The Inspiration of Venue Ultrasound

The papers that inspired the designers

Venue™ is a special kind of ultrasound system. It has been designed for many applications. Among its capabilities is a set of tools specially designed to be useful to clinicians managing patients in medical shock. The designers used a number of academic papers to guide their decision-making.

This white paper summarizes some of the key papers that influenced the design of Venue.

For each of the publications cited in this document, the authors' conclusions are based on their scientific studies, and must be evaluated by medically-qualified readers. GE does not endorse or support any conclusions or recommendations contained in these publications.

Venue is based on advanced technology, but its inspiration is not in software and fancy processors... it's in well-established medicine. While many care areas are important for a general purpose ultrasound system, in Venue we focused on tools to help caregivers attending to patients in shock. Our developers read hundreds of papers during the development. These are the top twelve that shaped our thinking. We thought you might like to read along with us.

The RUSH Exam: Rapid Ultrasound in SHock in the Evaluation of the Critically Ill

Phillips Perera, MD, RDMS; FACEP, Thomas Mailhot; MD, RDMS; David Riley, MD, MS, RDMS; Diku Mandavia, MD, FACEP, FRCPC. *Emerg Med Clin N Am 28 2010; 29–56*

Paper synopsis

The authors discuss the utility of the RUSH protocol to differentiate the four major types of shock: cardiogenic, hypovolumic, obstructive, and distributive.

RUSH
Rapid Ultrasound in SHock

VTI
Velocity Time Integral

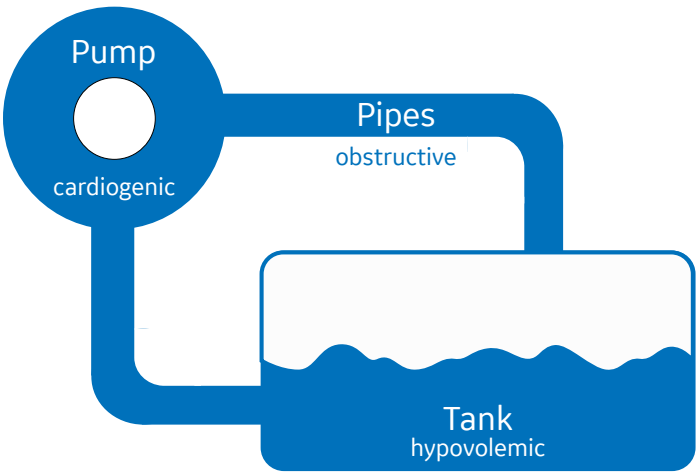
IVC
Inferior Vena Cava

How it shaped our design

This article provided the basis of the Shock Toolkit on Venue.

The features that make up the toolkit automate assessments (Cardiac, Lung, Abdomen and Vein) related to the RUSH vernacular of pump, tank and pipes.

The resulting Shock Toolkit includes three key tools (Auto B-line, Auto IVC and Auto VTI) intended to help clinicians rapidly determine the source of shock based on methodology described in the RUSH exam.



Relevance of Lung Ultrasound in the Diagnosis of Acute Respiratory Failure: The BLUE Protocol

Daniel A. Lichtenstein, MD, FCCP and Gilbert A. Mezière, MD. *CHEST 2008; 134 : 117 – 125*

Paper synopsis

This article describes the potential of lung ultrasound in diagnosis of acute respiratory failure. In this observational study, the authors prospectively evaluated 260 acute respiratory failure ICU patients with lung ultrasound and compared the results to the final diagnosis by the ICU team. The authors conclude that lung ultrasound can help the clinician make a rapid diagnosis in patients with acute respiratory failure, thus meeting the priority objective of saving time.

How it shaped our design

This article clearly described ultrasound findings and artifacts associated with different lung conditions. It described ultrasound scan techniques, probes, and technology that could impact the quality of lung imaging, and helped guide our thinking in developing lung imaging for Venue.

