

Critical Care News

Institutional experience of NAVA in neuro and cardiovascular intensive care patients

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Darryl Ewanchuk, RRT and Dr Jim Kutsogiannis with ventilation patient in the neuro ICU.

Institutional experience of NAVA in neuro and cardiovascular intensive care patients

The University of Alberta Hospital in Edmonton is one of Canada's leading clinical, research and teaching hospitals, treating more than 700,000 patients annually within the region.

In addition to a wide range of diagnostic and treatment services, the hospital provides specialized services within cardiac science, neuroscience, surgery, medicine, critical care and emergency and trauma care.

The institution was one of the first to implement and utilize NAVA – Neurally Adjusted Ventilatory Assist as this ventilation technology became available in the beginning of 2008. Two specialty critical care units have been gaining experience in specific patient categories for the past 10 months; the Cardiovascular ICU and the Neuro ICU, and the technology is in line to be implemented at the pediatric and neonatal ICU at Stollery Children's Hospital within the institution.

Use of NAVA in neuro intensive care patients

Critical Care News met with staff members of the Neuro ICU and Cardiovascular ICU to hear about their experiences with the clinical application of NAVA in specific patient categories, and heard about plans for educating and evaluating the use of NAVA in the neonatal/pediatric ICU.

The Neuro Intensive Care Unit of the Neuroscience Department of the University Hospital of Alberta, in Edmonton cares for approximately 700-900 patients on an annual basis, with 11 beds within the unit. The unit is dedicated and is one of only 2 neuroscience units in Canada, staffed by 10-15 neurosurgeons, 7 intensive care physicians and 8 respiratory therapists.

Dr Jim Kutsogiannis of the Neuro ICU described the various patient categories that are admitted to the unit. “We see traumatic brain injury and subarachnoid hemorrhage, brain tumors and spinal cord injuries as our major patient groups. We do some neurology, but it only accounts for about 10% of our total admissions. We care for predominantly neurosurgery patients, but we are also referred patients with severe stroke and neuromuscular disorders.”

Darryl Ewanchuk, RRT outlined the various ventilation therapies that are most frequently used on the unit. “We are traditionally using Pressure Regulated Volume Control (PRVC) and Volume Control, and when the patient is suitable for supportive modes we use Pressure Support and on occasion APRV. We typically use conventional ventilatory strategies for the majority of our patients, and when it comes to difficult patients we like to dig into our toolbox and pull out other alternatives.”

The average length of stay for patients in the Neuro ICU is generally around 5 days, but categories such as elective surgeries generally move through the unit more quickly, and spinal cord patients are treated in the ICU for an average of 1- 2 months. Dr Kutsogiannis comments,



Darryl Ewanchuk, RRT shares his experiences with NAVA in spinal cord injury patients.

“Spinal injury patients are also the longest length of stay category by diagnostic code in the USA as well, so weaning these patients is a challenge. There is a paucity of published literature regarding weaning and modes of ventilation in spinal cord injury.”

Experience of NAVA in spinal cord injury patients

The staff members of the Neuro Intensive Care Unit received education and training on NAVA in the beginning of the year, and initially tried NAVA on a few patients that were ready to wean,

to gain experience where they were reasonably sure to achieve success. The use of NAVA was avoided in severe head injury cases, due to the depth of sedation in these patients, but use of NAVA has focused on the difficult to wean patient categories, such as spinal cord injuries and longer-stay patients.

Experience with NAVA was ramped up and intensified during the summer trauma season, which typically starts with a long weekend in May. Darryl Ewanchuk explains, “We have had 20 quadriplegic admissions this year, and from there we ran NAVA on

10 patients with spinal cord injuries. Much of our hands-on knowledge was gained in the latter part of the summer, when Dr Kutsogiannis and I started discussing the possibility of structuring some study-based protocols.”

Dr Kutsogiannis clarifies, “I am an epidemiologist as well as an intensive care physician, and the studies I do are ones where we try out a method on a subgroup of patients, to get a feel for what is achievable and develop a protocol from this base. I think we are at a stage now where we have sufficient exposure with these patients that we can develop a protocol for how to wean these patients from start to finish. It will require some modification, but based on our experience over a few decades here with our dedicated neurosciences ICU, and our respiratory therapists that specialize in the spinal cord patient category, it is manageable.”

