What’s new with Echo in the cardiac ICU?

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Department of Surgery, University of Melbourne 
**Cardiac anaesthetist** 
Royal Melbourne Hospital + Monash Medical Centre
Disclosures

• Employed University of Melbourne
  • POC workshops, courses in clinical ultrasound
    Certificate, Diploma, Masters, Simulator program

• Equipment support
  – Ultrasound – Sonosite

• Infected with the ‘echo-virus’

• I am not an intensivist!
What’s new with Echo in the **cardiac** ICU?

1. TOE
2. TTE
3. Lung ultrasound
4. Research
   - Routine TTE/Lung ultrasound after cardiac surgery
   - Survey of practice in Australasian ICU’s
What’s new with Echo in the cardiac ICU?

1. Transoesophageal echocardiography
TOE is standard of care during cardiac surgery

- Pre-surgery check of pathology
- Post-surgery check of repair/replacement
- Haemodynamic monitor
Role of TOE AFTER cardiac surgery??

- Circulatory instability – superior to other monitors
- Pericardial tamponade
- Extracorporeal cannulae and devices
- Aortic injury / dissection
Competitors

Pulmonary artery catheter + other flow monitors – haemodynamic monitor
- Widely studied: no benefit in outcome demonstrated
- TOE: more reliable estimate of preload
- TOE: Provides *cause of instability*, rather than just haemodynamic state
  - eg. tamponade, valve failure, right vs. left heart failure

CT – aortic dissection/injury
- TOE: at bedside, no trip to radiology required
- TOE: can also image lungs – effusion, pneumothorax, ICC placement
Cardiac anaesthetist or cardiologist?

Intensivist?

Echocardiography in the intensive care unit: from evolution to revolution?

International expert statement on training standards for critical care ultrasonography
Evidence?
## Intensive Care – TOE after cardiac surgery

<table>
<thead>
<tr>
<th>Author / year</th>
<th>Patients / design</th>
<th>Changed Management</th>
<th>Medical %</th>
<th>Surgical %</th>
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<td>Harris 1999</td>
<td>206 retrospective</td>
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<td>Wake 2001</td>
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<td><strong>38</strong></td>
<td></td>
<td><strong>20</strong></td>
<td><strong>18</strong></td>
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</tbody>
</table>

### Medical changes
- Fluids
- Inotropes
- Vasoactive support
- IABP
- Treatment limitation

### Surgical changes
- Tamponade
- Endocarditis
- Aortic dissection
- VAD/ECMO
Miniature TOE - hTEE

IMACOR, New York
5.5mm
Monoplane 7 MHz, 15cm depth
Anteflexion/retroflexion possible
2D and colour flow Doppler
Limited to 72 hours (marketing)
Miniature TOE - hTEE

- Recommended views:
  - 4 chamber view: LV and RV contractility and size
  - Transgastric mid LV view: LV contractility and preload
  - Ascending aorta short axis view (SVC): Volume responsiveness
Miniature TOE - hTEE

- TOE trained intensivists
  - High incidence in change in management 50-90%
    - in high risk groups – shock, VAD
- TOE naïve intensivists
  - Insertion of probes without problem
  - Good agreement in interpretation with TOE trained cardiologist
Evidence?
Small observational studies encouraging

- Most in cardiac surgical ICU’s
- TOE trained intensivists
  - High incidence in change in management 50-90%
    - Haemodynamic management
    - in high risk groups – shock, post cardiac surgery, VAD
- TOE naïve intensivists
  - Insertion of probes without problem
  - Good agreement in interpretation with TOE trained cardiologist
  - Change in haemodynamic management
TOE

• BUT....

Requires lengthy training

SEMI-INVASIVE

Oesophageal perforation rate 1:1000

Mortality 1:5000

Piercey M et al Major complications related to the use of transesophageal echocardiography in anaesthesia. *Anaesthesia* 2009, 23, 62-65
What’s new with Echo in the **cardiac** ICU?

2. Transthoracic echocardiography
TTE

Unlike TOE, TTE:

• Easier to learn
• Non-invasive
• No lengthy cleaning procedures
• Probe only $10,000 (TTE) vs $60,000 (TOE)
TTE after cardiac surgery

Problems:

• Difficult imaging due to air, drains, dressings
• Requires cardiology staff – frequently unavailable
• Delayed result – may not assist urgent bedside decision-making
However...