ICU
Intensive Care Unit

COPD
Chronic Obstructive Pulmonary Disease

Rapid Ultrasound in Shock (RUSH) Velocity-Time Integral A Proposal to Expand the RUSH Protocol

Pablo Blanco, MD; Francisco Miralles Aguiar, MD; Michael Blaivas. *J Ultrasound Med 2015; 34 : 1691 – 1700*

Paper synopsis

The authors propose expanding the RUSH protocol (evaluating cardiac function, key vascular structures, and likely sources of hypotension) with the addition of an assessment of stroke volume (utilizing velocity-time integral of the flow of the left ventricular outflow tract as a surrogate marker).

How it shaped our design

This article provided a robust argument for why and how to incorporate the LVOT VTI into the RUSH exam. This provided motivation to develop an algorithm that would automate steps in obtaining this measurement, thus simplifying and reducing variability.

RUSH
Rapid Ultrasound in SHock

VTI
Velocity Time Integral

LVOT
Left Ventricular Outflow Tract

Point-of-Care Multiorgan Ultrasonography for the Evaluation of Undifferentiated Hypotension in the Emergency Department

G. Volpicelli, A; Lamorte, M; Tullio, L; Cardinale, M; Giraudo, V; Stefanone, E; Boero, P; Nazerian, R; Pozzi, M; F. Frascisco. *Intensive Care Med 2013 39 : 1290 – 1298*

Paper synopsis

The authors prospectively evaluated 108 patients for non-traumatic symptomatic hypotension, and demonstrated good agreement between ultrasound diagnosis and final clinical diagnosis.

They concluded that using ultrasound to help identify the cause and guide initial therapy has great potential.

How it shaped our design

This article advanced our understanding of ultrasound patterns found in patients admitted in undifferentiated shock. This helped guide our selection of the first algorithms to develop for the Shock Toolkit- Auto IVC, Auto B-line and Auto VTI.

RUSH
Rapid Ultrasound in SHock

VTI
Velocity Time Integral

IVC
Inferior Vena Cava

Inter-Rater Reliability of Quantifying Pleural B-Lines Using Multiple Counting Methods

Kenton L. Anderson MD; J. Matthew Fields, MD; Nova L. Panebianco, MD; Katherine Y. Jenq, MD; Jennifer Marin, MD, MSc; Anthony J. Dean, MD. *J Ultrasound Med 2013; 32 : 115 – 120*

Paper synopsis

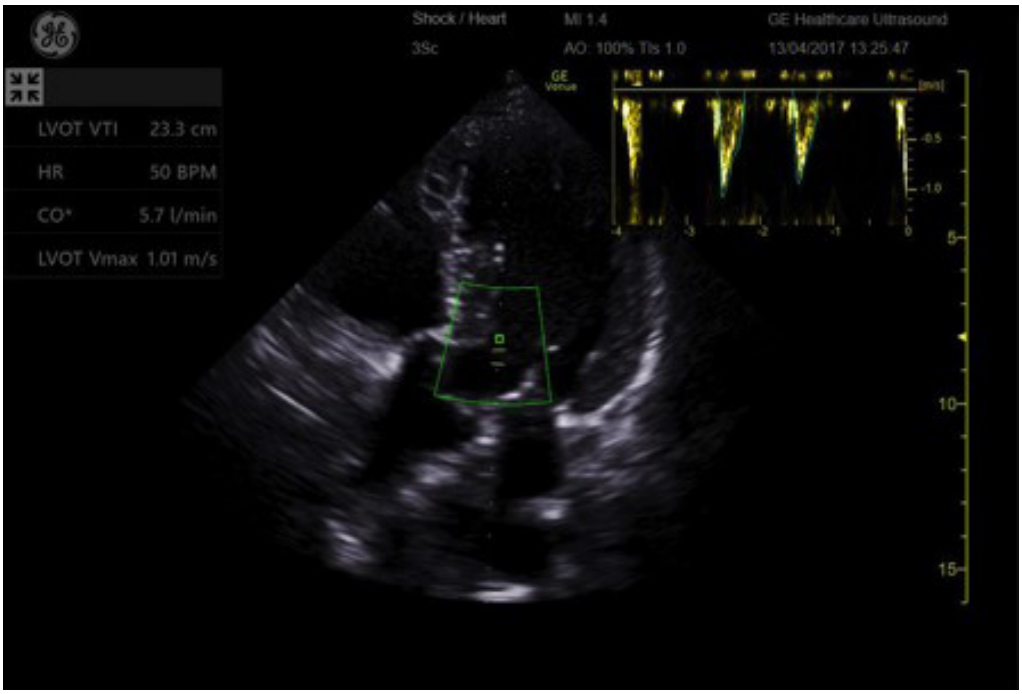
In this study the authors included a cohort of emergency department patients with dyspnea whose symptoms were consistent with acutely decompensated heart failure.

