ORIGINAL ARTICLE

Anesthetic Challenges during Endobronchial Brachytherapy: A Case Report

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ABSTRACT

Lung cancer is the leading cause of cancer death worldwide. It may present as airway obstruction in a patient with endobronchial masses. Endobronchial brachytherapy (EBBT) has been shown to provide palliative therapy. It is the insertion of a radioactive material near the mass to reduce tumor size, thereby improving airway obstruction. This is the first case of EBBT done in our institution during the COVID-19 pandemic.

A 53-year-old male, 60 kg, ASA Physical Status 2 for hypertension, smoker, malignancy, and previous pulmonary tuberculosis patient, presented with a cough and dyspnea. An endobronchial mass almost obstructing the right mainstem bronchus was seen on a computed tomography (CT) scan. He was diagnosed with squamous cell carcinoma of the lung and underwent radiotherapy and erlotinib chemotherapy. On repeat CT scan, there was no noted decrease in the size of the mass. EBBT was suggested, and a multi-disciplinary team was formed for the planned procedure. Pulmonology, radiation oncology, and anesthesiology teams were identified, and thorough planning was done prior to the actual procedure. Three fractions of EBBT were done under sedation using midazolam, fentanyl, and dexmedetomidine infusion. Lidocaine spray and transtracheal block were also performed as adjuncts prior to sedation. The procedure went as planned, and points for improvement were discussed for subsequent fractions. Due to persistent cough and discomfort from the catheter, additional ipratropium nebulization for minimization of secretions, and oral dextromethorphan for cough suppression were incorporated. After each fraction, the patient was monitored post-procedure for any side effects both from the radiotherapy and anesthetic technique. Qualitative reduction in mass size was noted in subsequent fractions. The patient was able to complete 3 fractions and was advised to follow-up after a month.

EBBT is an emerging palliative and treatment modality for lung cancer, especially for intraluminal masses. Anesthetic considerations will depend on each case's characteristics such as airway anatomy, patient comfort and capacity, and procedural requirements. Conscious sedation with topical anesthesia is an adequate and appropriate anesthetic option, especially in cases where severe airway obstruction may compromise ventilation if airway reflexes are blunted. A multidisciplinary approach with different services and stakeholders is important for the proper planning, execution, and management of such patients.

Keywords: lung cancer, endobronchial brachytherapy, case report, conscious sedation, dexmedetomidine, midazolam, fentanyl, lidocaine, dextromethorphan

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INTRODUCTION

Lung cancer is the leading cause of cancer-related death worldwide. Several risk factors are related to lung cancer with smoking history being the leading cause.[1] Lung cancers are often diagnosed at an advanced or late stage, limiting treatment options. There are cases in which patients develop symptomatic endobronchial involvement presenting with obstructive symptoms such as cough, dyspnea, and hemoptysis. This affects the quality of life of the patient.[2] Systemic chemotherapy and radiotherapy may offer some relief, but due to the advanced stage during diagnosis, the treatment is often palliative in nature and not curative.

EBBT is a palliative treatment aimed at reducing airway obstruction in locally advanced non-small cell lung cancer (NSCLC). This is intended for patients who previously received external beam radiotherapy (EBRT). The technique usually involves fiberoptic bronchoscopy (FOB) to guide the placement of a polyethylene catheter that will contain the radioactive source. This is usually done to reduce tumor size, thereby relieving airway obstruction. High doses of radiation are emitted for a few minutes, and usually, 3-4 fractions are needed to achieve the desired effect.[2-5]

The anesthesiologist needs to consider difficulties in managing and maintaining the airway as well as the provision of safe and adequate anesthesia through various stages of the procedure. The catheter inserted must be kept in place, as the dose of radiation is calculated based on the actual catheter position. In the time of the COVID-19 pandemic, additional protocols must be added to reduce the spread of the virus to all who are involved.

This case discusses the anesthetic management of a patient with locally advanced non-small cell lung cancer who underwent EBBT. This is the first EBBT done in our institution, and success was centered on proper planning, communication, and feedback among all services involved.

