Ventilation procedures for intensive care air transports
Many metropolitan area hospitals are facing difficulties in densely populated urban areas: how to transfer intensive care patients to centers where there are open ICU beds or adequate staffing this week, or specialized centers for advanced treatment care needs. In addition to these logistics, transferring the ventilated patient from one ICU to another poses additional therapeutic challenges. The University Hospital System in Munich has defined a systematic approach to ICU patient treatment and transport.

**Ventilation procedures for intensive care air transports**

How many intensive care patients are transported here on an annual basis?

In 2004 we had 1,900 patients by land and 860 by air transport, or a total of 2,760 patients. This represents primarily the area of Bavaria and Baden Württemberg, where we are receiving patients, but sometimes the patients can be transported from here, to Hamburg and Berlin.

What are the proportions of emergency and planned air transports of intensive care patients?

Of total patients in air transports, about two-thirds are intensive care patients and about one-third are from acute emergency situations. Of the intensive care patients, approximately 50% are emergency and 50% are planned transports. Most of these patients are coming from smaller hospitals in Bavaria and some are coming from central hospitals in Munich, smaller hospitals without special care units, or without cardiac or neurosurgery, for example.

Are these transports generally during daylight hours, or are they day/night transports?

Our helicopter and ambulance services run day and night. But at night, the helicopter primarily does emergency cases.

What is the average transport time for a ventilated patient by helicopter?

It depends entirely on the patient situation; we have flight times of a few minutes up to several hours. On one occasion last year, we took a ventilated patient from Marseille to Munich, so it can vary. But in general, for the majority of intensive care patients, transport time is up to one hour in the air.
Which types of intensive care patient categories do you primarily transport by planned air transport?

There are a wide variety of intensive care cases: ARDS, infants, trauma, neurological cases and cardiac patients, heart failure, or pericardial infusion and coronary syndromes, coming from a peripheral hospital for specialized surgery.

The infants are often premature, but there are also many full-term infants coming here for specialized surgery for congenital defects.

In these types of patient transports, what type of clinical performance is required from the ventilator?

It depends on the patient of course. Cardiac and neurological patients are often sedated and on controlled ventilation. In these patients it is pretty straightforward, since they have normal lungs, and normal resistance and compliance. But in the ARDS patients, we need a good intensive care ventilator, delivering pressure supported and pressure controlled therapy, or in very severe cases extracorporeal membrane oxygenation (ECMO), also during the transport. Pressure controlled ventilation is also sometimes needed for infants.

Is there a profile or any type of clinical criteria intensive care patients must fulfill to be transported by air?

The indication for air transport is dependent upon the patient. A patient with ARDS with unstable respiratory mechanics is stabilized on the ward of the remitting hospital. Other patients may be unstable and need hemofiltration, and then we try to transport them as urgently as possible. Each underlying disease or condition is different. We have no exclusion criteria, but I would not transport patients with acute bleeding, for example, or a ruptured aortic aneurysm. They require extensive blood transfusions, and that can be difficult to manage in the air. In our experience, almost every other patient, depending on their situation, may be transported by air or land. It is difficult to intubate or put in IV lines or a CVC during transport, but we have done this when necessary. If these types of interventions are needed, often we usually want to make sure that they are already in place prior to transport.

What are the types of ventilation strategies or modes commonly used during transport?

We have all modes of ventilation, protocols coming with high PEEP and high peak pressure, sedated patients, some patients with non-invasive ventilation by mask, for example with cystic fibrosis or lung fibrosis, coming to the transplant center here.

What is the normal range of trigger settings used during transport?

We try to determine what is good for that particular patient: for a patient on supported ventilation, we use flow triggering, which is best in my experience. But controlled ventilation is
used for sedated patients, who are in the majority. Primarily, we try to maintain the same ventilation strategy initiated by the remitting hospital, continuing the same strategy during air transport until the patient reaches our center here. However, there are cases where we try to adapt a good ventilation strategy during the transport. If the patient is not being optimally ventilated when we receive him, we titrate the settings and adjust to our own ventilation strategies enroute to this hospital.

**What are some of the challenges in treating these ventilation patients in air transports?**

The main challenge is the transport situation itself: you have a lot of equipment – several IV lines where you want to avoid disturbance, the ventilation circuit and tubes. The most important thing is to avoid leakage or disconnection in the ventilatory circle. In ARDS or ALI patients, the challenge is to improve patient oxygenation and recruiting lung area, or improving the ventilatory strategies of the remitting hospital.

