



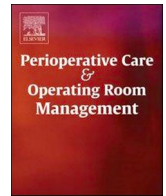
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NORA: Considerations during COVID 19 Pandemic–The New York Experience

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ABSTRACT

Hospitals rapidly developed new procedure and protocols and engaged in emergency construction projects to adapt their facilities and procedures to provide safe and effective patient care during the COVID-19 pandemic surge in the New York metropolitan area. Physical and procedural revisions were necessary in the operating room to continue to care for emergent patients both with and without COVID. Similar adaptations in non operating room procedure suites, recognized commonly as Non-operating Room Anesthesiology (NORA), necessitated the engagement of multiple departments in order to develop protocols and to redesign procedural areas. This article describes in detail the collaborative planning, construction and preparation implemented in two academic medical centers with regard to their various NORA programs. In developing patient care, personal protective equipment training and repurposing of procedure suites, the multidisciplinary collaborative teams have taken into consideration the professional national societies governing Gastroenterology, Cardiology, and Interventional Radiology.

1. Introduction

The pandemic of COVID (Corona Virus Disease) due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), presents serious challenges to public health.^{1–4} There have been more than 52.3 million cases with 1.28 million deaths around the world, 10.6 million cases with over 247,000 deaths in US and over 577,000 cases with nearly 34,000 deaths in New York State as of November.^{4–6}

Noting the considerable growth of NORA procedures in the past several years,^{7,8} a high volume of emergent NORA procedures continued to be necessary at two major tertiary centers in the New York metropolitan area: North Shore University Hospital⁹ on Long Island and New York-Presbyterian Hospital/Weill Cornell Medicine in Manhattan. Both institutions quickly implemented changes involving procedural protocols and physical construction to adapt to the challenges of providing care during the pandemic. In both institutions the NORA sites were impacted on two fronts. They were relied upon to perform temporizing procedures to increase hospital discharges thus increasing capacity for

COVID patients. .

Hospitals implemented infection prevention protocols as well as strategies to manage their resources: staff, space, equipment and supplies.^{7,9} While preparing the operating rooms to care for COVID patients required collaboration among engineering, epidemiology and perioperative services, preparing the non-operating room anesthesiology (NORA) locations proved even more challenging. Interventional radiology (IR), endoscopy, echocardiography, catheterization and electrophysiology laboratories, presented complex challenges due to characteristics of cases performed and equipment necessary to ensure both patient and staff safety.

As patients began to be admitted to the hospital, it was immediately recognized that the anesthesiology personnel, NORA proceduralists, nurses and technicians were not experienced at donning and doffing PPE. With some variations, both institutions employed training in donning and doffing. At Weill Cornell a team of anesthesiologists led live donning and doffing in the simulation laboratory, and cartoon diagrams depicting the process were laminated and placed at the entrances of each

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procedural suite.

At Northshore training videos of the PPE donning and doffing were produced by the anesthesia department and distributed to the personnel.

Both institutions “performed” in room simulations”.

Engineering and Infection Prevention and Control personnel were involved in the process as well as in determining which procedure rooms were best suited to accommodate COVID-19 patients.

Separate elevators and routes for transport and from floor to floor or ICUs were delineated in conjunction with transport teams in order to minimize the exposure of other patients or staff.

At Northshore, a “Central Command” location was assigned for the daily distribution of PPE, where every morning N95 respirator masks, goggles, face shields, disposable scrubs, shoe covers and “bunny suits” were distributed to one designated person from the department daily and kits containing PPE were made in order to expedite the process of donning.

2. Crisis planning

Based on the recommendations and guidelines of the CDC and subspecialty professional societies, the individual institutions analyzed the specifics of procedures for each area and held multidisciplinary meetings/webinars to decide how to best implement and adapt those recommendations to the particular hospital. These webinars included participation of epidemiology (Infection Prevention and Control), facilities management and engineering in addition to the clinical teams, to address the allocation of resources and the step-by-step everyday

operations of the NORA locations. Every clinical department was represented: anesthesiology, interventional radiology, interventional neuroradiology, gastroenterology, cardiology, and nursing.