- Transthoracic echocardiography:
  - technology improved – *better pictures*
  - can now be performed by non-cardiologists – *when required*
  - Miniaturisation – *equipment more available*
  - only a few windows / views are required – *don’t need complete study*
Endorsement

EXPERT CONSENSUS STATEMENT

Focused Cardiac Ultrasound: Recommendations from the American Society of Echocardiography

Kirk T. Spencer, MD, FASE, Bruce J. Kimura, MD, Claudia E. Korcarz, DVM, RDCS, FASE, Patricia A. Pellikka, MD, FASE, Peter S. Rahko, MD, FASE, and Robert J. Siegel, MD, FASE, Chicago, Illinois; San Diego and Los Angeles, California; Madison, Wisconsin; Rochester, Minnesota

- Focused TTE by non-cardiologists
- Endorsed by Cardiologists
‘Focused TTE
Ultrasound assisted examination’

Ultrasound guided cardiac care

LV/RV failure
Valve disease
Hypovolaemia
Vasodilation

Hypovolaemia → fluid
Cardiac failure → fluid restriction, inotrope
Vasodilation → vasopressor infusion
Valves → stenosis vs. regurgitation
Invasive monitoring and postop ICU

Normal TTE
Normal management
Non-invasive
No delay
Less $
Evidence?
## Intensive Care – TTE

<table>
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<tr>
<th>Author / year</th>
<th>Patients / type of ICU</th>
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<tbody>
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<td>Vignon 1994</td>
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<td>Jensen 2004</td>
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<tr>
<td>Orme 2009</td>
<td>187 / non-cardiac</td>
<td>51</td>
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<tr>
<td>Manasia 2005</td>
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<td>37</td>
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<tr>
<td>Stanko 2005</td>
<td>126 / mixed</td>
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</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td><strong>34</strong></td>
</tr>
</tbody>
</table>

*Included cardiac surgery patients*
What’s new with Echo in the *cardiac* ICU?

3. Lung Ultrasound
Lung ultrasound

Diagnosis
- Pneumothorax
- Consolidation / empyema
- Acute pulmonary oedema
- Pleural effusion
- Pulmonary embolus
- COPD
- Diaphragm function

Procedures
- Pleural catheter
- Pleural tap
- Abscess aspiration
Lung ultrasound

• Available immediately at the bed-side
• No ionising radiation
• Useful in diagnosis of acute dyspnoea + respiratory distress
• Guide appropriate insertion of intercostal catheters
Volume (mL) = distance (cm) x 200
= 3.8 x 200
= 760 mL
Sensitivity/Specificity

Pneumothorax\(^1\) 81%/100% (CT)
Consolidation\(^1\) 89%/94% (CT)
Acute pulmonary oedema\(^2\) 100% (CT) 93% (x-ray)
Pleural effusion\(^3\) U/S guided insertion ICC’s reduces complication rate

Reduces requirement for chest-XR and CT\(^4\)

1. Lichtenstein DA Meziere G. *Relevance of Lung Ultrasound in the Diagnosis of Acute Respiratory Failure* *The BLUE Protocol.* CHEST 2008, 134;1
Ultrasound of the heart – focused echocardiography

- LV/RV failure
- Valve disease
- Hypovolaemia
- Vasoldiation

Ultrasound of the lungs – respiratory/lung ultrasound

- Pulmonary oedema
- Pleural effusion
- Consolidation
- Pneumothorax

Ultrasound guided cardiac care

Ultrasound Assisted Examination

Ultrasound guided respiratory care
What’s new with Echo in the cardiac ICU?

4. Research

1. Routine TTE/Lung ultrasound after cardiac surgery
ITRACS STUDY

Impact of Transthoracic and Respiratory ultrasound Assessment after Cardiac Surgery

Collaboration with Division of Cardiac Surgery at KFCC
Background

ICU performed TTE in ICU influential on diagnosis and management in
When INDICATED
- shock, cardiac failure, murmur etc.

Cardiorespiratory complications are common after cardiac surgery
Current monitors have limitations – Swan, chest x-ray, CT

Is there benefit of ROUTINE TTE and lung ultrasound
after cardiac surgery?
Hypothesis

Routine and repeated TTE and lung ultrasound:
Performed at 3 time points after cardiac surgery
1. is feasible
2. changes the diagnosis
   - of clinically important cardiac and respiratory disorders
   compared with clinical assessment + review of chest x-ray
ITRACS STUDY

- Ethics approved
- Prospective observational study 91 patients – PILOT study
- King Fahad Cardiac Center of King Saud University between July 2011 and August 2012
- All cardiac surgery requiring sternotomy Age>18 years
- Focused TTE and lung ultrasound
  - 1. Day 1 after surgery
  - 2. After extubation and removal of drains
  - 3. Prior to discharge from the ward
Methods

Treating doctor standard assessment
- clinical, haemodynamic monitors + Chest X-ray