CASE PRESENTATION

A 53-year-old, 60 kg male initially presented with a cough and difficulty breathing. On history, the patient is hypertensive and has completed treatment for pulmonary tuberculosis. He was a smoker with a 40-pack-year history and a heavy alcoholic beverage drinker. An initial workup with a CT scan showed a mass in the right lung. A bronchoscopy was performed with a biopsy of the mass showing poorly differentiated carcinoma favoring squamous cell carcinoma. He underwent EBRT with concurrent erlotinib treatment. There was no noted improvement in size and symptomatology of the patient, hence he was advised for palliative EBBT.

Pre-anesthesia evaluation revealed that he still had a cough and occasional dyspnea on exertion. Physical examination revealed decreased breath sounds on the right lung field. The airway was assessed to predict possible difficulty in management and showed a Mallampati score of 2, mouth opening of >4 cm, and thyromental distance of <6 cm, with noted missing dentition. The rest of the physical examination findings were unremarkable.

Chest CT scan showed lobulated soft tissue mass measuring 2.1 x 2.2 cm extending into the right mainstem bronchus resulting in its complete cut-off and collapse of the right upper lung (Figure 1). There were hypodensities within the atelectatic lung suspicious for tumor extension while the right middle and lower lobe bronchi were fluid-filled and obstructed resulting in the collapse of the middle and lower lobes. There was a marked shifting of mediastinal structures to the right and compensatory hyperaeration of the left lung. There were also a few subcentimeter nodules in the right paratracheal region.

To plan for the procedure, a multidisciplinary group with radiation oncology, pulmonology, and anesthesiology services was formed. Several discussions together with the patient and relatives were conducted, and COVID-19 protocols were ensured prior to the start of the first fraction.

Initial FOB by Pulmonology service was followed by bronchoscopy-guided insertion of the EBBT catheter by Radiation Oncology service. A surveillance chest CT scan

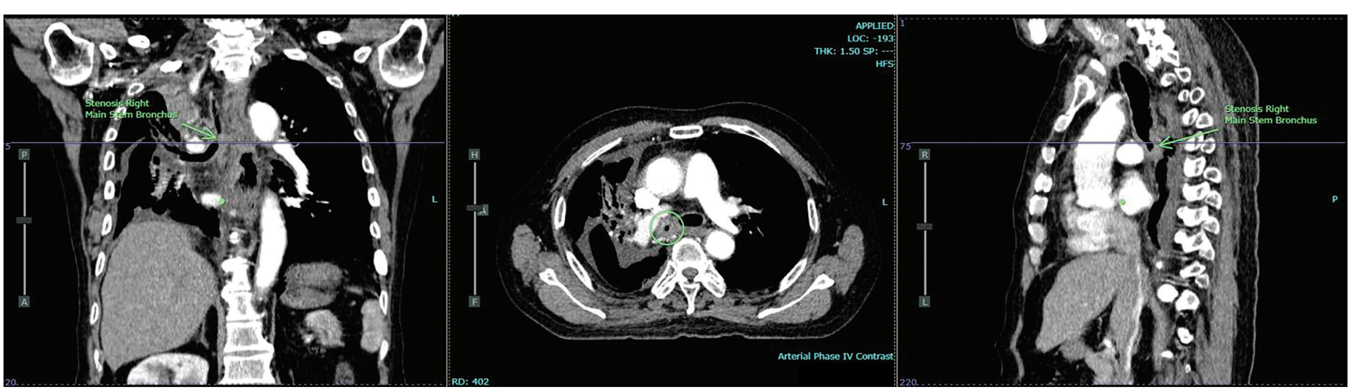

Figure 1. CT scans showing the obstruction of the right main bronchus *(green arrow and green circle).*

was done to verify placement before the delivery of high-dose brachytherapy. Since the catheter insertion and scanning area was different from the radiation area, the availability of anesthesia airway equipment and medications were ensured prior to the start of each fraction for all locations.

The patient had a negative COVID-19 reverse transcription-polymerase chain reaction (RT-PCR) result prior to each treatment fraction. All staff wore appropriate personal protective equipment for each fraction. The anesthetic plan was conscious sedation using dexmedetomidine infusion accompanied by topical anesthesia via mucosal spray over the nasal and oral cavities and transtracheal block.

