PORTABLE CT IN A PEDIATRIC ICU SETTING

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DISCLOSURES

• None
OBJECTIVE

- To describe the use of portable CT in neonatal, cardiac, and pediatric intensive care unit patients. Challenges of use, types of scans performed, and typical patients will be described.
OBJECTIVES

• At the end of this presentation you will be able to:
  • Understand the risks of transport of critically ill patients
  • Recognize the benefits of portable CT scanning
  • Recognize the challenges of its use in an ICU setting and with Extracorporeal Membrane Oxygenation (ECMO) patients
  • Identify the types of scans that can be performed
CHILDREN’S HEALTHCARE OF ATLANTA AT EGLESTON

1928 • Henrietta Egleston Hospital for Children opens

1956 • Emory and Egleston form a teaching relationship

1980 • Egleston’s first kidney transplant

1984 • Egleston’s First blood and bone marrow transplant

1987 • Egleston’s first liver transplant

1988 • Egleston’s first heart transplant

1991 • Egleston offers ECMO

1993 • Egleston performs first lung transplant

1995 • Aflac Cancer and Blood Disorders Center opens

1998 • Egleston and Emory perform revolutionary cord blood transplant

2009 • Egleston patient receives Georgia’s first Berlin Heart

2011 • Egleston becomes 1st Level I Pediatric Trauma Center in Georgia
RISKS OF TRANSPORT TO THE CT SUITE

- Critically ill patients are at risk for complications when being transported from the ICU
- Those risks include:
  - Ventilation – extubation, hyperventilation, increase in ventilator-associated pneumonia
  - Sedation – increase in dose
  - Unstable Intracranial pressures (ICPs)
  - Staff required for transport not being available in the ICU
  - Lines and drains
  - Equipment related incidents
GUIDELINES FOR PORTABLE

- Portable CT scanner purchased in 2009
- A guideline was created to ensure that the portable CT scanner be used appropriately to provide service to unstable, critically ill ICU and ECMO patients.
- The portable CT scanner is reserved for those patients too unstable to be transported to the main CT department. The decision is made by the attending ICU physician.
Radiology and Sedation Services Departmental Guideline

GUIDELINE

1. PURPOSE
To ensure that the portable CT scanner be used appropriately to provide service for our unstable, critically ill ICU and ECMO patients.

II. PROCEDURE
The portable CT scanner is reserved for those patients who are too unstable to be transported to the main CT department as indicated by the attending physician. All orders for portable CT must be placed in Epic with an appropriate reason for exam. The reason for requesting the CT as a portable is entered in Epic before being able to move forward with ordering the exam. The ordering physician or provider should also mark this inside the exam as “portable,” set STATs in Epic.

The Epic order set will consist of the following reasons for exam:
- ECMO
- HFOV
- VAD Berlin (mechanical circulatory cardiac support)
- Unstable Cardiac
- Temporarily paced/pacemaker dependent
- Unstable Respiratory
- Unstable Neuro
- Unstable ICU
- Unstable NIPPV
- High dose vasopressors
- On respirator, intubated

The portable CT scanner is limited in the exams that can be performed. Below is a list of those exams:
- CT scan of skull/head and without contrast (all ages)
- CT scan of abdomen and pelvis (patients ≥ 12 yrs)
- CT scan of chest (all ages)

Once the order is placed, a CT technologist, patient care technician or technical assistant will respond to the portable request with a phone call within 10 minutes. At the time of the phone call, an estimate of the time of the scan will be given, and any questions can be answered. Timelines before the estimated scan time, an additional call will be made to the patient’s nurse to discuss whether or not the patient is ready for the scan.
Too unstable to travel defined as:

- ECMO (extracorporeal membrane oxygenation)
- HFOV (high frequency oscillating ventilator)
- VAD (ventricular assist device)/Berlin heart (mechanical circulatory cardiac support)
- Unstable cardiac status
- Temporarily paced; pacemaker dependent
- Unstable respiratory status
- Unstable neuro status
- On specialty inhaled gases
ORDER QUESTION IN EPIC
ECMO (EXTRACORPOREAL MEMBRANE OXYGENATION)

- What does ECMO stand for?
  - Extracorporeal: outside the body
  - Membrane: a type of artificial lung
  - Oxygenation: the process of getting oxygen into the blood
ECMO CONTINUED
ECMO CONTINUED
HFOV (HIGH FREQUENCY OSCILLATING VENTILATOR)

- High frequency oscillatory ventilation (HFOV) is a type of mechanical ventilation.
A ventricular assist device (VAD)

- mechanical pump that's used to support heart function and blood flow.
- The device takes blood from a lower chamber of the heart and helps pump it to the body and vital organs, just as a healthy heart would.

