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M2D2
UMASS Advancing Med Device & Biotech Innovations
CAPCaT
Center for Advancing Point of Care Technologies

Point of Care Lung V/Q Scan

GE Research

Project Team

GE Research
UMASS MEDICAL SCHOOL

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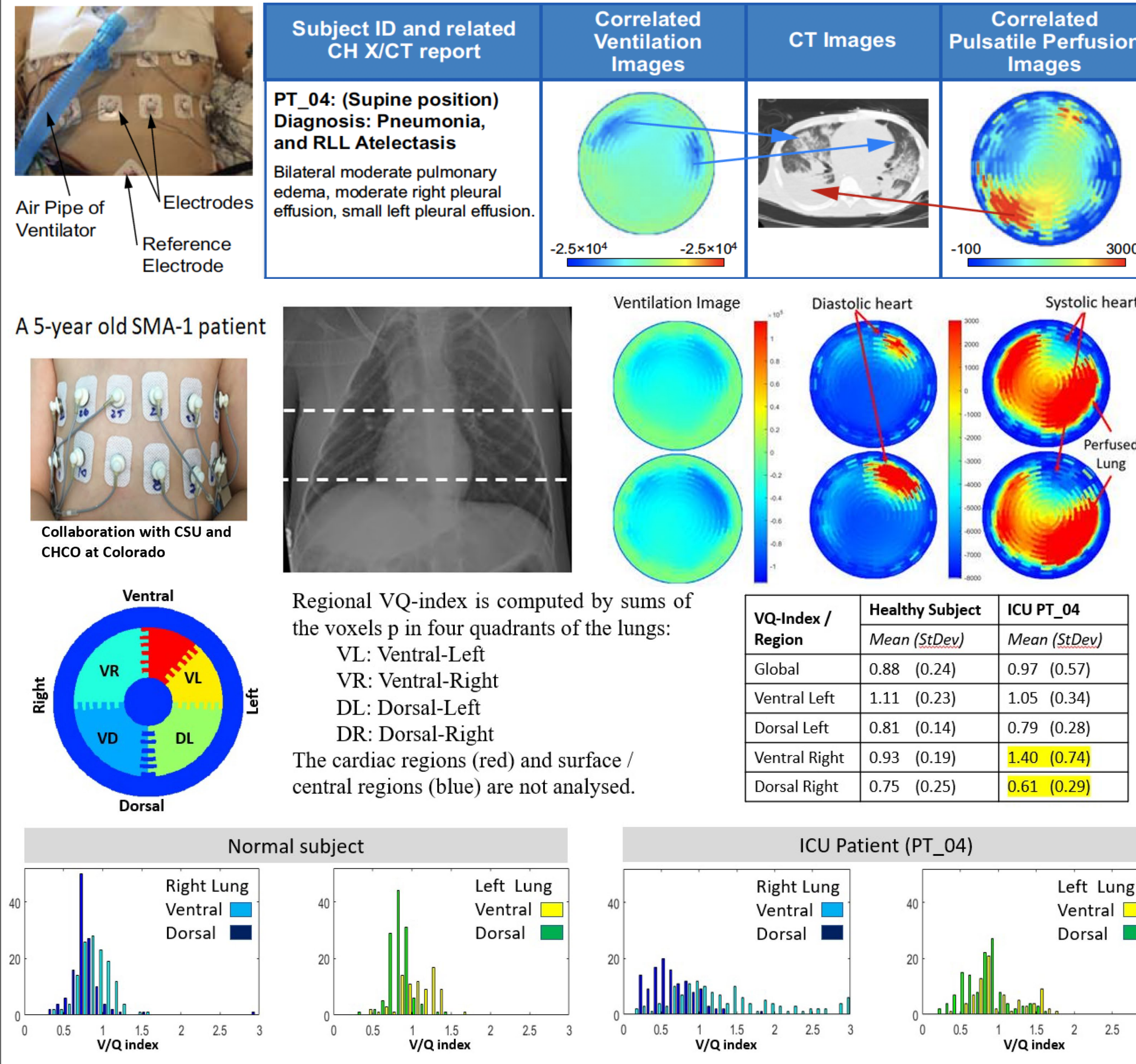*GE Research – Niskayuna, NY*

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Motivation

Ventilation/Perfusion (V/Q) matching is highly relevant to monitoring respiratory function of mechanically ventilated COVID-19 and ARDS patients. V/Q scans are performed with nuclear imaging and are rarely used for critically ill patients. There is a need for a new, continuous, bedside V/Q scan to guide respiratory therapy and improve patient outcomes.

Project Goals

- Validate SMS-EIT derived lung Ventilation/Perfusion distributions with SPECT-CT V/Q scans on 20 patients.
- Evaluate workflow efficiency using electrode textile applicator patches.
- Engage with clinicians to validate unmet needs for respiratory monitoring of mechanically ventilated patients.

