Gaining clinical experience in non-invasive ventilation
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.

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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-
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 hypercapnia. If you are able to correct the hypercapnia 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 PaO2 and CO2 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 ventilation intermittently. They customarily have a high level of PaCO2 and a low level of PaO2 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...**

**Professor Antonelli at bedside.**
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
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.

References