

Critical care News

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concept and
treatment

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A ventilator treatment program that reduces complications and ventilator hours, while saving \$US 4.5 million per year

CoxHealth Hospital Systems, Springfield MO



ICU environment in the 90s, with SERVO 300 ventilator. These are rapidly being replaced by the more modular, user-friendly SERVO-i.

Critical Care News was published from 1989 to 1999. It was well known to ICU physicians and staff worldwide as a forum for sharing experience on a peer-to-peer basis, and as a “window” on the ventilation strategies and treatments being used by fellow physicians, nurses and respiratory therapists in intensive care wards throughout the world.

Bridging the clinical experience of the past and the ventilatory therapies of today

Much has happened in ventilation therapy since issue 9 of Critical Care News in 1999. At that time, the SERVO ventilation product line was owned by Siemens and comprised two models. The classic SERVO 900C revolutionized intensive care in 1972. The SERVO 300 was introduced in 1991. This offered one ventilator model for all patient categories, from neonatal to adult. NO and Automode options were added in the mid 90s for nitric oxide and patient interactive therapy.

Since that last edition, we have moved into a new millennium. The SERVO ventilator range is now offered by MAQUET Critical Care

and consists of one universal platform, which can be configured for neonatal, pediatric and adult patients, with a range of options for standard and complex ventilation therapies.

The continuum of care

The topics of uncompromised care during transport, weaning patients, the Open Lung concept and the growing interest in cost-effectiveness were significant issues for intensivists in the last issue of 1999. These matters are, if anything, even more critical in today's ICU environment.

In this issue of Critical Care News, the feature article focuses on the clinical experiences and working environment of the critical care departments of CoxHealth in Springfield, Missouri. Respiratory Care Administrative Director David Tucker reviews the subjects of shorter time of stay on ventilators and shorter hospital stay, which have been extensively documented in the Clinical Management Program.

Dr John Wolfe of CoxHealth also relates his experience in regard to Open Lung ventilation, which has progressed from a concept to a therapeutic application in his intensive care environment.

Continuing trends in non-invasive ventilation therapy

During the late 1990s, non-invasive ventilation was a hot topic that generated much debate and interest in scientific meetings and papers. It is now becoming standard practice for certain patient categories.

Dr Massimo Antonelli shares his clinical experiences of non-invasive ventilation in this issue of Critical Care News. He describes the

“Once you start having positive outcomes, it’s easy to get people’s attention.”

Dr David Tucker,
Respiratory Care Administrative Director,
CoxHealth, Springfield, Missouri

treatment strategies used in the department of anesthesiology and intensive care at Università Cattolica del Sacro Cuore in Rome, and the patient categories he prefers to treat with NIV. He also outlines the prerequisites for and benefits of non-invasive ventilation therapy from his clinical perspective.

The special world of neonatal intensive care

Within intensive care, the NICU is something of a unique world of its own, with special considerations, clinical challenges, and decisions to be made.

In 1999, Critical Care News covered a range of neonatal ventilation strategies that were of interest, including nitric oxide. What ventilation strategies are being used today in the NICU, and what treatment trends are growing? In this issue, we pose these questions to Dr Satoshi Ibara, Clinical Professor and Chief of Neonatology at

Kagoshima City Hospital in Japan.

His ICU staff meet the challenges of providing ventilatory care to 800 premature infants per year. He discusses their experiences of treatment strategies, special patient cases, and the information and considerations they provide to the parents of their very small patients.

Welcome back

Critical Care News welcomes back all past readers, whether you are a physician, nurse or respiratory therapist. We hope you will find these clinical reports continue the high level of quality and therapeutic interest you remember from past editions. We also welcome all our new readers, and hope you will like the “clinician-to-clinician” format of the publication, and the opportunity to peek through this window into other ICU environments around the world. ■



Lung recruitment strategies have gone from concept to clinical application.



The patient ventilator transport situation has been improved by practical solutions.



The process of weaning is increasingly significant.

CoxHealth in Springfield, Missouri, USA, has 9,000 employees and provides care to 750,000 people. In response to challenges in the high-risk, high-cost environment of mechanical ventilation, the institution set the goal of developing a method to improve clinical outcomes, decrease length of hospital stay, decrease health care costs, and increase clinician and patient satisfaction.

The solution was a Clinical Management Program from the ventilator manufacturer, based on the Open Lung recruitment concept. This was introduced in 2000. Within two years, the program achieved a 34% decrease in the number of ventilator hours, a 68% decrease in ventilator-associated pneumonias, and a 23% decrease in length of hospital stay for a selected group of non post-op patients. This represents a decrease in hospital costs of approximately \$US 4.5 million per year.

Critical Care News talked to David Tucker, Director of Respiratory Care Services at CoxHealth, and Martin Rohrer, Assistant Director, about the development of the program.

A ventilator treatment program that reduces complications and ventilator hours, while saving \$US 4.5 million per year



David Tucker, RRT, and Martin Rohrer, RRT, reflect on the benefits of the Clinical Management Program.



Martin Rohrer and critical care team leader Paul Luehrs, RRT, assess a critically ill dialysis patient.

What factors led to the establishment of the Clinical Management Program?

David Tucker: Martin Rohrer, myself and some other colleagues had been using the SERVO 900 ventilator for years. That was really the workhorse ventilator. We probably ended up using it longer than we should have, but we just weren't ready to give it up. But graphic monitoring was becoming prevalent, and we wanted a more comprehensive protocol; we only had a two-page protocol at that time. We wanted to use technology to optimize our therapy. When we saw the program we could get with SERVO-i, we thought that was an opportunity to streamline and provide a better protocol for ventilation care. It was a win-win situation.

Martin Rohrer: In 1995 and 1996, we were searching for better ways to ventilate our patients. We knew we needed improvement in that area. Our ventilation management was inconsistent; physicians were doing things in different ways. Therapists had different ideas and concepts. We needed to bring people

together, and we needed to utilize the technology that was out there. Graphic monitoring was coming along.

We knew from past experience that it can be hard getting everyone together and introducing new technology, and we didn't want to re-experience the failures of the past. We knew how hard it can be to change when you are accustomed to a specific ventilator. A program was needed to get everyone together – physicians, nurses and respiratory therapists. We decided that the Clinical Management Program could accomplish that, and we committed to purchasing a fleet of SERVO-i ventilators, which had graphic monitoring capabilities and were responsive to patients. The manufacturer assisted us in setting up the program.

We presented a package to our physicians, and they loved it. Our Medical Directors have been extremely supportive to us over the years, and I think that is key. The administration approved budgets and meeting time. We utilized the Train the Trainer program, and things took off from there.

We educated our staff in groups on the Open Lung concept, which was the focus of the Clinical Management Program.

When did you first become familiar with the Open Lung concept?

Martin Rohrer: In 2000. After reading the Clinical Management Program material from the manufacturer, we were really excited about what we could do, and we incorporated all of it into our education program. We gave classes during day and night shifts to get everyone on board. It just snowballed.

David Tucker: We had to convince hospital administration. I felt confident in the Open Lung concept, as did many others on the staff. We had to bring the program in, identify the appropriate patients, and see if we had success. Once you start having positive outcomes, shortened length of stay and other results, it's easy to get people's attention. In 2001, we adopted our department motto: "Open up the lung and keep it open."

What were the early staff experiences of Open Lung management? Were there learning thresholds to overcome?

David Tucker: Our staff started telling me that they were seeing wonderful results. After 12-18 months, I looked at the numbers in detail, and the benefits were evident. I sent the findings to the Quality Resource Department. They mapped the figures out, and the result was simply impressive. The staff motivation was just wonderful. The real winners here are the patients and the ICU staff.

Martin Rohrer: There were some key individuals who were able to grasp the concepts early on. They were working on the protocol while we were running the education. At the same time, our staff started applying some of the principles. The physicians tried the program, and they started to see patients getting better, and getting off the ventilators quicker.

We still didn't have our protocol finalized, but we were already utilizing the techniques and protective lung strategies of the Open Lung concept. It was just amazing. The conclusion was: "I know how to do this, how can we keep patients waiting and deny them these benefits while we are waiting for the protocol to be finalized?" In a way, this affected our data collection, starting our education before the protocol was out. A couple of months prior to rolling out the protocol, we were already using the method and getting good results.

From the Medical Directors' standpoint, we discussed the need for consistent ventilation management at CoxHealth. We wanted to incorporate evidence-based science at our institution. The Medical Directors saw the benefits of that and we received their backing. The administrators wanted to know the financial value to the institution, and we were

able to show that if we decrease length of ventilator time, we decrease medications and complications. The ground work showed the benefits, and it made sense to everyone.

The staff, including nurses, RTS and pharmacists, quickly understood the benefits of applying a protocol to get the patients off the ventilators more quickly. The nurses are patient care oriented, and loved the benefits.

