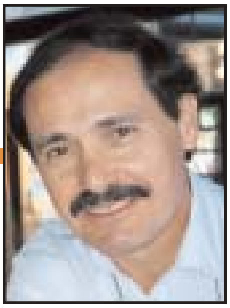

FLOW-THROUGH VENTILATION

by John Marini MD

Although exchange of respiratory gases with the atmosphere is essential for all life, there is considerable variation in the ways different species accomplish this task. Humans are designed with a reciprocating (two-phase) pump - our respiratory system - that conducts fresh and stale gases through a conducting air channel to the alveolar site of diffusion exchange. While this arrangement helps conserve body heat and moisture, the anatomic 'deadspace' that does not expose air to blood degrades its efficiency. In their low oxygen aquatic environment, fish do not have the luxury of allowing low efficiency nor the need for either heat or moisture conservation. Theirs is a one-way, flow-through, higher efficiency system. On the surface, it would seem that this cross-species comparison of anatomy and physiology is of purely academic interest, as we never encounter flow through ventilation in the clinical setting. Almost true enough. However, once in a while in our intensive care environment we challenge Nature's rules when we splice artificial support into the biological pump. Two examples from my personal experience, one occurring long ago and one very recently, reminded me of that fact and may be instructive to recount.

> ***Once in a while in our ICU environment we challenge Nature's rules when we splice artificial support into the biological pump***

About 25 years ago, while still in Seattle, I fielded a call from a physician in the Midwest who needed some help in managing a difficult patient with an unusual respiratory problem. He was dealing with a middle aged man with barotrauma, a very common problem at the time for patient's receiving mechanical ventilatory support in the high tidal volume era. The patient had some underlying bullous lung disease, as I remember, and bilateral bronchopleural fistulae following chest trauma. The air leaks were described as "quite substantial". The patient had no other acute medical problems, good cardiac function, and rather normal metabolic demands--no sepsis, hyperthermia, metabolic acid production, etc. The problem, I was asked to help with was an impressive respiratory alkalosis. Well, this was going to be an easy phone consult. "Simply turn down the ventilator's mandatory rate, reduce the ventilator's triggering sensitivity, and if necessary, sedate him.", I advised. (and under my breath thought 'next case!') The practitioner on the other end of the line, however, was much sharper than I had assumed. I was both a little embarrassed and more than a little fascinated when he casually mentioned that unfortunately, doing so would not be possible, as the patient was not on a ventilator, and incidentally, wasn't taking any breaths at all! The resulting respiratory alkalosis had shut down his drive to breathe. (By the end of the phone call I recommended turning down the suction force and going to water seal if possible, and if not, to operative pleurodesis for leak closure.) With that case I learned an important lesson. It was only a little later that several papers were published showing that bronchopleural fistulae--while seldom so effective as in this case--do indeed eliminate CO2 and in this sense are not entirely wasted ventilation. In fact, this patient had "flow through" ventilation so efficient as to meet all of his ventilation needs and then some.

Fast forward to one week ago. Our MICU admitted a woman with massive aspiration pneumonia that had occurred during operative jejunostomy for feeding tube placement. This unfortunate woman had undergone an esophagectomy with intestinal pull-through interposition 5 years earlier, and was currently in the middle of a course of irradiation for suspected recurrence in the mediastinal nodes. She was very poorly nourished, could not eat, and had been experiencing incessant coughing of bilious material for several weeks. With her intubated, ventilated and deeply sedated I performed bronchoscopy upon arrival to the MICU and documented the expected tracheo-enteric fistulous communication located near the carina. Bilious material was refluxing into the respiratory tree, which was contaminated by thin, green stained secretions, which bubbled during bronchoscopic suctioning through the lima bean sized communication between the trachea and GI tract. Almost immediately after the procedure, an oro-gastric tube was advanced to an appropriate distance and continuous gastric suctioning begun. Rather than help with ventilation and oxygenation by decompressing the belly and improving compliance, things deteriorated. The Respiratory Therapist became alarmed enough to page me back to the bedside because the patient was now impossible to ventilate. Returned volumes were half of those being given and frequency had been raised to more than 30/minute. The abdomen was neither more distended nor decompressed than when I had last seen her and there was no E-T cuff leak. It didn't take too long before my mental penny dropped and I asked the nurse to pinch off the oro-enteric suction tube. The returned volumes now equaled those set. In a sense, she, too, had one-way ventilation, but this time much of the "flow-through" gas never reached the alveoli but exited through the GI suction line. Effectively, this was an "enteric steal" at the pre-carinal level.