The institutional-specific generated algorithms addressed:

- specific procedural areas for COVID patient in each NORA location
- specific areas for patient recovery
- protocols for equipment protection and disinfection
- the use of personal protection equipment (PPE)
- communication amongst the teams involved to facilitate work flow, equipment availability and re-stocking of supplies

3. Specialty NORA sites and scheduling

Specific subspecialty societies developed protocols to guide patient selection, define emergent procedures, recommended level of clinician involvement and teaching and identified which procedures carried high risk for aerosolization⁹⁻²³. Many of these recommendations are summarized in Table 1. Subspecialty societies and both institutions provided recommendations on regarding scheduling which are summarized in Table 2.

4. Procedure suite selection and preparation

In anticipation of treating COVID patients, the multidisciplinary assessment of the Interventional Neuroradiology Suite (INR), including Infection, Prevention and Control staff and engineering identified a

Table 1
Case triage guidelines by the professional societies.

	Emergent Indications for Non-COVID related procedures	Urgent Indications for non-covid related procedures	COVID Bedside Procedures	Aerosolizing Procedures	Separate COVIDroom?	Equipment Protection*
INR	Stroke Intra-cerebral Hemorrhage	Severe carotid stenosis with TIA	Not possible	No	Often not possible	Stroke and COVID +
IR	Pulmonary embolism Postpartum hemorrhage	Cancer ablation Biopsy for cancer diagnosis which would change treatment	Whenever possible for ultrasound based procedures	PEG	Yes depending on imaging modality	Yes COVID+ and PUI
EPS	Catheter ablations: VT CIEDs: Lead revision for malfunction PM for high grade AVB Lead extraction for infection	Catheter ablations: AF, Aflutter, WPW CIEDs: secondary prevention ICD Generator change for ERI	Cardioversions	No	Yes	Designated equipment for interrogation of CIEDs in COVID patients
Cath	STEMI TAVR for critical AS	TAVR	Not possible	No	Yes at NSUH No at WCM	Shared COVID room for EPS and Cath at NSUH
GI	Hemorrhage Obstruction, Migrated stent	Cancer evaluations, Prosthetic removals Significant symptoms	If fluoroscopy not required	All procedures	Yes depending on imaging modality	Yes COVID+ and PUI
Bronchoscopy	Severe or moderate tracheal or bronchial stenosis Symptomatic mucous plug Hemoptysis Migrated stent	Lung mass or adenopathy suspicious for cancer Foreign object aspiration, Mild hemoptysis, Pulmonary infection	If fluoroscopy not required	All procedures	No	Yes
TEE	Diagnosis of endocarditis Type A aortic dissection Initiation of mechanical circulatory support Myocardial infarction with mechanical complications	Prosthetic valve assessment	Yes	All procedures	Yes at NSUH, No at WCM	Yes COVID+ and PUI; dedicated equipment at NSUH

*Equipment Protection: Dedicated equipment if possible, anesthesia machine covered in plastic, all supplies maintained outside of room

Abbreviations: AF-Atrial Fibrillations, Aflutter-Atrial Flutter, AS-Aortic Stenosis, AVB-Atrio-Ventricular Block, ERI-Elective Replacement Interval, CIED-Cardiac Implantable Electronic Devices, ICD-Implantable Cardiac Defibrillator, INR – Interventional Neuroradiology, IR – Interventional Radiology, EPS- Electrophysiology, Cath – Cardiac Catheterization, GI – Gastrointestinal Endoscopy, PM-Pacemaker, PUI-Person Under Investigation, STEMI-ST Elevation Myocardial Infarction, TAVR-Trans catheter Aortic Valve Replacement, TEE – Transesophageal Echocardiography, TIA-Transitory Ischemic Attacks, VT-Ventricular Tachycardia, WCM – Weill Cornell Medicine, WPW-Wolf Parkinson White, NSUH – North Shore University Hospital

Table 2
Scheduling Recommendations for NORA Procedures.

Essential/emergent/urgent procedures or procedures necessary to continue an established therapeutic treatment plan
Minimize supplies use - do not over-prepare; ensure availability of supplies but do not open until absolutely needed
Telehealth/virtual pre-procedure assessment
Informed consent via phone or telehealth
Screen all patients for symptoms and exposures
Test all patients (PCR) prior to procedure as close to procedure date as possible but usually within 72 hours.
Require patients to self-quarantine between testing and procedure
Optimize staffing to ensure social distancing wherever possible
Telehealth/virtual follow-up visits whenever possible
COVID patients in designated suites at end of day if possible

PCR: Polymerase Chain Reaction.

complicated structural aspect of the Weill Cornell INR suite was that an open control room serviced two procedure rooms. There were no doors separating the control room environment from the procedure suite and the airflow in the procedure suite was positive with relation to the hall and with relation to the control room with no ability to change it to negative pressure. In order to isolate the control room from the two procedure suites temporary plastic walls were erected with zipper doors (Fig. 1) Using two such walls for each procedure room, the control room was separated from the procedure room with an anteroom to act as a buffer zone. (Fig. 2) The zippered walls made the control room “positive” to the anteroom (Fig. 3) which provided some assurance to the technical and nursing staff located there. In spite of this all personnel in the control room wore N95 masks throughout the procedure.

