MHIF™ Research Highlights: October 2020

Transcatheter Cardiovascular Therapeutics 2020 – ONLINE NOW!

30+ MHI physicians and MHIF staff participated:
- 2 late-breaking clinical trial sessions
- 2 live cases
- 8 podium presentations
- 20+ virtual poster presentations

SPECIAL CALL OUTS:
- **Drs. Bapat, Cavalcante, Shakrullah** and **Sorajja** performed hybrid, open-transcatheter mitral valve-in-valve procedure
- **Drs. Brilakis** and **Burke** performed percutaneous coronary intervention of a chronic total occlusion (CTO)
- MHIF and **Dr. Garcia** announced first outcomes from the North American COVID-19 ST-Segment Elevation Myocardial Infarction (NACMI) Registry

MHIF FEATURED STUDIES:

**COVID PACT**
Comparing anticoagulation therapy in COVID+ patients in the ICU; Dr. Brandon Wiley

CONTACT:
Christine Majeski - Christine.majeski@allina.com

**Proact Xa**
Anticoagulation therapy with On-X aortic valve; Dr. Benjamin Sun

CONTACT:
Alyssa Taffe - Alyssa.taffe@allina.com

Thanks to our MHI physician partners who are helping us complete tasks to get patients enrolled in research studies as appropriate during COVID-19!

We appreciate our partnership with you!
MHIF FEATURED STUDY: COVID PACT

DESCRIPTION:
The purpose of this trial is comparing antiplatelet and anticoagulation strategies in critically ill COVID19 patients.
Patients will be randomized to 1:1 to these treatment arms and then further randomized into anti-platelet vs no antiplatelet treatments and followed for thrombotic complications.

CRITERIA LIST/QUALIFICATIONS:

**Inclusion:**
- 18 or older
- Acute infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV2)
- Currently admitted to an intensive care unit (ICU)

**Exclusion:**
- Ongoing (>48 hours) or planned full-dose (therapeutic) anticoagulation for any indication
- Ongoing or planned treatment with dual antiplatelet therapy
- Contraindication to antithrombotic therapy or high risk of bleeding
- History of heparin-induced thrombocytopenia
- Ischemic stroke within the past 2 weeks

CONDITION: COVID-19

PI: Brandon Wiley, MD

RESEARCH CONTACT: Christine Majeski christine.majeski@allina.com | 612-863-3546

SPONSOR: The TIMI Study Group

OPEN AND ENROLLING:
EPIC message: Research MHIF Patient Referral
Point-of-Care Ultrasound
Applications for the Cardiologist

Brandon M. Wiley, MD, FACC, FASE

Disclosures:
None
Objectives
(Career Roadmap)

POCUS
Holistic POCUS Bedside Exam

LUNG ULTRASOUND
Diagnosis of Dyspnea
Prognosis in Heart Failure

LUS+Stress Echo
HFrEF
VHD

Critical Care / Medicine
Medicine/Cardiology
Cardiology

Case 1
Shock and Hypoxia after STEMI + CPR

55 year-old male presented to CVICU after VF/VT arrest and STEMI

- Cath PCI Cx/RCA
  - V-Fib x 6
- CVICU
  - Shock
    - Epi/norepi/vaso
  - Hypoxic (100% FiO2)
Case 1
Shock and Refractory Hypoxic after STEMI/CPR

RV Infarct
Shock
Refractory Hypoxia?

“Activate MTP - Level 1 infuser and blood products”
Case 1
Shock/Hypoxia after STEMI/CPR

POCUS

POCUS is an ultrasound exam **Performed** and **Interpreted** by the **Practitioner** at the **Bedside**

**POCUS** is not **Echocardiography**
Why is Point-of-Care Ultrasound Important?

The Traditional Bedside Clinical Exam is Difficult

• Jugular veins identified in 72-94% patients\(^1\)
  • 50% accuracy for high vs low CVP
• Correct timing of cardiac murmur 66\(^2\)
  • Cause of murmur 26\(^3\)
  • Agreement among Cardiologists for +S3 is \(\sim\)30%
• Study of 442 consecutive patients
  • Only 40% diagnosed appropriately by history and physical\(^4\)

\(^1\)McGee Am Heart J 1998
\(^2\)Vukanovic-Criley Arch Intern Med 2000
\(^3\)March, Mayo Clinic Proc. 2005
\(^4\)Paley, Arch Intern Med. 2011

Why is Point-of-Care Ultrasound Important?