How is the program coordinated?

Martin Rohrer: Once you have all the players on board, the management program and all of the functions, we believe it's important to establish a critical care supervisor with team leaders from all the ICUs. The supervisor is the point person for the program, for research, expert help, and for pulling all of the components together, between nurses, physicians, etc. That has been an integral part of the program and well worth the investment.

Have you had any special cases for which the protocol did not work?

Martin Rohrer: This is not a panacea. We are not curing patients from their disease – that is not the purpose of this program. The purpose is to protect the lungs and gain FRC so that other medical interventions can proceed. We want to protect the lungs with protective therapy. Early on, we established that we could not do this in every situation. Once fibrosis starts, for example, you can't reverse it and you need steroids and the body's own mechanisms.

What we want to do is catch patients early on; we don't want to wait to intubate when too much damage has been done due to their disease process. Get them on early, maintain, and give the body and therapies a chance to work. Then get them off as quickly as

possible. The longer they are on ventilation, the greater the chances of infection and other complications associated with ventilation therapy. Open them up, protect them, and then get them off.

David Tucker: Physicians have the option of managing the patient without the protocol. Within the protocol, they can manage individual parameters for individual cases. This allows the therapists to wean down on the FiO₂ as the SpO₂ improves, and adjust ventilation peak pressures as they improve.

Were the early indications in line with expectations?

Martin Rohrer: The results were above all of our expectations. But the early results also showed us areas where we needed to go back and improve. We did great when the patient was on the ventilator – we opened the lungs and saw improvement. But when we looked at the length of hospital stay, we saw that we needed to get better at weaning. It was a catalyst that led us to make improvements in other areas.

Will you be expanding or modifying the protocol in the future to include other patient categories or outcomes?

David Tucker: We are trying to move in the direction of allowing a bit more hypercapnia. We think greater use of hypercapnia will give better outcomes for some patients. Current literature indicates that you should look at the clinical situation for the individual patient. And we think we have some opportunities to allow for this in our current protocol version 4.0.

We have a standard protocol that allows us to tailor ventilation therapy according to need. It is critical to optimize each situation for the best outcome.

Roles and responsibilities of core members

Members	Role	Responsibilities
VP Clinical Services	Administrative leader	Administrative approval
Pulmonary Physicians	Medical director and staff	Guide and monitor for best practice, medical approval and medical liaison
Respiratory Director/ Assistant Director	Department and project leaders	Administrative liaison
Respiratory Therapists	Clinical specialist	Researcher, patient advocate, implementation specialist
Data Analyst, QRD	Data analysis	Harvest and analyze data to evaluate opportunities
Director, QRD	Support	Provide resources for PI Process
Critical Care Nurse Manager	Member	Provide expertise and champion for nurse buy-in

Martin Rohrer: Using non-invasive ventilation with SERVO-i is of great interest right now. We started this a few months ago, and have had great success. This ventilator is more responsive to the patient and their needs than other ventilators. We are looking further into comparison data for non-invasive therapy between SERVO-i and other ventilators.

What has been the financial impact for the ICU and the hospital as a whole?

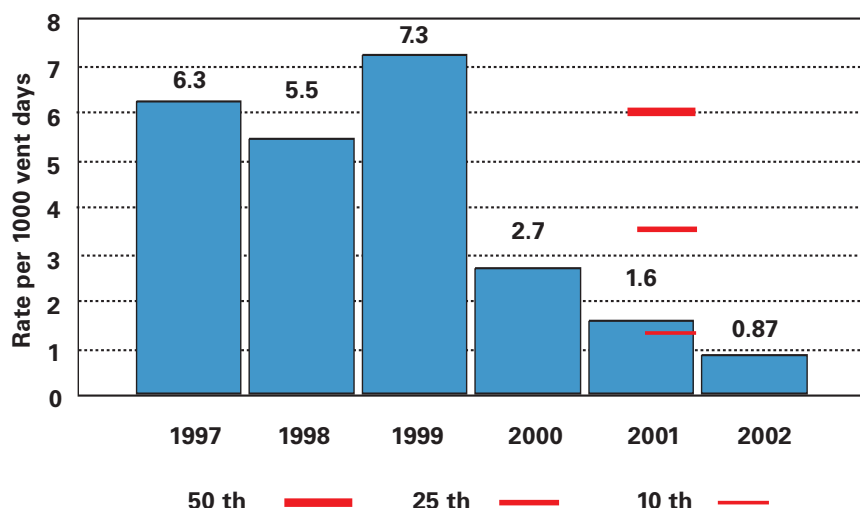
David Tucker: We have a QRD department with statisticians, which has given us statistics

on savings. These have gone far beyond the cost of the systems and start-up time. The savings from the most important clinical benefits, i.e. reduction in complications, ventilator hours and length of stay, were calculated at \$US 4.5 million per year.

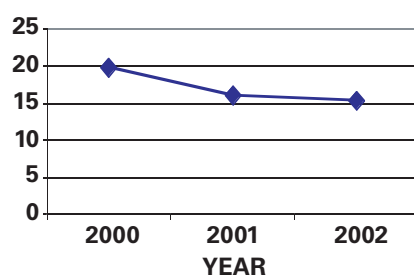
Both the ICU department and the hospital have benefited from the program. Our hospital administration always wants to do what is most appropriate for the patient. When we invested in the SERVO-i ventilator fleet, they were very supportive.

Indicator	Pre-protocol	Post-protocol	% improvement
Ventilator-acquired pneumonia	2.7/1000 vent days	0.87/1000 vent days	68%
Ventilator hours/patient	200 hours	130 hours	34%
Average hospital length of stay	19.8 days	15.3 days	23%

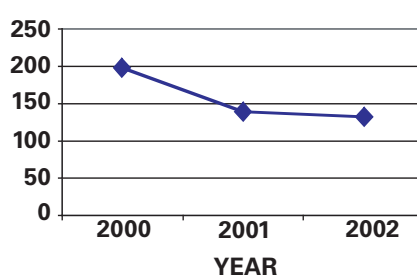
VAP rates dropped 68%, from 2.7 to 0.87 pneumonias per 1,000 adult ventilator days, in CoxHealth Medical Intensive Care Unit (MICU). The US national average is 5.5.



Average hospital length of stay, days



Average ventilator hours per patient



Comparing baseline calendar year 2000 with 2002, the ventilator hours per set-up decreased from 200 to 130. CoxHealth Hospital LOS fell from 19.8 days to 15.3 days for a selected group of non post-op patients.

Biographies

David Tucker, BS, RRT, is Director of Respiratory Care Services at CoxHealth, where he has practiced for 30 years. He is head of the Respiratory Department and staff, and the administrative liaison between all functions involved in the Clinical Management Program.

Martin Rohrer, BS, RRT, is Assistant Director Respiratory Care at CoxHealth, where he has practiced for 29 years. He is responsible for project leaders and administrative duties within the Clinical Management Program.

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I CoxHealth Co-Medical Director I

Critical Care News discussed the dynamic processes involved in establishing the protocols for the Clinical Management Program with James Coulter MD, Medical Co-Director and Pulmonologist at CoxHealth.

Who was involved in establishing the Clinical Management Program?

Basically, five pulmonologists. We are the Co-Directors of Respiratory Therapy and Services department: Dr John Wolfe, Dr Edward Gwin, Dr Brian Kim, Dr Terrence Coulter and myself. Three of us have been here for 30 years. We have been very fortunate to have outstanding respiratory therapists, who have helped us move into the 21st century.

We are using non-invasive ventilation as a means to keep patients off of invasive ventilation. Or, with our Open Lung protocols, to reduce the length of time on the ventilator for intubated patients. Obviously there are substantial reductions in cost for management of these patients, but more importantly, there are much better outcomes.

The significant decreases in length of hospital stay, ventilator-associated pneumonias and time on vent have been outstanding. The protocol for intubated patients was based on Open Lung ventilation.

When did you first become aware of the Open Lung concept?

Three or four years ago. We had some therapists who were very actively involved and wanted to keep up-to-date. The whole group of pulmonologists reviewed the concept, and decided it was the way to go.

Open Lung is the keystone. It has made a significant difference to maintaining adequate oxygenation. We don't worry quite so much where the PCO_2 is; we feel that the oxygenation is extremely important. By maintaining that oxygenation, and a lower

FiO_2 , we are able to preserve better lung function, avoid the complications of oxygen toxicity, and get patients off the ventilator much quicker.

Was it a challenge to get everyone on board?

Not really. We five Co-Directors have always been very actively involved in what the department does. We listen to the department leaders, and they listen to us. But of course there is always a certain degree of hesitancy when people have to get used to a new way of doing things. After a few early successes, everyone came on board. Once the results came in, everyone was convinced.