COVID- designated procedure suites were cleared of all non-essential inventory and materials and the remainder of equipment was covered in

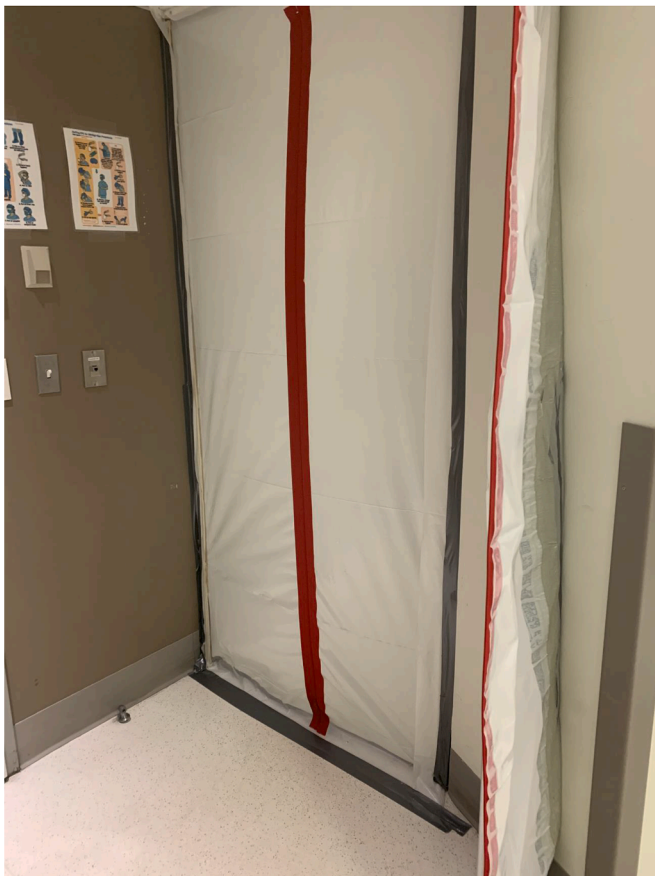


Fig. 1. Temporary Zipper Walls used to build functional anterooms and protect shared control room.

plastic to allow easy disinfection between patients. Each provider team also had a designated “clean” runner that stayed outside the immediate procedure suite to obtain equipment, take specimens and call for assistance if necessary.

In 2001 the American Institute of Architects (AIA) revised its guidelines for ventilation for operating rooms and procedure suites²⁴ and this has formed the basis for CDC guidelines in this regard most recently updated in July 2019²⁵. In addition to whether the pressure in the room is positive pressure with relation to the surrounding corridor, the number of air changes per hour (ACH) is important in protecting against aerosolized infectious agent exposure *within* the procedure suite. Negative pressure recovery rooms have an ACH = 12 and were much smaller than the procedure suite. Engineering confirmed that the ACH of the INR procedure rooms was 22 air changes per hour, which would mean that 99.9 % of airborne contaminants would be removed in 21 minutes, 99 % in 14 minutes.²⁶ (Fig. 4) The Society of Neuroanesthesia and Critical Care recommendations are to intubate stroke patients in a negative pressure room and then transport them to the procedure suite,^{12,13} where they would be disconnected from a transport ventilator to be connected to the anesthesia machine. Due to the high ACH of the INR suite and the urgent nature of any stroke in COVID positive patients or persons under investigation (PUI) the decision was made to intubate in the procedure suite and have the procedure begin immediately with all personnel utilizing PPE for aerosolizing procedures. Additionally the ACH = 22 reassured staff that the patients could be extubated safely in the procedure suite with all possible precautions to minimize aerosolization. While this situation may not pertain to many institutions, it illustrates the importance of knowing the ACH of the procedure suite in addition to whether the room is negative or positive pressure.²⁷