POCUS Improves the Clinical Exam

• POCUS reduces missed major CV exam findings 43% -> 21%
• Students+POCUS outperformed cardiologists
  • Etiology of systolic murmur 93% vs 62%
  • Detection of diastolic murmur 75% vs 16%
• Multicenter ICU study with 1,215 POCUS studies
  • Change in diagnosis 24.9%, change management 44.0%

Spencer, JACC. 2001
Bernier-Jean JCM 2015
“Trust in the Force (physical exam) to guide you”

The Death of the Stethoscope
The Death of the Stethoscope
Evolution of the Bedside

POCUS: Goal Directed
Holistic Bedside Ultrasound Evaluation

- Abdominal US
- Vascular US
- Pathology
- Lung US
- Cardiac US
POCUS: Goal Directed Holistic Bedside Ultrasound Evaluation

Hypoxia

Abdominal US

DVT

Vascular US

Lung Sliding A-line Pattern

Lung US

Cardiac US

Dilated RV

POCUS: Goal Directed Holistic Bedside Ultrasound Evaluation

PE

Abdominal US

DVT

Vascular US

Lung Sliding A-line Pattern

Lung US

Cardiac US

Dilated RV
Focused Assessment with Sonography in Trauma (FAST)
- Intraperitoneal Fluid
Renal US
Liver US
- Portal Vein

Inferior Vena Cava
Aorta
- Ascending/Abdominal
Compression Venous US
- Femoral/Popliteal

Vascular US
Pathology
Cardiac US

Lung US

BiVentricular Function
Valvular Disease
Doppler Hemodynamics
Pericardium

Pleura
- Motion/morphology
Parenchyma
- Congestion/Consolidation
Pleural Space

Free Fluid
Collapsed IVC
(low CVP)

Lung Sliding
B-Lines
(no PTx)

Abdominal US

+FAST

Normal LVEF
Cardiac US

Lung US
59 y.o. female w/ ICM presents with SHOCK after AICD placement.
55 year-old female HoTN s/p MVA

Cardiac-Focused Diagnosis: Severe Hypertrophy of left ventricle

55 year-old female HoTN s/p MVA

Pseudo Hypertrophy of left ventricle from profound hypovolemia
Components of Lung Ultrasound

- Pleura
  - Morphology
  - Motion ("sliding")
  - Effusion
- Lung Parenchyma
  - Aeration pattern
- Diaphragm
  - Motion

Diagnose
- Pulmonary Edema
- Volume Status
- PCWP
- PNA/ARDS
- Pneumothorax
- Pleural Effusion
- Diaphragmatic Paralysis

Scanning Technique

Probe indicator 12 o’clock position

Rotate probe axis
Oblique Scan – Probe Axis Parallel to Ribs

Lung Ultrasound Key Findings

Assess pleural line
- Normal “lung sliding”
- Abnormal: no “lung sliding”, irregular/thickened

Assess parenchyma
- Normal: nothing present (“A-Lines”) 
- Abnormal: B-Lines, Consolidation

Assess pleural space
- Normal: nothing present
- Abnormal: fluid
Normal Lung Ultrasound Findings
Pleural Sliding and A-Lines

A-Lines + pleural sliding = aerated (dry) lung

Pneumothorax
Absence of “Lung Sliding” and B-Lines

Parietal pleural layer without interface with visceral layer (no B-lines)
Pleural Line Abnormalities
Fibrotic/Intrinsic Lung Disease or Infectious/Inflammatory

Pneumonia/Fibrotic Lung
• Subpleural consolidations

Normal pleural line

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Abnormal Lung Ultrasound Findings: B-Lines – “Interstitial Process”

B-lines
- Correspond to *increased lung density* (decreased aeration)
  - Fluid (extravascular lung water)
  - Inflammation
  - Fibrosis
- ≥ 3 B-Lines in intercostal space (zone)
  - Interstitial process

B-Line Pattern

- Increased Lung Density
- Fluid Fibrosis
- Inflammation
- B-Lines

Mallamaci et al. JACC:IMG 2010
Abnormal Aeration
- Dense lung
- Interstitial Process

