to minimize the dispersal of respiratory secretions and reduce environmental contamination.

We consider that, currently, there is too little evidence to recommend the routine use of patient masks by asymptomatic low-risk patients. We do, however, recommend that local protocols should advise that patients with symptoms of COVID-19, or those judged to have suspected or probable infection, should wear a surgical mask when undergoing imaging or other ultrasound investigation.

PERSONAL PROTECTIVE EQUIPMENT

The SARS-CoV-2 virus is spread mainly by close contact and respiratory droplets, with airborne transmission being likely in specific circumstances²¹. In general, respirators, as opposed to surgical masks, are recommended for healthcare personnel who come in contact with patients with strongly suspected or confirmed COVID-19 infection, however, surgical masks are an acceptable substitute when supply of respirators is limited²². A detailed description of available surgical masks and respirators is provided in Appendix 3.

Staff age and comorbidities

- Ultrasound providers of advanced age or with health conditions that predispose them to infection and severe disease should avoid scanning patients with suspected or confirmed COVID-19 disease, and should consider wearing appropriate PPE when working in a region affected by the COVID-19 pandemic, even if they are examining an asymptomatic and TOCC-negative patient.

- Individuals at highest risk for severe COVID-19 disease and death include those aged over 60 years and those with underlying conditions, such as hypertension, diabetes, cardiovascular disease, chronic respiratory disease and cancer.
- Individuals who have a comorbidity should ensure that their occupational health departments are aware of their underlying condition, age and area of deployment.

General considerations

- Attention should be paid to train ultrasound providers on safe donning, doffing and disposal of PPE^{23,24}.
- Proper functioning of respirators requires that an effective seal is created between the mask and the face of the wearer. Variation in face size and shape, and availability of different respirator designs, mean that a proper fit is only possible for a minority of healthcare workers for any particular mask. All healthcare workers should therefore undergo a fitting test for respirators and should continue to wear the type of respirator for which they have been fit-tested.
- Hand hygiene should be performed before and after patient contact, contact with potentially infectious material, and before putting on and after removing PPE, including gloves. Hand hygiene after removing PPE is particularly important to remove pathogens that might have been transferred to bare hands during the removal process. Hand hygiene should include use of 60–95% alcohol or washing hands with soap and water for at least 20 sec.

When managing patients with confirmed or suspected COVID-19 infection, or if there is widespread community transmission²²

- To avoid infection through respiratory droplets, practitioners should don appropriate PPE, including a surgical mask, upon entering the ultrasound room.
- To avoid infection through contact, all patients with suspected or confirmed COVID-19 disease should preferably be scanned in a single dedicated room. The practitioner should don appropriate PPE, including gloves and gown, upon entering the ultrasound room, and use of disposable equipment should be preferred, where possible.
- To avoid airborne transmission, the patient should be asked to wear a surgical mask if they are symptomatic or have confirmed COVID-19 infection. The healthcare worker should wear appropriate PPE, including a fit-test approved respirator or surgical mask, depending on the level of infection risk, gloves, gown, face and eye protection, upon entering the room. High-risk healthcare workers should be restricted from entering the ultrasound room and disposable equipment should be used where possible.

PPE in obstetric, gynecological and early-pregnancy scans (Appendices 4 and 5)

Guidance is provided in Table 1 according to patient symptoms and infection status, considering three groups of patients:

1. Asymptomatic and TOCC-negative patients in a region in which there is no widespread community transmission.
2. Asymptomatic and TOCC-positive patients in a region in which there is no widespread community transmission.
3. Patients with suspected/probable/confirmed COVID-19 disease or in a region in which there is widespread community transmission.

There is little difference between gynecological, early-pregnancy and obstetric scans from the standpoint of infection, so precautionary measures are applicable to all three fields. Transvaginal ultrasound probes should undergo high-level disinfection as condoms and commercial covers may break²⁵. Tracing and record keeping for high-level disinfection is essential. Detailed guidance regarding ultrasound equipment and transducer cleaning in the context of COVID-19 has been provided in a separate document²⁶.