A minor challenge is that we have developed so many protocols, which have all been approved by the Executive Medical Committee. The average non-pulmonary or non-critical care physician can be left somewhat in the dark. We have been very fortunate in that the medical staff have accepted what we have recommended, and allow us to actively participate in the care of the patients.

Dr James Coulter, Co-Medical Director and pulmonologist, with a staff member.



In many intensive care units, staff have different ideas, equipment and therapies, and everyone is doing their own thing, whereas here you have developed a common, structured approach to treatment. Is that quite unique?

It's a bit like the airline industry. One reason for its success is that the people who fly the planes all follow the same procedures. There is no room for idiosyncrasies. What works works, and everyone follows that principle. That may sound a bit dogmatic, but as long as you are reviewing what you do on a continuing basis, staying up-to-date with the scientific literature and ensuring that the outcomes are successful, people are likely to say, "hey, this is the way to go." So the discrepancies or disparities that may occur with individual therapists quickly become lost as they see how they are going forward.

The person who is giving the therapy can be compared to a pilot. Just as pilots are updated on a regular basis, so therapists have ongoing training to stay current.

We believe that the more you allow individuals to use their own expertise, the more committed they will be to the program. We have the protocols, but they have to make decisions based on the protocols and care paths. This can be a threat to some physicians, who feel there is someone else driving the process, and some individuals don't feel comfortable doing new things.

It is very important to instill confidence, worth and value in your staff. This gives them a tremendous source of satisfaction in providing good treatments and outcomes.

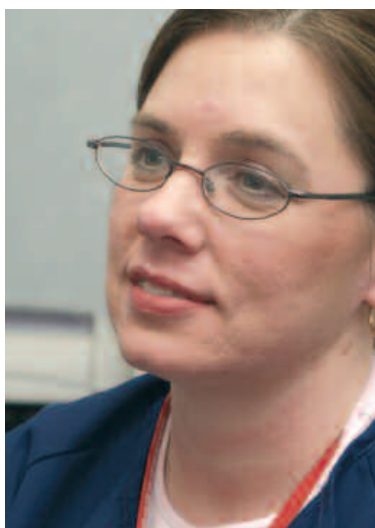
Healthcare is constantly evolving, and we took a giant step forward in the management of ventilation patients about three years ago. Others have yet to come on board. But you can't be static; you need to be dynamic in order to go forward.

Biography

Dr James Coulter received his medical degree at Marquette University in Milwaukee, Medical College of Wisconsin, and performed his residency and fellowship at the University of Kansas. He is a pulmonologist and Medical Co-Director of Respiratory Care at CoxHealth, where he has been working for 30 years.

I CoxHealth Surgical ICU I

Marsha Ballard is Nurse Manager of the Surgical ICU at CoxHealth, and oversees the operation of the unit and its 12 beds. Critical Care News talked to her about practical implementation of the Clinical Management Program at her unit, and the collaborative effort with disciplines in other ICU departments.



Marsha Ballard, RN, Nurse Manager of the Surgical ICU, reports only one case of ventilator-associated pneumonia in six months.

Can you briefly describe your Surgical ICU and staff?

We have 36 staff – 30 nurses, and 6 in ancillary/support staff. We have 12 beds in the Surgical ICU. The majority of our patients are surgical, with some overflow from other units needing beds. 46% of our patient days are devoted to cardiovascular patients, bypass and valve replacement – 460 patients in 2004. We also have other surgeries, including vascular and thoracotomies.

What is your experience of the Clinical Management Program?

We have had staff education with alveolar recruitment and techniques to improve ventilator patient results, and we have seen decreased ventilator days and ventilator-associated pneumonias, which have decreased dramatically in our surgical intensive care unit. We have only had one case of ventilator-associated pneumonia in the past six months, which is exceptional.

How are you training the nurses in Open Lung methodology?

Initially, much is done at the bedside with respiratory therapists and nurses in all the group units at the facility. We work well in collaborating on patient care. There is a lot of informal teaching about patients when they come from the OR, primarily teaching the nurses to not break the patient circuit, so that lung recruitment is not jeopardized and no values are lost. These are small but very important details.

How has the Clinical Management Program improved collaboration between functions?

It has worked really well; the respiratory therapists are involved in the patients' care and willing to assist the nurse in a number of things, such as suctioning and trach care. If the patient's saturation rates are dropping, they are willing to help at the bedside to identify causes. The nurses are very receptive to the RTs' ventilatory knowledge, and clearly see the point of teaching and learning together.

How do you manage transfer of care and therapy for patients moving from the SICU to other units?

We have everyone involved who should be – nurses from the receiving unit, nurses from our unit, and the respiratory therapist who is involved with that patient. Most often, we transfer care to our neighboring unit in Neurotrauma Intensive Care.

They have recently been using the SERVO-i more frequently than the Ambubag in transport, especially for patients receiving or requiring higher pressures to ventilate well. You don't want to lose the recruitment or values during the transport time to CT or to another ICU. I think this has also been a factor in the good results we have been getting, by keeping patients on their therapies without interruption.

I CoxHealth Neurotrauma ICU I



Cheryl Dill, RN, Neurotrauma ICU.

Critical Care News spoke to critical care nurses Cheryl Dill and Heather Lobough at the CoxHealth Neurotrauma ICU about their observations on the Clinical Management Program.

Can you describe your situation in the Neurotrauma ICU?

We have 12 beds in Neurotrauma, which are constantly full. We have a few patients on non-invasive ventilation therapy, but most patients are intubated here.

How long have you been working with the Clinical Management Program?

Since the start of the program here at CoxHealth. We had initial training, along with the other ICU departments, when the protocols were developed.

How do you practically implement lung recruitment here?

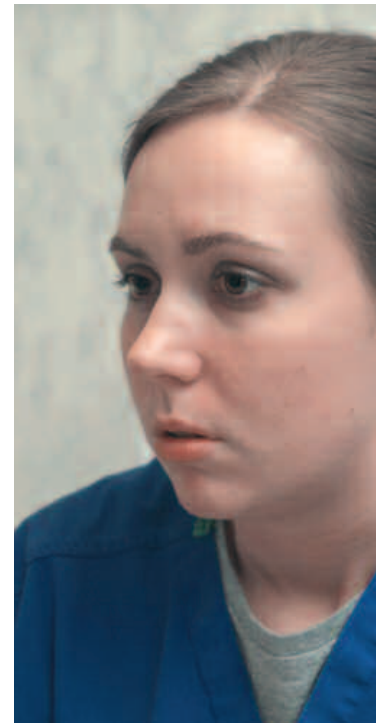
The respiratory therapists manage the recruitment maneuvers, but we nurses are familiar with Open Lung and monitor the settings. The relationship between the nurse and respiratory therapist is unique here. We monitor and discuss the clinical situation of the patients, and the respiratory therapists adjust the recruitment therapy if needed. Initially, we had to do more education and work more closely with the respiratory therapists, as neurotrauma patients can differ dramatically from the surgical patients; we had to understand their protocols.

What effect has the Clinical Management Program had on care in the Neurotrauma ICU?

"We have observed a tremendous decrease in pneumonias. And in weaning patients, what used to take days has gone down to hours".

We have observed a tremendous decrease in pneumonias. And in weaning patients, what used to take days has now gone down to hours. There is also a decrease in the amount of sedation, since the patients are so comfortable on the ventilation. From a nurse's point of view, this weaning process is tremendous.

Each patient is individual, but they all tolerate it very well. The exception may be some cases with severe trauma. However, this protocol even helps them as starting the alveolar recruitment process so early minimizes the risk of going into ARDS.



Heather Lobough, RN, Neurotrauma ICU.

I CoxHealth Co-Medical Director, Medical ICU I

Critical Care News met up with Dr John Wolfe between rounds at the Medical ICU at CoxHealth, to discuss lung recruitment and non-invasive ventilation therapy. Dr Wolfe is a pulmonologist and Co-Medical Director of Respiratory Therapy at CoxHealth.

What factors led to the establishment of the Clinical Management Program?

It was taking a lot of our time to take care of our patients – we don't have residents or fellows and we needed someone to help out with ventilated patients. The respiratory therapists here are very open to new ideas and eager to help, so we included them. This has been very helpful and has saved a lot of time. Some of the respiratory therapists have also made suggestions that we have used. It was very much a joint effort.

When you and the other Medical Directors developed the protocols, which patient categories did you decide upon?

All categories – everything from post-op anesthesia care patients to patients ventilated for short periods of time, as well as patients needing chronic ventilator therapy.

When did you first become familiar with Open Lung methodology?

A few years ago. It has been very helpful in treating some patients, particularly those with atelectasis, ARDS, or stiff lungs.

Has the Clinical Management Program improved efficiency in the working environment and collaboration between functions?

