Light in a window: nurse practitioners utilizing bedside ultrasound

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Introduction & Background

Since the 1980s in Canada, the addition of the role of the Nurse Practitioner (NP) to the healthcare system has enhanced and improved the continuity of acute care and patient outcomes (Sangster-Gormley, Martin-Misener, Downe-Wamboldt, and Dicenso, 2011). NPs have helped reduce physician workloads and have assisted in the delivery of complex diagnostic, prescriptive, and procedural care. This trend has been evident at Calgary's South Health Campus (SHC), where I work as a critical care ICU Nurse Practitioner. The facility opened in 2013 and now has 2,400 full-time staff positions and 180 doctors and 25 NPs.

The Department of Critical Care Medicine (DCCM) at SHC supports the implementation of technology in the facility's clinical program, and it promotes the training of ICU NPs to utilize these tools and contribute to the health-care teams' services. For instance, over the past three decades with respect to the application of bedside ultrasonography (U/S), emergency department physicians have traditionally been the personnel designated as the sole implementers of the procedure (Palma, 2015). However, at SHC, as well as in other institutions, NPs have increasingly been delegated to receive specific training in bedside ultrasonography and its application, which has resulted in: (a) expanding U/S's availability to assist the critical care team in treating patients requiring immediate interventions; (b) aiding in reducing misdiagnoses that had been shown to arise from inaccuracies in the conventional physical examination or from incomplete patient medical histories; and (c) decreasing procedural risks in administering prescribed ICU protocols.

In 2014, DCCM Calgary, provided funding for me to complete an ultrasound course offered by the Society of Critical Care Medicine (SCCM) in Chicago, where I learned theory and application of bedside ultrasound technology. The course provided attendees with interactive presentations, realistic practice at guided skill stations, personalized SCCM faculty mentorship, and hands-on sonogram experience with live models. Upon my return to SHC, I began applying these newly acquired skills, and was also aided by the echo cardiology technologists and Dr. Patrick Champagne from the Department of Cardiology, who provided me with further opportunities to implement my ultrasound knowledge.

Highlights

Highlights of my application of bedside ultrasound in our ICU, and that of other NPs

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who received this training, were that we have confidence of indirect visualization in placing central venous catheters in patients; to correctly establish difficult peripheral Intravenous access; to accurately identify important anatomical structures for safe chest tube insertions and pleurocentesis; and to have access to an important adjunctive assessment tool in the determination and differentiation of shock.

A key feature that our ICU team has noted is that the addition of this 2D ultrasound has improved overall patient safety. One sentinel example has been our common use of the internal jugular veins for central venous cannulation for central line placement, dialysis catheter, and plasmapheresis. Traditionally, when anatomical landmarks were used to guide practitioners in placement of lines, complications such as inadvertent puncture of the carotid artery and subsequent hematoma, thrombosis, embolism, pneumothorax, and/or nerve injury especially with repeated attempts to cannulate the vessel were more prevalent (O'Grady, Alexander, Burns, Dellinger, Garland, Heard, Lipsett, Masur, Mermel, Pearson, Raad, Randolph, Rupp, and Saint, 2011).

However, in contrast, with use of ultrasound guidance, we were able to confirm indirect 2D visualization of patient anatomy and were consequently able to reduce the emergence of complications largely because of increased initial success rates. We confirmed that using ultrasound to improve first attempt cannulation of large vessels benefitted both the patient and the ICU team in several ways: by promoting prompt treatment of shock with rapid fluid/ blood product resuscitation, by providing vasopressor support, by monitoring central venous blood gas, and/or by increasing ease of drawing blood samples frequently needed in the critically ill.

We also observed that using ultrasound guidance reduced stress on ICU team members (RNs/ RTs) who were awaiting the completion of the procedure (cannulation of a central vein) to proceed with further stabilization or advanced resuscitative therapy, including massive transfusion, vasopressor/inotropic support with patients in shock, prompt initiation of dialysis, or plasmapheresis. All of these critical care therapies are based on having accurate central line access.. We were gratified that these positive observations we have witnessed over the past years at SHC appear to confirm what previous research had reported regarding the efficacy of bedside ultrasound technology in improving NP clinical decision-making and successful patient care (Brass, Hellmich, Kolodziej, Schick, and Smith, 2015).