Table 1: Personal protective equipment (PPE) recommended for use by ultrasound providers based on risk assessment of patient for COVID-19

PPE	Asymptomatic and TOCC negative	Asymptomatic and TOCC positive	Suspected*/probable/confirmed COVID-19 or where there is widespread community transmission
Clothing	Dedicated work clothes	Dedicated work clothes	Dedicated work clothes
Hand hygiene	Yes	Yes	Yes
Surgical facemask	Yes†	Respirator (N95, FFP2/3)‡	Respirator (N95, FFP2/3)‡
Respirator	No	Respirator (N95, FFP2/3)‡	Respirator (N95, FFP2/3)‡
Isolation gown	No	Disposable fluid-resistant and impermeable protective gown (e.g. AAMI level 3)	Disposable fluid-resistant and impermeable protective gown (e.g. AAMI level 3)
Disposable gloves	Yes	Yes (two pairs)	Yes (two pairs)
Eye protection	No	Goggles or face shield	Goggles or face shield
Hair cover	No	Yes	Yes
Additional consideration for transvaginal scan or invasive procedures	Standard condom or commercial transducer cover ²⁵	Standard condom or commercial transducer cover; cover for cable if available ²⁵	Standard condom or commercial transducer cover; cover for cable if available ²⁵
Staffing/environment	—	—	Ideally scan at bedside rather than in a clinic; minimize number of staff in room and ensure that most senior person is undertaking scan
Disinfection/cleaning ²⁶	Low-level disinfection for external probes; high-level disinfection for internal probes	Low-level disinfection for external probes; high-level disinfection for internal probes; additional low-level disinfection for ultrasound machine and cables	Low-level disinfection for external probes; high-level disinfection for internal probes; additional low-level disinfection for ultrasound machine and cables

*Symptomatic patient with or without travel, occupation, contact and cluster (TOCC) risk factors, in area in which there is widespread community transmission. †Extended use of surgical facemasks is practice of wearing same surgical facemask for repeat close-contact encounters with several different patients, without removing facemask between patients. In most cases, one face mask can be safely used for a typical clinic of 3–4 h. Surgical facemask should be removed and discarded if it is soiled, damaged or hard to breathe through. Healthcare workers should take care not to touch their surgical facemask; if they touch or adjust their surgical facemask, they should immediately perform hand hygiene. Healthcare workers should leave patient care area if they need to remove their surgical facemask. Re-use should be implemented according to CDC guidance²⁷. ‡All healthcare workers should undergo training on appropriate use of and fit testing for respirators. Alternatives to respirators: filtering facepiece respirator, elastomeric half-mask and full facepiece air purifying respirator, if available; all these alternatives provide equivalent or higher protection than N95 respirators when worn properly. Extended use refers to practice of wearing same N95 respirator for repeat close-contact encounters with several different patients, without removing

respirator between patient encounters. Extended use of respirators is well-suited to situations in which multiple patients with COVID-19, whose care requires use of respirator, are cohorted (e.g. housed in same hospital unit). Limited re-use of N95 respirators when caring for patients with COVID-19 might become necessary. However, it is unknown what is the potential contribution of contact transmission for SARS-CoV-2, therefore, caution should be exercised. Re-use should be implemented according to CDC guidance²⁸. **Recommendation:** When putting on new mask/respirator, even if it is type, size and shape that fitted last time, recheck sealability, not only in neutral head position, but also in positions taken when actually scanning a patient, for example, by turning head to side or tilting chin up to face monitor, or during use of two hands to hold transducer or other device.

