Ventilating infants in critical care air transports
Over the past two years, more than 40 critically ill infants have received intensive care quality ventilation in air transports within Sweden and destinations in northern Europe. These transport opportunities have evolved from a close collaboration between the Swedish Air Ambulance company (Svensk Flygambulans AB) and the Astrid Lindgren Children’s Hospital at the internationally renowned Karolinska Hospital in Stockholm, as well as new technological solutions that provide support to ventilated infants in fixed wing aircraft.

Critical Care News met with team members of this collaborative effort from both groups; representatives from PETS (Pediatric Emergency Transport Service) at Astrid Lindgren Children’s Hospital, as well as representatives from Swedish Air Ambulance, to hear about how this collaborative effort and transport solutions developed within the group.
and sent one of their children to us and seen that it works, they want to use us again. PETS are not only air transports, but also land based ambulance and helicopter intensive care transports as well. Whatever the transport means, the program can be considered as a mobile ICU for infant and pediatric patients.”

The PETS program has twelve physicians as well as twelve nurses, in order to provide staffing around the clock. Dr Hamrin explains: “In the very beginning, staffing was on voluntary basis among our colleagues. A patient transport request came to the doctor on call at the PICU, who then contacted us by mobile text messages that were sent to all of us, and those who had the opportunity to accompany the patient transport could respond. From the beginning of this year, we have chosen to have one physician on rotation for transports for one week at a time. We are also working on a proposal for a rotational schedule among our pediatric intensive care nurses and pediatric anesthesia nurses. It is extremely important that our PETS staff have a good knowledge of how we care for our patients, and that they have worked at least two years at our unit in the hospital.”

The Pediatric Emergency Transport Service (PETS) at Astrid Lindgren Children’s Hospital and the Swedish Air Ambulance company each have a longstanding tradition of transporting critical care and emergency patients.

The PETS service – with origins in the early 90’s

The Astrid Lindgren Children’s Hospital within Karolinska Hospital in Stockholm has a long and well-established tradition of transporting children, primarily newborn infants, originating from a decision to centralize cardiac surgery in Sweden to the university hospitals in Lund and Gothenburg in the 1990’s. Dr Tova Hannegård Hamrin, anesthesiologist at Karolinska’s Astrid Lindgren Children’s Hospital, outlines the development process after that point: “We came to believe that there were many critically ill children in general ICUs in hospitals around Sweden, who would perhaps get better care in a dedicated pediatric intensive care unit. That is how the idea for PETS was born, and it started as a project in 2005. We have observed that more and more hospitals have contacted us to transport and treat more and more children.” Dr Hamrin has been involved in the PETS program from the very beginning, and is currently responsible for PETS operations, which is a part of the Department of Pediatric Anesthesia and Intensive Care group at Astrid Lindgren Children’s Hospital.

“Last year we had 27 PETS transports in total, from January to April this year we are already up to 18 PETS transports, an increasing tendency. I think this increase is due to familiarity and confidence, once a hospital has heard about the program

Swedish Air Ambulance – over 30 years of operations

The Swedish Air Ambulance company started its operations in 1976 with the very first air ambulance in Sweden, and has continually developed ever since. Last year over 1100 patients in different categories were transported, in a fleet of three Beechcraft 200 aircraft based in Sweden. Managing Director Åsa Englund states “We fly primarily in Sweden and northern Europe on flights between 2-3 hours. After that, refueling is usually necessary, but is also dependent upon the load that the aircraft is carrying. Each flight has a captain, co-pilot, and aircraft nurse. We have a high requirement for our nurses, who must have flight medical training, emergency training, and maintain clinical competence in order to provide patient care, in case there are situations where no PETS team members are present.
The Swedish Air Ambulance became very interested in the infant pod solution that the PETS group had discovered, since it is a much simpler solution to travel with when a transport incubator is not really needed. Dr Hamrin states that the only time when a transport incubator can be needed is when the infant cannot maintain body warmth, which generally is only a problem with premature babies, in her opinion.

