US in the Complex NICU Patient

Harriet J. Paltiel, MD
Boston Children’s Hospital
Harvard Medical School

Relevant Financial Relationships
• I have no disclosures to make

US in the NICU

• US is a powerful, inexpensive and ubiquitous tool
• Particularly suitable for diagnosis and treatment of critically ill neonates
• Certain imaging procedures and operative management may be impractical or impossible due to marginal clinical status of these patients
• Minimally invasive bedside diagnostic and interventional techniques highly desirable

US Diagnosis

• Radiographic chest opacities
• Vascular thrombosis
• Diaphragmatic paralysis
• Neonatal sepsis
• Visceral anatomy in patients with heterotaxy

Radiographic Chest Opacities

• US used to distinguish pleural from parenchymal causes of opacification
• Transudates anechoic or echogenic
• Exudates more often complex collections with fibrin septations
  – associated pleural thickening and parenchymal abnormality
  – hemothorax and empyema appear complex with thick fluid and septations
• Consolidated lung is echogenic and contains air-filled and/or fluid-filled bronchi

Vascular Thrombosis

• Great vessels
• Portal vein
• Renal vein
• Peripheral veins
### Aortic Thrombosis
- Usually in neonates
- Complication of umbilical artery catheterization
- Clotting and cardiovascular disorders
- Associated with renal artery thrombosis
- Most patients symptomatic
  - Catheter dysfunction, hematuria, hypertension
- Duplex and color Doppler US determine extent of thrombosis and monitor changes in flow during treatment
- Flow reconstituted via collateral vessels
- Long-term sequelae:
  - Hypertension and lower extremity growth impairment

### Vena Caval Thrombosis
- Indwelling catheters
- Dehydration
- Sepsis
- Tumor
- Usually due to spread from veins in lower limb, pelvis, kidney or liver
- Focal expansion of vessel lumen
- Echogenicity of thrombus depends on its age
  - Chronic thrombi may calcify
- Color Doppler reveals intraluminal filling defect
- Spectral analysis produces no signal

### Portal Vein Thrombosis
- Dehydration
- Shock
- Umbilical vein catheterization
- Coagulopathy
- Cirrhosis
- Budd-Chiari syndrome
- Tumor
- Pylephlebitis

### Renal Vein Thrombosis
- More common than renal artery thrombosis
- Prematurity
- Prothrombotic abnormalities
- Central venous line
- Diabetic mother
- Asphyxia
- Infection
- Infants:
  - Thrombosis initiated in interlobular and arcuate veins
- Older children:
  - Thrombosis initiated in IVC and extends into renal vein

### Renal Vein Thrombosis
- Acute:
  - Flank pain, hematuria
- Chronic:
  - Venous collaterals, insignificant symptoms
- Outcome varies from complete recovery to severe renal atrophy:
  - Depends on rapidity and extent of venous occlusion
  - Venous recanalization and/or collaterals result in decreased edema, arterial reperfusion and improved outcome

### Peripheral Veins: Indications for US
- Chronic occlusion due to IV catheter use and venous thrombosis results in difficult central venous access in many hospitalized and chronically ill patients
- US ideal for identifying suitable sites for venous access
## Diaphragmatic Paralysis

- Phrenic nerve injury
  - birth trauma, cardiac surgery, TE fistula repair, chemical injury from parenteral fluid extravasation
- Infants dependent on diaphragmatic function for adequate ventilation
  - poorly developed intercostal muscles, mobile mediastinum
- Prompt diagnosis permits early diaphragmatic plication which reduces incidence of severe lung infections and mortality in selected patients
- Advantage of US diagnosis over fluoroscopy is lack of ionizing radiation and portability

## Neonatal Sepsis

- Early-onset in first week of life
  - maternally transmitted prior to or during delivery
  - risk factors include group B streptococcal infection during pregnancy, preterm delivery, prolonged rupture of membranes, chorioamnionitis
- Late-onset between days 8 and 89 days of life
  - risk factors include prolonged hospitalization, indwelling catheters
- US useful in identifying focal sites of infection, including abscesses and fluid collections

## Visceral Anatomy in Patients with Heterotaxy

- Disordered development of left-right body axis with abnormal arrangement of thoracic and/or abdominal viscera
- Ciliopathy
- Group of genetically and phenotypically heterogeneous disorders
- Ciliary dysfunction common pathological mechanism
- Specific clinical features dictated by subtype, structure, distribution, and function of affected cilia

## Heterotaxy

- Male-to-female ratio 2:1
- Known environmental risk factors:
  - twin gestation, maternal diabetes, maternal cocaine use
- Wide phenotypic spectrum and range of associated congenital anomalies has hindered clinical care and research
- Clinical evaluation focused on delineating anatomy and managing the congenital anomalies
- Visceral situs anomalies, congenital heart defects, asplenia or polysplenia, biliary atresia, midline defects

## Conclusion

- US is a versatile, noninvasive tool that provides rapid anatomical and physiological information critical to the management of the fragile NICU patient