Air Pipe of Ventilator — Electrodes — Reference Electrode

A 5-year old SMA-1 patient

Collaboration with CSU and CHCO at Colorado

Ventral
Right — VR | VL — Left
VD | DL
Dorsal

Subject ID and related CH X/CT report	Correlated Ventilation Images	CT Images	Correlated Pulsatile Perfusion Images
PT_04: (Supine position) Diagnosis: Pneumonia, and RLL Atelectasis. Bilateral moderate pulmonary edema, moderate right pleural effusion, small left pleural effusion.	−2.5×10⁴ −2.5×10⁴		−100 3000

Ventilation Image | Diastolic heart | Systolic heart
Perfused Lung

Regional VQ-index is computed by sums of the voxels p in four quadrants of the lungs:
VL: Ventral-Left
VR: Ventral-Right
DL: Dorsal-Left
DR: Dorsal-Right
The cardiac regions (red) and surface / central regions (blue) are not analysed.

VQ-Index / Region	Healthy Subject Mean (StDev)	ICU PT_04 Mean (StDev)
Global	0.88 (0.24)	0.97 (0.57)
Ventral Left	1.11 (0.23)	1.05 (0.34)
Dorsal Left	0.81 (0.14)	0.79 (0.28)
Ventral Right	0.93 (0.19)	1.40 (0.74)
Dorsal Right	0.75 (0.25)	0.61 (0.29)

Normal subject | ICU Patient (PT_04)
Right Lung — Ventral / Dorsal | Left Lung — Ventral / Dorsal | Right Lung — Ventral / Dorsal | Left Lung — Ventral / Dorsal
V/Q index

Pilot Study Findings

Our data from neonate, pediatric and adult patients demonstrates the capability of our SMS-EIT to generate physiologically relevant lung ventilation and perfusion images. We have defined a *novel V/Q-index parameter* from these impedance images and shown agreement with lung pathophysiology observations from X-ray and CT-scans.

What is SMS-EIT?

Electrical Impedance Tomography (EIT) is a non-invasive, non-ionizing imaging technology that estimates electrical properties inside the body using measurements from surface electrodes.

GE Research developed a novel, *simultaneous multi-source EIT* (SMS-EIT) with 32 independent channels. Each channel consists of individual current source and voltage measurement circuits.
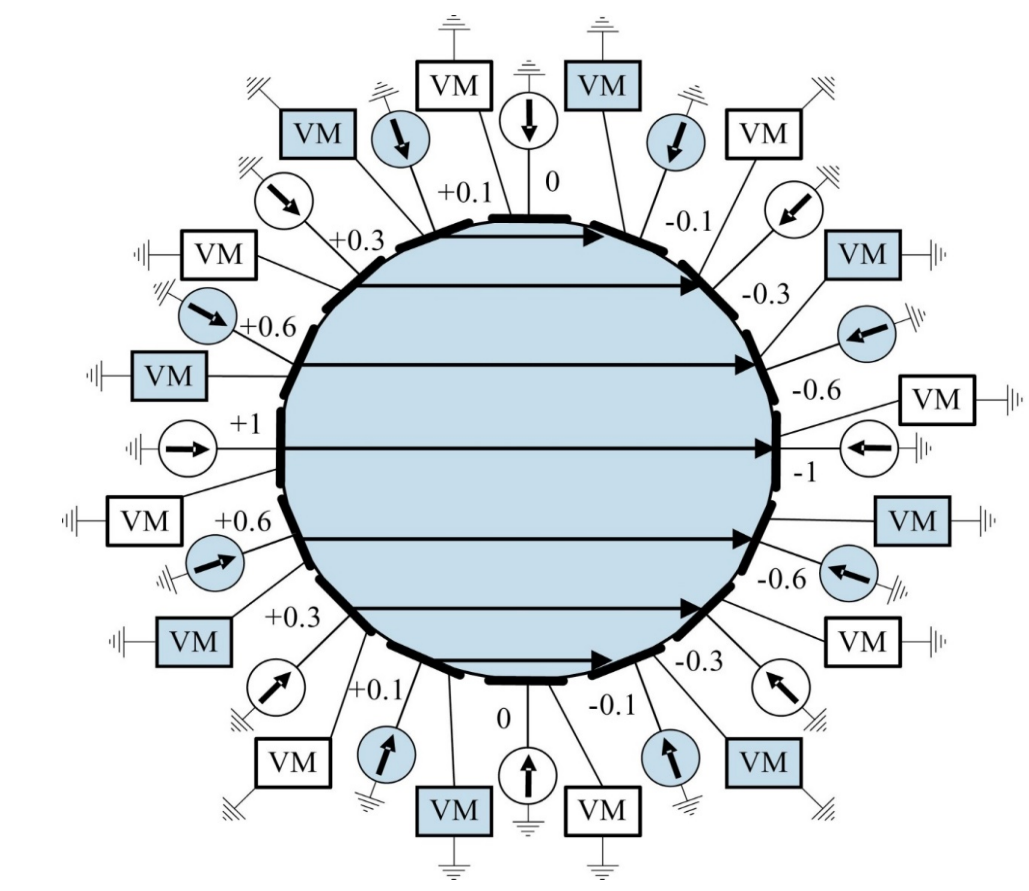
SMS-EIT clinical prototype (left); Independent channels enable generation of current patterns to optimally measure impedance within the body (right)

Advantage of SMS-EIT

Our SMS-EIT design provides uniquely greater sensitivity to image pulmonary perfusion in addition to ventilation.

SMS-EIT can generate images of lung ventilation, perfusion, and V/Q ratio maps in real time – *breath to breath and beat to beat* – without injected contrast or prolonged breath holding.