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REFERENCES

1. European Centre for Disease Prevention and Control (ECDC), 2020. Infection Prevention and Control For the Care of Patients With 2019-nCoV in Healthcare Settings. <https://www.ecdc.europa.eu/sites/default/files/documents/COVID-19-guidance-wearing-and-removing-personal-protective-equipment-healthcare-settings-updated.pdf>
2. Centres for Disease Control and Prevention. Coronavirus Disease 2019 (COVID-19). Frequently Asked Questions about Personal Protective Equipment. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirator-use-faq.html>
3. World Health Organisation (WHO), 2020. Novel Coronavirus (2019-nCoV). <https://www.who.int/westernpacific/emergencies/covid-19>
4. Public Health England. Guidance. COVID-19: Infection Prevention and Control Guidance. <https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control>
5. Bourouiba L. Turbulent Gas Clouds and Respiratory Pathogen Emissions: Potential Implications for Reducing Transmission of COVID-19. *JAMA* 2020. DOI:10.1001/jama.2020.4756.
6. Abu-Rustum RS, Akolekar R, Sotiriadis A, Salomon LJ, Da Silva Costa F, Wu Q, Frusca T, Bilardo CM, Prefumo F, Poon LC. ISUOG Consensus Statement on organization of routine and specialist obstetric ultrasound services in the context of COVID-19. *Ultrasound Obstet Gynecol* 2020. DOI: 10.1002/uog.22029.
7. Ong SWX, Tan YK, Chia PY, Lee TH, Ng OT, Wong MSY, Marimuthu K. Air, surface environmental, and personal protective equipment contamination by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) from a symptomatic patient. *JAMA* 2020. DOI: 10.1001/jama.2020.3227.
8. World Health Organization. WHO Guidelines. Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care. https://apps.who.int/iris/bitstream/handle/10665/112656/9789241507134_eng.pdf;jsessionid=403613D204AC57EDB11B41001DED8149?sequence=1
9. COVID-19 Guidance for infection prevention and control in healthcare settings. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/874316/Infection_prevention_and_control_guidance_for_pandemic_coronavirus.pdf
10. Istituto Superiore di Sanità. Rapporto ISS COVID-19 n. 4/2020. Indicazioni ad interim per la prevenzione e il controllo dell'infezione da SARS-CoV2 in strutture residenziali socio-sanitarie. <https://www.epicentro.iss.it/coronavirus/pdf/rapporto-covid-19-4-2020.pdf>
11. World Health Organization. Interim Guidance. Infection prevention and control during health care when novel coronavirus (nCoV) infection is suspected. [https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-\(ncov\)-infection-is-suspected-20200125](https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-(ncov)-infection-is-suspected-20200125)
12. World Health Organization. Handbook for management of public health events on board ships. <https://www.who.int/ihr/lyon/surveillance/infectioncontrol/en/>
13. Royal College of Obstetricians and Gynaecologists. Coronavirus (COVID-19) infection and pregnancy. <https://www.rcog.org.uk/globalassets/documents/guidelines/2020-03-26-covid19-pregnancy-guidance.pdf>
14. Patel A, Jernigan DB; 2019-nCoV CDC Response Team. Initial Public Health Response and Interim Clinical Guidance for the 2019 Novel Coronavirus Outbreak - United States, December 31, 2019-February 4, 2020. *MMWR Morb Mortal Wkly Rep* 2020; **69**: 140–146.

