The benefits of a portable head CT scanner

by Dr Andrew P. Carlson

Computed tomography (CT) has become the most accessible standard technique in the diagnostic toolkit for head and brain imaging. The use of head CT in general has led to a major paradigm shift since its advent in the 1970s and 80s, making the days of exploratory burrholes unnecessary. The development of CT imaging with funding from the recording company EMI led to a Nobel prize in Physiology or Medicine in 1979 [1]. Since the time of the installation of the first EMI scanner of the head at the Mayo clinic, the hardware and software improvements have been monumental.

A more recent development in CT imaging has been the development of a portable head CT scanner [2,3]. Though there are several types, the NeuroLogica CereTom (Danvers, MA, USA) is the best evaluated and will be discussed here. There are many theoretical and actual benefits to such a technology. Besides having utility in clinical decision-making, the scanner is a cost-effective investment as well.

Overview

The scanner itself weighs around 750lb, and can be wheeled either manually or by a joystick control by one person. The scanner and its separate control tower can be stored in a hallway or spare room. [Figure 1]. Once the scanner is positioned, the scans are carried out by precisely advancing the scanner itself on a “centipede” system of tracks. The scanner has eight detectors, and has been carefully independently assessed and found to produce high quality, diagnostic images with similar radiation dose to conventional scanning [4]. All standard CT settings are adjustable to the radiologist’s preferences and there are several dose settings and types of reconstruction algorithms for images.

Clinical utility of portable CT

There are at least three key advantages to the use of portable CT head imaging:

1. Portable CT allows for critically ill patients to remain in one place without risking transportation-related morbidity.

The risk of intra hospital transportation to patients is increasingly being recognised. A typical visit to radiology at our institution requires that all of the patient’s monitoring cables be shifted to a small transport monitor. Most invasive neuromonitors are disconnected and not monitored during transportation. The endotracheal tube is either connected to a portable ventilator or a bag-valve mask (though recently efforts are being made to transport without any circuit disconnection, so the entire ventilator is brought). The nurse, one of the two patient care technicians for the unit, and the only respiratory therapist then accompany the patient down an elevator and through a hall. The patient and all the lines are then slid onto the CT table, the scan is performed, and the patient and all the lines are slid back.

During this period, there are many occasions when a central line, arterial line,
external ventricular drain or other monitoring device can be displaced. One report noted that such mishaps occur in 40-60% of patient transports [5]. Performing the CT at the patient's bedside has been shown to decrease the risk of complications from 25% to 4.3% in high risk patients [6]. Besides these kinds of events, many critical monitoring parameters may not be recorded during the scan and transport. For neurosurgical patients, this may be particularly relevant if the CT scan is attempting to answer a physiologic question such as is the case with a CT perfusion or xenon/CT blood flow study. If the patient's intracranial pressure or oxygenation probes are not recording, it may be difficult to correlate the tomographic data with the continuous data back in the ICU [Figure 2].

2. Portable CT provides fast access to information for making emergent patient care decisions.

Speed in decision-making is often critical in neurological situations and the now familiar “time is brain” mantra is true for many critical conditions. Pooled estimates of recovery with tissue plasminogen activator (t-PA) in cases of acute stroke show a better rate with the continuous data back in the ICU. Furthermore, respiratory or critical monitoring parameters may cause a portable CT to be too unstable to be transported safely. Bedside imaging would then be the only way to obtain information with regard to intracranial processes. Patients with a post-operative haematoma can be diagnosed quickly and brought back to the operating room if needed. The scanner can be used to check the position of ventricular catheters in the brain at the bedside immediately after placement or even during the procedure [Figure 3].

3. Portable CT allows for anatomic imaging in locations within the hospital that typically do not have access to CT imaging.

Besides the intensive care unit, there are several areas that might not have access to scanning where it may be useful. We found that when portable CT scanning was used in the operating room for a specific procedure such as the placement of a shunt catheter or tumour resection, changes were made in 32% of cases [2], [Figure 4]. Intra-operative imaging is increasingly being used, but for many institutions it is cost prohibitive. A fixed CT or MRI scanner in the operating room will be unused for much of the time, so hybrid systems are in use where routine scans can be performed in an adjacent room, but this still limits scanning to one specially equipped operating room. CT certainly does not offer the resolution of MRI that is needed for some specific applications, but for most situations it is probably adequate. The versatility of a portable system means that a scan can be performed in any operating room. Some uses that have been explored are confirmation of catheter placement, confirmation of deep brain stimulation lead placement, ruling out haematoma or mis-targeting after biopsy, facial fracture reduction and foreign body removal. Intra-operative scanning can also be used to update neuro-navigation with changing intra-operative landmarks to improve accuracy.

CT scanning in the angiography suite may occasionally be desired, especially in the case of balloon test occlusion for performing tomographic SPECT or other physiologic CT based CBF studies. These kinds of real-time tomographic assessment could not otherwise be made. A role has been suggested for a portable scanner in the outpatient clinic setting, particularly in otolaryngology, where sinus imaging could be performed immediately if it was considered necessary, potentially avoiding several clinic visits and a delay in diagnosis.

Cost benefits of portable CT

With increased reliance in medicine placed on assessment of cost benefit, it is critical to understand both the actual and potential
costs of implementing a new technology such as portable CT. A group from the Cleveland Clinic has transitioned to exclusive use of the portable CT scanner in the neuro ICU. In the first six month period, 502 scans were performed, and an estimated cost savings of over €39,000 based on personnel costs for scanning was reported [7]. An internal rate of return of 169% on the investment with a break-even point of 6.9 months was reported. In addition, it was noted that there was increased efficiency in use of the conventional scanner. This is intuitive as well, since in an institution where both emergent and scheduled scans are performed on the same scanner, there will often be times when the scanner is waiting for an emergent case.

The above-mentioned review, however, did not explore many of the additional potential cost related issues of implementing a scanner as they may be more difficult to estimate. Any true cost/benefit assessment must also consider the costs of transportation related morbidity mentioned above. This is especially true with regard to central line and ventilator tube disconnection, which may not only increase costs of replacement, but of hospital acquired infection as well. Other less defined costs, such as the burden placed on the remaining staff in the intensive care unit when a nurse, a patient care technician and respiratory therapist are off the floor for the scan are difficult to quantify, but are nevertheless important factors.

Increasing speed of access to imaging has the potential to allow for intervention earlier in situations such as stroke, and it is clear that earlier intervention can improve clinical outcomes in stroke and related conditions. This offers a cost benefit that may be significant over a population if it results in a decreased rate in morbidity, dependency and loss of productivity.

Conclusion
Portable head CT imaging represents a significant advance in diagnosis and treatment of patients with cranial pathology. Bringing the technology to the patient can increase the speed and safety of imaging, which is critical, particularly for many neurologic emergencies. There is a further benefit in that it decreases personnel costs in ICU patients and increases efficiency of fixed scanning. It is likely, for the reasons discussed, that such technology will become standard of care over the next decade.

References

The author
Andrew P. Carlson, MD, MSCR
Department of Neurological Surgery
University of New Mexico School of Medicine
Albuquerque, New Mexico USA