“We feel that these spinal cord injury patients are a population of patients that is ideal for NAVA, as very few of the spinal cord patients have severe head injuries. They are awake and their brains work, but have neuromuscular weakness from their spinal cord injury. Their diaphragms are mainly preserved, so what they need is augmentation of their natural relay between the brain and the diaphragm. They are a “clean” patient population in that they are reproducible; they do not have any other disease factors. Physiologically it makes sense to utilize NAVA in this patient population. This has also been borne out in our experience to date where we have had success with NAVA so far.”

NAVA from start to finish

Darryl Ewanchuk and fellow respiratory therapists have been educating their colleagues in the emergency room about the function and placement of the Edi catheter. He summarizes the situation: “In a crisis situation after intubation in the ER, we have educated how the Edi catheter should be inserted, so that everything is in place in the patients when they arrive to our unit a few hours later. This enables us to monitor their Edi status as soon as we receive the



Dr Jim Kutsogiannis is interested in studying NAVA in depth in spinal injury patients, as they are typically the longest staying patient category in hospital.

patients. Spinal cord injury patients have so much to deal with anyway with these types of injuries, they are often young and their whole world has changed, so we are adverse to extra interventions when they are awake in our unit.”

Dr Kutsogiannis adds “Our colleagues in the ER contact me when they receive patients with spinal injuries not resulting in neurological deficit, for example spinal fracture but the spine is intact, and ask me if the Edi catheter should be placed in these patients. It is a good cooperation between the ER and the ICU that assists us in implementing NAVA early in the patient care process. We had two particular patients at the end of the summer that were treated with NAVA concurrently. We were fortunate that from the time the patients were admitted right up to the time they were transferred out of the ICU, they were solely ventilated on NAVA from beginning to end. We have met with some hurdles along the way, it requires bedside

focus, troubleshooting and learning to understand the Edi signal in relation to recovering neuromuscular condition of the diaphragm. One needs to try it out on several patients and observe it systematically. These patients that were on NAVA from start to finish required it for approximately two weeks.”

Spinal cord injury patients were defined as an interesting category by the staff members to gain experience with NAVA, as they do not require a great deal of sedation and initially have healthy lungs. They may develop pneumonia during the course of their stay in the ICU, but they generally are not ARDS patients. The spinal cord patients often receive bronchodilators, anti-mucolytic therapies and antispasm drugs for muscle spasms. Neuropathic pain is dealt with by means of certain analgesics, and sleeping aids are also administered, but these patients usually do not receive much medication in comparison to general ICU patients, according to Dr Kutsogiannis.



Darryl Ewanchuk and Dr Kutsogiannis have educated ER colleagues about the use of NAVA in spinal cord injuries, so that the Edi catheter can be placed as soon as possible after patient admission.

Avoiding rapid disuse atrophy

In terms of titrating the NAVA level in spinal cord injury patients, there are three parameters generally used. Dr Kutsogiannis explains: “Work of breathing, rapid-shallow breathing index and another index we are developing are used to titrate the NAVA level. The latter parameter incorporates respiratory rate and inspiratory time. During the day we will allow the patient to work more, and at night we are more restrictive, meaning more assist and unloading from a higher delivered NAVA level. What is critical is measuring work of breathing, because we do know from esophageal balloons and traditional respiratory physiology that beyond a certain level of work of breathing it is not possible to sustain breathing. Dr Christer Sinderby and I have had discussions regarding this, and we will incorporate parameters in our protocol in these patients to look at NAVA compared to conventional mechanical ventilation.

We have started to systematically collect information every hour, to observe the ranges in these parameters in order to plan for our protocol.”

Darryl Ewanchuk agrees. “There was a study published in the New England Journal recently about rapid disuse atrophy, and in recent years we have really shifted our whole philosophy. When I first started here, our spinal cord patients came in through the emergency department and would struggle in a trauma unit with pneumonia and other complications, and we would see them in a crisis situation. Today, interventions are occurring earlier in the ER, they are getting intubated and put on partially supported modes of ventilation whenever possible, to avoid atrophy. This is why I think NAVA will give us the potential to shorten our weaning times and lengths of stay for these patients, compared to supported modes of ventilation. There is a big shift in a consistent pattern in how we deal with these patients, a more systematic approach.”