15. Poon LC, Yang H, Lee JCS, Copel JA, Leung TY, Zhang Y, Chen D, Prefumo F. ISUOG Interim Guidance on 2019 novel coronavirus infection during pregnancy and puerperium: information for healthcare professionals. *Ultrasound Obstet Gynecol* 2020. DOI: 10.1002/uog.22013.
16. Lu S, Lin J, Zhang Z, Xiao L, Jiang Z, Chen J, Hu C, Luo S. Alert for non-respiratory symptoms of Coronavirus Disease 2019 (COVID-19) patients in epidemic period: A case report of familial cluster with three asymptomatic COVID-19 patients. *J Med Virol* 2020. DOI: 10.1002/jmv.25776
17. Wang Q, Yu C. Letter to editor: Role of masks/respirator protection against 2019-novel coronavirus (COVID-19). *Infect Control Hosp Epidemiol* 2020. DOI :10.1017/ice.2020.83.
18. Canini L, Andréoletti L, Ferrari P, D'Angelo R, Blanchon T, Lemaitre M, Filleul L, Ferry JP, Desmaizieres M, Smadja S, Valleron AJ, Carrat F. Surgical mask to prevent influenza transmission in households: a cluster randomized trial. *PLoS One* 2010; **5**: e13998.
19. MacIntyre CR, Zhang Y, Chughtai AA, Seale H, Zhang D, Chu Y, Zhang H, Rahman B, Wang Q. Cluster randomised controlled trial to examine medical mask use as source control for people with respiratory illness. *BMJ Open* 2016; **6**: e012330.
20. Chughtai AA, Seale H, Islam MS, Owais M, Macintyre CR. Policies on the use of respiratory protection for hospital health workers to protect from coronavirus disease (COVID-19). *Int J Nurs Stud* 2020; **105**: 103567.
21. World Health Organization. Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations. <https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations>
22. Centres for Disease Control and Prevention. Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings. <https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html>
23. Centres for Disease Control and Prevention. Sequence for putting on Personal Protective Equipment. <https://www.cdc.gov/hai/pdfs/ppe/ppe-sequence.pdf>
24. Livingston E, Desai A, Berkwits M. Sourcing Personal Protective Equipment During the COVID-19 Pandemic. *JAMA* 2020. DOI: 10.1001/jama.2020.5317.
25. Basseal JM, Westerway SC, Hyett JA. Analysis of the integrity of ultrasound probe covers used for transvaginal examinations. *Infect Dis Health* 2019. DOI: 10.1016/j.idh.2019.11.003.
26. Poon LC, Abramowicz JS, Dall'Asta A, Sande R, ter Haar G, Maršal K, Brezinka C, Miloro P, Basseal J, Westerway SC, Abu-Rustum RS, Lees C. ISUOG Safety Committee Position Statement: safe performance of obstetric and gynecological scans and equipment cleaning in the context of COVID-19. *Ultrasound Obstet Gynecol* 2020. DOI: 10.1002/uog.22027.
27. Centres for Disease Control and Prevention. Strategies to Optimize PPE & Equipment. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/face-masks.html>
28. Centres for Disease Control and Prevention. Strategies for Optimizing the Supply of N95 Respirators: Contingency Capacity Strategies. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirators-strategy/contingency-capacity-strategies.html>

APPENDICES

Appendix 1 Snapshot of measures taken globally to reduce hazard of SARS-CoV-2 infection, in context of ultrasound examinations (based on feedback from a number of units in each territory but not intended as a comprehensive guide)

	Europe (UK, Italy)	Scandinavia (Sweden, Norway)	Southeast Asia (Singapore, Hong Kong)	Australia/New Zealand	North America
Before ultrasound scan	Screen patients using standardized checklists for symptoms and risk factors. If patient has symptoms, postpone non-essential examinations.	Screen patients using standardized checklists for symptoms and risk factors. If patient has symptoms, postpone non-essential examinations.	Screen patients using standardized checklists for symptoms and risk factors. If patient has symptoms, postpone non-essential examinations.	Screen patients using standardized checklists for symptoms and risk factors. If patient has symptoms, postpone non-essential examinations.	Prioritize examinations (emergency vs routine or essential vs non-essential). Interview patients by phone before arrival.
During ultrasound scan	Accompanying persons limited to one, or none allowed.	No accompanying person allowed.	In Singapore, one accompanying person allowed, who is subjected to same screening criteria as patients. In other territories, no accompanying person allowed.	No accompanying person allowed or accompanying person undergoes same screening procedure as patients.	No visitors allowed in room with patient during ultrasound examination, unless they are essential to patient care (mobility, language). It is reasonable not to allow trainees or students to participate.
PPE	For screen-negative women, mask and/or gloves are variably used during ultrasound examinations. For women with suspected or confirmed COVID-19 infection, appropriate PPE is used.	For screen-negative women, mask and/or gloves are not used during ultrasound examinations. For women with suspected or confirmed COVID-19 infection, appropriate PPE is used.	For screen-negative women, surgical facemask and/or gloves are used during ultrasound examinations. For women with suspected or confirmed COVID-19 infection, appropriate PPE is used.	For screen-negative women, surgical facemask and gloves are used during ultrasound examination. For women with suspected or confirmed COVID-19 infection, appropriate PPE is used.	Surgical facemasks are essential for protection. These must be put on before entering patient room or care area. When available, N95 (or higher level) should be used.
Other measures		In many Scandinavian countries there is shortage of PPE,	Use of surgical facemask, respirators, eye protection	Use of surgical facemask, respirators, eye protection	