It has; it is definitely a team effort, with nurses, therapists and pulmonologists. Communication is very important. You get a dynamic situation when you have a number of people working together toward a common goal.

What are your experiences of non-invasive ventilation?

It is relatively new here. We have been using the SERVO-i ventilator with the special software for that. It allows us to monitor more values compared with other methods of non-invasive ventilation.

We have been using NIV for about 4-6 months. The patients of particular interest are



Dr John Wolfe discusses non-invasive ICU patient care with respiratory therapist Greg Epps.

borderline in terms of mechanical ventilation. We use it to try to buy time and to treat the underlying disease process. Sometimes we use it to keep them off the endotracheal intubation, sometimes to bridge the gap between extubation and the time they go home.

Have you noticed earlier weaning as a result of non-invasive ventilation?

Yes, it gives us the possibility to get them off quicker. The other big advantage is that it avoids intubation and associated complications such as nosocomial pneumonia, bronchospasm, as well as complications of the endotracheal tube itself.

I think there will be a trend towards more non-invasive ventilation, but there are some limitations. There is a risk of aspiration if the patient is vomiting, which is a concern, and I try to avoid using it with those patients. But I

think it will be used more and more frequently, as we become more experienced with it.

The biggest problem is aerophagia, and subsequent abdominal distension. Patients with GI problems are also not good candidates. We learn which patients are suitable as we go, and this will help us develop a protocol for which types of patients are good candidates.

Biography

Dr John Wolfe received his medical degree from the University of Kansas Medical School, where he performed his residency in internal medicine, and obtained his Pulmonary Disease Fellowship in 1976. He is a pulmonologist and Co-Medical Director of Respiratory Therapy at CoxHealth, where he has been working for 25 years.

I CoxHealth Round Table: Critical Care Team Leaders I

Critical Care News participated in a lively round table discussion with the team leaders in respiratory therapy at CoxHealth. We talked about the challenges they faced, and their critical role in taking clinical management protocols from theory to practical application on a hospital-wide basis. We also discussed their experiences as “missionaries” to other institutions interested in ventilator management programs.

Have there been challenges in training staff and getting everybody on board with the same treatment strategy?

We get amazed looks from our students and trainees once they have experienced the protocol for the first time. Protective lung strategy, and being able to tailor the therapy to each individual patient, is tremendous. Once they see how well it works, we get past any potential objections. We have all of the positive outcome results well documented in data. But when they start to apply the recruitment, and see the benefits to patients on a case-to-case basis, the value is self-evident.

Is it really that easy?

When we first started, we were trying to get education for everyone at one time. A lot of people were using graphics, which we hadn't really used before, so everyone was excited about that. They started a little bit in advance; they were already learning before the program was really finalized and rolled out. The general reaction was, “now that we have learned about this, how can we justify not using it?” There was some irritation at first too, since



The team leaders include respiratory therapists Tom McCue, Diane Meinhardt, Cliff Skidmore, Mike Ingram, Angie Coufield, Jarrett Thomas, Paul Garoutte, Paul Luehrs, Kara McIlvain, Steve Paris, Jim Dameron and Janna Brown.

“But when they start to apply the recruitment, and see the benefits to patients on a case-to-case basis, the value is self-evident.”

you can only educate so many groups at one time. So the practitioners who were trained first went out and started using the strategy, and got great results. But there were other people we hadn't had the chance to train yet. It is amusing now to look back, but there was some irritation and discord, since we just couldn't get the education out fast enough!

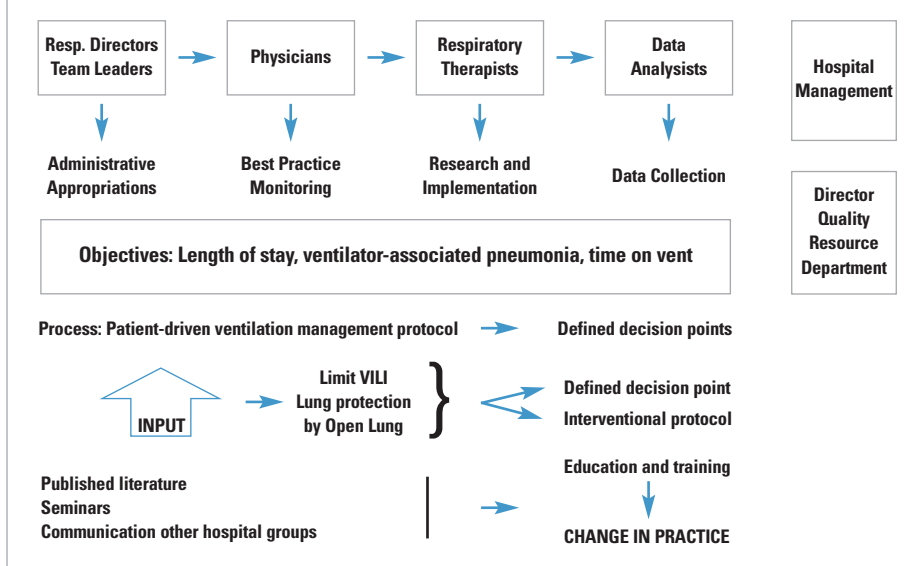
You have tailored your treatment strategy in the process. What will be fine tuned as you go forward?

We are starting to use recruitment maneuvers very frequently, and that makes a big difference. Even if it isn't indicated for everyone, it works very well for the vast majority of patients we screen.

When we first started out, the physician was supposed to be at the bedside. It was frightening at first, since everyone was a little unsure.

The doctors did want to be present at first; they told us which pressures to use and for how long, and then they started to let us do it while they walked back to the charts, so the trust in the respiratory therapists had started. Now, it is part of our protocol.

Clinical Management Program Flowchart



The physician is at bedside to help us to determine if the patient will benefit from a recruitment maneuver, and we therapists take it from there.

Team leaders keep everyone focused. We are not afraid to use new technologies. Even with the substantial positive results we are getting from the Clinical Management Program, we still want to learn and improve. We remember the beginning, when we started the Open Lung recruitment maneuvers and the patients did so well, but we still had trouble with inconsistent weaning. We knew as a group that we had to work on improving our weaning processes. Once we had that in place and it was working, we educated all of the team leaders and nursing staff; it was all a building process.

So now we have the Clinical Management Program and early intervention, we have evidence-based science on how to ventilate invasive patients more effectively. But that is not enough; we need to incorporate other things as well. You can't be stagnant; you need to fine tune and not be afraid to try new things.

One thing that the Clinical Management Program allowed us to do was to learn the importance of incorporating newer information into everyday practice, rather than looking at the textbooks we had in school. We learned to look at current literature, and attempted to apply that as a driving force, with new avenues and new techniques.

What criteria do you use to determine whether a patient is a good candidate for a recruitment maneuver?

Primarily lung compliance, hypoxemia, and chest x-ray. If they fulfill those criteria, we will recruit, monitoring blood pressure and heart rate as we go. Sometimes we don't get the desired result with just one recruitment maneuver, so if they tolerate it in terms of blood pressure, we do it again. There are some instances where we expect the patient to benefit from a higher-pressure recruitment maneuver. We contact the physician when we think they might benefit from higher pressure, and we get that order.

How do you define high pressure?

For a recruitment maneuver we use pressures up to 55 cm H₂O for a short period of time. Otherwise, when a patient's peak ventilatory pressures exceed 30 cm H₂O we intervene to lower peak pressures and provide lung protective strategies.

What are your opinions on non-invasive ventilation?

We use it more frequently, learning as we proceed, and watching the literature. We definitely see patient benefits, which is why we want to do more non-invasive.

The Clinical Management Program allows us time to do other things. Non-invasive ventilation has been amazing in congestive heart failure patients who get fluid overload. In the past, we would go from two liters to five liters to 55%. Then they would be on 75-80%, and a day later we would have to intubate them. With non-invasive, we put on the mask, support ventilation with bi-level followed by CPAP, and four hours later they are off ventilation. Some never have to go to the ICU.

You are not only providing better care and patient benefits, but also saving money for your institution, with a better team effort as a result. Shouldn't this be of interest to other ICUs around the world?

Some of us have become Clinical Management Program ambassadors, making some local and regional presentations. There is interest and momentum to spread the word to other institutions. The program contributed to CoxHealth's JCAHO (Joint Commission of Accredited Hospitals) accreditation. We submitted our data to VHA (Voluntary Hospitals of America) and we were honored with a Finalist Award in 2004.

It is very important to mention that without support from physicians and administration, we couldn't achieve these results. It is an investment, but it pays back big dividends over time. The interface between physicians, respiratory therapists and nurses is critical. It takes a team to optimize ventilator management. ■



Management team members Tom McCue, RRT, Paul Garrouette, RRT, and Cliff Skidmore, RRT.

