Obstructive Sleep Apnea (OSA) is a syndrome categorized by collapse of the upper airway during sleep, associated with disruptions in ventilation. These disturbances lead to hypoxemia and hypercarbia, triggering arousal from sleep, re-instituting normal motor control of the upper airway muscles.1 Under anesthesia, this arousal response is lost, with airway obstruction a primary cause for hypoxemia during sedation. During general anesthesia, airway obstruction is a known risk factor for difficult mask ventilation as well as endotracheal intubation,2,3 and is the leading cause of major airway events occurring during emergence.4

Techniques and devices are available to facilitate oxygenation and intubation, but complications are not uncommon. Pre-oxygenation improves non-hypoxic apnea time,5 as does passive oxygenation during laryngoscopy.6 These techniques, however, often fail in the setting of airway obstruction and morbid obesity, where oxygen consumption is high, functional residual capacity is low, and obstruction prevents oxygen from reaching the hypopharynx.6,7 The American Society of Anesthesiologists strongly suggests using an awake approach to intubation for general anesthesia when a difficult airway is identified pre-operatively and a formal airway management plan in preparation to treat inadequate ventilation after extubation.8,9

We present a case of a 46-year-old man with OSA and an anticipated difficult airway requiring general anesthesia for an epicardial ventricular tachycardia ablation. The plan included a sedated fiberoptic intubation with nasal positive pressure, followed by an extubation directly to positive pressure, continued during transport and in the post-anesthesia care unit (PACU) until the patient’s home continuous positive airway pressure (CPAP) could be initiated. Peri-operative nasal positive pressure was delivered via the SuperNO2VA® device (Revolutionary Medical Devices, Inc., Tucson AZ, USA), a nasal anesthesia mask designed to deliver positive pressure when connected to an anesthesia circuit. We present this to introduce the SuperNO2VA® as a useful adjunct during induction and emergence of anesthesia in patients with anticipated difficult airways and encourage formal research moving forward.

This is a 46-year-old man undergoing an epicardial ventricular tachycardia (VT) ablation under general endotracheal anesthesia. He has a height of 70 inches, weight 98 kg, and a history of OSA on CPAP, obesity, hypertension, hyperlipidemia, diabetes, chronic obstructive pulmonary disease, and intermittent VT with an implantable cardioverter defibrillator. The epicardial approach incurs a 5-10% risk of major complications, requiring general anesthesia with an endotracheal tube and arterial catheterization. External airway exam included a large neck circumference, Mallampati 4 airway, missing teeth, limited neck motion and thyromental distance > 3cm. He is compliant with
home CPAP nightly for sleep. All patient information, data, and photos were taken with permission from the patient.

In the operating room, vital signs were BP 170/90, HR 73, SpO2 95% on room air. The SuperNO2VAâ—including the device was placed over his nose, and connected to the anesthesia circuit. Additional oxygen tubing from auxiliary oxygen on the anesthesia machine was connected to the superNO2VAâ—including the superNO2VA via the side oxygen port. Fresh gas flow was set to 15 liters/min (L/min) on both the anesthesia circuit and auxiliary oxygen source, totaling 30 L/min, and the adjustable pressure limiting (APL) valve was open to zero cmH2O. Dexmedetomidine 15 mcg was given followed by an infusion at a rate of 0.4 mcg/kg/hr. Lidocaine 5% gel was delivered to the oropharynx with a tongue depressor, held in place for 5 minutes followed by 3 mL oral atomized lidocaine 4%. When patient had no response to oropharyngeal stimulation, a bite block was placed, fentanyl 50 mcg given intravenously, and APL valve closed to 10 cmH2O. Positive pressure was shown on the monitor along with successful spontaneous respiratory efforts appreciated by changing pressure and flow waveforms. The bronchoscope was inserted; upon visualization of the vocal cords, 3 mL 4% lidocaine was sprayed on the cords and 60 seconds given for effect to take place. The bronchoscope was inserted between the vocal cords and a size 8.0 endotracheal tube was passed over it into the trachea. Tube position was confirmed by bronchoscopy. The cuff was inflated and bronchoscope removed; the circuit was taken from the SuperNO2VAâ—including the superNO2VA and connected immediately to the endotracheal tube. Vital signs were stable throughout the intubation and SpO2 remained at 100%. Ventilation was confirmed via end-tidal carbon dioxide, the SuperNO2VAâ—including the superNO2VA was removed, and propofol, Sevoflurane, and Rocuronium was given for induction of general anesthesia.

