Can Machine Learning Tools Bring Diagnostic Imaging to the Home with Safety and Efficacy?

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Butterfly Network™
Time Matters

2/3 of Diagnostic Dilemma’s Can be Solved with Simple Imaging

Ordering Studies Results In Delaying Treatment
The Journey to the Left of the Care Continuum
From hospitals to primary care offices and home

Home, Doctor’s Office, Pre Hospital, Hospital PoC, Ultrasound Lab

Upstream Diagnostics: Personalization of Imaging

Lower Costs
Improved Outcomes
Increased Patient Satisfaction

Critical Value Based Care Priorities
Home Diagnostics Have Proven Value

Present

Future
Safety & Efficacy Threshold For Imaging In The Home

Consumer Level Interface
Exam is Easy to Perform
Reproducible Results
Accuracy that Matches Professional Guidelines For Physician Notification
Key Questions to Resolve

• Are there clinical conditions in which scanning at home makes sense?

• Can a patient be taught to scan themselves reliably?

• Can AI make this easier and more reliable?

• Are there devices available that can practically achieve this?

• Are there reimbursement models in place to incentivize?
High Impact Opportunities

1. Clinical Conditions

Average 16 office visits per year
ED visit every other year
1/3 of these result in hospitalizations

5 Million ED Visits
4 Million Hospitalizations
Mean Cost/Adm. $11,552

NEUROGENIC BLADDER

Living with Congestive Heart Failure

Adv Urology 2012
Circulation 2018
Ultrasound is Clinically Useful

1. Clinical Conditions

Bladder scan accurately determines bladder volume

B-lines arise from pleural line
Number and intensity proportional to pulmonary edema
How Hard Is it to Learn Ultrasound?
How Long Does it Really Take to Learn POCUS?

**TABLE 2**

Point-of-care ultrasound: How accurate? How much training?

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Training requirement</th>
<th>Time required to perform protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation for left ventricular systolic function (compared with expert sonography)</td>
<td>69%-94%</td>
<td>91%-94%</td>
<td>8 hours of training or 20 practice exams</td>
<td>*</td>
</tr>
<tr>
<td>Evaluation of IVC to determine volume status and predict readmission for CHF</td>
<td>81%</td>
<td>72%</td>
<td>4 hours of training and 20 practice exams</td>
<td>*</td>
</tr>
<tr>
<td>Evaluation for pleural effusion (compared with CT or expert sonography)</td>
<td>94%</td>
<td>98%</td>
<td>3 hours of training</td>
<td>*</td>
</tr>
<tr>
<td>Evaluation for pneumonia (compared with x-ray or CT)</td>
<td>90%-96%</td>
<td>88%-93%</td>
<td>3 hours of training</td>
<td>*</td>
</tr>
<tr>
<td>Evaluation for pulmonary edema (compared with final diagnosis by blinded chart review)</td>
<td>86%-100%</td>
<td>92%-98%</td>
<td>5 practice exams</td>
<td>*</td>
</tr>
<tr>
<td>Screening exam for AAA (compared with expert sonography)</td>
<td>100%</td>
<td>100%</td>
<td>50 practice exams</td>
<td>&lt;4 minutes</td>
</tr>
<tr>
<td>Evaluation for proximal leg DVT (compared with expert sonography)</td>
<td>95%</td>
<td>96%</td>
<td>10 minutes to 5 hours of training</td>
<td>&lt;4 minutes</td>
</tr>
</tbody>
</table>

AAA, abdominal aortic aneurysm; CHF, congestive heart failure; CT, computed tomography; DVT, deep vein thrombosis; IVC, inferior vena cava.

*Time required to perform was not evaluated for these protocols in the literature that was reviewed.
Studies Are Underway

Patient Performed Lung Ultrasound (PLUS) UCLA Dr. Alan Chiem

Teleguidance for Home Lung Ultrasound in Patients with CHF NYU Dr. Harold Sauthoff
2. Education Barriers

Not This Easy

Not This Hard


Mackay FD¹, Zhou E², Lewis D³, Fraser J⁴, Atkinson PR⁴.
Is A Home System Feasible?
Emergence of POCUS

3. Devices Available?

History of size and weight.

History of transducer material and bandwidth.

1995

Future

Piezo Single Crystal

Piezo-Polymer-Composite

Piezo-Electric Ceramics (ex. PZT)

CMUT

Ultrasound-on-Chip™
New Handhelds unlock the Full Potential of Ultrasound.

- Reduced Cost
- Increased Portability
- Competitive Image Quality
Value Proposition of Machine Learning

Image Interpretation

Image Guidance
4. Image Interpretation

Image Interpretation Work is Exploding

Automated B-Line Counter
4. Role of Machine Learning

**Image Guidance**

- FDA approves AI-based software that helps doctors take ultrasound pictures of the heart

- Accelerate Competence for Novices

- Promote Consistent Image Quality

- Reduce Scan Times

- Expand Access by Including other Classes of Health Care Professionals

- Path to the Consumer?
Why Is this So Important?

1 in 4 Patients with CHF Readmitted within 30 Days!
5. Reimbursement Models
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