Kagoshima City Hospital has the largest NICU facility in Japan, and serves the 1.8 million population of the Kagoshima prefecture. With 17,000 births per year, the neonatal death rate of 1.3 per 1000 live births is one of the lowest in the nation. Critical Care News met Professor Satoshi Ibara MD, Chief of the hospital's neonatal division, to discuss the therapeutic strategies that have contributed to saving the lives of its very premature patients.

Developing new neonatal strategies and improving survival rates



Satoshi Ibara, MD, PhD, is Chief of the Division of Neonatology at Kagoshima City Hospital.

You have conducted extensive research in the field of surfactant therapy. What is your experience of surfactant replacement in neonatal patients?

We use surfactant produced in Japan from calves. Before birth, we check amniotic fluid to establish whether or not the baby has surfactant. If the baby's surfactant is insufficient, we prepare the surfactant before birth. We intubate the baby immediately at birth, and administer surfactant supplement as quickly as possible. That is our Open Lung approach for the premature baby, to ensure there is no alveolar collapse. This way we prevent cyclic opening and closing, and low volume injury.

Extremely low birth weight infants, less than 1000 grams, are mechanically ventilated long term, and need preventative measures for ventilator-induced lung injury (VILI), with respect to premature development of respiratory center and lungs, underdeveloped chest, respiratory muscles and circulatory system.

When did you establish this procedure, and what effect has it had on your survival rates?

We started following this procedure 13 years ago. It has had a very big impact on our survival rates. The average for the past three years looks like this: 57% at gestational age

How many neonatal cases does the unit treat each year?

Approximately 800 patients per year in Kagoshima, with about 70 patients weighing less than 1000 grams, and about 80 patients in the 1000-1500 gram range. We have around 250 invasive mechanical ventilation cases. Only 4-5 babies are treated with ECMO per year.

What are your special ventilatory treatment considerations for "micropreemies", i.e. infants weighing 1000 grams or less?

For the past five years we have primarily been using SERVO ventilators, with SIMV and Pressure Support treatment. We have mostly SERVO 300 ventilators, but a few Babylog and Stephanie machines as well. We also have two SERVO-i ventilators from MAQUET Critical Care in this hospital, but these are shared between ICU departments.



Dr Ibara observing the progress of one of Kagoshima City Hospital's patients.

Survival rates at Kagoshima NICU, 2002-2004

2002											
Weeks	22	23	24	25	26	27	28	29	30	31	32
Number of patients	1	4	9	10	10	13	7	14	21	14	24
Survived	0	3	6	8	10	11	7	13	21	12	23
Died	1	1	3	2	0	2	0	1	0	2	1
2003											
Weeks	22	23	24	25	26	27	28	29	30	31	32
Number of patients	4	8	9	13	15	16	17	17	13	23	25
Survived	2	7	4	11	13	15	13	16	12	22	25
Died	2	1	5	2	2	1	4	1	1	1	0
2004											
Weeks	22	23	24	25	26	27	28	29	30	31	32
Number of patients	2	1	10	11	8	8	3	15	12	25	20
Survived	2	1	7	9	6	7	3	14	12	25	19
Died	0	0	3	2	2	1	0	1	0	0	1
2002-2004											
Weeks	22	23	24	25	26	27	28	29	30	31	32
Total	7	13	28	34	33	37	27	46	46	62	68
Survived	4	11	17	28	29	33	23	43	45	59	67
Died	3	1	11	6	4	4	4	3	1	3	1
Survival rate %	57	85	61	82	88	89	85	93	98	95	99

22 weeks; 85% at 23 weeks; 61% at 24 weeks. But there are many here that include TTTS – 82% at 25 weeks; 88% at 26 weeks; 89% at 27 weeks. Last year, all patients born at 22 weeks gestation survived.

What method of suctioning does your NICU use?

Open suctioning systems are currently predominant in other NICUs in Japan. We started using a closed system here about 10 years ago. Closed systems maintain the PEEP, which is very good for the lungs. If you use an open system, there is no PEEP during suctioning, which means that alveolar compartments will collapse. This can induce volume-related injury. Hasty insertion of an aspiration catheter in the trachea of these patients may complicate conditions. The catheter tip may hit the trachea and bronchi, generating damage to the airway mucosa. If it is grave, an ulcer is generated with formation of granulation.

Insertion of the suctioning catheter is very important. If done incorrectly, it can cause stenosis and injury to the trachea or main bronchi. This can result in atrophy, emphysema or atelectasis. The closed suctioning catheter should be introduced very slowly while watching the pressure drop, in



A total of 74 neonatal patients were in the NICU the day Critical Care News visited.

order to minimize risk of injury. We avoid inserting it past the tracheal tube, but where this is necessary we do not past it by more than 5 mm so as not to injure the bronchi. The number of cases using dexamethasone has been rapidly and significantly reduced.

How do you manage leakage in a clinical situation for neonatal patients?

We use flow volume loops to monitor leakage. If the baby has a leak, we adjust the endotracheal tube. We have to reduce the leakage because we want to provide patient-triggered ventilation. We use slightly larger tracheal tubes for the tiny babies than other institutions, but we don't have many tracheal problems.

Patient-triggered ventilation is part of our lung protective strategy. The weaning period is very short as a result of this strategy.

What are the key components of your ventilation therapy for neonates?

Our general lung protective strategy has many components: closed suctioning, humidification, early surfactant therapy, and reduction of oxygen toxicity. It also includes ventilator settings, especially PIP and inspiratory pressure.

Are there any special clinical cases where you are developing new strategies?

We are using a lung protective strategy for the diaphragmatic herniation baby. Almost all situations utilize hyperoxemia for the



Dr Ibara, and Dr H. Maruyama.

diaphragmatic herniation baby. We have just started using a low O_2 , so lung damage is reduced. We keep saturation by pulse oximetry between 85 and 91, and measure SVO_2 (saturation central venous O_2). We measure pulmonary vascular resistance using ultrasonography.

We keep mixed venous saturation (SVO_2) above 70%, in contrast to the normal 80% or 90%, so the baby has no pulmonary hypertension. We think that SVO_2 is a very important pulmonary vascular consideration. The pulse oximeter indicates saturation from the heart to the organ. SVO_2 presents the net value. Pulmonary artery blood saturation is dependent on the SVO_2 , so we think pulmonary vascular resistance is affected by this as well. This is a very new approach to diaphragmatic herniation, and we have had very successful early results. I want to reduce

pressure, inspiratory time and O_2 concentration as much as possible. This is our objective with every patient. We are also starting to measure a DNA marker (8 hydroxy – 2'deoxyguanosine) that is attacked by the oxygen radical; we measure this substance in urine. High concentration of O_2 results in a high marker. The baby's blood has many scavengers, so now we are checking the origination of these substances.

How are you weaning from invasive mechanical ventilation?

Our first activity is to establish that FiO_2 is less than 30%, and respiratory rate less than 20. If the baby has good activity and a good triggering response, we extubate. We have a success rate of about 80%. In the remaining 20% we must re-intubate or start nasal CPAP.

After extubation, nasal CPAP therapy usually lasts three to five days, depending on the baby.

Can you tell us about the NICU facility and staff?

We have six physicians and eight residents, with 117 nurses in the NICU including CCU. We have two nutritionists, one clinical engineer, and one psychologist on staff for parents.

The babies are on three separate ward facilities on two stories of the building. We also have our own neonatal surgical theatre, as well as a specially equipped NICU ambulance service.

We encourage the infant's mother and father to be at the NICU between 2.00 pm and 8.00 am the next day. We have an average of 80 patients per day, and 32 mechanically ventilated babies.

Biography:

Satoshi Ibara is Chief of the Neonatology Division and Perinatal Medical Center of Kagoshima City Hospital in Japan. He graduated from the Faculty of Medicine at Kagoshima University Hospital in 1981, and worked as a research fellow in 1984-5 at the Division of Maternal and Fetal Medicine at the University of California, Irvine. After several resident and staff positions at Kagoshima City hospital during 1986-9, he returned to the University of California, Irvine, from 1990-1, as visiting Assistant Professor at the Department of Obstetrics and Gynecology. He became Clinical Professor at the Faculty of Medicine at Kagoshima University in 2002.

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Kagoshima NICU ambulance service

The Kagoshima City Hospital NICU provides a unique and dedicated NICU ambulance service to the city and outlying islands and areas of Kagoshima Prefecture. Dr Hideki Maruyama of the Perinatal Medical Center described the set-up.

How many patients does the NICU ambulance serve?

With 17,000 births per year in the prefecture, the NICU ambulance is used in about 150-200 emergency births per year.

How is the NICU ambulance equipped?

We have two incubators constantly on stand-by and warm, to meet any emergency situation. We have a specially designed shock-resistant bed for some of the mountain terrain in the prefecture. There is a ventilator, an oxygen blender to reduce risk of toxicity, and a generator for supplemental power in case of battery failure.