During the first fraction, he was positioned supine, and standard ASA monitors were attached. Initial vital signs were as follows: blood pressure (BP) of 180/90 mmHg, heart rate (HR) of 120-126 beats per minute, respiratory rate (RR) of 24-30 breaths per minute, and oxygen saturation (O_2sat) of 97-98%. Dexmedetomidine infusion was started at 0.5 mcg/kg/hr. Lidocaine 10% was sprayed over the nasal and oral cavities. Midazolam 1mg and fentanyl 25mcg IV were given prior to the transtracheal block using lidocaine 2%. Supplementation with lidocaine 1% via the bronchoscope's working channel was administered during insertion of the bronchoscope. The total lidocaine dose was monitored to not exceed the toxic dose.

To maintain airway patency, a nasopharyngeal airway (NPA) was inserted into one nostril and attached to a breathing circle, supporting ventilation. A flexible bronchoscope was inserted through the opposite nares. The mass was visualized abutting the carina and causing 80-90% obstruction in the right mainstem bronchus (Figure 2).

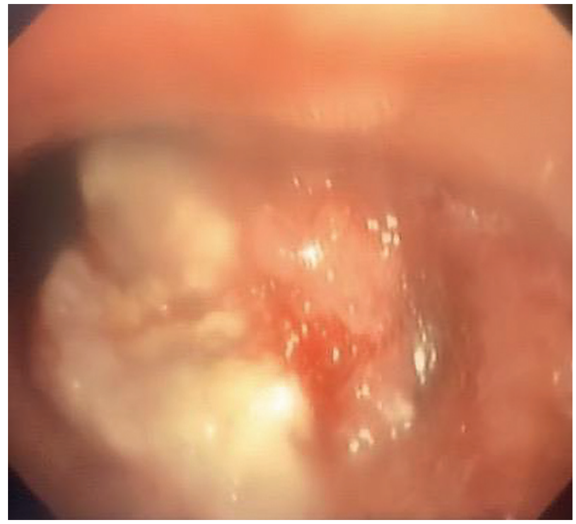

Figure 2. Bronchoscopic visualization of the mass seen obstructing the right main bronchial lumen.

The airway support was shifted to the nasal cannula to free the NPA. The EBB catheter was then inserted via the NPA up to the mass level and was secured thoroughly to the tip of the nose (Figure 3). The bronchoscope was carefully removed. At this point, the patient was noted to have occasional cough sensation which decreased after reassurance. CT simulation commenced, and he was transferred with monitors into the brachytherapy room for radiation.

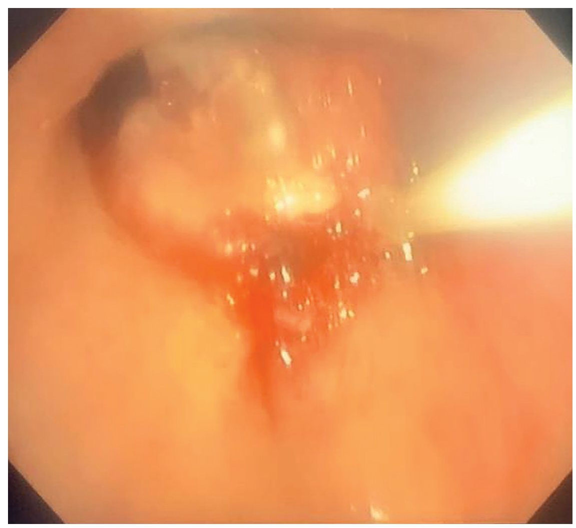

Figure 3. Bronchoscopic visualization of the EBBT catheter in place lateral to the mass.

During the simulation, the patient was comfortable with occasional coughing sensations, with no episodes of desaturation or respiratory distress. Secretions were suctioned thoroughly, and the patient was instructed to avoid coughing as this may cause malposition of the catheter. Dexmedetomidine was only discontinued after the conclusion of EBBT. At this point, the patient's vital signs were noted to improve to BP 140/80 mmHg, HR 90-98 bpm, RR 20-24 cpm. O_2sat was maintained at 97-98%. The initial brachytherapy fraction lasted for 22 minutes. Because of the high radiation dose, some of the staff stayed outside the radiation room, while some stayed in a separate control room.