An understanding of airflow and ACH is critical in determining room cleaning/decontamination and turnover between patients. The turnover protocol for the interventional radiology suite (IR) at WCM, which has an ACH of 12 per hour, is as follows:

- **COVID (+) to COVID (+):** no wait to clean after patient has left the room; full airborne PPE to clean
 - Machines and monitors are covered with plastic bags - these stay on if bringing a confirmed + in after another confirmed +
 - Post procedure all uncovered surfaces get wiped with sodium hypochlorite (bleach) wipes and the lead glass gets cleaned with quaternary ammonium wipes after to remove cloudy residue
 - Angiography, Computed Tomography, and Ultrasound machines get wiped with sodium hypochlorite (bleach), as well, but the screens of CT and US machines get wiped with Sani-Cloth, Germicidal Disposable Wipes. After the 2 minute wet time the screen is dried with a paper towel to prevent streaking. Angiography monitors are wiped with paper towels and warm soapy water if they do not have a plastic screen protector. If the monitor does have a plastic protector then sodium hypochlorite followed by purple wipes are to be used.
 - Plastic covers cleaned with Sani-Cloth, Germicidal Disposable wipes
 - PPE worn: N95 mask, surgical mask, inner and outer bouffant, goggles/welders mask, contact gown, 2 pairs of gloves, and disposable knee high shoe and boot covers
- **COVID (+)/PUI to COVID (-)/PUI:** 45 min wait after patient has left the room, droplet & contact precaution to clean
 - machines and monitors are covered with plastic bags - these are removed if bringing a confirmed COVID –negative or PUI in after a confirmed COVID –Positive or PUI
 - Same cleaning protocol as above
 - PPE worn: surgical mask with face shield, bouffant, contact gown, 2 pairs of gloves, knee high shoe covers
 - **COVID (-) to COVID (-):** no wait, regular room turnover machines are not covered

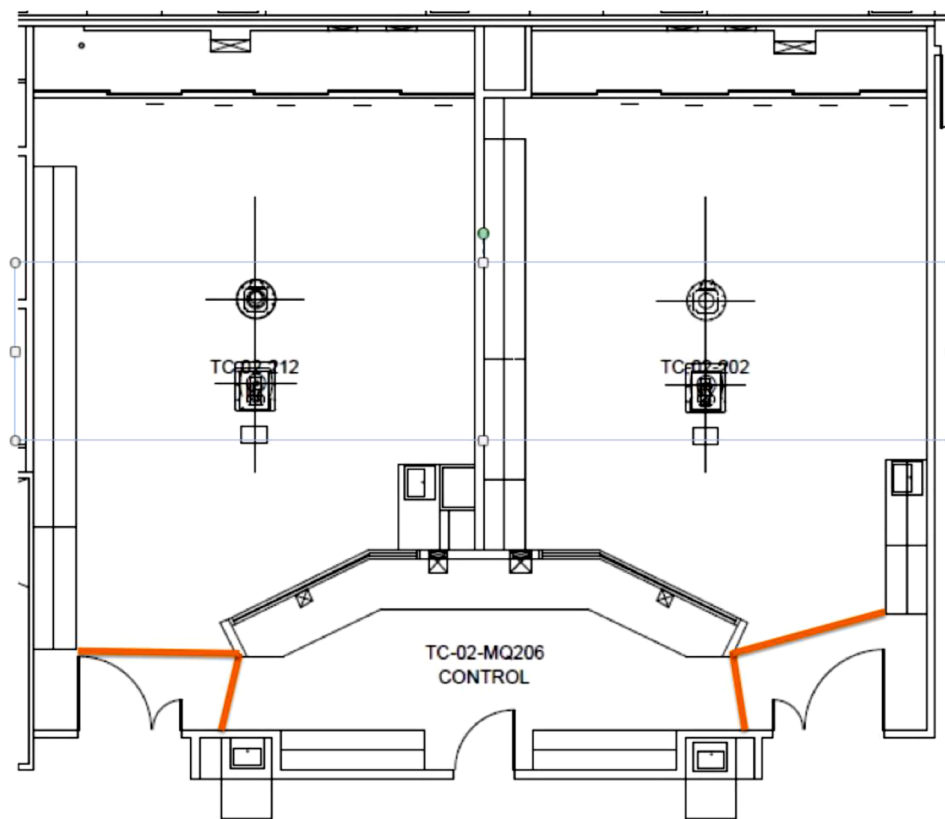


Fig. 2. Diagram of Interventional Neuroradiology (INR) Suite with shared control room; Orange lines indicate the location of temporary zipper walls.