How long have you been providing this service, and what have been the results?

The special NICU ambulance has been in service for five years. Prior to introducing it, we usually had three to four deaths on arrival per year in our area. After implementation of this service, we are proud to say that we have had no deaths on arrival. ■



Dr Hideki Maruyama and the NICU ambulance.

The University Hospital VU Medical Center (VUMC) in Amsterdam defined the need for new strategies and technology. This has led to new educational opportunities and research. Critical Care News spoke to Professor Armand RJ Girbes, head of the Department of Intensive Care, who shares his experiences of this continuing development.

Research and practical application of Open Lung strategies: The ongoing process at a university teaching institution



Armand RJ Girbes and staff with patient at bedside.

When did you first become familiar with the Open Lung concept, and what were your early experiences of lung recruitment?

I became familiar with the concept in about 1998, through discussions with colleagues at various scientific meetings. I started as chief of this institution at that time as well. When we first started applying mechanical ventilation therapy, we would adjust settings to achieve the best PEEP and the best Tidal Volume for the patients. The basic principle of mechanical ventilation, in my opinion, is that the most important thing is to do as little harm as possible. Mechanical ventilation is harmful to the lung and patient, and you must minimize that harm. To have acceptable oxygen saturation in the blood, look for the best PEEP, and the highest compliance of the lung. So looking back, we had already been doing that more or less for some time. The big difference is that we were more anxious about giving PEEP to patients than we are now.

When did you start to apply the Open Lung concept in clinical practice?

I attended a two-day training course in Rotterdam in 1998. When I became head of this ICU, there were some very enthusiastic intensivists who were more liberal with PEEP than I was used to; it became a natural thing to use this systematically with patients.

What activities have followed since then?

We decided recently to have a new fleet of mechanical ventilators in our unit. We instigated a comprehensive process within the hospital, with committees of nurses and doctors, together with the Anesthesiology and Emergency Room departments, to evaluate what was available, and to advise on which ventilator technology we should invest in. We have a "cluster system" here, so the hospital is divided into specialities. Our cluster is surgical theatre – anesthesiology, cardiology, cardiothoracic surgery, orthopedic surgery, physiology and intensive care. We decided we needed to standardize, to avoid having different ventilator models in the different departments. We chose MAQUET SERVO-i ventilators. This was quite a big change, as we previously had primarily Dräger machines. But we are very happy with the SERVO-i ventilator, and now have 40 units throughout the hospital. I am quite active



Armand RJ Girbes.

within the European Society of Intensive Care Medicine, for example as chairman of the Emergency Medicine and Trauma section, and I was involved in organizing the European Congress several times. I had very good contact with Göran Hedenstierna in Uppsala, Sweden. I was very interested in his incredible level of knowledge of mechanical ventilation, and we shared our concerns about ventilation with 100% oxygen. He was researching lung atelectasis at that time, which I was also interested in. Part of the program when we bought the SERVO-i ventilators was cooperation and training with the group in Uppsala, which is very active.

So the decision was based on a combination of things, doing research in this area, your relationship with Göran Hedenstierna and his group in Uppsala, and the need to standardize your ventilation therapy?

Yes, and it was also essential to have the highest available level of ventilator technology. We are a teaching hospital, so we consider it very important to fulfill this teaching role – not only for fellows, but also as a referral center for other hospitals and intensivists. We decided to focus on mechanical ventilation. As we had very enthusiastic intensivists for the Open Lung concept, in this case



Armand RJ Girbes.

Dr Spijkstra and Dr Biermann, this was a very good opportunity to standardize Open Lung treatment. The process was started in 2003, and was substantiated in 2004. We went to Uppsala last year, to study recruitment with the Open Lung Tool®.

Has the process gone smoothly?

Very smoothly. In my view, it is important how you handle such major changes as a management team, where there could be some opposition. It is quite a job, to have a group of 200 people getting used to new technology. But the preparations were very important, such as establishing a group of people to support the platform, with help from the manufacturer. We clearly see the new opportunities that the new software provides. We also want to be at the frontier of the practical knowledge. But we must be modest with respect to our research in mechanical ventilation so far. Much has been published in the field of intensive care by our group, but we still have a lot to learn when it comes to ventilation. It is an ongoing process. We plan to have a combination of research and practical training on the concept of the Open Lung Tool, to make people understand the idea behind lung recruitment and the use of PEEP. Everyone here has that experience; it is part of our basic training and is common practice. But we now have the opportunity of sharing this and teaching it to other

intensivists and institutions. We currently have an initiative where intensivists spend a few weeks with us to see and learn how we do mechanical ventilation. It is very interactive, and I believe you cannot learn that from books. You must do it at the bedside, and see how the patient responds. The clinical trials that have been conducted so far are very limited in my view. They have a value, but we know from experience that the inclusion criteria of a patient can change in ten minutes. A patient who is in bad shape can improve quite rapidly in terms of respiratory parameters. It is therefore very difficult to do these clinical trials with a large number of patients.

Is patient heterogeneity also a consideration?

Absolutely. I usually tell my fellows: "You can be the best mechanical ventilator doctor, but if these patients continue to have a septic focus, you will not be able to cure them." That makes it even more difficult. The trials that have been done so far should be interpreted with caution. More studies are needed, but the way they are designed should also be reconsidered carefully. The current inclusion criteria are not sufficiently appropriate in my view. It's an ongoing challenge to ventilate the patient for the best, but it may be impossible to solve this by clinical trials. So we may need to go back to the beginning: achieve a better understanding of what we are doing, and a better understanding of the pathophysiology.

Then we will be able to give each individual patient the best possible treatment.

Can you expand on your planned educational activities in lung recruitment for other intensivists and institutions?

We think the research we are doing with training of other intensivist colleagues is important, and we plan to have workshops established before summer, to apply this training in a pig model, in the same manner as we have worked with Hedenstiernas group in Uppsala. We think it is feasible to offer training sessions with the same pigs as we use for research, in order to make the best use of the animals. The workshops will be two-day sessions, and we anticipate a group size of about 10 participants, so that the training can be tailored for each participant. We want to share this knowledge, and we have good support from MAQUET.

In your experience, which patient categories benefit most from the Open Lung procedure?

What I call "fresh" patients; the patients who arrive with recent onset of disease, and secondary ARDS. There you can see the biggest improvement in oxygenation, and in recruitment. You can hear this with your stethoscope at the bedside, and see it on the

screen. We also treat patients with long standing ARDS, who we take on from other hospitals, but the recruitment maneuver has a lesser effect. Patients arriving directly from the surgical theatre with atelectasis also benefit from lung recruitment. We use recruitment in severely ill patients in combination with prone positioning of the patients. In a relatively short period of time, we can improve compliance and oxygenation with the recruitment procedure. The Open Lung Tool is very helpful for understanding what you are doing and explaining this to your fellows.

You are planning to conduct research in Positron Emission Tomography (PET) measurements as an alternative to CT. How has this evolved?

This is a project within the department. Professor Johan Groeneveld, Dr Jan Jaap Spijkstra, Dr Hagen Biermann and Dr Huib van Genderingen are the main researchers. It is a team effort. We are looking for a better bedside understanding of what we are doing in mechanical ventilation, how to open the lung, and how to avoid overdistension. There are millions of alveoli, and what is good for one may be harmful to another.

We want to do as much good, and as little harm, as possible. The question you want to answer is: "Did I safely open the lung and get rid of the atelectasis?" So that is why we want to simultaneously observe all of the parameters, using PET scanning to measure the amount of air and blood in a certain region, and to cross-match the information.

We would also like to investigate using electrical impedance tomography measurements in this manner. We would like to try to couple this with PET scanning, and make it feasible at the place we do the PET scan. You have real-time information, which gives a model for dynamic information. When you use the CT scan, you only have static information. A CT scan is always a shadow of reality, as I see it. By using markers in the air and the blood, we can get a better idea of what is happening in that region.

When will you begin using this with patients?

I have just discussed this with the primary investigators, and we hope it will start before this summer. We will investigate using animal models initially in a feasibility study, and then after evaluation, we will undertake further plans. We will coordinate this with the research group in Uppsala.

Could this research establish another means of navigation in pulmonary mechanics and diagnosis?

Well, I hope to define our patient population in a better manner, to help to structure new studies. Intensive care research is very difficult, as there is so much happening. It is quite absurd to think that only one intervention can have a decisive role, as the dynamics are so challenging. There is a need to define parameters for general care. We have recently published on ventilator-associated pneumonia (VAP), as I consider it a quality parameter of ventilator care. In 1998, I saw many VAPs, and wanted to know the cause. We set up procedures to raise staff awareness of VAP, and teach them how to influence it. Now, we have a very low number of VAPs, even without selective bowel decontamination. We set up a strategy and study to establish our reductions:

Ventilator-pneumonia (VAP)

	2001	2003
Number of patients at risk of VAP	82	78
Number of patients with pneumonia	13	2
Percentage	15.9%	2.6%
Patients with pneumonia/1000 vent days	12.2	1.6
95% confidence interval	5.6-18.8	1.0-3.8

What we do is really missionary work. The role of the team and the leadership can be underestimated in intensive care. It is much more important to have dedicated intensivists who are active at the bedside, and to pay more attention to nurses' collaboration with the doctors, than to have a very new and sophisticated drug. These basics are very important.