Implementation and Results

Case 1

I present three cases as examples of how my personal experience with bedside ultrasonography has aided our ICU team to provide clarity in administering appropriate patient care. The first case is illustrated by the accompanying graphic, which is a 2D ultrasound image on an obese patient. The

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photograph illustrates that if the practitioner were to insert the tube a few millimetres too far, he/she would likely cause an iatrogenic carotid arterial puncture as the needle passed through the jugular into the carotid artery. However, ultrasound technology diminishes the chance of such an error by indirect visualization of the tip of the needle tracking into the desired vessel.

Furthermore, at the time of this writing, the SHC ICU has not had a central line infection in NP-placed CVL lines in over the past year, a fact we attribute to the benefit of sterile procedure during line placement and reduction of multiple attempts at vessel cannulation (O Grady, et al., 2011).

Case 2

A second example was an 80-year old female who was admitted post-operatively to our ICU for further critical observation, because she had a few critical moments while in the OR. The patient was otherwise well, and in the pre-operative interview she had denied any significant medical /known cardiac history and was not taking any medications. She presented to the Emergency Department with right lower quadrant pain, and the surgical team had proceeded with an incarcerated inguinal hernia repair. In the operating room, after receiving 20 mg of propofol, a sedative/ anesthetic induction agent, she suffered a brief but significant bradycardic and severe hypotensive episode. She received one cycle of CPR and intravenous epinephrine. She quickly rallied and the bowel resection was completed. Afterward, because of her seeming clinical

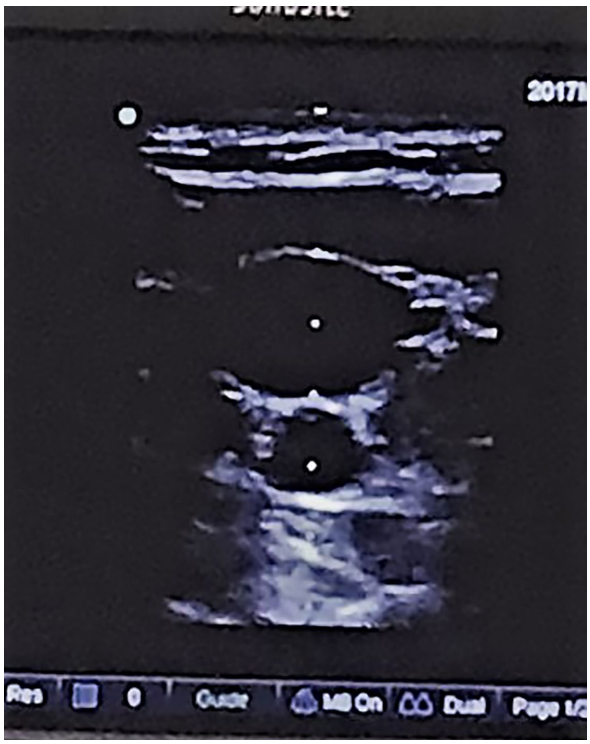

Figure 1. Right internal jugular mm superior to carotid artery

stability, she was extubated and removed from the ventilator, and brought to the ICU for post-operative monitoring.

Her post-op course required several IV crystalloid fluid boluses for decreased urine output and hypotension or “soft” blood pressure. However, after receiving the IV fluid boluses, she again became bradycardic and significantly hypotensive. Our NPs were immediately called to the bedside and detected a loud systolic murmur and obtained bedside ultrasound images to further guide and identify the cause of this shock. The parasternal long/short axis view (PLAX, PSAX) identified a completely stenotic mitral valve. A formal echo was then

ordered, and the echo cardiologist confirmed that the patient had a severe rheumatically diseased mitral valve with elevated left atrial and right heart pressures.

During this episode, a cardiac-specific functional inquiry occurred. The patient divulged that she had rheumatic fever at age 16 but said that she never considered it a medical issue for her, and she did not think it was necessary to disclose that detail in her pre-op surgical interview, because it had not been of any significance for her. Within minutes of this information, our team was able to implement bedside U/S and echo procedures, to form a treatment plan, to guide overall patient management, and to discuss treatment options with the patient and her family.