Post-procedure, the catheter was carefully removed, secretions were suctioned, and NPA was removed. Dexmedetomidine was discontinued. The patient was admitted overnight to observe for any complications. He had a febrile episode with a temperature of 39°C, which resolved with one dose of paracetamol which was attributed to a radiation reaction. He had occasional hemoptysis but had no respiratory distress, cyanosis, or decrease in sensorium during admission. The total duration of the fraction from scanning to catheter removal was 2 hours and 40 minutes.

After the first fraction, points for improvement for subsequent fractions were discussed by the team. These included the addition of ipratropium nebulization for minimization of secretions, and oral dextromethorphan for cough suppression.

Dextromethorphan was taken 2 hours prior to the second fraction. Nebulization was done prior to local anesthesia administration. The rest of the anesthesia technique was maintained. However, after transfer to the brachytherapy unit, we noted persistent coughing, presumed to be due to the NPA, rendering the patient restless and uncomfortable. The NPA was pulled a few centimeters out to alleviate the patient's comfort and proceeded with the second fraction. Post-procedure, there was occasional hemoptysis. There were no other symptoms noted thereafter.

For the last fraction, adjustments in technique were made as previously mentioned. Further decrease in obstruction was noted. Post-procedure, the patient was admitted due to unexplained cheek swelling. On assessment, he had some cheek discomfort and swelling which may be due to airway manipulation, and was relieved with paracetamol. The patient was sent home and advised to follow up after one month.

On follow-up, there was a qualitative decrease in luminal obstruction during each fraction and the patient also had subjective improvement in symptoms. He had regular follow-ups with his physicians. He was able to comply with his monthly follow-up, until four months later, when he suffered from a suspected myocardial infarction at home. He was brought to the nearest health facility from his residence, but the patient eventually expired.

DISCUSSION

EBBT is a minimally invasive, localized radiation procedure indicated for immediate palliation of locally advanced non-small cell lung cancer of the airway alone or in conjunction with other treatment modalities. The main goal of EBBT is to decrease the tumor size and relieve symptoms such as dyspnea, hemoptysis, and cough.[2-5]

The therapy involves transnasal FOB to determine the extent of the disease and to visually guide the placement of catheters with radiopaque wires into the affected bronchi in proximity to the tumor. The position of catheters is verified via fluoroscopy and secured.[3,5] The bronchoscope is then removed and the catheter is loaded with a radioactive source remotely.

Anesthetic approaches for EBBT may vary depending on each case's characteristics such as complexity of airway anatomy, patient comfort and capacity, and procedural requirements. Topical anesthesia alone or in combination with sedation and general anesthesia may be employed. Anesthetic concerns include 1) preoperative assessment focusing on the airway and cardiorespiratory system; 2) protection of airway integrity and maintaining adequate oxygenation; 3) maintenance of adequate anesthesia; 4) mitigation of patient's movement; and 5) safe transport of patient.[6,7]

Preanesthetic Management

Coughing is a common symptom seen in respiratory diseases and increases with airway manipulation. Preprocedural dextromethorphan was used as an antitussive for the second and third fractions to minimize coughing during the procedure. Dextromethorphan as a noncompetitive N-methyl-D-aspartate (NMDA) receptor antagonist decreases postoperative pain and opioid use when given preoperatively.[8,9] A study by Schwarz and colleagues used dextromethorphan as a premedication for FOB. The results showed better analgesia and anxiolysis with oral premedication of 90 mg of dextromethorphan. It was also noted that less midazolam and lidocaine instillation were needed in patients who had dextromethorphan prior to FOB.[8]

Another problem encountered during the first fraction was airway hypersecretion which makes the procedure difficult to perform as well as triggers the coughing reflex. To address this, nebulized ipratropium bromide was given prior to the start of the procedure. Ipratropium is an M3 receptor antagonist inhibiting the acetylcholine receptors found in respiratory smooth muscle, submucosal glands, and airway epithelial cells thereby inhibiting the production of mucus.[10]

Anesthetic Technique

Conscious sedation in conjunction with topical anesthesia was our anesthetic of choice.

