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Performance of electrophysiology procedures at an academic medical center amidst the 2020 coronavirus (COVID-19) pandemic

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Abstract

A global coronavirus (COVID-19) pandemic occurred at the start of 2020 and is already responsible for more than 74 000 deaths worldwide, just over 100 years after the influenza pandemic of 1918. At the center of the crisis is the highly infectious and deadly SARS-CoV-2, which has altered everything from individual daily lives to the global economy and our collective consciousness. Aside from the pulmonary manifestations of disease, there are likely to be several electrophysiologic (EP) sequelae of COVID-19 infection and its treatment, due to consequences of myocarditis and the use of QT-prolonging drugs. Most crucially, the surge in COVID-19 positive patients that have already overwhelmed the New York City hospital system requires conservation of hospital resources including personal protective equipment (PPE), reassignment of personnel, and reorganization of institutions, including the EP laboratory. In this proposal, we detail the specific protocol changes that our EP department has adopted during the COVID-19 pandemic, including performance of only urgent/emergent procedures, after hours/7-day per week laboratory operation, single attending-only cases to preserve PPE, appropriate use of PPE, telemedicine and video chat follow-up appointments, and daily conferences to collectively manage the clinical and ethical dilemmas to come. We discuss also discuss how we perform EP procedures on presumed COVID positive and COVID tested positive patients to highlight issues that others in the EP community may soon face in their own institution as the virus continues to spread nationally and internationally.

KEYWORDS

coronavirus, COVID-19, electrophysiology laboratory, pandemic

1 | INTRODUCTION

In December 2019, a highly infectious novel coronavirus (COVID-19) outbreak was reported in Wuhan, China.[1] Less than 3 months later, we are now amidst a global COVID-19 pandemic which has disrupted the international economic order and significantly altered activities of daily living and personal interactions for nearly everyone on earth, due to requisite social distancing,

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"shelter-at-home" and lockdown orders instituted in many locations.

In New York state, as of April 6, 2020 there are over 130 000 confirmed COVID-19 cases, the most in the United States. The vast majority of COVID-19 diagnoses have been made within the densely populated New York City, which itself has 72 000 confirmed cases and is now considered a COVID-19 epicenter. At NewYork-Presbyterian Hospital (NYPH), the case rate is nearly doubling every day, which mirrors the overall state trend. Personal protective equipment (PPE), as has been reportedly nationally, is at a critical shortage.

The coronavirus principally causes pulmonary manifestations of fever, cough and dyspnea with occasional rapid progression to severe respiratory failure and acute respiratory distress syndrome in both high-risk and healthy patient populations. Yet between 7.2% and 12% of total COVID-19 patients manifest cardiac injury and progression to fulminant myocarditis was recently described.[2-4]

Importantly, there are likely to be several electrophysiologic (EP) sequelae of COVID-19 infection. Wang et al[2] describe arrhythmia burden of 16.7% in 138 total COVID-19 patients and 44.4% of COVID-19 ICU patients. As yet, it is unknown whether the virus directly seeds the cardiac conduction system. Electrophysiologists will play an important role in the upcoming months, especially since COVID-19 treatments such as hydroxychloroquine carry known deleterious electrophysiological effects.[5] EPs may see more cases of drug-induced torsades in the near future. There have also been recent reported cases of ventricular arrhythmias due to COVID myocarditis.[6]

It was therefore important to institute specific EP laboratory protocols not only to treat the inevitable COVID-19-infected patient requiring any urgent or emergent procedures, but also so that we may continue to treat sick, non-COVID infected patients with a high quality standard of care. Management operations are in flux during this crisis and may even change from day-to-day. We present our overarching workflow model to optimize laboratory function with the aim of both adequately protecting providers, successfully treating patients and conserving PPE during this unprecedented period. This has been an urgent collaborative formulation by the Columbia University Electrophysiology subdivision at Columbia University Medical Center, and is not a reflection of official NYPH policy. We present this as a model for other EP labs in the nation who are facing or soon may be faced with this healthcare challenge.