A VAD can help support your heart:

- During or after surgery, until your heart recovers.
- While you're waiting for a heart transplant.
- If you're not eligible for a heart transplant.
Type of VAD used with pediatric patients awaiting transplant at Children’s Healthcare of Atlanta
BERLIN HEART CONTINUED
UNSTABLE RESPIRATORY

- Difficult airway or intubation
- Status asthmaticus
- On specialty gases such as isoflurane
- NIPPV (non invasive positive pressure ventilation)
UNSTABLE NEURO STATUS

- Head injury with altered mental status
- Increasing ICP (intracranial pressure)
- Status epilepticus
- Drug overdose
- Post anesthesia
- Brain tumor with blown pupils
CLINICAL CRITERIA FOR PORTABLE CT AT CHILDREN’S HEALTHCARE OF ATLANTA, EGGLESTON
(95 CASES IN 2015)
CLINICAL DIAGNOSIS AT ADMISSION OF PATIENTS SCANNED IN 2015

- Respiratory failure
- Septic shock
- MVC/Peds vs Auto
- Shunt patient/revision
- Altered mental status
- Seizure
- CVA
- Liver failure/transplant
- Diabetic ketoacidosis
- Non accidental trauma
- Hypoxic brain injury or TBI
- Gun shot
- Cancer
- Heart disease/failure
- Cardiac Arrest
TYPES OF SCANS PERFORMED

- Any studies can be performed on children small enough to fit on the infant platform and into the bore of the scanner.
- The majority of our scans are of the head
- we have also scanned the chest, abdomen/pelvis, spine and have performed CTA scans of the head and chest.
TYPES OF SCANS 2015

- Head CT: 92
- C-spine: 1
- Chest: 2
POSITIONING AND ACQUIRING
POSITIONING PLATFORMS
INFANT PATIENTS

- Infant is lifted straight up from crib, and crib is pulled away.
- The infant is then placed on the infant platform in most cases head first.
POSITIONING PLATFORMS
POSITIONING PLATFORMS
ACQUIRING/USING SCANNER

• 8 slice CT scanner
• Scanner is on casters for moving and scans by incremental movements on a centipede track system
• Scanner weighs approximately 750lbs
• Has a drive system which can be used to drive the scanner with a joystick
The scanner is on wheels/casters and is moved over the patient's head in a caudal direction to the skull base.
• The scanner moves cephalad off the patient as it acquires images.
The scanner holds the raw data and communicates with the laptop.
The laptop connects to our RIS and allows us to pull up our worklist and store the patient data.
Protocols are loaded into the laptop computer workstation and then can also be accessible from the LCD touch screen on the scanner itself.
The laptop is a workstation that allows for data manipulation such as multi-planar reconstruction, image compare, and post-reconstructions.
The standard DICOM images are uploaded to our hospital PACS immediately after scanning.
CHALLENGES
TECHNICAL CHALLENGES

- Accessing the room – equipment and space.
• All non-necessary items are removed. Booms and poles are moved to side of bed. Headboard is removed. Scanner and platform can then be brought to the bedside.

Pediatric platform being brought in.

Scanner being brought in.
• It takes a team of nurses, respiratory therapists, and CT technologists to position platform and move patient.

Platform has been secured.

Respiratory therapist securing ET tube while patient is moved.
Patient moved onto pediatric scan board with CT technologist, respiratory therapists and nurses.
• Poles, lines, respiratory equipment must be carefully secured and moved with patient.
OTHER CHALLENGES

• ICU staff not being ready or available upon our arrival
• Trauma stat page alert
• Patient decompensation
• CT staff availability
The average time to do a portable CT from start to finish is 45 minutes at our facility. They can be as short as 20 minutes but as long as 1 ½ to 2 hours.