Annika Schön, anesthesiology nurse in the PETS group, describes the infant pod solution: “The infant pod is lightweight as it is composed of styrofoam, and has a five point strap system crossing over the child as a harness to keep the infant in place on the mattress. The mattress is a vacuum type, which can be adjusted if the child needs further support within the pod. The pod is affixed to the stretcher at the hospital, and the concept works as one unit from the hospital to the aircraft, during flight and upon arrival at the receiving hospital.”

Over 90% of the transports are planned, and 10% are acute, according to Åsa Englund, and the company transports in any situation around the clock. Registered Flight Nurse Carina Ramstedt explains: “It could be a patient that has to be transferred to a specialty center for transplantation, or a patient returning home after specialized care. Sometimes we get patients that have become ill during a business trip or vacation trip. We can provide flight support like an ambulance, ICU or sometimes the patients are capable of sitting upright. We also act as an extended arm. We had a number of patients that arrived in Sweden after the tsunami 2004, who were transported back to their home hospitals.”

Collaboration leads to new infant transport solutions

Karolinska Hospital and Swedish Air Ambulance have collaborated with patient transports for many years, in many different patient categories.

The PETS group has used different transport solutions for infants, with different experiences and drawbacks. Dr Hamrin explains about some of the limitations they have encountered and the discovery of the infant pod solution: “When you transport with an incubator, the infant is the component that weighs the least. Transport incubators are large and cumbersome, and not easy to work with. One of our colleagues heard about the infant pod solution in Great Britain, where it has been in use for some time. We purchased one infant pod (BabyPod manufactured by Advanced Healthcare Technology Ltd, U.K.) and started to use it for transports of our infants with congenital heart disease, and it worked very smoothly. In about the same time frame, SERVO-i ventilator became available for air transports. The transport incubators today have a rather basic ventilator solution that does not provide high quality ventilation treatment.”

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**Intensive care ventilation in-flight**

The pod solution became very popular for transporting infants, but ventilation was an issue that still needed to be addressed. Swedish Air Ambulance Flight Nurse Carina Ramstedt describes some of the practical problems of the past: “For infants, the greatest concern has always been the risk of extubation when entering or leaving the aircraft. We always worry about tubes or cords fastening somewhere, or movements that might disturb the patient and the equipment, such as one of the staff stumbling, etc.”

For the PETS team, the quality of ventilation treatment for infants has been a primary concern. Dr Hamrin explains: “When PETS began, more than 70% of our transported patients were referred because of respiratory insufficiency. In transporting these infants with sick lungs, it can affect the level of treatment quality to transport without a high quality ventilator. We were purchasing the SERVO-i in the hospital to replace our old SERVO 300 fleet in the PICU, and as the SERVO-i can be adapted for transports and was approved for flight, the idea was born to transport with a ventilator that provided ICU quality ventilation, and to use it on the infant during the entire course of therapy, including bedside. This helps us maintain the same ventilator quality without interruption.”

“The Swedish Air Ambulance company was attentive to us when we discussed the fact that the old model of baby transport ventilator was not sufficient for these infants with sick lungs. In the process we took a SERVO-i ventilator and received flight approval for it, and they followed the same process. They also heard about the transport cage to attach and stabilize the SERVO-i to the stretcher, and informed us, as they have always been very attentive to our requirements in regard to ventilation quality during the transport process. The collaboration continues to develop.”

The Swedish Air Ambulance company initiated a process to be able to use the SERVO-i ventilator in flight. Åsa Englund clarifies: “We developed the solution to anchor the ventilator and cage to the stretcher on a bottom plate, which is stable from all directions. After that we conducted a series of tests to evaluate stability, electrical disturbance on other instrumentation, and tests to establish that the ventilator was not affected by changes in cabin air pressure or vibrations, and tests of the connecting cables as well.” The Swedish Air Ambulance company appreciated the concern about the quality of ventilation in flight. Åsa Englund points out: “It is important that transport of these small ICU infant patients should just be considered as a continuation of the treatment and care they have received at bedside. They are treated in the pediatric ICU, and during the air transport process the treatment should continue smoothly at the same level as at bedside, the only difference is that we are moving the patient from Point A to Point B.”