1.1 | Indications for procedures from the outpatient setting

As per the recent consensus statement from the Heart Rhythm Society, American Heart Association and American College of Cardiology, only urgent and emergent procedures were performed during the current upswing of the COVID-19 infection curve to minimize virus transmission between patients and providers.[7] Emergent procedures according to clinical discretion may include cardioversion, implantation of temporary or permanent pacemaker (PPM), or ablation for arrhythmias refractory to medical management. The goal is to reduce nonurgent person-to-person interactions. "Elective" cases that ultimately may be life-prolonging or symptom-relieving have been delayed, since incidental and unpredictable infection with COVID-19 in a stable out-patient would be regrettable and harmful. As of March 16, NYPH suspended elective cases to concentrate equipment, supplies, and providers on responding to the COVID-19 public health crisis.

Elective cases have consisted of routine ablations for paroxysmal supraventricular tachycardia (SVT), atrial fibrillation (AF), premature ventricular contractions or ventricular tachycardia (VT) and device implant procedures such as primary-prevention internal cardioverter defibrillator (ICD), PPM for sinus node dysfunction with stable rhythm or asymptomatic 2:1 atrioventricular block, cardiac resynchronization therapy or upgrade, as well as cardioversion for symptomatic AF and loop recorder implantation. Patients with canceled elective procedures have been followed with weekly check-ins and use of telehealth services as needed to reevaluate their clinical status. Deferment of elective cases have been rationalized to patients either by phone or telemedicine visit, and during these communications health care providers ensure patients have sufficient medication to manage their arrhythmias for at least 3 months or longer.

1.2 | Indications for procedures from the in-patient or unstable out-patient setting

Before performing a procedure on patients from both the in- or out-patient setting, COVID testing is performed on all patients with the understanding that there may be false negative results. It is important to ensure sufficient standard PPE for procedures is identified ahead of time, as hospital resources diminish quickly. We have prioritized and performed due to their urgent/emergent nature: PPM for symptomatic, high-grade or wide-complex complete heart block, generator change for PPM-dependent patient with device nearing end of life (EOL), cardiac resynchronization therapy devices nearing EOL to prevent detrimental hemodynamic consequences, VT ablation in unstable/hospitalized patients with VT storm refractory to medication, accessory pathway ablation in pre-excited AF, and device/lead extraction in an unstable patient with active sepsis. We have also performed pacemakers immediately after urgent/emergent transcatheter aortic valve replacement with resultant heart block to facilitate discharge on the same day.

The expedition of urgent procedures for patients waiting in intensive care units (ICUs) is paramount. We have structured a multidisciplinary approach with ICU and nursing staff to facilitate performing procedures on extended weekday and weekend hours to minimize use of institutional resources and free up much-needed ICU beds for the growing COVID-19 patient population.

The more challenging decision involves semi-urgent indications for EP procedures such as secondary prevention ICD, primary prevention ICD in a very high-risk patient (ie, ischemic heart disease

with nonsustained VT, muscular dystrophy or sarcoid), or lead revision/replacement in the setting of malfunction/dislodgment in patients who are currently or imminently will be hospitalized. It may be necessary to rely on a wearable defibrillator (LifeVest, Zoll, Chelmsford, MA) for the secondary prevention patient population until the inflection point of COVID-19 cases is reached and transmission risk is lower. Furthermore, maximal medication management has been implemented for patients with symptomatic, recurrent SVT at the current time. Alternatively, these procedures must be evaluated and performed on an individual case-by-case basis to weigh risk versus benefit from the procedure. If it is decided that cardiovascular benefit outweighs the risk, then scheduling the patient for the earliest daytime slot possible to facilitate same-day discharge is advisable. Coordination with infectious disease (ID) prevention and control colleagues is also essential.

