Best Practices in X-Ray and Ultrasound of Infants

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Outline

- The physicist’s role in:
  - Selection for purchase
  - Equipment configuration and optimization
  - Acceptance testing
  - Developing a technique chart
  - Staff training
  - Periodic testing
  - Monitoring image quality
  - Monitoring radiation dose
- Conclusion

Purchase Selection of X-Ray for Infants

- Understand use
  - How old will the oldest patient imaged be?
  - What is the likely workload of this unit?
  - Is use of this unit likely to change?
  - Will urgent x-rays be acquired on this unit?
  - What will the training of the people using this unit be?
- Advocate for needed features
  - Advocate for displayed dose and dose indices
  - Advocate for an appropriate service contract
  - Advocate against costly extras that are not useful
- Advocate for interchangeability

- Minimum kVp
- Minimum mAs
- Granularity of mAs
- Detector size
- Filtration options
- Tech comfort
- Fit with existing equipment in NICU
- Durability
- Resistance to liquids
Purchase Selection of Ultrasound for Infants

- Understand use
  - How old will the oldest patient imaged be?
  - Will this unit be used in a neonatal ICU?
  - Is use of this unit likely to change?
  - What will the training of the people using this unit be?

- Advocate for needed features
  - Pediatric radiologist should be involved in transducer selection
  - Advocate for an appropriate service contract
  - Advocate against costly extras that are not useful
  - Advocate for interchangeability

- Sector, 4 – 12 MHz, Doppler
- Wideband array, 5 – 8 MHz
- Curved, 4 – 8 MHz
- Linear, 7 – 15 MHz, Doppler

Configuration and Optimization of Infant X-ray

- Filtration
  - Pediatric units
  - Shared-use units

- Techniques
  - Unprogrammed
  - Disable techniques that aren’t needed
  - Adjust for filtration
  - May need to adjust after acceptance testing

Configuration and Optimization of Infant Ultrasound

- Pediatric radiologist will have default preferences
- Physicist should be familiar with any new/different features
- Keep a list of radiologist’s original preferences for each transducer and exam type
- Physicist needs to know how to change protocols
- After use, physicist will adjust protocols for radiologist
- Find out from the vendor what the prerequisites are for exchanging a damaged transducer for a new one
Acceptance Testing of Infant X-Ray

- Test kVp accuracy down to the lowest kVp available
- Test mAs linearity down to the lowest mAs available
- If filtration can be changed, test all possible settings with an infant phantom (or 2–4 inches of Lucite)
- Perform any tests you need to set initial techniques
- Perform any tests you need to educate technologists on this specific unit; include tests to make graphs
- Perform all your usual x-ray tests including light field and scatter
- Program and post your technique chart
- Compare to specifications and/or contracted capabilities

Acceptance Testing of Infant Ultrasound

- Test each transducer’s most common default protocol
- Also turn each feature on and off for each transducer and note changes
- Essential: uniformity, distance accuracy (both directions), near field, resolution, and monitor grayscale
- If possible also test visibility of cysts and other lesions, low contrast, and Doppler accuracy
- If possible, run through every protocol for every transducer, checking just uniformity
- Compare to specifications and/or contracted capabilities

How to Develop a Technique Chart

- Make sure filtration is as it will be, measure output; this can be used to estimate ESE
- Place low-contrast test object on detector with 1 inch (extremity) up to 5+ inches Lucite on LCTO; acquire images at multiple mAs for multiple kVp; evaluate CNR
- Work with your pediatric radiologists to agree on a reasonable balance of ESE and CNR
Staff Training for Infant X-Ray

- First gain buy-in from manager
- May have to overcome knowledge left from screen/film and CR, and teach new dose indices
- Images and graphs are extremely persuasive
- One hour once or twice a year may be sufficient
- Peer pressure is persuasive
- The easier you make it for the technologists to succeed, the more they’ll cooperate

Periodic Testing of an Infant X-Ray Unit

- Make sure filtration remains close to initial value
- Test over the applicable range of kVp and mAs for that unit
- Check all of the programmed techniques
- Test programmed chest and abdomen techniques with a 2 – 4 inch thick Lucite or other infant phantom
- Perform all your usual x-ray tests including light field and scatter
- Compare measurements to acceptance test results

Periodic Testing of an Infant Ultrasound Unit

- Test each transducer’s most common default protocol
- Also turn each feature on and off for each transducer and note changes
- Essential: uniformity, distance accuracy (both directions), near field, resolution, and monitor grayscale
- If possible also test visibility of cysts and other lesions, low contrast, and Doppler accuracy
- Compare with results from acceptance tests
Monitoring Image Quality of an Infant X-ray Unit

• The first week, look at every single infant image, the kVp, mAs, dose indices, and radiologists’ comments on image quality in the report as well as through any other channels
• If necessary, change the settings and chart or prepare to return to train x-ray technologists again
• Join the radiography QC group and look at selected images every month
• Monitor the unit’s statistics at least quarterly: reject rate, distribution of DI in sent and in rejected images

Monitoring Image Quality of an Infant Ultrasound Unit

• The first week, look at every single infant image and radiologists’ comments on image quality in the report as well as through any other channels
• If necessary, discuss with pediatric radiologist changing protocols
• Join the sonography QC group and look at selected images every month

Monitoring Radiation Dose of an Infant X-ray Unit

• For the first few weeks following any significant change, check distributions of DI, of kVp, and of mAs weekly
• If necessary, talk with the manager about training
• Monthly check distributions by DI, by kVp, by mAs, and by technologist
• A small number of technologists deviating is an opportunity for peer teaching
• Encourage radiologists to establish a policy for which infant exams will be ultrasound first
In Conclusion, Physicists Should Assist With:

**Radiography**
- Purchase Decisions
- Acceptance & Annual Testing
- Technique Chart Development
- Routine QC Including Image Review, Repeat Rates, and Distribution of Dose Indices
- Technologist Training and Educational Materials
- Compliance with Technique Chart

**Sonography**
- Purchase Decisions
- Acceptance & Annual Testing
- Routine QC Including Image Review
- Policy Development Based on ACR Appropriateness Criteria
- Appropriate Training/Apps
- Compliance with Policy

Advocating for patients and staff