Diagnosis recorded

TTE and lung ultrasound

Diagnosis recorded again

differences before and after ultrasound recorded
Focused Cardiac Ultrasound

- iHeartScan™ protocol
- Designed to be performed in < 10 min
- Using 2D and colour flow Doppler only
  - Haemodynamic state
  - Empty or full?
  - LV (EF< 50%) or RV failure
  - Vasodilation
  - Tamponade
- Basic Valve assessment
  - Nil/mild – no haemodynamic instability
  - Mod/severe – may cause haemodynamic instability
Lung ultrasound

- Pneumothorax
- Consolidation
- Acute pulmonary oedema
- Pleural effusion

RESULTS – Feasibility

- 91 patients
- Cardiac ultrasound was interpretable in at least one echocardiographic window in 99% of patients
- All studies performed by experienced sonographers
  – is this reproducible by less experienced operators?
<table>
<thead>
<tr>
<th>Cardiac or respiratory disorder</th>
<th>Day after surgery</th>
<th>After extubation and removal of chest drains</th>
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<td>Alveolar interstitial syndrome</td>
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<td>(APO)</td>
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RESULTS – New findings

New findings with ultrasound – total 67%

Cardiac disorders 66%
- Cardiac failure 42%
- Pericardial effusion 5%
- Valve dysfunction 1%
- Hypovolemia 1%

Respiratory disorders 20%
- Pleural effusion >500mL 33%
- Pneumothorax 3%
- Consolidation 1%
- Acute pulmonary edema 3%

* Pleural effusion >500mL

Cardiac and respiratory (mixed) 14%
RESULTS – Findings *EXCLUDED*

Findings suspected clinically

EXCLUDED with ultrasound – 20%

- **Cardiac Disorders** 5%
  - Cardiac failure 1%
  - Pericardial effusion 3%
  - Valve dysfunction 1%

- **Respiratory Disorders** 15%
  - Pleural effusion > 500mL 14%
  - Consolidation 1%
RESULTS – Pattern over time

Image quality

Change in cardiac diagnosis

Change in respiratory diagnosis
Conclusions

Routine transthoracic echocardiography and lung ultrasound is

1. Feasible
2. And frequently alters diagnosis in patients after cardiac surgery.
Acknowledgements

King Kalid Hospital Riyadh
- A Alsaddique
- M Fouda
- A Mobeirek
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- N Rabie
- K Asfena
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University of Melbourne
- C Royse
- A Royse
- A Bowyer
- Z Williams
- J Egan

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What’s new with Echo in the cardiac ICU?

4. Research

1. Routine TTE/Lung ultrasound after cardiac surgery
2. Survey of practice in Australasian ICU’s
Background

• Slow uptake of TTE, TOE and lung ultrasound in Australasian ICU’s\textsuperscript{1,2}
• …Yet being incorporated into curriculum


Aims

Identify:

1. Expertise, use and training of TTE, TOE and lung ultrasound by ICU consultants in accredited ICU’s in Australasia
2. Barriers

To aid in assisting implementation in identified areas of need.
Method

• Ethics approved, conducted May – June 2015 - ongoing
• Survey emailed to all ICU’s in Australasia accredited by CICM (114)
  • Questions:
    1. current level of provision of TTE and TOE, lung ultrasound,
    2. training programs and perceived obstacles,
    3. Recommended training pathways
• Follow up by email and telephone


## Results

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<tr>
<th>TABLE 1:</th>
<th>Response rate (%)</th>
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<td>Hong Kong</td>
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</table>
%ICU staff performing ultrasound

- TTE 51%
- Lung 43%
- TOE 11%
Level of ultrasound practice

TTE (%)

None  |  Focused  |  Diagnostic
---    |          |          
0      | 60%       | 20%

Lung Ultrasound (%)

None  |  Focused  |  Diagnostic
---    |          |          
0      | 50%       | 0%

TOE (%)

None  |  Focused  |  Diagnostic
---    |          |          
0      | 60%       | 0%

No use of miniature TOE
Training

Echocardiography (%)

- No current training: 60%
- Out-sourced: 10%
- In-house training: 30%

Lung Ultrasound (%)

- No current training: 80%
- Out-sourced: 0%
- In-house: 20%
Training pathways recommended (%)
Perceived Barriers to Echocardiography Practice (%)
Cardiothoracic surgery ICU’s Differences

• **Expertise**
  – Slightly higher level of expertise in TTE + TOE
  – Less expertise in lung ultrasound

• **Training**
  – All echo and lung ultrasound training done in house
  – Similar training pathways

• **Barriers to ICU physician echo and ultrasound**
  – Better service provided by cardiology
  – Less problems with equipment and training
• Acknowledgements

Kacey Williams – anaesthesia trainee, Melbourne
Yang Yang – Intensivist, Western Hospital, Melbourne

No grant support