It takes a team effort with close communication:
- RTs
- Nurses
- Respiratory therapists
- ECMO specialists

With ECMO patients the team is very large with all of the above staff needed to safely maneuver the patient.
BENEFIT OF PORTABLE CT

• Without a portable CT scanner, these critically ill patients might not be imaged.
• Being able to provide this service to the ICUs enables the clinicians to make immediate decisions regarding patient care.
UNRESTRAINED PASSENGER IN MVC

Scanned on portable CT

Scanned on our stationary scanner s/p OR
HEPARINIZED PATIENT ON VV ECMO, S/P CARDIAC ARREST

- You can see the ECMO cannulas
7 WEEK OLD WITH RSV AND RESPIRATORY FAILURE NOW ON ECMO

• Patient was given contrast but it went into the circuit quickly and was not visible in the images
S/P CARDIAC SURGERY WITH CARDIAC ARREST
17 YEAR OLD WITH SEPSIS
3 YO WITH MYOCARDITIS AND SHOCK WITH CONCERN FOR ISCHEMIC INJURY
Sequential scans revealed right MCA and PCA strokes (stars) with subsequent contralateral frontal and intraventricular hemorrhage (arrows) and ventriculomegaly.
GUNSHOT WOUND POST CRANIECTOMY TO EVALUATE FOR HEMORRHAGE

Scan revealed right MCA and bilateral ACA ischemia with right temporal hemorrhage. Ballistic fragments present.
CERVICAL SPINE CT TO CLARIFY QUESTIONABLE FRACTURE FRAGMENT ON RADIOGRAPH

- Excellent quality of reformatted sagittal and coronal images of cervical spine that proved questionable fragment to be artifactual.
NEW ACUTE RIGHT HEART FAILURE ON VA ECMO – SUSPECT PE
DOSE AND RADIATION CONSIDERATIONS

- Dose to patients is similar to our stationary scanner. Our protocols on the portable are not as numerous but still accommodate for size of patient.
- Typical technique for a teenage head CT on portable is 120 kVp and 5 mA at a 2 second rotation.

<table>
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<th>Series</th>
<th>Type</th>
<th>Scan Range (mm)</th>
<th>CTDIvol (mGy)</th>
<th>DLP (mGy.cm)</th>
<th>Phantom</th>
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<td>1</td>
<td>Scout</td>
<td>-267 - -37</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>2</td>
<td>Axial</td>
<td>-247 - -77</td>
<td>29.47</td>
<td>500.99</td>
<td>Head 10cm</td>
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IN COMPARISON

• On our stationary scanner, typical technique for a Head CT is 120kVp with 150mA at .5sec rotation

Exam Description: CT HEAD W/O CONTRAST

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<th>Series</th>
<th>Type</th>
<th>Scan Range (mm)</th>
<th>CTDIvol (mGy)</th>
<th>DLP (mGy-cm)</th>
<th>Phantom cm</th>
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<td>1</td>
<td>Scout</td>
<td>-</td>
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</tr>
<tr>
<td>2</td>
<td>Axial</td>
<td>162.750-52.200</td>
<td>22.78</td>
<td>387.83</td>
<td>Head 16</td>
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Total Exam DLP: 387.83
DOSE CONTINUED

- In the CTA case study we reviewed, the patient was a 6 week old. We used 100 kVp and 3 mA at a 1 second rotation.
- The CTDIvol was 5.40 with a DLP of 60.75 mGy/cm
RADIATION CONTINUED

- No one stays in room
- Scanner is completely lead lined along with lead drapes
IMAGE QUALITY

• Reformats:
  • Quality has been sufficient for diagnostic purposes
  • New model has improved upon step artifact
• Grey-white differentiation
  • Not as good as stationary CT
  • Also improved on new model
CONCLUSIONS

- Portable CT provides an excellent option for patients unable to travel to the CT department for a traditional scan.
- The use of the scanner does entail technical challenges as shown in the setup, and requires the assistance of two technologists and unit staff.
- Portable CT should lead to decreased transportation-related morbidity and improved rapid decision making in the ICUs.
CONCLUSIONS

• We have used portable CT with a great deal of success. It has been generally accepted by CT staff and unit staff because it is believed that it will improve patient care and outcomes.
QUESTIONS OR COMMENTS