Topical Anesthesia

One of the foundations of successful FOB is the proper use of topical anesthesia. Adequate topical anesthesia is necessary to abate coughing which may cause malposition of the radioactive source. It has been shown to decrease sedative medication requirements. Lidocaine is the most commonly used local anesthetic for topical anesthesia during FOB due to its rapid onset, short half-life, and safety profile.[11-13] Various techniques utilizing lidocaine may be applied. We opted to use Lidocaine 10% spray via the naso- and oropharynx in combination with transtracheal block with Lidocaine 2% as part of the topical anesthesia. Lidocaine spray and transtracheal block have been shown to be superior to nebulization and spray-as-you-go techniques in terms of decreasing cough severity, procedural satisfaction, and total dose administered.[13,14]

Conscious Sedation

FOB alone causes sympathetic responses including increased HR, elevated BP, oxygen desaturation, and arrhythmia. Sedation has been proven to diminish sympathetic responses.[15] Since the patient presented with intraluminal obstruction, maintaining spontaneous respiration is prudent. Conscious sedation is a level of sedation wherein consciousness is depressed, but the patient still controls his airway protective reflexes. It requires the patient to be cooperative and not in respiratory distress. Dexmedetomidine infusion was utilized to achieve this level of sedation. It is a selective alpha-2 agonist with sedative and analgesic properties that does not cause respiratory depression in recommended doses.[16-19] A study comparing the combination of dexmedetomidine and fentanyl versus propofol and fentanyl concluded that in terms of incidence of hypoxemia, a combination of dexmedetomidine with fentanyl is superior to propofol and fentanyl. However, the combination of dexmedetomidine and fentanyl results in bradycardia and longer recovery time.[20]

One of the challenges posed with this procedure is transferring the patient from one unit to another, thereby risking the dislodgment of the EBBT catheter. With conscious sedation, the patient can maintain his position comfortably. Also, the patient can maintain spontaneous ventilation, therefore avoiding positive pressure ventilation that may dislodge the catheter within the trachea and less contraption such as a mechanical ventilator. During transfer, complete monitors, oxygen support, and a traffic-free route are prudent to ensure patient safety.[21]

As for all anesthetic procedures especially involving the airway, emergency airway equipment and a resuscitation cart should be within proximity for safety.

COVID-19 Protocol

As the first fraction of this procedure was done in March 2021, during the height of the COVID-19 pandemic, national and hospital protocols were followed. The patient was required to undergo COVID-19 RT-PCR testing prior to each session and must be asymptomatic at the time of the procedure except for coughing, as this was part of his symptomatology. The procedure involves bronchoscopy which is an aerosol-generating procedure that exposes health care workers to contagion. All personnel involved with the direct care of the patient were required to don a level 3 personal protective equipment which included the following: National Institute for Occupational Safety and Health (NIOSH) N95, goggles or face shield, gloves, surgical cap, gown, and shoe cover (see Appendix).[22]

Postprocedural Monitoring

The patient was admitted overnight after each fraction to monitor for possible complications. Complications after EBBT may include major or minor bleeding, apnea, bronchospasm, pneumothorax, pneumomediastinum, airway trauma, fistula formation, and fever among others.[2-5] Our patient presented with non-significant hemoptysis and fever as post-radiation effects which were managed prior to discharge.

CONCLUSION

This study discusses the different anesthetic challenges in managing patients undergoing EBBT. Anesthetic considerations will depend on each case's characteristics such as the complexity of airway anatomy, patient comfort and capacity, and procedural requirements.[6,7] Anesthetic techniques of choice vary from topical anesthesia and sedation to general anesthesia. The procedure warrants open communications among services of radiation oncology, pulmonology, and anesthesiology from defining the plan and management to execution of the procedure. The patient and relatives should be involved in the discussion and planning including the possible risks and benefits it would incur, including post-procedural complications. Conscious sedation combined with topical anesthesia is an adequate and safe anesthetic option, especially in cases where severe airway obstruction may compromise ventilation if airway reflexes are blunted.

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Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

All authors declared no conflicts of interest.