Three different B-line scoring methods were investigated, and they used inter-reader variability to recommend an approach.

How it shaped our design

This study helped us understand challenges that clinicians face in measuring and counting B-lines, and prompted our thinking of how to develop a simple tool that would help reduce error, speed results, and increase reproducibility.

One key piece of information from this paper that impacted the design was the clear definition of the B-line measurement. This definition was implemented directly into the auto B-line algorithm on the Venue system.



The Auto-VTI tool calculates the velocity-time integral and cardiac output in a single step.

Ultrasound Assessment of Lung Aeration Loss During a Successful Weaning Trial Predicts Postextubation Distress

Alexis Soummer, MD; Sébastien Perbet, MD; Hélène Brisson, MD; Charlotte Arbelot, MD; Jean-Michel Constantin, MD, PhD; Qin Lu, MD, PhD; Jean-Jacques Rouby, MD, PhD; and the Lung UltraSound Study Group. *Crit Care Med 2012; Vol. 40, No. 7*

Paper synopsis

The authors studied lung ultrasound determination of aeration changes during successful spontaneous breathing trials. They concluded that these may be used to accurately predict postextubation distress.

How it shaped our design

This article described the Lung Tool which is incorporated into our design as a method to document changes in lung aeration over time.

International Evidence-Based Recommendations for Point-of-Care Lung Ultrasound

Giovanni Volpicelli, Mahmoud Elbarbary, Michael Blaivas, Daniel A. Lichtenstein, Gebhard Mathis, Andrew W. Kirkpatrick, Lawrence Melniker, Luna Gargani, Vicki E. Noble, Gabriele Via, Anthony Dean, James W. Tsung, Gino Soldati, Roberto Copetti, Belaid Bouhemad, Angelika Reissig, Eustachio Agricola, Jean-Jacques Rouby, Charlotte Arbelot, Andrew Liteplo, Ashot Sargsyan, Fernando Silva, Richard Hoppmann, Raoul Breitkreutz, Armin Seibel, Luca Neri, Enrico Storti, Tomislav Petrovic. International Liaison Committee on Lung Ultrasound (ILC-LUS) for the International Consensus Conference on Lung Ultrasound (ICC-LUS)

Paper synopsis

This document reflects the overall results of the first consensus conference on point-of-care lung ultrasound, attended by 28 multidisciplinary experts. The group produced recommendations to guide implementation, development, and standardization of lung ultrasound in relevant settings.

How it shaped our design

These evidence-based recommendations and definitions were used to define B-lines for the algorithm incorporated in the Auto B-line tool, and to guide implementation and development of lung ultrasound imaging on Venue.

The recommended terminology and use of ultrasound in lung conditions influenced our training and documentation.