How to manage the problem of maintaining adequate ventilation while preventing distention of the abdomen with gas?

continued on page 89

Flow-Through Ventilation... *Continued from page 86*

Apart from upright body positioning, I asked the nurse to suction the stomach intermittently at 30 minute intervals for less than 30 seconds at a time. Remembering that she had no esophagus or esophageal sphincter and had shown free bile reflux during bronchoscopy, I also placed an abdominal binder to reduce abdominal compliance relative to the rib cage and thereby help prevent gas entry into the abdomen through the stomach. I was feeling rather proud of myself for being such a good bedside physiologist and went for a coffee break. I was about halfway through when I was interrupted by another page from the Unit. More trouble--apparently achieving better ventilation was not the end of the story. This time the therapist and nurse were concerned that they simply could not clear the airway of bilious secretions; in fact, suctioning just seemed to make ventilation worse. Having just done the bronchoscopy, I understood why. The combination of airway suctioning, increased abdominal pressure due to binding and absence of oro-enteric suctioning encouraged the airway catheter to pull bilious secretions into the trachea via the fistula. My solution was to suction the airway and turn on the gastric suctioning simultaneously—"Do not airway suction without unclamping the oro-gastric tube first". (We never needed to undo the binder during airway suctioning, but that was my planned next step.) She was extubated successfully the next day, the binder was released, and she was placed in an upright position and breathed comfortably. This was another example of flow-through 'bypass' ventilation with potentially adverse consequences.

In my view, these cases illustrate that there simply is no substitute for physiological understanding and well-honed analytical skills for on-the-fly management of difficult cases. Respiratory Caregivers are on the front lines of such struggles - We should all remember that there are few professionals satisfactions that compare to successfully reasoning through tough problems to help patients who really need it.

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Hyperbaric Medicine... *Continued from previous page*

Although hyperbaric treatment is very safe, the contents of this document can sound scary if not explained within context. The consent form describes any possible problem or potential hazard that can occur as a result of hyperbaric therapy. This form is verbally presented and signed by the physician and then signed by the patient (which denotes understanding), and witness or quardian if required. Separate sections are including, which require additional signatures, for photographing wounds, use of conscious sedation, or use of patient information in research when applicable.

Discharge education (provided post-treatment) is also important and should also be available in multi-language versions. For example, every patient discharged following treatment for carbon monoxide poisoning and decompression illness (DCI) receive written information specific to these problems. Patients that are treated for DCI are provided information that we have downloaded from the Divers Alert Network web site. Examples of these topics are; when can I return to diving, how soon can I fly after diving, and DCI recovery times. The patient treated for carbon monoxide poisoning must be aware of symptoms that could return after treatment and discharge. If heat and fire were evolved with the poisoning, other concerns must be highlighted which could appear 24 hours after the incident. There are two very important sections that must be included in these 'take-home" documents; the section on the recognition of recurring symptoms or side effects and the section on how and when to communicate back to the department or hospital. Is the phone number on your form correct for the hyperbaric or emergency departments?

There are certainly more topics under the heading of patient education than discussed here but I believe these to be the core of most programs and a starting point for your own assessment. Since patient education can have such a significant impact on safety, patient care and quality of life, we should all strive to give it the attention it truly deserves.

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