- post procedure quaternary ammonium wipes drying screens with paper towels after the 2 min wet time were used
- PPE worn: surgical mask and gloves

5. Interventional radiology (IR)

IR plays a vital role within the healthcare system providing both supportive procedures and primary treatment/management of certain disease entities. The minimally invasive nature of IR procedures and the relative efficiency and accuracy of image guided techniques proved essential in the care of the COVID patient. Local hospital/institution factors such as limited hospital bed/ICU capacity, limitations on elective and urgent surgical procedures and redeployment of surgical and medical providers to ICUs and the emergency department have dramatically increased utilization of IR resources.²⁸ Due to the aforementioned factors, hospital-based IR practices had to strictly define selection of procedures, prepare staff and facilities to treat patients, and optimize workflows to fit site specific needs to decrease risk to both patients and health care personnel. Finally, an understanding of the aerosol generating potential of the various IR procedures as well as facility characteristic such as ACH is important to best determine appropriate PPE for health care providers, and to develop optimal workflows.

In late March 2020, the Society of Interventional Radiology (SIR) provided a clinical notification and guidelines on identification of aerosol generation procedures and provided an algorithm for treatment.^{9,10} The guidance highlights procedures that may cause mechanical dispersal of aerosols, violate the pleural space (lung biopsy, thoracentesis, chest tube placement), directly involve the airway (bronchial stenting) or may induce coughing secondary to placement of a NG tube (enteric tube placement). With this guidance, specific areas to perform IR procedures on confirmed COVID patients or patients under investigation (PUI) should be designated taking into account appropriate air exchange and a direct route to the procedure suite to limit risk

of surface contact. The fundamental goal to limit patient and clinician exposure was addressed at various points of patient interaction.

Conforming to guidance from government entities and institution leadership, protocols to triage patients into emergent, urgent and elective categories were established. Pre-procedure workflows were adapted to incorporate screening of patients for exposure to or symptoms of COVID, as well as a clinical discussion with the primary physician to confirm the urgency of the procedure. If an outpatient ambulatory procedure was warranted, scheduling, registration and recovery were all streamlined to limit co-mingling with other patients. Such patients were scheduled at the beginning of the day to take advantage of fewer patients in the procedure area as well as guaranteed procedure room availability- limiting time, if any, in the waiting/registration areas. Inpatients with COVID were brought by specialized transport teams directly to "COVID-designated" procedure rooms.

It is also important to think outside of the traditional areas radiologists perform procedures and look to areas such as the operating room, where air exchanges may be superior. The patient's bedside also offers advantages as it limits the risk of transporting a patient throughout the hospital hallways. Once the facilities are established, specific protocols and designated roles for each member of the procedure team were clearly delineated and simulated to ensure comfort of all providers involved. We found it helpful during our first two weeks to designate an "observer" within the department that monitored the workflow of each procedure team to identify areas to streamline steps and to remind providers of proper donning of doffing of PPE. Strict inventory and protocols were created for each piece of equipment being used to ensure availability during the procedure. This is even more essential when performing bedside procedures where the donning and doffing event may take more time than the procedure itself.

During the pandemic, the IR service was exceptionally busy, performing a wide range of cases including vascular access, temporary and permanent dialysis catheters, and occasional percutaneous



Fig. 3. Control Room Zipper Door “Bowing” into Anteroom –indicating positive pressure in control room

cholecystostomy and thoracentesis. If possible, procedures were performed at the bedside under ultrasound guidance. The institutional protocol recommended informed consents to be obtained via phone or telemedicine, keeping the patient’s stretcher in the procedure suite whenever possible, maintaining one circulating nurse with full PPE but not touching patient, remaining “clean” to retrieve supplies and open doors. A team of two anesthesiology providers was assigned to each case to streamline intubation, charting, medication administration and obtaining supplies. Prior to transport the team would either hand off the patient to a transport team, or would doff the contaminated PPE and don clean PPE to transport, and doff that PPE in the patient’s room or an anteroom, if available. Non-ICU patients recovered in the procedure room. If at all possible COVID patients were scheduled at the end of the day.