POC
Point of Care

POCUS
Point of Care Ultrasound

EGLS: Echo-guided life support: An algorithmic approach to undifferentiated shock

Jean-Francois Lanctot, Maxime Valois, Yanick Beaulieu
Crit Ultrasound J (2011) 3:123–129

Paper synopsis

The authors present an algorithm to guide management of patients with undifferentiated shock. The basis of the algorithm is simple clinical questions that incorporate ultrasound findings from the lung, heart and inferior vena cava.

How it shaped our design

This paper encouraged us to incorporate a simple approach to the assessment of shock in a way that provides quick access for clinicians, including evaluations of the lung, heart, and inferior vena cava in one application.

Caval Sonography in Shock: A Noninvasive Method for Evaluating Intravascular Volume in Critically Ill Patients

Dina Seif, MD, MBA, RDMS, Thomas Mailhot, MD, RDMS, Phillips Perera, MD, RDMS, Diku Mandavia, MD

Crit Care Med 2012 Vol. 40, No. 7

Paper synopsis

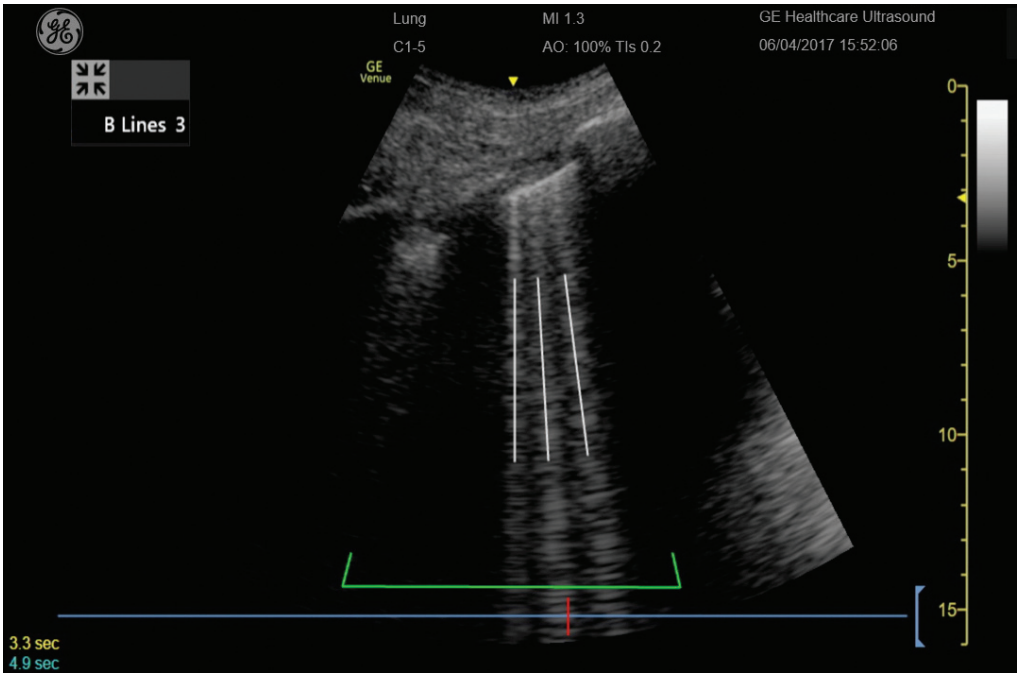
The authors describe caval sonography and how the assessment of the inferior vena cava can provide quick information to help guide resuscitation of patients in shock.

This article defines the IVC Collapsibility Index (also known as the Caval index) for spontaneously breathing patients in assessment of volume status of patients in shock.

How it shaped our design

This provided the background for our development of the Auto IVC tool in the Shock Toolkit on Venue. It helped to define the measurement locations and methods. We used this information to refine the presentation of the results of measurements of the IVC.

IVC
Inferior Vena Cava



The Auto B-line tool highlights and counts B-lines in real-time.