Edi signal monitoring is also used as a tool to determine the level of support needed. There has been some experience in using the Edi signal and tracing as a diagnostic parameter in conventional ventilation modes, according to Darryl Ewanchuk. In regard to spinal cord injury patients on NAVA, data is downloaded every morning, in order to see and compare patterns at night and in daytime. Dr Kutsogiannis states, “We are using these tools based on sound respiratory physiology, but I think this will be an area of research for us in the future. We know that these patients need to be breathing to some extent, in order to strengthen their diaphragm and avoid disuse atrophy. At the same time, we know if they breathe on their own for too much, they may decompensate and it may take a long time to get them back to where they were. It is a delicate balance, as training for a marathon, which may be a good analogy to describe the situation.”



Darryl Ewanchuk is interested in the potential of NAVA to avoid diaphragm disuse atrophy.

Training and educational effort

All of the staff members within the Neuro Intensive Care Unit have had various levels of training from the start of the implementation of the modality within the unit. Dr Kutsogiannis has been spearheading this modality with his ICU physician colleagues and distributing literature and information. The nursing acceptance of NAVA is critical as well and there is a learning curve in this respect, as something new may be a subject of resistance which requires a lot of education and reassurance for a positive implementation, according to Dr Kutsogiannis.

An educational package has been provided to respiratory therapists and nursing staff members, according to Darryl Ewanchuk, and since the spinal cord injury patients are seasonal, a roll-out of education sessions for nurses is planned in the early spring. He also agrees that education and reassurance are important factors, and states, "There has been some doubt with some of

my colleagues, but one of them was involved with a spinal cord patient that was ventilated with NAVA from start to finish, and at the end of the case she told me that she wouldn't have believed it if she had not seen it herself."

"Bedside experience of observation of the patient and the Edi signal is critical. We need to integrate respiratory physiology with what we learn with NAVA at the bedside in order to go forward, and in some cases re-learn old knowledge. The fact that we have put some of these spinal cord patients on NAVA upfront is really remarkable, considering that we do not often put these patients on Pressure Support from the beginning. NAVA gives us the opportunity to augment these patients own drive to breathe enough to recover more quickly."

Within the Neuro ICU, the respiratory therapists are responsible for placement and verification of the Edi catheter. In an early case with a patient with Guillain-Barre syndrome, it was not possible to obtain an Edi signal, since there was so

little electrical activity of the diaphragm. This was also a learning experience for the respiratory therapists, as Darryl Ewanchuk explains, "We decided to leave in the Edi catheter, and as the patient improved, we found that the Edi signals started to appear and develop. I came in the morning and a colleague told me we were getting Edi signals, which were amazing. This patient was switched to a t-piece trial very quickly after that and was soon off the ventilator."

Dr Kutsogiannis agrees that NAVA offers new learning opportunities. "We had a meeting recently with resident education, in terms of studies and trials, and I think we may have been at risk of losing basic physiology with some of the residents. Things like work of breathing is fundamental in terms of respiratory physiology, but we seem to tend to be bogged down in logistics, such as weaning protocols and other operative issues, where it is easy to lose the fundamentals of basic physiology and anatomy. The New England Journal study of rapid disuse atrophy earlier this year



Darryl Ewanchuk and Dr Jim Kutsogiannis are also interested in studying NAVA in other patient categories that may be prone to muscular fatigue.

highlights this point; we need awareness of diaphragmatic issues in order to build sound clinical applications. We need to consider why asynchrony may occur in mechanically ventilated patients.”

Future use of NAVA in the Neuro ICU

In the process of developing guidelines for conditioning and weaning of spinal cord injury patients with NAVA, Dr Kutsogiannis mentions that a randomized trial comparing traditional mechanical ventilation with NAVA in spinal cord patients is planned. “I think our endpoint will be length of stay and ventilator-free days, but we have not yet started our calculations. Interventions and complications are also interesting endpoints, since these are the longest staying patients in the hospital, to determine improving patient care.”