6. Gastroenterology (GI)

The American Gastroenterological Society released recommendations regarding surgical response to COVID-19, recommending cancellation of all screening and elective procedures, virtual visits in place of office visits and virtual multidisciplinary meetings.^{14,15} Endoscopy procedures are high risk of exposure both because patients infected with COVID-19 may present with gastro-intestinal (GI) manifestations, and

the fact that Sars-CoV-2 has been isolated in cells in the GI tract, saliva, enteric contents, and stool. This enhanced risk of exposure requires strict and full use of PPE by all personnel present to protect against aerosolization. The society further cites the removal of caps on endoscopes, as well as the withdrawal of biopsy instruments through the endoscope channels, as times of increased risk of aerosolization. These recommendations may also apply to any fiberoptic bronchoscopes used by anesthesiology.

Although some patients required intubation for their procedure, close fitting facemasks with apertures for endoscopes or bronchoscopes have been utilized to contain droplets within the facemask both as the scope is passed in and out of the mouth and in case the patient coughs during or following the procedure. Both institutions made the use of such a mask a standard precaution for all upper endoscopy, bronchoscopy and transesophageal echocardiography. As a large number of COVID patients required anticoagulation and antithrombotic medication, the number of endoscopies and colonoscopies for gastrointestinal bleeding increased in frequency and severity. While some of these procedures could be performed at the bedside in the ICU, some required fluoroscopy and thus transfer to the endoscopy suite.

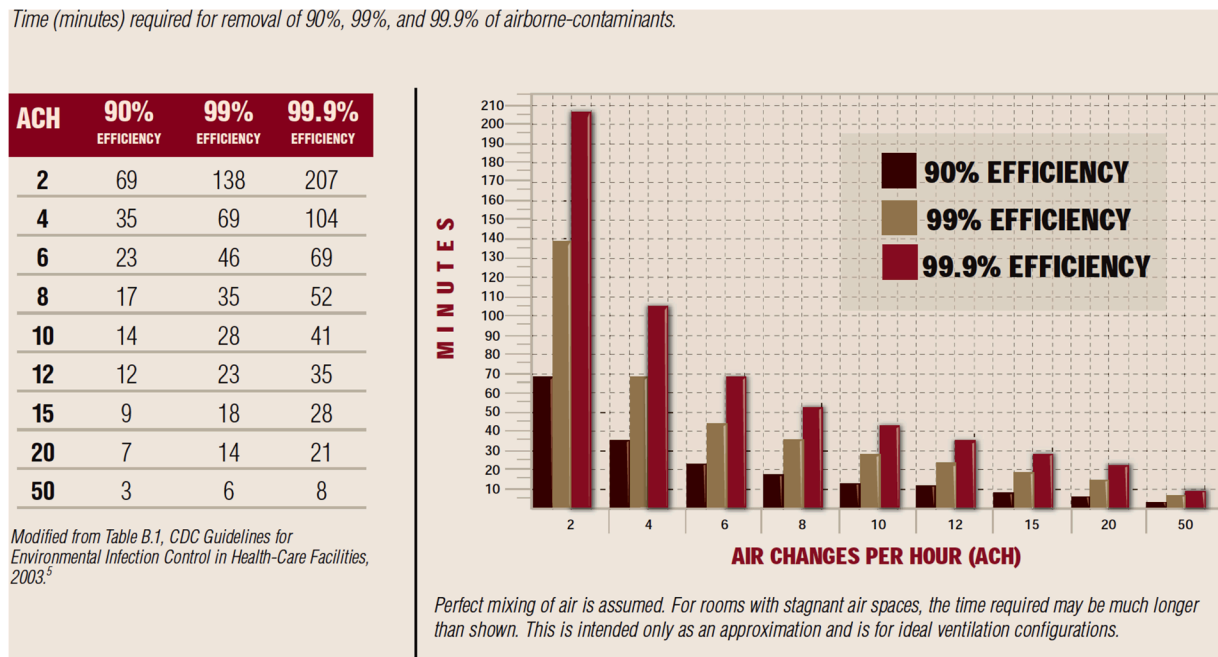


Fig. 4. Air change per hour and airborne contaminant clearance rate (From www.health.state.mn.us/oep/training/bhpp/isolation.html - open source)

7. Bronchoscopy

The American College of Chest Physicians and American Association for Bronchology and Interventional Pulmonology published guidelines recognizing that all bronchoscopy procedures are aerosolizing, necessitating heightened vigilance and universal use of airborne protective PPE.¹⁶ Bronchoscopy suites are generally negative pressure environments. Emergent, urgent and elective procedures were delineated as noted in Table 1. They also addressed the timing of procedures in patients who had a previous positive COVID test. Findings that the rRT-PCR from Sars-Co-V2 may remain positive for up to 37 days after symptom resolution in lower respiratory tract samples¹ led to the recommendation that, if at all possible, bronchoscopy should be delayed until 30 days from resolution of symptoms and after two negative nasopharyngeal swabs.