Bedside Ultrasound in Resuscitation and the Rapid Ultrasound in Shock Protocol

Dina Seif, Phillips Perera, Thomas Mailhot, David Riley, and Diku Mandavia. *Critical Care Research and Practice.* Volume 2012, Article ID 503254

Paper synopsis

This paper introduces the RUSH protocol, and compares it with other resuscitation protocols. This article emphasizes the terms 'pump' (heart), 'tank' (IVC) and 'pipes' (aorta, DVTs) to describe the core areas of assessment.

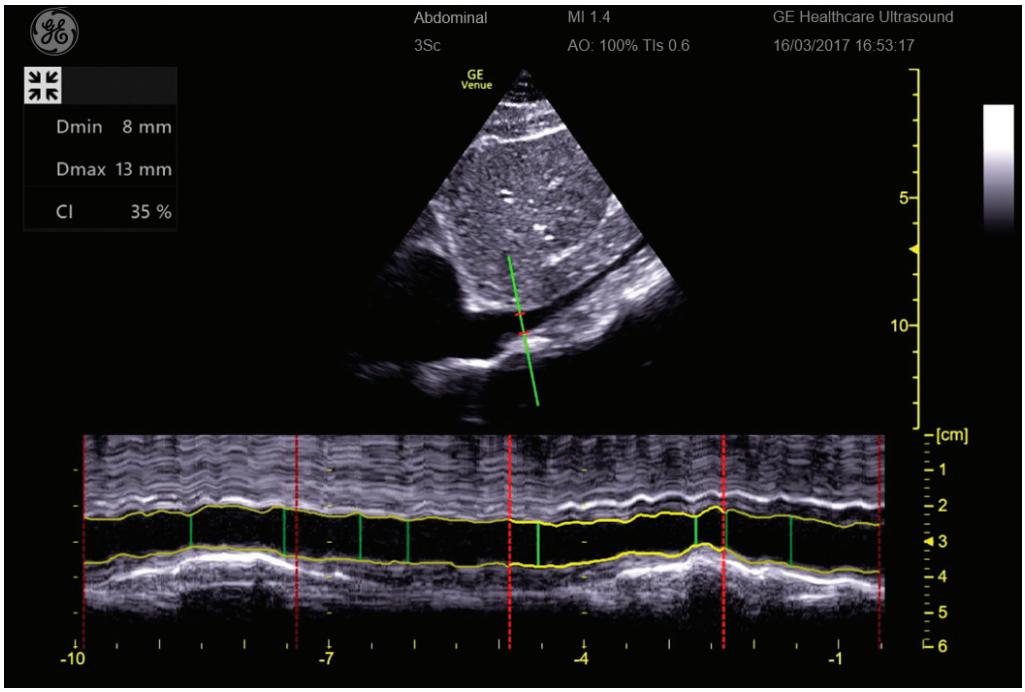
How it shaped our design

This paper presented the need for the automated IVC and VTI algorithms. The paper also provided information about the location and imaging techniques for acquiring the B-lines, which was incorporated into the design of our automated B-line algorithm.

DVT
Deep Venous Thrombus

VTI
Velocity Time Integral

IVC
Inferior Vena Cava



The Auto-IVC tool measures IVC collapsibility. There is a visual representation of the diameter change and it only takes a few respiratory cycles to get the result.

Early Fluid Loading in Acute Respiratory Distress Syndrome with Septic Shock Deteriorates Lung Aeration without Impairing Arterial Oxygenation: A Lung Ultrasound Observational Study

Fabiola Prior Caltabeloti, Antoine Monsel, Charlotte Arbelot, Hélène Brisson, Qin Lu, Wen-Jie Gu, Guang-Ju Zhou, José O C Auler Jr, Jean-Jacques Rouby. *Caltabeloti et al. Critical Care 2014; 18 : R91*

Paper synopsis

Improvements in cardiac preload with fluid loading for septic shock (improving hemodynamics and related oxygenation of vital end organs) is limited by the potential for the extra fluid load. Lung ultrasound can be used to monitor aeration changes which may serve as a safeguard against excessive fluid loading.