“Secondly, looking at economics worldwide in regard to spinal injury patients and implications for costs in hospitals is an important factor. If

we can shorten their length of ICU and hospital stay in rehabilitation, this would be a big benefit for these patients as well as the institutions caring for them” says Dr Kutsogiannis.

In terms of additional research and areas of use for NAVA in the future, Dr Kutsogiannis mentions other patient categories, including COPD, and Edi monitoring in head injury patients and difficult to wean patients. “Chronic COPD patients spend a lot of time in the ICU after their initial situation is dealt with, they have neuromuscular fatigue and their lung function is weakened. They spend a lot of time in the ICU in the weaning process, and this is another opportunity for NAVA I see. They are also awake and alert patients, and need to regain strength to come off the ventilator.”

Dr Kutsogiannis is interested in Edi monitoring of head injury patients in future, in order to monitor signal patterns in severe injuries and to determine the point that they start to recover.

“There are sedation levels and brain function, and we have implemented continuous EEG monitoring here, so I would like to look at continuous EEG monitoring and the relationship with Edi signals in these patients as they start to normalize, to determine if this happens synchronously or not.” In terms of other difficult to wean patients, he is interested in knowing if the conventionally mechanically ventilated patients are being ventilated optimally. He would like to study Edi signals in these patients to determine if they are being oversedated, or if there is a need to change the parameters of the conventional modes being used.

Dr Kutsogiannis summarizes future challenges by stating that “In pioneering new methods and modalities, the biggest obstacles are often ourselves. People may be resistant to change, but that does not advance medical care”.

Use of NAVA in cardiovascular ICU patients

The University of Alberta Hospital in Edmonton is one of the largest transplant centers in Western Canada, with approximately 25 heart transplants and 33 heart-lung transplants conducted annually. With over 14,000 open heart surgeries per year, the institution is planning to open the Mazankowski Alberta Heart Institute in 2009, one of the largest centers of its kind in North America, with some of the most advanced technology in the world.

The Cardiovascular Intensive Care Unit provides care to patients pre and post open-heart and transplant surgery, and contains over 20 beds. In addition to 10 surgeons, there are 8 intensive care physicians on staff, and over 25 respiratory therapists and 95 nurses within the unit, as well as pulmonologists and physiotherapists on the interdisciplinary team. Average weaning time for ventilated patients may range from 8 hours for CABG (coronary arterial

bypass graft) patients to 4.7 days in more complex cases such as lung transplants. Staff members within the unit started experiencing use of NAVA in January 2008, and intensive care physician **Dr Craig Guenther** states, "I read the original research article in Nature Medicine in years past, and when we saw that NAVA became available, we regarded it as a weaning modality, for our patients that are here for 4-6 days and are difficult to wean. Long-term ventilation in the global literature is about 96 hours, so this is something we are very interested in influencing if we can." Respiratory Therapist **Kevin Coghlan, RRT** agrees "The intensive care group is very progressive and tend to listen to new ideas and new aspects of ventilation. I kept discussing the idea of NAVA and as we learned more, I was fortunate to attend a symposium in New York in 2006, and after that it seemed very clear that we should be investigating this possibility.

Using NAVA in failure-to-wean patients

NAVA has been run in a wide variety of critical care patients in the Cardiovascular ICU, including COPD, lung transplant and delirium patients, and other patients that may be experiencing dyssynchrony. Kevin Coghlan states "We have used NAVA on delirious patients, and we tend to get a bit of that with the elderly and anesthetics, and NAVA works well for those types of patients. We have also used NAVA on lung transplant cases and we have been able to diagnose a diaphragmatic paralysis with the Edi catheter in one case." Dr Craig Guenther adds "The diaphragmatic paralysis patient was an interesting case, as we were trying to learn the technology. We were having difficulties in weaning this patient, and trying to figure out rational reasons for these difficulties. It was pretty apparent when switching over to NAVA that he was having difficulties in triggering despite the fact



Kevin Coghlan, RRT and Dr Craig Guenther observe Edi monitoring trends of a lung transplant patient.

that we knew that the Edi catheter was in the right spot. We did not see any diaphragm activity going on, which led us to believe that there was phrenic nerve involvement. That led to a bilateral ultrasound investigation that confirmed the paralysis.” Kevin Coghlan agrees: “The diaphragmatic paralysis case was interesting, he was only 3 days out and the surgeon decided to plicate the diaphragm very quickly. In doing that, I think the patient was spared from a long wean, and avoided problems with consistent collapse. But we also utilize Edi monitoring to understand other modes of ventilation, as we had with a 26 year old lung transplant patient today. You can adapt it and learn from it.”