8. Echocardiography suite (TEE)

The American Society of Echocardiography, as well as the British and Italian Societies, released several statements on protection of patients and echocardiography service providers during COVID. These statements address the questions of whom, where and how to image, as well as protocols for personnel and equipment protection.¹⁷⁻²¹ Similar to upper endoscopy, TEE may produce aerosolization of significant viral load. The need for TEE is individually assessed and, whenever possible, the exam takes place at the bedside to minimize the number of staff involved and avoid the risk of transport.

At Northshore, the TEE suite did not have fully enclosed individual treatment areas, so those procedures were relocated to a procedure suite in the catheterization/electrophysiology lab. One procedure room was designated for COVID patients who required cardiac catheterizations, electrophysiology procedures or echocardiography. This location had assigned equipment (anesthesia machine, echocardiography machine) monitors and carts. An additional procedure room was transformed into a recovery area, as the preoperative holding area and recovery room area for the catheterization laboratory were repurposed as intensive care units. One of the procedure rooms was designated as an area for storage of equipment, carts and PPE. Following the procedure the scope is

withdrawn inside of a protective sleeve and disinfected according to the manufacturers instructions.²⁹

9. Electrophysiology suite (EPS) and cardiac catheterization laboratory (CATH)

Very early on during the pandemic, the ACC/HRS released recommendations regarding the performance of electrophysiology and catheterization cases.^{22,23}

The statement paper addresses not only the potential risk to practitioners, industry representatives and administrators, PPE and guidance on how to triage and proceed with the electrophysiology procedures, but also details the urgent/emergent, semi-urgent and non-urgent procedures^{17,18} (Table 1). In a report from Wuhan, China, 16.7% of the hospitalized and 44.4% of the ICU patients infected with COVID-19 had dysrhythmias.⁴ Based on these recommendations, the cardiology departments formulated protocols regarding managing the EP procedures in our institutions The Heart Rhythm Society guidance on management of Cardiac Implantable Electronic Devices (CIED) for both outpatient and inpatients recommended all outpatient monitoring be done remotely, when possible. For inpatient or emergency room management, consultation and interrogation should be done only if will have an impact on patient care, and preliminary discussion should be performed virtually. Necessary device evaluation included suspected device malfunction (inappropriate pacing or shocking), elective replacement interval (ERI), preoperative evaluation when the recommended interrogation did not take place, urgent/emergent MRI evaluation, syncope or untreated tachycardia in patients with CIEDs.²³ If possible use the “in hospital” remote monitoring technology. Rather than interrogation, magnet placement is encouraged for suspending anti-tachycardia therapies in patients with defibrillators and in pacemaker-dependent patients when electro-magnetic interference (EMI) is expected. Dedicated interrogation devices with cellular and internet connections are strongly encouraged. All interrogation equipment should be cleaned with disinfecting wipes after each use.^{30,31}

While both institutions described in this manuscript followed and implemented the general guidelines established by the professional societies and both formulated protocols for each NORA location, each had

variations and particularities in implementing them.

As the number of COVID-19 cases diminished over time and elective cases started to be performed, gradually some of the stringent measures used during the height of the pandemic in New York were relaxed. The zippered plastic enclosures were reduced in some areas where they hindered the workflow.

At Weill Cornell N95 respirator masks and eye protection (shield or goggles) are used for all aerosolizing procedures (intubations, TEE, upper endoscopies, Bronchoscopies) and each area has a designated procedure room for the occasional COVID-19 patient.

Infection Prevention and Control updated their recommendations in regards to pre-procedural optimal testing of not less than two days or greater than 5 days prior to procedure.

In conclusion, NORA-based procedures accounted for a significant share of total cases during the COVID pandemic surge. Multidisciplinary collaboration proved essential in developing protocols to ensure patient and clinician safety in navigating the need to provide care under unusual and stressful circumstances. Consideration should be given to maintaining many of the procedural and physical changes to NORA sites implemented during the pandemic in order to continue to protect staff and patients from COVID and other infectious diseases.

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Declaration of Competing Interest

None.

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