		especially P3 and P2 masks, and clinicians are advised to save PPE until expected large wave of COVID-19 patients.	(extended use). Use of gloves and gowns (single use).	(extended use).Use of gloves and gowns (single use).	
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Appendix 2 Infection rate of ultrasound providers: experience from Wuhan

In China, there is a medical specialty known as ‘ultrasound doctor’. These doctors see many patients per day and perform only ultrasound. The comparison to practice outside China is transferable to the extent that the findings might apply to any doctor or imaging practitioner, for example, sonographers or midwives, whose work is largely ultrasound-based.

Based on a study by Xie and his team conducted at the epicenter in Wuhan, the SARS-CoV-2 infection rate of ultrasound staff is approximately 3.4%, which is considerably higher than the estimated overall infection rate of 2.2% among Wuhan healthcare workers, regardless of their specialty (Table 1).

The overall number of staff infection in Wuhan is subject to further verification, as no official update on staff infection figures is currently available and because the total number of healthcare workers on Wuhan Health Commission official website was last updated in 2017. There are also certain specialties (e.g. rehabilitation) who might be considerably less active than other teams (e.g. respiratory, cardiovascular and radiology, including ultrasound departments) during the lockdown.

The reported zero infection rate among the rescue medics from the rest of China who were on the frontline in Wuhan, in the whole of China emphasizes the importance of sufficient personal protective equipment (PPE) provision and donning/doffing training. However, the case of a nurse who suffered cardiac arrest and its critical consequence highlights PPE’s possible, though rare, adverse impact on wellbeing, and the need to consider carefully a time limit for how long PPE should be used while doing intensive work.

Table 1 Preliminary comparison of COVID-19 infection rate between ultrasound staff and other healthcare groups

	Wuhan ultrasound workforce ¹	Wuhan all medics*	Rescue medics from rest of China [†]
Infection rate (% (n/N))	3.4% (43/1252)	2.2% (3000/136 300)	0.0% (0/42 600)

*Estimated number as no detailed figures have been released. †Although zero COVID-19 infection rate was reported for rescue medics, one suffered cardiac arrest believed to be caused by wearing 3rd degree PPE for too long; nurse is still on external cardiopulmonary support at time of writing.

Reference

1. Wang J, Zhang W, Chen QC, You MJ, Yang YL, Lü Q, Zhang L, Xie MX. Ultrasound staff infections in Wuhan during the COVID-19 epidemic (in Chinese). *Chinese Journal of Ultrasonography* 2020 [accepted for publication].