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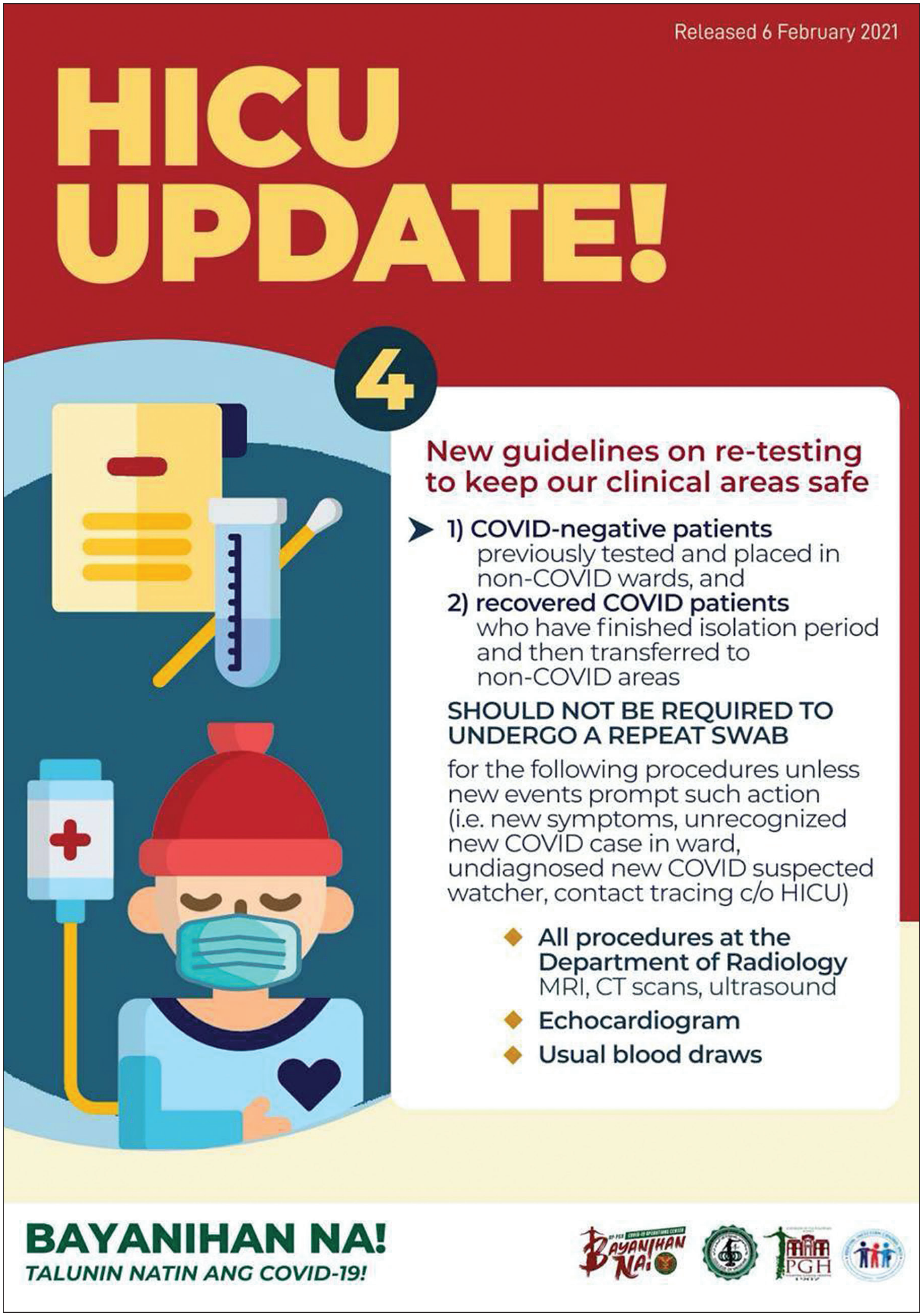
APPENDIX



Hospital Infectious Control Unit (HICU) COVID-19 Protocol as of February 6, 2021.

Hospital Infectious Control Unit (HICU) COVID-19 Protocol as of February 6, 2021 *(continued)*.