

REFLECTIONS ON MANUAL VENTILATION

by John Salyer RRT-NPS, MBA, FAARC



One of my favorite cartoon characters is "Obvious Man". He is the creation of cartoonist Wiley Miller and is on a quest to point out the obvious; something we often trip over in our daily lives. Having been kicking around Respiratory Therapy for a long time, I have the luxury of the long perspective. This long perspective reminds me of the first flow-inflating style resuscitator I ever encountered. It was a Rees T-piece circuit and as a new inhalation therapist in the Navy, I was expected to master its use during manual ventilation with a mask. I was informed that it was "better" than those pedestrian self-inflating bags because it allowed me to "feel" changes in lung compliance, and because it could deliver 100% oxygen. Besides, it was obviously "cooler" than a self-inflating bag. I accepted this conventional wisdom without question. Later, however, I began to have doubts about the benefit of flow-inflating bags in general. This came from experience in watching many RT's, nurses, and doctors try to use them. There was (and is) a tremendous range of skill in the use of manual resuscitators throughout the hospital. They are used by experienced anesthesiologists, inexperienced registered nurses, medical students, residents, RT students and others. With this observation under my belt, I began to wonder how much variation there was in the basic parameters of ventilation between different styles of resuscitation bags.

Jim Keenan and I studied this at Primary Children's Medical Center on a bench model of neonatal and pediatric mechanical

ventilation. Our research showed that in a group of pediatric RT's and RN's of varying degrees of experience, flow-inflating bags produced much more variation in delivered tidal volume and PEEP than did self-inflating bags. Later, Don Foubare and I studied this again in a different group of pediatric RT's and found essentially the same findings, e.g. the flow-inflating bag produced more variation in tidal volume and PEEP than the self-inflating bags. A corollary to our findings was the observation that all forms of manual resuscitators studied, produced large variations in tidal volume.

So, who gives a rip about differences in ventilation variability between bags? If you don't care, you should. As I have mentioned in an earlier column, there is now a growing consensus that careful control and limitation of tidal volumes helps to minimize the risk of ventilator induced lung injury. Also, we are also learning that variations in PEEP, especially drops in PEEP can also contribute to lung injury through alveolar de-recruitment. Going back to the obvious man analogy; we spend a lot of time and effort to utilized techniques on the ventilator that will ensure a minimization of tidal volumes, but often pay no attention to this when hand bagging. And don't be lulled into a warm sense of well being by use of a pressure manometer during bagging. In all of the above mentioned studies the clinicians used a manometer, and concentrated on giving precise pressures, and yet tidal volumes were highly variable. Isn't it obvious that we should be thinking about techniques and equipment that minimize variation in tidal volume and PEEP during manual ventilation?

But what about the argument that flow-inflating bags allow the clinician to "feel" changes in compliance. Sacred cows do make the best hamburger, and this is one seriously tasty whopper. We also studied the ability of clinicians to "feel" changes in compliance while ventilating a test lung with different style bags. We found no difference between flow-inflating and self-inflating bags when testing a group of RT's from a pediatric hospital. Other researchers have called the whole issue of "feeling" compliance changes into question. Spears et al, reported a study in 1991 in which they demonstrated that only 14% of a group of 24 anesthesiologists, both faculty and residents, pediatric and adult, could correctly identify a complete occlusion of the endotracheal tube while ventilating a neonatal and pediatric test lung with flow-inflating bags in anesthesia circuits.


There are design flaws in both style bags. The self-inflating bag can be used without a flow of source gas and thus the clinician can be fooled into thinking they are giving supplemental oxygen when they are not. And the self-inflating bag cannot give 100% oxygen, but when properly configured and operated, can come very close. Our testing of neonatal and pediatric size bags indicates that when a reservoir is used and flows are properly adjusted, FIO₂ is consistently greater than 92%. The flow-inflating bags cannot operate without a flow of source gas and thus are useless in the event of an unplanned loss of source gas.

Finally, the flow-inflating bag is more "technique-dependent" and because of this, more prone to operator error. It

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via VPICU telemedicine. The Japanese patient had diaphragm pacers surgically implanted in LA using the innovative thoracoscopic technique originally developed there. Because pacing is not actually started until 2-months after surgery, the option of VPICU telemedicine was used.