Appendix 3 Comparison of masks and respirators

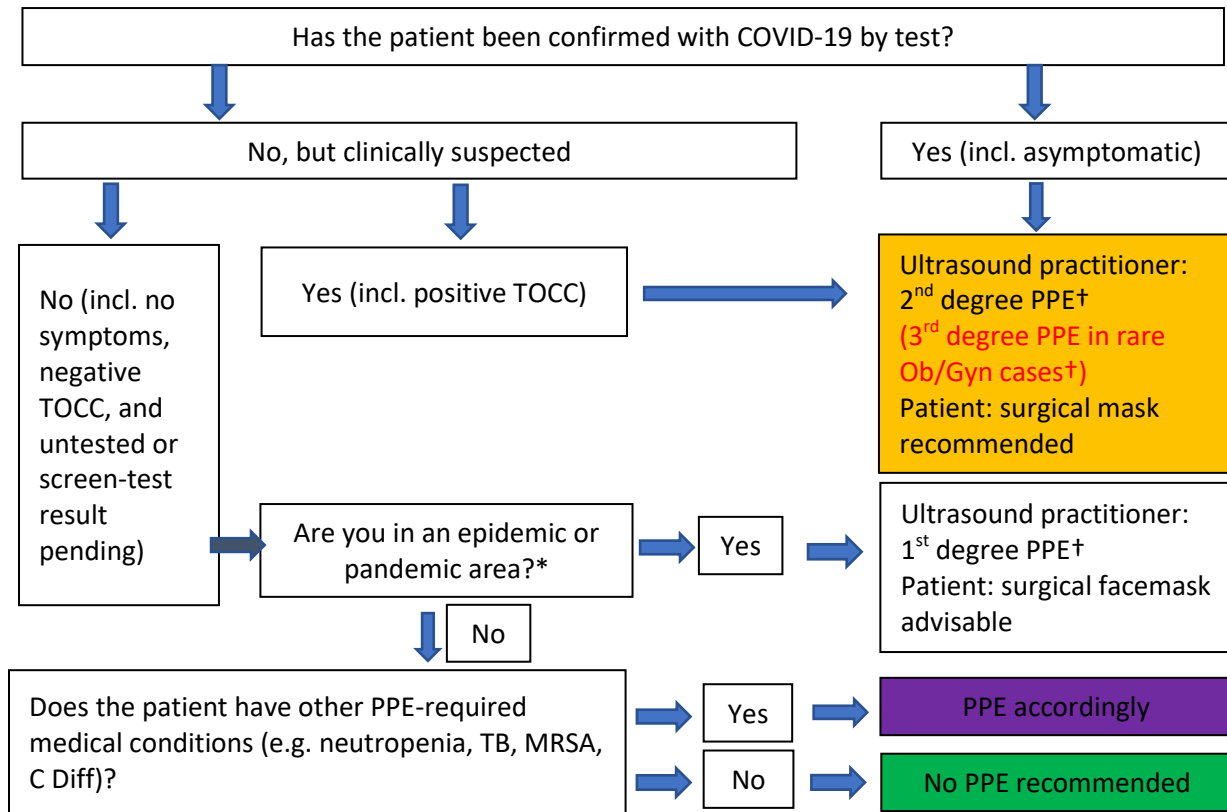
	Surgical mask	FFP2 or N95 respirator	FFP3 or N99 respirator	Powered Air Purifier Respirator (PAPR)
Testing and approval	Cleared by FDA.	Approved by NIOSH as per requirements stated in 42 CFR Part 84 or European Standard EN 149.	Approved by NIOSH as per requirements stated in 42 CFR Part 84 or European Standard EN 149.	Approved by NIOSH as per requirements stated in 42 CFR Part 84.
Intended use and purpose	Fluid resistant and provides wearer protection against large droplets, splashes or sprays of bodily or other hazardous fluids. Protects others from wearer's respiratory emissions.	Reduces wearer's exposure to particles, including small particle aerosols and large droplets (only non-oil aerosols).	Reduces wearer's exposure to particles, including small particle aerosols and large droplets (only non-oil aerosols).	Used to protect against gases, vapors or particles, if equipped with appropriate cartridge, canister or filter.
Face seal fit	Loose fitting.	Tight fitting.	Tight fitting.	Loose- and tight-fitting options available.
Fit testing requirement	No.	Yes.	Yes.	Loose-fitting PAPR does not require fit testing and can be used with facial hair. Tight-fitting PAPR requires fit testing.
User seal check requirement	No.	Yes. Required each time respirator is donned.	Yes. Required each time respirator is donned.	Yes. Required each time respirator is donned.
Filtration	Does not provide wearer with reliable level of protection from inhaling smaller airborne particles and is not considered respiratory protection.	Filters out at least 95% of airborne particles, including large and small particles.	Filters out at least 99% of airborne particles, including large and small particles.	PAPRs equipped with high-efficiency particulate air filters provide 99.9% filtration of airborne particles.
Assigned protection factor (APF)	Not applicable	10	20	25
Leakage	Leakage occurs around edge of mask when user inhales.	When fitted and donned properly, minimal leakage occurs around edges of respirator when user inhales.	When fitted and donned properly, minimal leakage occurs around edges of respirator when user inhales.	When fitted and donned properly, minimal leakage occurs around edges of respirator when user inhales.
Use limitations	Disposable. It should be discarded after each patient encounter.	Ideally, it should be discarded after each patient encounter and after aerosol-	Ideally, it should be discarded after each patient encounter and after aerosol-	Reusable and must be cleaned/disinfected and stored between each patient