Carina Ramstedt is Flight Nurse at Swedish Air Ambulance.

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The ventilator is securely mounted to the stretcher by means of a special transport cage, which maintains stability throughout the flight.
She has also noted increasing trends in acceptance and utilization of the solution: “From November 2006 up to and including the year 2007, we had 27 air transports with the single unit infant pod/SERVO-i ventilator solution. Interestingly, so far this year in the first four months from January to May first, we have already had 18 transports. There is a growing tendency to request and utilize this solution. I think perhaps it is due to the fact that hospitals throughout the country are becoming familiar with this possibility, contacts have been established and they see that the transport solution has worked well. I think that we have passed an initial level of knowledge and acceptance, and the requests for infant transports with this solution will continue to grow.”

Bedside quality ventilation therapy - wherever the infant may be

Dr Hamrin also addressed the benefits of using the same ventilator in the ICU and in the air. “We have many SERVO-i ventilators that are approved for flight, so it is a benefit if the child can continue ventilation on the same ventilator upon arrival without having to switch ventilators. It is what is best for the infant, and reinforces our ambition to provide the same level of quality in ventilation therapy in the air as well as bedside in the PICU.”

Single unit concept – infant pod and SERVO-i mounted to the same stretcher

After the different stages of the process, with the discovery of the infant pod solution by the PETS team, and the flight validation of the SERVO-i and transport cage solution by Swedish Air Ambulance, the one unit concept was first utilized during an infant transport flight from Sweden to Dublin, Ireland. Carina Ramstedt recalls the first experience: “The opportunity of mounting the ventilator on the same stretcher where the child is positioned in the pod makes the solution a single unit, which provided a new sense of security. In the past, it has always been a concern with separate lifts of the ventilator and the child, with concern for the tube and risk of extubation. The single unit concept of infant pod and SERVO-i worked very well, and made our work easier.”

Annika Schön who has flown for many years with PETS at Karolinska Hospital in cooperation with Swedish Air Ambulance, agrees that the current single unit solution that so many have contributed to, with the infant pod and SERVO-i ventilator both fixed on the same stretcher has made the process much easier. “Since the children we treat have respiratory problems, we do not like the traditional infant incubator-based transport ventilators. These old traditional infant transport ventilators have a lower level of clinical performance, and sometimes we had to increase sedation for the patient in order to ventilate them on the older transport ventilators. Since we have SERVO-i in the PICU, it delivers ventilation with the clinical performance that is required by these infants with respiratory problems, at bedside in the PICU as well as in the air during transport. This is the most optimal situation for the patient if they receive their treatment on the same ventilator at bedside in the ICU prior to transport, in flight during transport and at bedside at the PICU at the receiving hospital. This also means that treatment parameters, such as settings and sedation levels, can remain the same. For us staff members, it is also optimal from the perspective that we are working with the same equipment in flight that we know and use at bedside in the unit.”
that is difficult to manage, and they ask for advice. In these situations, we may offer to take this child, with a difficult respiratory insufficiency, to be transported to our center for treatment. Other diagnoses may include sepsis, meningitis, lung disease or perhaps an infant with cardiac difficulties. All of these infants are in need of qualified ventilatory treatment. We also have cases of children receiving Extra Corporeal Membrane Oxygenation or ECMO, which need to be transported, or returned to their home hospital post ECMO treatment. Many of the children with cardiac difficulties have been born with abnormalities and are in need of heart surgery in specialist hospitals in another part of the country. We should also mention here that the infant pod has also been used for children up to 6-8 kilos.

Carina Ramstedt of Swedish Air Ambulance concurs. “We fly everything between short 30 minute ‘jumps’ to up to 3 hours, with infant transports. Our most frequent route is Stockholm – Malmö, 1 hour and 15 minutes for infants needing heart surgery at Lund University Hospital. But flight length depends upon the destination; to Ireland or other parts of northern Europe it may be 2.5 to 3 hours, and to different regions of Sweden it might be 1-2 hours.”