1.3 | Urgent/emergent procedures in COVID-19 infected patients

Unless urgent/emergent, we have avoided performing procedures on COVID-19 infected patients in the EP laboratory to prevent transmission not only during transport to the laboratory, but also to prevent seeding the lab itself in the case of a prolonged operation. The coronavirus may maintain aerosolization for an unspecified time period and was recently shown to stay viable for up to 72 hours on stainless steel surfaces,[8] which are readily found in EP laboratories.

In light of myocarditis and elevated inflammatory markers in active COVID infection, there are likely to be patients that develop clinically-significant bradyarrhythmias during their course. Since these will presumably be more severely-ill patients amidst a prolonged hospitalization, we have used medical management with dopamine and avoiding any medications that may be overtly catecholaminergic due to concern of myocarditis. If clinically significant bradycardia persists, then temporary ventricular pacemaker (TVP) placement is the best option. TVP placement is quick (typically <10 minutes), may be performed at bedside, involves less hospital transport with the potential for aerosolization and health care provider exposure, and allows temporization until the patient either recovers from their systemic illness or deteriorates further.

If it is decided that a COVID-19 infected patient must have a procedure performed in the EP laboratory, we have a protocol illustrated by Figure 1. If the patient is not intubated, a mask is placed on the patient before transport and there is a specific room designated for infected patients. That room is thoroughly disinfected after the procedure.

1.4 | Pre-procedure workflow

To prevent virus transmission, preserve PPE and protect patients, the typical and familiar pre-procedure workflow patterns should be significantly altered.

First, with regard to EP attending allocation, each day there is only one designated procedure attending in-house. A back-up attending is on-call within range of the hospital in case of a second emergent case. This shift-based arrangement is meant to prevent the potential for widespread and unintentional doctor-to-doctor transmission, and thus minimize the risk of "wiping out" an entire EP department, which would be devastating. Additionally, elderly (>60-years-old) attendings at high-risk for severe COVID-19 infection are encouraged to avoid hospital-based patient care and instead focus their attentions on telehealth visits or urgent out-patient clinic consultations.

Patient time in the pre-procedure "holding area" is minimized as possible and in-patients are brought down directly to the procedure room to prevent lingering in multiple different hospital areas. Although it is not current NYPH policy, with the medical-legal team and laboratory directors, we have considered transition of patient consent to a strictly verbal process to minimize patient-provider contact through touchscreen, pen or clipboard exchange.

1.5 | Performing the EP procedure

Since the majority of cases performed during the present era of exponentially rising COVID-19 infections are implantable devices, the rule for us has been single-operator cases only. Our academic attending role as educator currently plays a secondary role to efficiency and safety at this time. Performing single-operator cases has been adopted to preserve the critically low PPE supply. For more complex procedures such as unstable VT or system extraction, the EP fellow assists either by running the console stimulator or lending an extra set of operative hands. Our EP fellows have served as scrub nurses and circulating nurses since there has been redeployment of our highly trained nurses to the emergency room or ICU. If available, a negative pressure procedure room is ideal for treating COVID-19 infected patients. In emergent cases, where there is no COVID testing and little patient medical history available, it may be prudent to treat the patient as COVID-19 positive, since coughing or vomiting during emergent circumstances may pose an exposure threat to the health care providers.

If anesthesia deems a patient to be at high-risk of respiratory failure, it is prudent to perform endotracheal intubation before the procedure (ie, in the patient's room) to prevent aerosolization of viral particles in the case of emergent intra-procedure intubation and suctioning. The closed-system mechanical ventilator is preferred to the higher-risk bi-level positive airway pressure or nonrebreather systems. Additionally, during ablations or extractions, it is advisable for the proceduralist to use intracardiac echocardiography instead of anesthesia-operated transesophageal echocardiography to prevent aerosolization.