**What are the contrasts in ventilation treatment during air transport with an intensive care ventilator compared to traditional transport ventilators?**

It is generally the same contrast that you have in the hospital, coming from the OR or in the ICU. Generally, uncomplicated and sedated patients do not require advanced ventilatory therapy. But if you have a patient with respiratory failure, whether in the ICU or in the air, you need a good intensive care ventilator. But since you never know what the next patient’s condition will be, it is better to have both solutions – the intensive care ventilator for complex cases, and the transport ventilator for general cases. I think that only about 50% of our total transport patients require a sophisticated intensive care ventilator, but in those patients it is really a necessity. If we did not have it, we could not transport these patients. In air transports, we frequently use the intensive care ventilator even in uncomplicated patients. The unit is already there and can simply be switched on. About 30% of our ventilated patients get hand ventilation from the remitting hospital to the ambulance or helicopter, where they are put on the intensive care ventilator and treated with supportive modes.

**What types of preparations are needed for planned air transport of an intensive care patient; at the remitting hospital, and at Grosshadern where the patient is received?**

It always depends on the underlying disease and the condition of the patient. Uncomplicated patients usually require no further preparation. Critically ill patients, on the other hand, with heart failure, respiratory failure or sepsis for example, often require hemodynamic stabilization, e.g., catecholamines, improved
ventilator strategies, nebulization of iloprost or NO ventilation, and sometimes insertion of central venous catheters or arterial catheters. The most demanding patients are the ARDS patients, since they are frequently in a critical and unstable condition when we receive them.

What are the average transport times by land?

We have a lot of transports from one Munich hospital to the other, for specialized types of surgeries. These transports are usually 30 minutes by land, and from ICU to ICU about 90 minutes. For hospitals in Bavaria outside of Munich, there can be a wider range of times. There can be extreme cases too: we had an intensive care patient transport to Bonn last year by land, when the weather did not permit air transport.

How big is the medical team that accompanies each intensive care patient by air?

In the majority of cases, the medical team consists of one doctor and one medic per patient. In some cases we might have three members in the medical crew. But it is a calculation of the crew weight and the total weight with fuel that determines how many medical team members the helicopter pilot will permit.

How do ventilated patients who are not sedated generally experience the air transport process?

I usually give a light sedation, but most of the patients are not nervous or fearful of the flight. They are generally comfortable, and they have headphones so they can talk with the medical staff members.

Can you give us an example of a “worst case scenario” for a ventilated patient during helicopter transport?

The worst case scenario is losing the airway in a patient who could not be intubated conventionally, for example a dysmorphic newborn, or discovering empty oxygen tanks and a patient with respiratory failure in need of an FiO2 of 1.0.

What do you think will be the future trends in regard to transport of intensive care patients? Will there be increasing numbers, requirements or special demands in future?

The trend we have seen in recent years is one I think will continue. There are more and more critically ill patients being remitted by smaller hospitals to the large research centers. There are also more problems with intensive care department capacities that we are seeing more frequently, due to lack of beds or staff. Therefore the need for inter-hospital transfer with intensive care facilities will increase. In addition, the requirements for the quality of air transport will also increase, as well as the need for continuing therapy during air transport. Weight is the major problem for air transport, so every kilogram is important. Lighter weight and more advanced equipment to be used for more sophisticated ICU therapies is needed in future development to meet these future directions and trends.

Biography

Dr Gerhard Kuhnle is Assistant Professor of Anesthesiology and Intensive Care at the University of Munich. He conducted his medical studies at the Universities of Tuebingen and Munich during the years of 1981 and 1988, and conducted research during the years of 1988 and 1993 at the Department of Surgical Research, University of Munich. He was named Professor and has been employed at the Department of Anesthesiology, University of Munich. He was named Professor and has been employed at the Department of Anesthesiology, University of Munich, since 1994, and is currently a Director of Inter-Hospital Intensive Care Transport at the University of Munich hospital system. His special interests are in the areas of critical care medicine (ARDS, ventilation, inter-hospital transport) and anesthesia (surgery, neurosurgery, gynecology and obstetrics, ENT surgery, pediatric anesthesia, regional anesthesia), as well as pain therapy.