Among the longer range flights, we have been to Paris, France where there is a radiologist who is a specialist on birth deformities in infants. When we fly to Dublin, Ireland or to Germany it may be in connection with ECMO cases. Usually these infants are transported post ECMO treatment, and in some cases we have accompanied children to Germany for treatment when the ECMO facility in Sweden has had no available capacity.”

The infant transport process – meticulous planning and mobilization

Staff members from PETS and Swedish Air Ambulance are required to follow detailed routines and checklists at each institution, prior to transport. The PETS team members take about one hour to mobilize, from the point of contacting medical staff at home, who initiate the preparation process on the way to the...
hospital, depending upon the patient situation. According to Dr Hamrin, the same routines and checklists are followed, whether the patient transport is land based, helicopter or fixed wing aircraft. “We have different partners for each alternative, and we always choose the appropriate transport alternative depending upon the patient situation. We receive a call from a referring hospital, often from an intensive care physician, and we find out as much as we can about the clinical situation; which medications the child has received, type of ventilation therapy, drains and which infusion pumps are being used. This gives us a picture of the situation in regard to what we need to bring with us for this particular patient.”

“We have a transport inventory where we keep our equipment, and where we have packed and sealed transport bags for different patient age groups; newborn infants, small children and teenagers that are almost fully grown. If the child is receiving a certain type of medication that we normally do not keep in inventory, we make sure that we have it with us. We keep a standard assortment of materials in the bags, which are always filled and on stand by, but there can be special needs to customize in special situations. We test all equipment before we leave, see that the batteries are charged for the monitors and infusion pumps, and anything that runs on electrical current. We also double-check if we need oxygen or NO with us.

These preparations are mainly logistical, but critical for us to ensure that everything works as smoothly as possible when we receive the child. It is an advantage that we have a relatively small size working group, and once you have done a certain number of transports, the logistics become routine fairly quickly. When we return to our hospital, we complete the patient records and equipment log sheets, and see to it that the equipment is in good working condition for the next transport, we refill the bags and inventory to replace anything that has been used. The bags are then sealed so the next staff members on the next transport can feel confident that everything is in order.” Routines and checklists are also carefully followed by the Swedish Air Ambulance group, according to Åsa Englund: “The care team is a combination of PETS staff members and the aircraft staff, or 3 persons in total. One aircraft nurse, who is an anesthesia nurse responsible for the cabin and the equipment and safety within the aircraft, and one PETS nurse, who can be a pediatric anesthesia nurse or a pediatric intensive care nurse, and one pediatric anesthesiologist from PETS accompanies the patient. Usually there is no room in the aircraft for family members, who have to make the trip on a commercial flight. Each transport situation is unique and requires careful preparation, in terms of the flight and the patient. We follow thorough and detailed checklists.”

As an anesthesiologist, Dr Hamrin addresses additional challenges in treating ventilated infants in transport. She says that the worst case scenario would be an accidental extubation and losing the airway, requiring re-intubation. “Fortunately this has never happened to us. Another negative case scenario would be cases with diaphragmatic herniation with high airway pressures, where there is a risk of pneumothorax, but fortunately that has never happened to us either. However, we do plan and prepare to be able to handle any type of situation.” The new technology and solutions have also contributed to minimizing these risks.
Intensive care transport trends in future

Representatives from both groups shared the opinion that the trend for air transports of ventilated patients will continue to grow in the future. In regard to the infant transport solution, Annika Schön feels that there is still potential for further development of the concept. “The next step is perhaps a bit larger stretcher for larger children, where the ventilator can also be mounted to serve as a one unit concept. And developments for weight reduction will continue to be important – weight is always a factor for consideration in air transports.”

Åsa Englund expressed that the limitations of current land based ambulance models will continue to be a factor for increases in air transports. “I believe that the number of transports will steadily increase, even in the adult patient category. In terms of adults, there is a problem today that conventional ambulances are limited and cannot transport intensive care patients, and there are very few mobile ICU ambulances that are equipped and tested.”