Case 3

The third example I present occurred in May 2017, regarding a 64-year old female, who was admitted to the ICU post-operatively with a complex reconstruction of her right femur. Through her OR course, anesthesiologists utilized vasopressors to maintain an adequate blood pressure. The patient later arrested in ICU, and the on-coming ICU bedside MD ran a code blue. However, just prior to the arrest episode, a NP had successfully obtained bedside U/S images. The ultrasound revealed that the right ventricle was markedly dilated and was accompanied by a deviated and flattened intra-ventricular septum with an under-filled left ventricle. These images signaled the acute right ventricular strain and a pulmonary vascular obstruction—a pulmonary embolism, or a fat embolism leading the differential diagnosis. These findings were communicated to the attending intensivist on call with a degree of certainty concerning the etiology of the arrest. As a result, thrombolysis was promptly ordered and delivered, and the patient was resuscitated successfully and fortunately did not suffer post TPA hemorrhage post operation. Of note, a confirmation echo was ordered, which subsequently confirmed our bedside U/S findings.

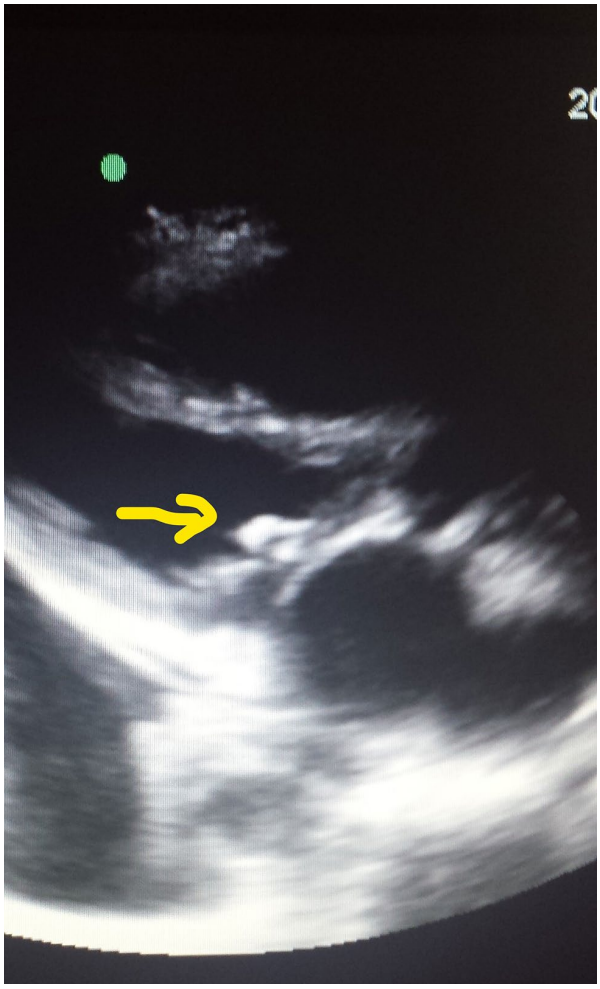

Figure 2. PLAX (Parasternal long axis) view of stenotic mitral valve; arrow indicates the stenotic lesion

Lessons Learned

As shown by these examples, the entire ICU team in our facility has benefitted in several pragmatic ways from having interested NPs receive training to apply U/S technology. These benefits are: broadening the accessibility of the U/S devices, strengthening the ease of use of the equipment, enhancing team-members' skill-based competence and confidence, building a spirit of team collaboration, and bolstering overall staff

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Figure 3. Robert Ralph, ICU NP

morale. These results have helped create what we called a "light in the window" in reference to the U/S anatomical picture window that is visualized by the operator.

Next Steps

As with any technical skill, bedside U/S requires both practice by personnel and oversight by qualified mentors, as postulated by Benner (2001) in her novice-to-expert conceptual model of clinical development. This theoretical model has implications for training NPs to use bedside U/S in ICU. By providing such experiences as on-the-floor training under the guidance of experts and by offering supportive professional courses, we believe that healthcare administrators and educators could enhance the building of professional skill, proficiency, and satisfaction among novice NPs. Such initiatives could help ensure that critical ill patients in Canada would have the safety net of the bedside ultrasound procedure during technical invasive treatment. We have learned in our unit that under critical life-threatening circumstances, NPs who have training in bedside U/S can provide critical information to bolster the traditional clinical exam by offering clear diagnostic cues in guiding treatment choices in real time. This indeed would brighten the light in the window.

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