NAVA in delirium patients

Dr Guenther states that one of the aspects he is most impressed with regarding NAVA is related to the issues of dyssynchrony in spontaneously breathing patients and night resting possibilities. “One of our hypotheses is to determine if you can actually provide the patient with REM sleep with greater episodes

at night, and would this technology provide this? As you enter into the unit, it is busy and the patients are agitated, so they are usually put on a rate at night. When we have switched to NAVA, we realize that their respiratory rate is 45, but no REM sleep is being seen on the EEG. We have a delirium project that is planned for the near future to further investigate these possibilities with our new information system, that is similar to the one Johns Hopkins Hospital is using.”

“The Edi signals absolutely give us new dimensions to see things we would not have seen before. We have to take it to the next level, which is defining an intervention path that affects these factors, requiring science and documentation, but it is very interesting to see so far. We are all interested in delirium, we are all getting older patient populations wherever we are in the world, as our 82 year old mothers are having surgeries that they have never had before. The one thing in cardiac surgical literature that is very clear is that delirium after bypass surgery is a very great mortality-related phenomenon.” Any aspect of care, such as ventilation,

that can affect delirium, is very valuable according to Dr Guenther.

Monitoring of the Edi signal

Kevin Coghlan finds it fascinating to monitor Edi signals of conventional modes, such as PRVC and Pressure Support, prior to switching to NAVA. He describes, “We can learn so much about everything that we thought we knew, only to discover that we need to learn more. We are re-learning. The Edi catheter allows us to see that work of breathing is twice or three times what it should be in some cases, and allows us to study screens and trends. We really have to start thinking about other modes and why they have not been optimal, and what little adjustments we need to make or titrate. We typically have patients on PRVC, and as they rewarm and hemodynamics are in balance, we move to Pressure Support. We really have opened our eyes in regard to Pressure Support and the parameters we set, when we have observed the Edi signals and seen the whole process.”



Dr Craig Guenther and Kevin Coghlan, RRT, are interested in studying Edi signals of delirium patients and with regard to their REM sleeping patterns.

In terms of titration of the NAVA level, the staff members generally start with the NAVA preview, and the NAVA level is titrated up or down, based on the respiratory rate and minute ventilation of each particular patient, according to Kevin Coghlan. “Typically we titrate very slowly, in increments of 0.1 or 0.2 and observe how the patient is doing in the process as a graduated response.”

“What really struck me with NAVA is that it challenges respiratory therapists to think about what is going on in the patient, and the therapist-patient-ventilator interaction. It is very much Back to Basics physiology. For a lot of these patients it can be difficult, lung transplant cases may have 5 chest tubes in place, and their thoracic compliance is quite different to other patients, which means you must ask yourself – which work load does that mean for these patients? In addition to NAVA, Edi monitoring would be great to have on all ventilators.”

Esophageal ECG monitoring, and different pacing devices

The staff members have had early experiences with interference of the Edi catheter with specific pacing devices, and also with details provided by esophageal ECG monitoring. Dr Guenther explains “Sometimes rhythm disturbances may occur to post-op cardiac patients. We had a NAVA patient in atrial fibrillation on a pacemaker, and the esophageal ECG picked up the fibrillation which the ordinary surface ECG leads did not. There were clearly atrial dysrhythmias that were not picked up by the surface electrodes”.