Dr Hamrin cited the needs of continuing development and the increasing focus on centralization and quality care in transport as important issues for the future. “There is a need for continued development. Weight and space are always important issues in transport situations and will continue to be so. Alarms can be difficult to hear in the air, especially in helicopters. This means that we continuously need to keep our eyes on the user interface screen, and to be able to see the screen values and alarms clearly.”

“There is an increasing tendency to centralize specialized treatments at certain centers, which means an increase in the need for patient transports. There is a movement to more and more quality care during the transport. I think that if you are going to transport intensive care patients, by whatever means, the goal must be to provide the same level of intensive care treatment, and not to accept a lesser level of care during the transport, after receiving the patient. That simply is indefensible.”

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Biography

Tova Hannégård Hamrin received her medical degree at Karolinska Institute, Stockholm, Sweden in 1990. Her internship and residency in Anaesthesiology and Intensive Care took place at Sundsvall Hospital, Sweden 1990-1994. She was certified as a specialist of Anesthesia and Intensive Care by the Swedish National Board in 1998 and worked as a specialist at Stockholm South Hospital, Sweden from 1994-2001. Dr Hamrin was Specialist in Paediatric Anesthesiology and Intensive Care from 2000 to 2007 at Astrid Lindgren Children's Hospital, Karolinska University Hospital, Stockholm, Sweden. She currently holds the position of Director, Paediatric Anaesthesia at Astrid Lindgren Children's Hospital and has been responsible for the PETS (Paediatric Emergency Transport Service) program from 2005 to the present time.

Annika Schön obtained her initial nursing degree in 1986, and worked initially in the adult intensive care unit of St. Göran's Hospital in Stockholm. She received her nursing degree in anesthesiology at the Karolinska Institute University Hospital in 1990-1991, where she also worked within the central anesthesia clinic, as well as within intensive care in the ambulance service at that institution. Annika Schön has held positions within pediatric intensive care at St Göran's Hospital since 1995 and at the Astrid Lindgren Children's Hospital in 1998, where she has been part of the PETS (Paediatric Emergency Transport Service) group from the start. Annika Schön is also currently working to achieve her PhD degree at the Institute for Women's and Children's Health at the Karolinska Institute.

Åsa Englund received her initial nursing degree in 1987, and her nursing degree in anesthesiology in 1993. She was employed as an emergency room nurse at the Halmstad Community Hospital in 1988 and as an anesthesia nurse at the Varberg Community Hospital in 1993. During the years of 1999-2000, Åsa Englund was employed as registered nurse on an international cruise ship, with nursing responsibility for guests as well as for fellow staff members from over 50 countries.

Åsa Englund started working at SOS Flygambulans (currently named Svensk Flygambulans – Swedish Air Ambulance) in 2001 as head nurse with responsibility for 15 nursing staff members. She became Operations Manager for the company in 2006, in charge of over 30 staff members and responsible for the medical department, marketing and property and operations. Åsa Englund became acting Managing Director of Swedish Air Ambulance in 2007. In this capacity she is currently responsible for corporate accounting, PR, marketing and chief of staff, and is a member of the management group as well as the board of directors. She also retains overall responsibility as Ambulance Chief for the flight planning center and medical departments.

Carina Ramstedt obtained her initial nursing degree in 1973 and her nursing degree in anesthesiology at Uppsala University Hospital in 1976. From 1976 to 1986, Carina Ramstedt was employed as a nurse at the Pediatric Intensive Care Unit of Queen Silvia’s Children’s Hospital in Göteborg. She has also worked as an ambulance nurse as well as nursing positions within coronary care and neurosurgical departments. Carina Ramstedt was also employed by the Swedish Defence Department as a field nurse with assignments in Lebanon in 1990 and in Bosnia-Herzegovina in 2000. She is currently employed as Flight Nurse at Swedish Air Ambulance, where she has been working since 2001.