Before the case, the procedure attending, scrub nurse or technician should don the appropriate PPE after proper hand hygiene is performed as recommended by ID prevention and

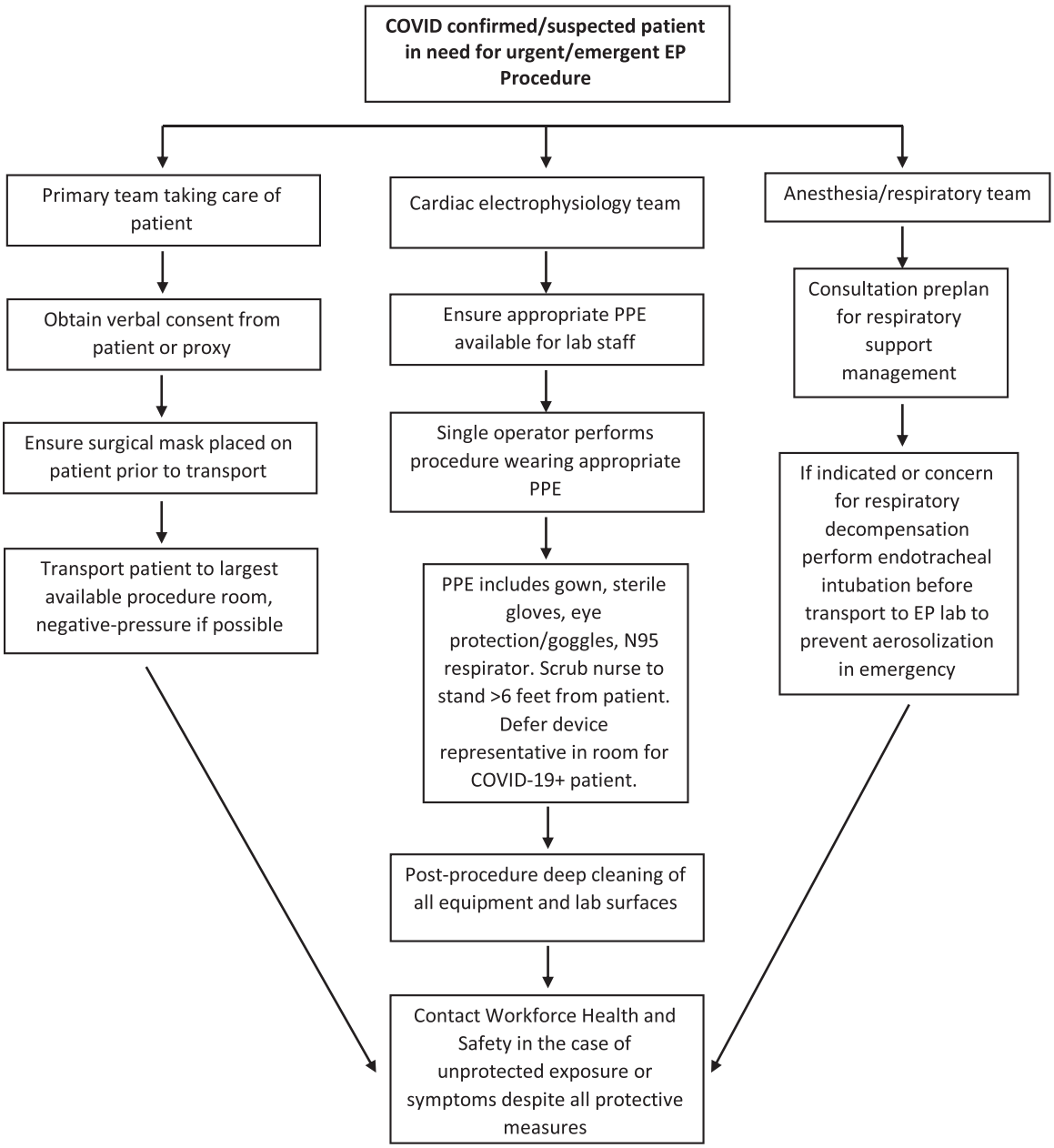

FIGURE 1 This diagram illustrates interdisciplinary collaboration of electrophysiologic work flow for COVID confirmed/suspected patient. PPE, personal protective equipment