		generating procedures. It should be discarded when it becomes damaged or deformed, no longer forms effective seal to face, becomes wet or visibly dirty, breathing becomes difficult, or if it becomes contaminated with bodily fluids. Can be used up to 8 h, continuously or with limited reuse.	generating procedures. It should be discarded when it becomes damaged or deformed, no longer forms effective seal to face, becomes wet or visibly dirty, breathing becomes difficult, or if it becomes contaminated with bodily fluids. Can be used up to 8 hours, continuously or limited reuse.	interaction. Dispose of filters/ cartridges after service life has expired.
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FDA, US Food and Drug Administration; NIOSH, National Institute for Occupational Safety and Health

Reference: <https://www.cdc.gov/niosh/npptl/Respiratory-Protection-Week-2019.html>.

Appendix 4 Reference chart for selection of personal protective equipment (PPE) before starting or during booking of ultrasound scan



*Refer to local, national and/or WHO declaration to determine if you are in epidemic or pandemic area.
 †See Appendix Error! Reference source not found.5 for 1st, 2nd and 3rd degrees of protection. If facing potential PPE depletion during a pandemic/epidemic, lower-grade PPE may be used as a substitute at local authorities' or operators' own discretion. C Diff, clostridium difficile; MRSA, methicillin-resistant Staphylococcus aureus; TB, tuberculosis.

Appendix 5 Categorization of personal protective equipment (PPE) protection

Degree	Comments	PPE
1 st	Default for most ultrasound patients during COVID-19 epidemic	Fluid-resistant plastic apron and surgical mask*, one layer of surgical gloves.
2 nd	For patients with suspected or confirmed COVID-19	Fluid-resistant full-isolation gown and cap, apron shielding exposed neck areas, eye shields or face visors, N95 or FFP2 respirator†, two layers of surgical gloves.
3 rd	Very rare in obstetric and gynecological practice (when performing ultrasound scan in intensive therapy unit or in operating theatre where AGPs are carried out)	Coverall‡, full-face visors, N95/FFP2 respirator†, two layers of surgical gloves. When performing AGP, upgrade: <ul style="list-style-type: none"> • coverall to anti-jet type, such as Type 3B or at least Type 4B (anti-spray); • face visors to tight-fit, anti-splash Goggles without vent; • respirators to N99†/FFP3†.

*EN14683 (EU) or YY0469-2010/2011 (China) certified or equivalent or higher grade. The fluid-resistant surgical mask cannot filter airborne SARS-CoV-2, but can filter droplets (which may contain the virus).

†EN149 (EU), NIOSH (USA); or KN95 GB19083-2010 (China) certified or equivalent or higher grade.

Lower-grade PPE is insufficient to filter viruses. ‡EN14126 (EU), ASTM F1671-97a (USA) or GB19082-2009 (China) certified or equivalent or higher grade coverall Type 3[B], 4[B], 5[B] or 6[B]. 'B' stands for anti-bio-agents; types without 'B' are only for anti-chemical agents. N.B.: Lower-grade PPE should only be used at local hospital/clinic' discretion or own discretion when no alternative supply is available (often experienced during a pandemic/epidemic). Ultrasound providers at higher risk for developing severe COVID-19 should be excluded from procedure. AGP, aerosol-generating procedure.

References:

1. <https://www.cdc.gov/niosh/npptl/topics/protectiveclothing/>
2. https://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/default.html
3. https://www.cdc.gov/niosh/npptl/pdfs/QUADCharts/93905MG_Portnoff_L_ViralPenetration_FY17Q_C-508.pdf
4. <https://www.dach-germany.de/en-14126>