This example illustrates how ventilatory parameters can change mainly by general measures. And the fact that we now have much better ventilators is also important for outcomes. In general, insufficient attention is paid to the importance of these basic factors. The goal of research is not to do research, but to improve patient care. And we must start by having a better understanding of what we are doing.

For more information about the mechanical ventilation workshop sessions offered at VUMC, please contact Professor Girbes: arj.girbes@vumc.nl, or info@criticalcarenews.com

Biography

Armand RJ Girbes, MD, PhD, is Chairman of the Department of Intensive Care of the University Hospital VU Medical Center of Amsterdam. He obtained his initial medical training and degree at the State University in Groningen, Netherlands, in 1984. He was named Professor in Intensive Care Medicine in 2001, and has conducted comprehensive scientific research, with numerous publications. He is Chairman of the Dutch Board of Training in Intensive Care Medicine, and served as Chairman of the European Congress of the ESICM in Amsterdam, 2003.

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VUMC ICU



Dr Wouter de Ruijter and Dr Inge Vergouwe.

Critical Care News met trainee anesthesiologists Dr Inge Vergouwe and Dr Wouter de Ruijter. They are currently practicing in the Medical ICU, where there are 26 beds, and 9 medium care beds. We discussed lung recruitment and the new technology.

What are your experiences of lung recruitment?

From an educational point of view, it has been very worthwhile to see how the pressures you are using to ventilate impact on different clinical situations. We have been trained in lung recruitment, and have been using it for the past few months. We don't use it with every patient yet; mainly with those where it is difficult to relate the information to the actual clinical situation.

As trainees, you have worked in different hospital departments. What is your experience of the standardization of ventilation technology?

The new ventilators with the touchscreen are easy to use, and it helps that they are the same in different departments. The software is useful. It is very good that the Pressure Support you give remains the same, while it is possible to vary the PEEP. It was quite easy to learn the Open Lung Tool as well, and it is easier to visualize what you are doing by using the incremental PEEP to help determine compliance, and when you have reached the maximum. We can recommend this to other teaching hospitals, to see what is going on and to help search for the optimal PEEP level.



Dr Inge Vergouwe.



Dr Wouter de Ruijter.

VUMC ER

Introducing new technology meant special challenges and special benefits for the dynamic Emergency Room environment at the University Hospital VUMC Medical Center. Critical Care News spoke to Irma M Spaans, ER Supervisor.



Irma M Spaans, ER Supervisor.

What kind of ER environment do you have?

We have 80-120 patients per day, primarily level 1 neurological or neurotrauma emergency cases, as well as cardiac/cardiopulmonary patients. Our staff consists of 45 nurses per day, with 2 or 3 physicians and a Medical Supervisor, working in 4-6 hour shifts. In addition to our normal ER services, we are constantly on standby for Schiphol airport, which is minutes away. We have special protocols for any eventual disaster situations.

What were your experiences of training and transferring to the new ventilator technology?

We installed two SERVO-i ventilators last year, and it was important that the entire staff be trained as quickly and thoroughly as possible. It was a challenge; 45 nurses were trained during special courses in three afternoons. The staff is a mix of younger and older nurses. Many had their primary experience with Dräger ventilators, so it was a big change.

What was the result?

The training was very satisfactory, and the ventilators were very easy to learn for most of our staff. It is useful that they can be mounted in various manners. In the ER, we almost always use Pressure Control or Volume Control initially. It benefits both patients and staff to have the same ventilators in all departments once patients leave the ER. ■

Università Cattolica del Sacro Cuore A Gemelli University Hospital, Rome, is one of the largest hospitals in Italy, and served by Professor Massimo Antonelli and colleagues. Professor Antonelli is Director of the General Intensive Care Unit and Director of the Institute of Anesthesiology and Intensive Care. Critical Care News met Professor Antonelli to discuss the growing interest in non-invasive ventilation therapy, and to share his broad experience in this area.

Gaining clinical experience in non-invasive ventilation



Professor Antonelli, Director of the Institute of Anesthesiology and Intensive Care at Università Cattolica del Sacro Cuore A Gemelli University Hospital, Rome.

How and when did you start using non-invasive ventilation therapy?

My experience in non-invasive therapy goes back to about 1985. We started research at the same time as a well-known group headed by Laurent Brochard in Paris. After the publication of Brochard's excellent paper on COPD patients in the New England Journal of Medicine, which several of my colleagues co-authored, we started to implement a program of non-invasive ventilation at the unit where I previously worked, La Sapienza University Hospital.

We started with a few patients to see how it worked. And it did work! So gradually, we extended the treatment to purely hypoxemic patients, and obtained pretty surprising results. Of course things have changed a lot over the last 20 years. New devices, techniques and approaches have emerged that have allowed us to widen the indication for non-invasive ventilation, and extend it to

patients with acute respiratory failure with greater confidence. When I first moved to this hospital, none of my colleagues had ever tried non-invasive ventilation. We began introducing the technique five years ago, and I must confess that my colleagues at that time were quite skeptical. They thought the technique might be risky for patients; they felt life-threatening conditions could not be handled properly without an endotracheal tube. However, after about a year they were so enthusiastic about non-invasive ventilation that they wanted to use it on almost all patients.

I moved to this hospital together with my close friend and colleague of 25 years Professor G Conti, who in many ways is like a brother. His support made it easier – we could give our colleagues the right input, pushing them a little to help them become more confident. The one-year learning curve was sufficient for everyone, including nurses, to be able to carry out effective non-invasive ventilation.

What is your current split between invasive and non-invasive?

This technique can never replace endotracheal and conventional mechanical ventilation. They are fundamental techniques that save millions of lives. Non-invasive ventilation certainly has a role, but even in more “aggressive” centers like ours, I don't believe that more than 20% of admissions can be treated with non-invasive ventilation. It also depends very much on pathology. Most patients with acute exacerbation COPD can receive non-invasive ventilation as a first-line intervention; in our ER and ICU, 80-90% of these patients are treated in this way. The ratio is much lower for patients who are purely hypoxemic, since these cases are more severe and more unstable. I would say that patients with ARDS or acute lung injury must first be treated exclusively within the ICU, which is not the case with COPD patients. About 10-15% of these patients could be treated with non-



Professor Antonelli tailoring ventilation therapy at patient bedside.

invasive ventilation, but you must start very early, at the very beginning of the syndrome.

So if you catch the opportunity very early in this indication, your chances of success are greater?

Yes, absolutely. This is clearly shown in medical literature. There are some excellent studies, by our group and many others, such as the one by G Hilbert in France. They studied the treatment of immunocompromised patients, where there is a very high risk of developing infectious complications. For these patients, as with those we have treated in transplant settings, avoiding endotracheal intubation is really beneficial and can be crucial. You can treat these patients for acute respiratory failure, avoiding intubation and improving their outcome, and reducing mortality. But none of the patients are identical. You need to choose the appropriate candidate, according to pathology, and tailor your therapy to each patient.

Do you follow any specific protocol for non-invasive therapy, depending on the patient category?

The idea is to start non-invasive ventilation therapy early in both COPD patients and other categories. We have a protocol for use of the facial mask, nasal mask or helmet, how to set up the ventilator, and how to manage the patient while initiating non-invasive therapy. But you need to adapt your protocol to the kind of patient you have. A patient who is unconscious and/or uncooperative is not the best candidate for non-invasive ventilation, so you need to intubate these patients.

But there may be an exception: if you have a COPD patient with acute exacerbation who is unconscious or not mentally competent, you may try using non-invasive ventilation for a short time. The unconsciousness may be strictly related to the hypercarbia. If you are able to correct the hypercarbia through non-invasive ventilation within about 30-45 minutes, you may continue. If you are unable to correct the situation and restore consciousness within this time, you need to intubate. This is a good illustration of how flexible you need to be, how you need to adapt the ventilator settings and the interface attachment, whether mask or helmet, and how you also need to choose your patient.

Another example more pertinent to other patient categories, ARDS, ALI or hypoxemic respiratory insufficiency, came from a large study in Europe and the US of more than 300 subjects with acute hypoxemic respiratory failure, published about three years ago in Intensive Care Medicine. The study showed that the patients who were at major risk of failure were those unable to improve their PaO_2 and CO_2 over 150 after the first hour of treatment.