As more patients are coming out of surgery with pacemakers, and as the different models of pacing devices are increasing, there is an interest to study the technology to determine how much interference can be attributed to the Edi catheter in specific types of pacing devices. Kevin Coghlan clarifies: “We had two patients with left ventricular assist devices, and one in particular was very interesting, with a pacing spec appearing as a big square wave on the Edi electrodes. That was an internal pacemaker, versus the external pacemaker that had a



Kevin Coghlan, RRT feels that NAVA offers educational opportunities in basic physiology, especially for hard-to-wean patients.

slightly different waveform showing up on the Edi signal. We have had two different pacemakers showing different disturbance patterns on the Edi signal”.

Dr Guenther concurs, “We are interested in this, since it helps us to understand. We are learning the benefits of NAVA and the physiology of breathing, and we would like to validate from a research perspective by doing more pacemaker patients in terms of the different pacemaker technologies. We want to define what interferes and what does not, in order to optimize the use of the technology”.

NAVA in future research areas

Dr Guenther believes that delirium patients will continue to be the primary area of interest for NAVA research within the unit, as they struggle to get their patients to sleep in a more restful manner. “NAVA will be a huge player in getting people to understand

what is happening with the delirium patient, and valuable in understanding the weaning process. Getting a more optimal ventilation method at nighttime is a significant factor and we need to know how we can better support these patients. That is the most important aspect to me, understanding the difficult to wean patient and making inroads in what is going on during nighttime.”

“You could never have tracked this, nor assessed this information with any other ventilation modality. This provides us with the means to learn, but we need to educate others as well. NAVA and Edi monitoring allows you to take information that you would not be supplied with otherwise, in order to see how Mrs Jones is doing at bedside at 2.30 in the morning. Delirium is not going to disappear, and the patients are not getting any younger. We need to understand modalities and rest at nighttime, and we need to use technology to help us. “

The educational plan for NAVA in the pediatric/neonatal ICU

After the introduction of NAVA in the Neuro ICU and the Cardiovascular ICU of the University of Alberta earlier this year, the next unit to be introduced to NAVA will be the pediatric/neonatal intensive care unit of the institutional children's hospital, the Stollery Children's Hospital.

Respiratory Therapist Julie Mitchell, RRT and RT Educator will be initiating this educational effort. As staff educator for all respiratory therapists within the institution, she has been responsible to coordinate training of staff with vendors. She defines her responsibility in this respect, "Basically I work in initiation of all educational requirements any time a vendor offers a new product or technology that we purchase to implement in our working day. When the vendors leave, I act as a coordinator for all staff questions."

With a staff of about 200 respiratory therapists at the University of Alberta and Stollery Children's Hospital, Julie Mitchell is not only the sole clinical educator but is also a general resource for the respiratory therapy staff members, including general education and policy and procedures as well.

NAVA educational effort

There was a structured plan in introducing NAVA to the two intensive care units previously in the year. The manufacturer representative was on site for the first weeks to help implement the start-up process. Julie Mitchell describes the process: "The first sessions were set up with a full week of education, with no implementation at that point. After that point, inservicing was set up with the schedule for all respiratory therapists, nurses and physicians within the intensive care units. We did have concurrent sessions for nurses, respiratory therapists and physicians that were invited to come morning and afternoon and at nighttime for night staff as well."



Julie Mitchell, RRT, is staff educator for all 200 respiratory therapists at the University of Alberta and Stollery Children's Hospital in Edmonton.



The pediatric and neonatal intensive care units of Stollery Children's Hospital are the next units in line for introduction of NAVA at the University of Alberta Hospital in Edmonton.

The second week consisted of implementation, finding appropriate patients, placing the Edi catheter and observing Edi signals at bedside, followed by running NAVA and observing and following up on patients. In the third week, the intensive care units were running the patients on NAVA themselves, with the representative available as a resource for questions.

Julie Mitchell coordinated follow-up sessions about 6 months after the introduction. "In the follow-up session, we gathered information about what we had learned and how we were troubleshooting. I prepared a summary after those sessions in how to use and troubleshoot NAVA. This summary, together with power point presentations and the user manual have been collected in a shared space in our computer system for the respiratory therapists. This will allow the staff members to access the information, together with policies and procedures when needed."