Aerated (Dry) Lung (A-Lines + Sliding)

Normal Aeration
Lung Sliding, A-Lines

Decreased Aeration
B-Lines, Effusions

"Bilateral pleural effusions. Mild interstitial prominence is noted in both lungs likely due to interstitial edema"
B-Lines Increase with Increased Lung Density from Extravascular Lung Water (Edema)

B-Lines Decrease with Fluid Removal

Change in B-Lines Pre- and Post-dialysis
• Patients admitted with AHF
• Lung ultrasound surface wave elastography
• Diuresis over 24 hours
  • Avg diuresis 2.1L
  • Avg decrease in B-Lines 13
• Decrease in lung surface wave speed
  ➢ Decreased stiffness
  ➢ Increased compliance

B-Lines Decrease Corresponds to Increased Lung Compliance

Consolidation

• Subpleural echo-poor region
• Tissue-like echotexture
• “Hepatization” of lung
Lung Ultrasound Key Findings

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Pleural Effusion
Pulmonary Edema
Severe Mitral Regurgitation
(Homogenous B-Line Pattern)

78 y.o. on BiPAP in ED and admitted for CHF
POCUS: Goal Directed Holistic Bedside Ultrasound Evaluation

Dyspnea

Abdominal US

Vascular US

Cardiac US

Lung US

Evaluation of dyspnea using Lung US

Ultrasound Interstitial Syndrome
“B-Line Pattern”
(Increased Lung Density/Decreased Aeration)

Fibrosis/infiltration of Interstitium

Interstitial Edema

Inflammatory

Non-inflammatory

Pulmonary Fibrosis
Interstitial Lung Dz

“Dry B-Lines”

Interstitial PNA/Pneumonitis
ARDS

Cardiogenic Lung Water
(Pulmonary Edema)
50 year-old shortness of breath, ICM LVEF 40%

Pulmonary Edema – Lasix
Diffuse Bilateral Ultrasound Interstitial Syndrome
50 year-old shortness of breath, ICM LVEF 40%

Focal Interstitial Process – not CPE

Medicine Admission!!

LUS Excellent Diagnostic Test in ED for Cardiogenic Pulmonary Edema

- SIMEU study of 1,005 pts presenting to ED with dyspnea
  - 6-Zone anterior lung ultrasound
  - CARDIOGENIC vs NON-CARDIOGENIC etiology

<table>
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<th>Sens.</th>
<th>Spec.</th>
<th>PPV</th>
<th>NPV</th>
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<tr>
<td>Clinical</td>
<td>85.3%</td>
<td>90%</td>
<td>88%</td>
<td>87%</td>
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<tr>
<td>LUS ≥2 zones (bilateral) 3 ≥ B-Lines</td>
<td>90.5%</td>
<td>93.5%</td>
<td>92.3%</td>
<td>92%</td>
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<tr>
<td>LUS + Clinical</td>
<td>97%</td>
<td>97.4%</td>
<td>97%</td>
<td>97.4%</td>
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<tr>
<td>CXR</td>
<td>69.5%</td>
<td>82.1%</td>
<td>76.8%</td>
<td>75.9%</td>
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Pivetta et al. SIMEU Group, 2015. Chest
Data Supports use of LUS for Diagnosis of Acute Pathology

- Diagnosis of Heart Failure in ED (B-Line pattern)
  - **85.3% sens., 92.7% spec.** (LR+ 7.4, LR-0.16)
    - CXR 56.9% sens. 89.2% spec
    - BNP (<100pg/ml) LR- 0.14

- Diagnosis of pneumothorax
  - **90.9% sens., 98.2% spec.**
    - CXR 50.2% sens., 99.4% spec.

- Diagnosis of PNA
  - 80-90% sens., 70-90% spec.
• 349 patients with ADHF (97% feasible)
• 4 zone LUS
• 35% no rales, 11% no congestion on CXR
• Divided into tertiles of B-Line burden
  • BNP increased
  • No diff in LVEF (39%) or comorbidities

In-hospital and Long-Term Primary Composite End-Point increased across tertiles

Increased Burden of B-Lines Identifies HF Patients at High Risk for HF Readmission or Death
Integration of LUS into Echocardiogram

Outpatient ECHO
Indication: possible CHF?