control. We have adopted using N95 for both intubated and non-intubated COVID+ patients for two main reasons: (a) dislodgement of the endotracheal tube may occur during movement of the patient onto or off the operating table, or during emergency resuscitation and (b) previous studies on human papilloma virus suggest that laser or electrosurgery plume may cause infectious aerosol hazards resulting in viral transmission.[9] We don a surgical mask on top of the N95 mask as per NYPH recommendation to preserve the length of use of the N95. Our surgical PPE includes goggles that form a seal around the eyes for splash protection, a surgical cap, shoe coverings, at least two layers of sterile gloves and a sterile surgical gown. We have all been trained in proper doffing of PPE which is deliberate and meticulous to adhere to the strict protocol of doffing with proper hand hygiene between steps.

1.6 | Nurses and device representatives

Scrub nurses and device representatives are an integral part of EP procedures and will remain as such. It is critical to avoid the loss of highly specialized EP nurses in the event of illness or home

quarantine, therefore nurses ought to similarly stagger their hospital attendance to prevent multiple concurrent staff losses.

In our laboratory, device representatives provide necessary functions such as lead selection counsel, intraprocedural interrogations and device programming. To limit risk, device companies have recommended that their representatives no longer present to the hospital daily unless requested for cases. We have assigned a different device company technician to each day of the week and sharing this schedule with the representatives (if a specific company's proprietary algorithm function is required). During cases, both device technicians and nurses should maintain more than 6 ft distance from the patient and don appropriate PPE.

1.7 | Postprocedure follow-up

The follow-up of patients after recent ablation or device placement have been significantly virtualized. After device implantation, each patient is discharged with remote monitoring device. To minimize vulnerable patient exposure to the high-risk hospital setting, telemedicine services have been enabled for video-visits between provider and patient. Furthermore, due to the ongoing COVID-19 national emergency, the Centers for Medicare and Medicaid services have relaxed HIPAA requirements for telehealth visits. To improve accessibility for patients, video chat applications such as Apple FaceTime, Facebook Messenger, Google or Skype may be used, as long as patients are aware of the third-party privacy risks.[10] These visits have been used to evaluate for postprocedure pain or palpitations.

Similarly, after an ablation, patients may use the digital electrocardiogram recording devices such as Apple Watch or Kardia application (AliveCor, Mountain View, CA) in lieu of a follow-up postprocedure electrocardiogram. If there is concern for recurrent arrhythmia, at home Holter monitoring may be arranged by mailing the apparatus to the patient with instructions. Lastly, if antiarrhythmic drug initiation is required, frequent transmissions may be used to estimate QTc interval change after dosages.

1.8 | Future questions and directions

Daily life around the world has changed significantly due to COVID-19. In addition to adapting to new home life and social distancing, work life and work flow must also adapt. The EP laboratory is no exception. We are living in unprecedented and precarious times where resource shortages may demand previously unimaginable ethical choices of us, such as whether a patient should or should not undergo a lifesaving procedure. We find that close collaboration and frequent communications by phone or teleconference at least once a day allows us to share the burden together and support one another. It is also crucial to support and salute the selfless nursing, hospital staff during this challenging time of collective action. We also appreciate the executive leadership of NewYork-Presbyterian for their transparency and daily communications with clinical staff and faculty.

Much remains to be discovered about COVID-19, especially with regard to the acute and chronic EP consequences. In light of viral-induced myocardial injury, it is likely that patients who recover from severe illness may develop cardiomyopathies or scar-related substrate for VT. The elucidation of viral shedding duration even after symptom resolution will be critical for future procedure timing in patients with history of COVID-19 infection. Lastly, it has been critical to establish COVID-19 dedicated hospitals, such as converting college dormitories or unused sports stadiums into care centers, to not only to expand patient care and relieve the front-line health care workers, but also to allow safer treatment of noninfected patients in the EP laboratory.

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