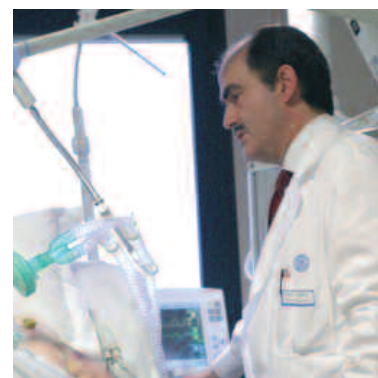
So in cases of hypoxemic respiratory failure where the patient is older and has a higher severity score measured by the SAPS II score (Simplified Acute Physiology Score), or where the patient has an ARDS, pneumonia, or is unable to improve his gas exchanges within the first hour of treatment, the probability of intubation is high. However, if you are an expert, you should be able to use non-invasive ventilation properly with complex patient categories, such as hypoxemic patients. If you are able to identify these risk categories, and more importantly, if your patient does not improve within one hour, do not hesitate to intubate the patient in order to avoid a dangerous situation.

CPAP is becoming a common treatment for patients with lung edema, while NIV is controversial in this setting. What is your view on this issue?

CPAP is a kind of non-invasive ventilation, which can be delivered by endotracheal tube, or facial mask or helmet. For those patients who are slightly hypercapnic, or whose respiratory work is dramatically increased, the combination of Pressure Support through non-invasive ventilation and CPAP could be the best option. However, we do not currently have any clear randomized trial that shows the superiority of non-invasive ventilation and Pressure Support versus CPAP. CPAP should also be applied as soon as possible for patients with acute pulmonary edema.

If you are giving advice to other intensivists around the world who are interested in non-invasive ventilation, which categories do you recommend they start with to gain experience?

I would advise them to start with easier patients, such as the COPD patient with acute exacerbation. This is because this category of patients can usually receive non-invasive



Professor Antonelli at bedside.

ventilation intermittently. They customarily have a high level of PaCO_2 and a low level of PaO_2 in their blood and can therefore tolerate periods without non-invasive ventilation. For example, staff may treat with non-invasive ventilation for a few hours, after the initial hour when values have improved. After a time, they might disconnect the non-invasive ventilation to give the patient relief, then restart again. This allows the physician to gain understanding and skill in the non-invasive technique.

When you use non-invasive ventilation with a hypoxemic patient, things are different. You need to evaluate the patient situation thoroughly in the ICU environment. You cannot take any risks with these patients. Hypoxemic patients are therefore not a category for the physician using non-invasive therapy for the first time.

My advice is to start with COPD patients, then after time and sufficient experience, move on to treating more severe and more specific patient categories – within the appropriate environment, and with close monitoring of all vital functions. If you start with more difficult patients, you risk failure. Simple lack of experience could give the false impression that the technique doesn't work, and you may inadvertently harm patients.

Another important message I would like to give to all those who are interested in starting a program of non-invasive ventilation, is that this technique requires patient collaboration. Communication is important. You need to explain to the potential patient candidate for non-invasive ventilation what you will be doing, step by step. Touch the patient and reassure them to ensure they are collaborating in the treatment. This is essential for success.

Do the facial masks or helmets cause some

patients to experience panic?

Yes, of course. You must be very selective and choose patients who are right for the procedure. But in some cases the patient may become intolerant after a few hours, since they are not accustomed to breathing with a tight-fitting mask, or to being unable to speak or interact with the external environment.

That is why the development of new interfaces is so interesting. One of the more recent developments is the helmets that we have been using. They are made of transparent PVC plastic with a soft collar that adapts to the neck of the patient. The helmet is connected to the ventilator by two separate ports, one for the inspiratory valve and one for the expiratory valve. It is fully extended when it is put on the patient. It is secured on the patient by a strap anchored under the armpit, which attaches to the anterior and posterior positions of the helmet. The advantage is that the patient is free to speak and drink, as there is a small port for a nasogastric tube or a straw. The patient can also move his head and read while he is being ventilated. This design gives much greater flexibility and freedom of movement, and the helmet can be on for a longer period of time.

If you are working in Pressure Support mode physiologically, there is a slight delay with the helmet. But as it is already providing a pressurized environment for the patient, a

few milliseconds to open the valve is not a problem – the patient is already breathing within a CPAP system. There are studies planned to examine the use of this helmet with a NAVA based system; the synchrony between the ventilator and the NAVA system seems to be perfect.

In the future we will have new applications, and a better understanding of some physiological details. But our current experience shows tolerability to be very good. In January, my good friend Marco Ranieri published a study on CPAP delivered by helmet or mask to patients with acute respiratory failure. This showed an improvement in outcome, including reduced mortality.

If you are able to obtain a fast improvement for the patient, you can decrease length of stay in the ICU and minimize the risk of patient complications – as well as achieving cost savings and reducing the workload for staff.

There are cases where you initially apply non-invasive ventilation, but then decide you need to intubate. Do you go back to non-invasive as part of the weaning process for these patients?

This is a good question. There is a lot of dispute on this issue, and controversy over the data. Some maintain that this application in weaning is good, but the patient numbers are not high enough. Others say that non-invasive ventilation should not be used in weaning. But centers that apply non-invasive ventilation use it not only for the acute phases of respiratory failure, but also for the weaning process. Those patients who are weaning candidates, but need to be sustained, can benefit well from non-invasive ventilation. But we cannot say it is applicable to everyone without solid data from sufficient numbers of patients.

What steps do you take to minimize leakage?

You can adapt the interface you are using, the facial mask fitting, the size of the mask, or use a helmet if the mask is not working. Some ventilators also have software that can compensate for leakage. If you do not have this type of ventilator with modern software, the patient may face the “hang-up” phenomenon. If you are working in Pressure Support, the patient to cycle from inspiration

to expiration must show a decay of inspiratory flow up to 25% of initial flow. If you have an air leak that the machine perceives as a requirement from that patient, the machine will deliver more and more flow, and the patient is unable to cycle from inspiration to expiration. Here you can change the mode from Pressure Support to Pressure Control, where the cycling from inspiration to expiration is no longer related to flow decay at the time. So you find when the machine has to cycle, in this case even in the presence of an air leak, you may continue non-invasive ventilation. With certain limitations, these challenges can be handled.

Do you experience earlier or easier weaning with non-invasive ventilation?

In my experience, we have earlier weaning. But seen from another perspective, you are still continuing the weaning process but with another interface. It may be intermittent, but the patient is still supported. One of Stephan Renada's best studies demonstrated that the application of non-invasive ventilation in COPD patients during the weaning process can improve outcome and reduce mortality.

Do you think non-invasive ventilation should be avoided in patients with gastric difficulties?

I am always surprised that this question comes most frequently from people in the United States. Many of my US colleagues are concerned about gastric patients and the possibility of regurgitation. Personally, I have never seen this. It is probably due to a different approach. In Europe, we do a lot more enteral feeding. And with non-invasive patients, we insert a nasogastric tube – not only for enteral feeding, but also to drain the excess swallowed by the patient, reducing the risk of regurgitation. If you have a collaborative patient, it is very, very rare in my experience. There are perhaps more strict protocols in the US, where the physician may be on call. In Europe, there is always a doctor present in the unit.

But what is true for all of these subjects is this: the treatment is first, and each patient is different. You have principles, guidelines, definitions, but you must always think about the best way to conduct your therapy, and tailor your therapy to your patient. When J Milic-Emili, one of the fathers of



Professor Antonelli demonstrates the application of the helmet in non-invasive ventilation.



Professor Massimo Antonelli.

mechanical ventilation, was asked to make a comment on data, he responded: "You must trust in the Bible, if the Bible is true."

You cannot assume that the numbers are correct – it's important to verify all aspects of the system and therapy so that you can validate your actions. ■

Biography

Massimo Antonelli is Professor of Anesthesiology and Intensive Care at Università Cattolica del Sacro Cuore A Gemelli University Hospital, and Director of the General Intensive Care Unit of the Policlinico A Gemelli University Hospital and the Institute of Anesthesiology and Intensive Care. He has been a member of the Italian Society of Anesthesiology since 1984, and a member of the European Intensive Care Medicine Society since 1986. In 1992, he became the Official Examiner of the European Academy of Anesthesiology, and was a member of the Council of the European Society of Intensive Care Medicine from 1995 to 1999.

Professor Antonelli is the author of more than 130 scientific papers covering the subjects of ARDS, shock and sepsis, and non-invasive ventilation, as well as a frequent lecturer and chairman at many of the International Intensive Care Society meetings. He is Associate Editor of Intensive Care Medicine, and an independent referee of JAMA, Critical Care Medicine, Anesthesiology, AJRCCM, European Respiratory Journal, Anesthesia and Analgesia, and Monaldi Archives.

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