Take a Deep Breath

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It is said that there is nothing new under the sun. It is also said that everything old is new again. Both adages are apropos when talking about ventilators—especially from a biomedical technician's viewpoint. Although newer universal ventilators may be in place at some facilities (see sidebar), in many locations the challenges facing biomedical technicians still involve streamlining maintenance of their traditional complement of equipment.

"There is not much out there that is new," says George Dowse, BMET, Kinetic Biomedical Services ventilator specialist assigned to St Peter's University Hospital, New Brunswick, NJ. "It boils down to either pressure or volume ventilators, and at our hospital we have a wide range of types. We are big on the neonatal side, so we use a variety of ventilators for that patient base. In the emergency room we also use models that do not have many different pressure support modes but instead offer just enough to stabilize the patient for transport to critical areas."

While St Peter's has tried some of the universal models in its neonatal intensive care

unit (NICU), Dowse says the units presented problems unrelated to their actual function.

"We did try a few, but the units themselves are too bulky for the space we have," he says. "In a hospital environment we have really tight quarters. When we have the bed, the ECG monitor, and 20 IV pumps in place, things can get really cramped. Size is a big thing. We try to keep our ventilators on the wall, so we are looking for smaller, more compact models."

The Next Big Thing

by Mario Carvajal

A growing trend in patient ventilation products over the past several years is the move to a universal ventilation system: one ventilator that can safely and accurately ventilate all patients—from the smallest neonates to children to adults.

Everyone started out with one ventilator system, and, while fringe products may have provided pressure ventilation, that was not the norm—until we learned that was a very viable way to ventilate adults and children.

For neonates, however, these early ventilators were not suitable, due to the difficulties caused by the need for very wide operating ranges for both volumes and pressures. Neonates, who are at the lowest end of the scale, require delivered-breath accuracy and resolution that is difficult to achieve. To properly ventilate neonates, more sophisticated drive systems and software control come into play.

Generally speaking, the mode of ventilation for neonates today is pressure control, while for children and adults it can be either pressure or volume control, depending on the situation.

Recently, however, there has been a big push for a universal ventilator that can be used with neonates, children, and adults. Essentially, this is a convergence of two separate product lines, made possible by advances in technology. Modern microprocessor-controlled pneumatic systems coupled with sophisticated software now offer options of pressure and volume suitable for a wide range of patient sizes, without sacrificing accuracy, resolution and safety all on the same machine.

The new universal ventilators are explicitly designed to address the very different requirements of adult, pediatric, and neonatal patients with one instrument. That means that preset ranges for all relevant flow and volume parameters can be automatically adjusted with a patient-range selection knob, and the practitioner can safely and flexibly customize preferred treatment parameters. This ability to ventilate any patient with a comprehensive range of features means that there is no longer a need for separate, specific ventilators operating in specific ICU environments—the user can move the ventilator to wherever it is most needed.

The benefit from a facility perspective is that hospitals can now make one purchasing decision that will meet the needs of all their patients.

From a sales perspective, however, selling one product to both the NICU and the ICU can be a challenge. The NICU staff traditionally has not wanted to take its ventilator out of the department because to accidentally hook a ventilator that has adult or pediatric settings to a neonate would be a catastrophe.

To address this concern, the latest designs have implemented safeguards to detect patients automatically. That way even if patients are hooked up prior to the ventilator being appropriately set, they will not be injured.

What all this means from the biomedical department's perspective is that there are fewer products it needs to service, and, if it has to supply parts, there is a cost savings as well.

In terms of training, the universal ventilator represents a significant cost savings also. If the hospital is purchasing only one ventilator, then the biomedical technicians will need to take only one class. That offers a sharper learning curve and productivity in a shorter amount of time.

In the clinical field, one hears a lot about standardization, which allows clinicians to go from one bed to another, and, although the patient is different, the technology is the same. That translates into ease and efficiency in terms of how devices are being applied to various patients, most notably during emergencies

There is a lot to be said for that from a biomedical department standpoint as well. Switching from one type of ventilator to another in the shop takes time. The biomed needs to change gears, so to speak. In addition, because each ventilator

requires countless testing accessories, supplies, and tools, a savings can be realized. In short, standardization means increased productivity and savings on training, test equipment, and parts.

For patients, the facility, and the biomedical technicians, the universal ventilator may truly be the next big thing.

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Humidification—The Adult World

"On the adult side we are using the Pall Ambient Temperature Humidification System (PATH). This means that we are not using electrical humidifier and heated-wire circuits, Dowse says. "The system essentially uses the patient's body temperature to create humidification through a heat-moisture exchanging filter. With that model, we do not see the rainout that occurs with humidifiers that use heated-wire circuits."

From a biomedical technician's standpoint, rainout on the exhalatory side of the circuit can cause a lot of damage to a ventilator. Once ventilator electronics get moisture inside them, it can lead to thousands of dollars in repair costs.