To support the goal of enhanced education VPICU has an education section, accessible from the top bar, where education material is presented in a practical format. Case studies, clinical examples, lecture material and interactive discussions are used. VPICU is hoping to develop an electronic tracking system that practitioners can use to track self-education. A "Question of the Month" is presented, with archives of past questions. Case studies are enhanced with clinical materials such as x-rays and lab values. The answer is also given at the bottom of the presentation.

The PICUList is an email mailing list for discussion of Pediatric Critical Care issues. To subscribe, send an e-mail to PICUList@vpicu.org with the word "subscribe," typed in the SUBJECT. All practitioners interested in pediatric intensive care medicine are welcome. At the main website click on "PICUList" and you will find Etiquette instructions and user instructions.

The "PICU Directory" can be used to search for a Pediatric Intensive Care Unit by state and/or by country. The hospital name and address is given and stats on admissions and staff are given. There is also contact information. If you are a registered facility you can update that information right from the website, or can initiate registering your facility.

If you click on "VPICU Directors" from the home page you will be taken to a list of the Directors. They are listed with their professional background information and personal contact information including websites. You can also read their Medical Practice Philosophy, their Professional Biosketch, and the Computer/Telemedicine/ Informatics Projects they've worked on.

The website itself is very easy to navigate. You will quickly find all the information that I have described and can link over to "myVPSOnline". Anyone with an interest in pediatric intensive medicine will find something of interest here. This would be a great place to initiate networking in the field. And if you are a PICU, certainly you will want to investigate participating in some or all of what this organization has to offer.

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"Nine to five might be a problem - I like to sleep in."

So there you have it. As Kent Savage said, we don't need to be challenged with organizing the clinical, financial and quality data needed to manage a sleep program. We don't need to cope with stacks of paper audits, calculations and manual reports. Some of the questions you may want to answer to determine your readiness for a database are: What data do you currently track and how do you report this data? What are my current financial and human resources available to coordinate this process? What obstacles do you anticipate in implementation of a database? Where do you want to be in the future with data management and reporting?

A database comprised of patient demographics, sleep related clinical measures, encounter history, quality audits and basic financial data can become the backbone of a sleep program management system. Combined with the expertise of a program's clinical and non-clinical human resources, the database becomes the tool for both clinical and fiscal operations leading to successful patient outcomes, clinical quality, clinical safety, accreditation and higher pay-for-performance.

Simply put, a database is a documentation tool. A database is designed to enter data at the time of collection, which results in reduction of stacks of paper and saving personnel time to collect data retrospectively, making the process extremely efficient and cost beneficial.

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Reflections on Manual Ventilation Continued from page 36

requires that flow rates into the bag be adjusted to keep the bag sufficiently expanded, but not *too* expanded. In some designs, there is also a requirement to adjust the flow out of the bag via use of a variable flow resistor where the gas egresses the bag. And in some designs the egress of the gas from the bag is controlled by partially occluding a hole in the bag with your thumb. In the hands of experienced clinicians, these design flaws can be overcome, but "experienced" clinicians are not always using the bags. I have personal knowledge of a number of adverse events related to clinicians misapplying flow-inflating resuscitation bags.

I have concluded that overall patient safety is enhanced by eliminating the use flow-inflating bags. And we have almost completely converted our hospital to self-inflating bags. Anesthesia remains a hold out and they have circled the wagons on this issue. They argue that they need flow-inflating bags to do inductions and intubations. They argue that they can attach the flow-inflating bag to the endotracheal tube and allow the patient to spontaneously breath, without imposing too much work of breathing on the patient. They claim that the valves in a self-inflating bag impose too much inspiratory work of breathing on patients, especially small children and infants. As indelicate as it may sound, I just don't believe this. If there is sufficient flow into a self-inflating bag with a duck bill grommet designed valve, the valve actually stays slightly open all the time. Our next stop on the issue is the bench. We intend to measure the imposed inspiratory work of breathing through endotracheal tubes of various neonatal and pediatric sized, while attached to different styles of manual ventilation bags. Obvious man may strike again.

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