Final Impressions
1. Severe mitral valve regurgitation with mild anterior leaflet override and a posteriorly directed jet. Apical displacement of the leaflets and annular dilatation suggest a functional etiology.
2. Mitral regurgitation ERO (PISA) 0.53 cm$^2$.
3. Mitral regurgitant volume (PISA) 73 ml.
5. Normal right ventricular size with mildly reduced systolic function.
6. Estimated right ventricular systolic pressure 56 mmHg (systolic blood pressure 122 mmHg).
7. Dilated inferior vena cava with reduced inspiratory collapse (<50%).
8. Lung ultrasound performed Evidence of B−lines suggestive of pulmonary edema.

Encourage the early detection of heart failure – before rales, weight gain

Objectives

Novel Applications of POCUS Techniques in Evaluation of Cardiovascular Disease
- Lung US + Stress Test
EVLW[+] WITH STRESS
- Resting RV dysfunction
  - No difference in LVEF
- ↑ PCWP
- ↑ RAP
- ↓ RV-PA coupling
  - S'/mPAP; FAC/mPAP; TAPSE/mPAP
- ↑ Hemoconcentration
- Loss of H20 from vascular space

Lung Ultrasound + Invasive Exercise Test
Etiology of Dyspnea

HFpEF (n = 61 patients)
Exercise EVLW/B-Lines (n=33; 54%)
Lung Ultrasound in Echo Stress Testing
LV Filling Pressure and Ischemic Evaluation

New B-Lines with Increase in LV filling pressure

Exercise/Ischemia induced ↑ LV filling pressure
Lung Ultrasound and Pulmonary Congestion During Stress Echocardiography

Methods
- 2,145 patients, prospective, stress echo
- LUS (4-zone AA/MA) pre- and post-stress
  - B-Line burden graded (none, mild, mod, severe)

Key Results
- Feasibility 100%
- Mortality/MI increased across groups
  - Mortality 8x in severe B-Line group
- Multivariable analysis for death/MI
  - Severe B-Lines (≥ 10) HR 3.544 p = 0.006
    - Heart rate reserve 2.276 (p=0.01), CFVR 2.178 p=(0.03), age 1.031 (p=0.04)

Mean gradient 5 mmHg @60 BPM
TR velocity 2.45 m/s
RVSP 29 mmHg
Lung Ultrasound in Echo Stress Testing
Evaluation of Severity of Mitral Valve Disease

Stress MV gradient 22 mmHg

Stress peak RVSP 42 - 50 mmHg ??
New B-Lines with Exercise
- Increased LAP
- Dynamic Pulmonary Edema
  - Objective findings of severe mitral valve disease

Summary
- Holistic POCUS Bedside Exam
  - Guide diagnosis/therapeutics at bedside
- Lung Ultrasound
  - Etiology of dyspnea
  - Monitor fluid status
  - Prognostic value in ambulatory/hospitalized heart failure
- Novel applications
  - LUS+Stress Echo
    - Etiology of dyspnea (HFpEF)
    - LV filling pressure, VHD
    - Prognosis in stress echo
Critical Care Ultrasonography Differentiates ARDS, Pulmonary Edema, and Other Causes in the Early Course of Acute Hypoxemic Respiratory Failure

Longitudinal Scan
Probe Axis Perpendicular to Ribs
Objectives/Roadmap

POCUS
Holistic POCUS Bedside Exam

LUNG ULTRASOUND
Diagnosis of Dyspnea
Prognosis in Heart Failure

LUS+Stress Echo
HFpEF
VHD

NOVEL CARDIOLOGY APPLICATIONS

Focused Assessment with Sonography in Trauma (FAST) - Intraperitoneal Fluid

Hepatorenal recess
(Morison's pouch)

Perisplenic recess

sens 82%, spec 99%
diagnose blunt force trauma

Rectovesicular space

Nishijima Ann Int Med 2012
Scanning Technique

POCUS: Goal Directed Holistic Bedside Ultrasound Evaluation
65 year-old with heart failure
BNP 1587

POCUS: Goal Directed
Holistic Bedside Ultrasound Evaluation

Abdominal US

Vascular US

Dyspnea

Cardiac US

Lung US
60 year-old female

dyspnea, O2 91%

Pulmonary Embolism

E/e' = 9

RVSP = 52 mmHg