"If one finds unusually (abnormal) high minute volumes, that's a good inkling that the water is creating a very tight exhale volume, and it's more than likely that either moisture or aerosols are getting in the circuit," Dowse says. "Water also does damage to flow transducers—the internal workings on the ventilator itself.

"This PATH design really cuts down on getting moisture inside the ventilator, and it cuts down on a lot of our work too," he adds. "In terms of troubleshooting, the therapists have a pretty good grasp on it too."

Still, it is not seen in many hospitals," he says. "If 100 hospitals nation-wide are using it, I'd be surprised."

The New Technology—Infant World

If there is any newer technology that St Peter's biomedical technicians are excited about, Dowse says, it is the use of a nitric delivery system in conjunction with conventional ventilation. The downside of this system is the high cost of the used gas making the treatment selection a priority.

The Return of Older Technology

In contrast to seeing a push for implementing newer, better technology, which presents new challenges to biomedical technicians, Dowse has seen a resurgence of some very old technology in his hospital. Bubble CPAP (continuous positive airway pressure), or underwater expiratory resistance, is re-emerging as an alternative to using electromechanical systems for CPAP.

"This is a pneumatic system that takes air and oxygen into a blender," Dowse says. "The blender output uses an oxygen flowmeter that is injected into a graduated cylinder measured off in centimeter intervals. The bubbles that are created give pressure to the patient. It kind of works using gravity to create the pressure, and it's a closed system."

From a clinical standpoint, the system has been shown to be an effective and inexpensive option for providing respiratory support to premature infants.1 It also represents a cost savings for hospitals and biomedical departments because they are using only a blender and humidifier.

"Rebuilding a blender costs about $200 versus $7,000 for a new CPAP ventilator," Dowse says.

Communication Issues

Making things easier from a troubleshooting perspective is another aspect of managing ventilators, and Dowse concedes that getting to the root of any problems quickly through good communication with staff members represents the biggest impact on his job.

"When I have problems, I go right to the source, which is the respiratory manager of the department," he says. "He holds meetings on the first of every month, and we sit down with therapists and discuss any problems that have been surfacing. Discussing problems with the rest of the department in that way lets us narrow down a lot of issues."

Dowse admits that the biggest difficulty for any biomedical technician attempting to work with ventilators—or any other equipment for that matter—is lack of adequate information.

"If you have a staff member who simply says 'It's broken' and does not describe the

problem to really narrow it down, it can take longer to fix," he says. "I always tell staff members to call me when the ventilator is on the patient. I'm in-house so we sometimes can even solve the problem before doing a change-out on the ventilator, as these can be easy fixes, like changing the tubing.

"If the nursing staff and respiratory staff are specific and fine-tuned, and they can give a good description of any problems, that can cut down on a lot of my time," he adds. "It goes back to the end user having a better knowledge of what's going on. That can reduce a lot of problems in ventilator treatment."

Centralized Monitoring Systems

Another method of reducing problems involves a combination of communication and technology. St Peter's has recently begun looking into adding a centralized monitoring system for all its ventilators.

"The Joint Commission on Accreditation of Healthcare Organizations is running up against issues of patient safety, which is why we want to go in this direction," Dowse says. "Ventilators are alarming, but we are often not hearing them outside of the room [in which they are installed]. Centralizing the alarms helps us cut down on any failure to respond to and minimizes any patient incidents."

The centralized system uses a PC and a telemetry system to communicate with all of the ventilators on the floor. A box on the ventilator hooks through an RS232 port, takes information from the ventilator, and transmits it through a wireless network to the computer.

"We will then be able to see all 25 ventilators on the PC, each with different alarm settings," Dowse says. "If the ventilator in room 1 goes into patient disconnect, an alarm also would be sent to a pager system that the respiratory clinicians carry. That leads to a quicker response to the ventilator, where we can correct the fault at hand."

The technology poses some questions of patient confidentiality and who will maintain the telemetry.

"We don't know yet if the biomedical technicians will have to maintain telemetry or if it will go to information technology," Dowse says. "That will be something the hospital, the respiratory department, the biomedical department, and IT will need to decide together.

"Having all that patient data on the PC is going to be really good for the biomedical department," Dowse continues. "Normally, if there is a problem in the room with the ventilator, we pull it, take it back to the equipment room to clean it, and usually change the settings. Now we can go back and review what the settings were when it had the problem.

"That will also help a lot more on troubleshooting different problems, to see if what we are dealing with is a common problem or something that is more user-related," he concludes. "We run across those occasionally and this will give us the opportunity to minimize those issues."

Reference

1. Lee KS, Dunn MS, Fenwick M, Shennan AT. A comparison of underwater bubble continuous positive airway pressure with ventilator-derived continuous positive airway pressure in premature neonates ready for extubation. Biol Neonate. 1998;73(2):69-75.

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