The 8.5-hour procedure was uneventful, with no major respiratory changes, and successful VT ablation. A total of 100 mcg of fentanyl was given during the procedure. After sterile drapes were removed, the SuperNO2VAâ—including the superNO2VA was replaced on the patient in preparation for extubation and neuromuscular blockade reversal given. Awake with the ability to follow commands, the trachea was extubated under positive pressure and the anesthesia circuit placed immediately onto the SuperNO2VAâ—including the superNO2VA with fresh gas flows set to 15 LPM and the APL valve closed to 10 cmH2O. Spontaneous ventilation was appreciated via the changing pressure and flow waveforms on the anesthesia monitor. To prevent upper airway collapse during transport and in PACU, nasal positive pressure was continued with the SuperNO2VAâ—including the superNO2VA by using a Mapleson circuit connected to an E-cylinder oxygen tank at 10 LPM (Baby safe, Vital Signs, Lake Forest IL, USA). The pressure relief valve was adjusted to deliver positive pressure, and ventilation was confirmed by visual inspection of the reservoir bag deflating and re-pressurizing during spontaneous ventilation. The patient was transported to the PACU without oxygen desaturation or other events. Upon admission to PACU, the oxygen tubing from the Mapleson circuit was connected to wall oxygen at 10 LPM fresh gas flow. Vital signs in PACU were reassuring and SpO2 99%. After transfer of patient care to the PACU nurse, the patientâ€™s home CPAP was retrieved and the patient placed on his normal care. CPAP was continued for the PACU stay and overnight for sleep. He was discharged from the hospital the next day without events.

The case demonstrates the utility of nasal positive pressure with the SuperNO2VAâ—including the superNO2VA device during awake fiberoptic intubation and upon emergence of general anesthesia. Although positive pressure devices are not new, the SuperNO2VAâ—including the superNO2VA device allows for it using already available anesthesia equipment in the operating room, permitting its use during anesthesia and for transport without additional capital equipment. As an effective, easy-to-use, and transportable device, the
SuperNO2VAâ“¢ should be considered as a tool during difficult or emergency airway management in high-risk patients, and should foster well-controlled prospective research in the future.

Other tools are available to improve safety in patients undergoing procedures like this one, such as high flow nasal oxygen via nasal cannula (HFNC).6,10 Through flow-dependent deadspace flushing, passive oxygenation during apnea is maximized, and advantageous for prolonging non-hypoxic apnea time.6,11 HFNC is useful for fiberoptic intubation in patients without airway collapse, however, with the addition of sedative medications, or upon emergence, upper airway collapse prevents flushing hypopharyngeal deadspace, as the mean nasopharyngeal pressures with HFNC range between 1-4 cmH2O, inadequate to reliably relieve obstruction.6,7 HFNC may have been helpful during fiberoptic intubation in this patient, but we have few high-flow regulators in our department necessary for its use. During emergence, it likely would have failed where upper airway collapse would have undoubtedly inhibited its utility.

Peri-operative CPAP, both nasal or full face, has demonstrated efficacy in reducing upper airway obstruction, hypoxemia, and other complications in patients with morbid obesity and OSA.12-14 However, conventional CPAP modalities require expensive capital equipment not readily available or transportable, making them difficult to utilize peri-operatively. Neligan studied the use of CPAP on morbidly obese and OSA patients initiated immediately after extubation versus starting upon arrival in PACU, showing improved respiratory parameters (forced vital capacity, forced expiratory volume in 1 second, and peak expiratory flow rate) on post-op day one when starting it immediately upon extubation rather than waiting until arriving in PACU.15

CPAP during bronchoscopy has been attempted since the 1990s with reports of success in difficult airways or for ventilatory support for acute respiratory failure.16-19 Prospective analysis showed improved tidal volumes and post-intubation end-tidal carbon dioxide against controls, suggesting an improvement in both oxygenation and ventilation.20 Despite these developments, little research has been devoted to studying positive pressure during bronchoscopy, in part because it is difficult to employ. CPAP masks are large and bulky, and CPAP machines or high-flow-capacity ventilators are expensive. A low-profile, inexpensive device that connects to anesthesia equipment and utilizes low fresh gas flows, such as the SuperNO2VAâ“¢, may circumvent these and allow for easy-to-implement, improved patient care.

The SuperNO2VAâ“¢ is a nasal mask designed to give positive pressure by using fresh gas flows and APL valves from readily available anesthesia circuits. Having easy access to non-invasive positive pressure in the operating room, during transport, and with wall or E-cylinder oxygen may prove to be an advantage when treating patients with airway obstruction.