Neonatal/pediatric start-up

When the physicians have confirmed the start-up date, Julie Mitchell will prepare educational materials as well as modules

and Edi catheters for the introduction. "The process will follow the same cycle: education during the first week and implementation during the second week. We will start out with Edi monitoring

focus, and go on to NAVA from there. We hope to give the staff members the same information as we did in the earlier educational sessions, but with more of a pediatric/neonatal focus. ■



The University of Alberta Hospital in Edmonton is one of Canada's leading clinical, research and teaching hospitals.

Biography

Jim Kutsogiannis, MD, MHS, FRCPC obtained his medical degree at Queen's University, Kingston Ontario, Canada, and completed a residency in Internal Medicine from the University of Western Ontario, Canada, followed by a fellowship in Critical Care Medicine at the University of Alberta, Canada. Thereafter, Jim Kutsogiannis completed research training in clinical epidemiology from the Johns Hopkins School of Public Health, in the USA. Jim Kutsogiannis is currently an Associate Professor of Critical Care Medicine at the University of Alberta, the co-director of the Neurosciences ICU and the Director of the Human Organ Procurement Program for Northern Alberta. Dr Kutsogiannis

has a research focus in critical care nephrology and neurocritical care.

Darryl Ewanchuk, RRT studied initially as Bachelor of Science at the University of Alberta, Edmonton, Alberta Canada in 1988. He received his Respiratory Therapy degree from the Northern Alberta Institute for Technology in Edmonton, Alberta, Canada in 1990. He started as Clinical Respiratory Therapist at the University of Alberta and Stollery Children's Hospitals from 1990-1994. He thereafter took a position as Clinical Respiratory Therapist at the King Faisal Specialist Hospital and Research Center in Riyadh, Saudi Arabia from 1994 to 1996. After serving as Clinical Respiratory Therapist at the University of

Alberta and Stollery Children's Hospitals from 1996-2004, Darryl Ewanchuk became Respiratory Therapy Supervisor Neurosciences at the same institution in 2004. Darryl Ewanchuk is currently serving as Respiratory Therapy Supervisor, Neurosciences/ENT/Surgery at the University of Alberta and Stollery Children's Hospitals, a position he has held since 2006.

Craig Guenther, MD, BSc Pharmacy, CCFP, FRCPC obtained his undergraduate degrees of BSc, MD and LMCC at the University of Alberta in Edmonton from 1976 to 1982. He completed his residency in Surgery (orthopedics) at Dalhousie University, Halifax, Nova Scotia from 1984-1985, and

residency in Anesthesia at Foothills Hospital at the University of Calgary in Calgary, Alberta from 1989-1991. Craig Guenther conducted his Clinical Research Fellowship at the Ottawa Heart Institute in Ottawa, Ontario in Cardiovascular Anesthesia and Critical Care from 1991-1992. His echocardiography training took place at Calgary General Hospital in 1996, and he obtained his Society of Cardiovascular Anesthesiologists (SCA) and Perioperative Transesophageal Echocardiography Examination (PTEeXAM) in 1998. Craig Guenther is currently Clinical Associate Professor at the Department of Anesthesia and Pain Medicine at the University of Alberta Hospital. Dr Guenther has a research focus in analgesia and sedation in the ICU and transfusion and coagulation in cardiovascular surgical patients as well as renal replacement therapy and dialysis in post-op cardiac surgical patients.

Kevin Coghlan, RRT received his degree from the Northern Alberta Institute of Technology in 1988. He has been Supervisor and Program Specialist for the Cardiovascular Intensive Care Unit of the University of Alberta Hospital in Edmonton since 1992. Kevin Coghlan RRT is currently taking an 8 month temporary assignment covering Pulmonary, Coronary and Emergency Care within the University of Alberta Hospital in Edmonton.

Julie Mitchell, RRT, received her Bachelors of Science Degree in 1995 at the University of Ottawa in Ontario, and her degree in Respiratory Therapy at Fanshawe College of London, Ontario in 1991. She worked as Respiratory Therapist from 1999-2006 at the University of Alberta Hospital in Edmonton. Julie Mitchell currently is Clinical Educator, Respiratory Therapy for the University of Alberta Hospital and Stollery Children's Hospital in Edmonton, a position she has held since 2006.

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