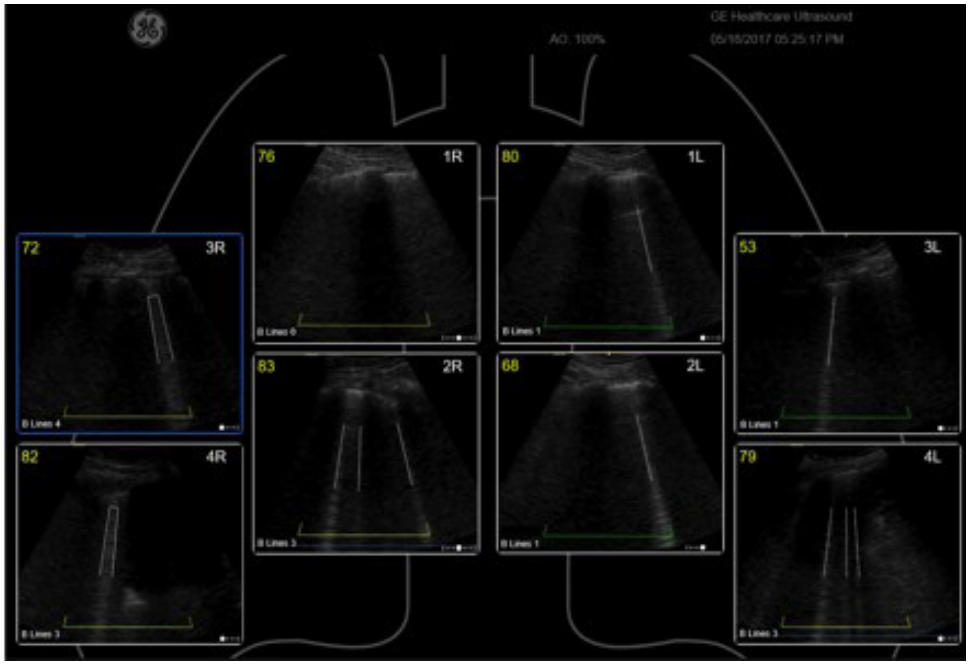
ARDS
Acute Respiratory Distress Syndrome

BLUE
Bedside Lung Ultrasound in Emergency

How it shaped our design

This paper demonstrated the potential utility of transthoracic lung ultrasound (rapid appearance of B-lines) to track aeration changes.

Along with other publications, this prompted us to incorporate a simple lung graphic and tool that allows clinicians to easily evaluate changes in the lung condition across multiple exams. The six region lung segmentation (also used in the BLUE protocol) is one of the lung segmentation graphics incorporated in Venue.



The Lung Tool keeps track of your segmental lung assessment.

BLUE-Protocol and FALLS-Protocol: Two Applications of Lung Ultrasound in the Critically Ill

Daniel A. Lichtenstein, MD, FCCP. Chest. June 2015: 1659 – 1670

Paper synopsis

This paper provides a summary of the BLUE and FALLS protocols. The BLUE protocol focuses on the assessment of respiratory failure and the FALLS protocol on circulatory failure.

BLUE
Bedside Lung Ultrasound in Emergency

FALLS
Fluid Administration Limited by Lung Sonography

How it shaped our design

This paper was key to the design of the lung and cardiac components of the Shock Toolkit on Venue, and the automation design to help streamline that workflow.


Venue

GE Healthcare provides transformational medical technologies and services to meet the demand for increased access, enhanced quality and more affordable healthcare around the world. GE (NYSE: GE) works on things that matter – great people and technologies taking on tough challenges.

From medical imaging, software & IT, patient monitoring and diagnostics to drug discovery, biopharmaceutical manufacturing technologies and performance improvement solutions, GE Healthcare helps medical professionals deliver great healthcare to their patients.

Product not available in all countries.

Imagination at work

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