Reducing
Heart Failure Readmissions
by Optimizing Discharge-Readiness

Addressing an unmet clinical need in decongestion monitoring through repeatable, non-invasive cardiac and pulmonary pressure sensing

ACORAI

ACORAI

Contents

Executive summary

Addressing an unmet clinical need in heart failure patient decongestion through non-invasive cardiac and pulmonary pressure sensing

Residual congestion remains a persistent problem in the hospitalized heart failure patient population. Patients are often perceived as clinically improved, yet still leave the hospital with residual or subclinical congestion, which is associated with worse post-discharge outcomes.[1,3,4] The clinical literature suggests that the field is moving toward more objective congestion assessment, but many existing tools remain operationally inadequate for repeatable and accurate inpatient decision-making.[5-11] The value of clinical tools to assess congestion depends on the physiologic relevance and actionability of the output that these tools provide, and whether it can be effectively protocolized during a heart failure admission without adding material workflow burden. Therein lies the strategic opportunity: operationalizing a workflow-embedded and repeatable way to assess congestion from the point of ED triage through daily inpatient management and improved discharge-readiness assessment. Non-invasive cardiac and pulmonary pressure sensing represents a crucial emerging clinical tool that can help achieve these goals and improve heart failure patient management.

1 The Problem: Residual Congestion as a Primary Driver of Readmissions

...cohorts and imaging-based studies suggest that a substantial proportion of patients hospitalized for acute heart failure are discharged with residual or subclinical congestion

Heart failure hospitalization is a high-cost, high-risk inpatient episode that does not end at discharge. The period immediately after discharge remains a vulnerable phase: patients are clinically fragile, therapeutic regimens are still being adjusted, and readmission risk remains concentrated in the first weeks to months after hospitalization.[1,2]

What Existing Literature Suggests About Decongestion Before Discharge

Residual congestion remains a central challenge in the heart failure patient pathway. Published cohorts and imaging-based studies suggest that a substantial proportion of patients hospitalized for acute heart failure are discharged with residual or subclinical congestion, approaching half of patients in some settings.[3,4] Residual congestion at discharge has been associated with higher risk of rehospitalization and death.[1,3,4] In practical terms, this suggests decongestion may still be incomplete at the time of discharge in a meaningful subset of patients.[1,11]

The literature supports the basic clinical thesis that achieving more complete decongestion before discharge matters. Observational studies have repeatedly linked persistent pulmonary or systemic congestion at discharge with worse outcomes.[1,3,4] In parallel, objective and physiologically anchored monitoring strategies have shown clinical promise, although results vary by modality and study design.[9,10]

Two evidence streams are particularly relevant. Natriuretic peptide-guided treatment has been studied across multiple randomized trials and meta-analyses, with pooled signals suggesting potential reductions in mortality and heart failure admissions, but with inconsistencies across individual studies.[9] Lung ultrasound-guided strategies have also shown encouraging pooled results, particularly for heart failure-related rehospitalization and composite adverse events, although results remain mixed across settings and study designs and operational feasibility remains a common concern.[10]

The field has identified the right problem but has not yet converged on an ideal operational solution.

What remains is an unmet need for a monitoring approach that is objective enough to be clinically meaningful and simple enough to be used repeatedly during routine inpatient care.[11]

Hospitals are often evaluated on index length of stay, throughput, and near-term utilization, yet the real clinical and economic burden unfolds over a longer horizon. A short initial admission may be a poor outcome if it shifts congestion-related deterioration into early readmission, emergency department reuse, or greater cumulative hospital time over the next 90 days and beyond.[2,12,13]

The strategic question is therefore not only how to discharge sooner, but how to discharge patients better, with improved decongestion.

2 Why Current Congestion Assessment Still Leaves a Gap and The Opportunity

The strategic question is therefore not only how to discharge sooner, but how to discharge better.

Standard tools used to assess congestion remain valuable for daily heart failure patient management. Physical examination remains universal and inexpensive; natriuretic peptides provide an objective biomarker signal; chest radiography is familiar and clinically informative. Lung ultrasound has emerged as a powerful bedside modality, and recent diagnostic literature suggests that natriuretic peptides, chest radiography, and selected point-of-care ultrasound findings may outperform traditional physical examination maneuvers for identifying volume overload.[5]

The gap in today's heart failure patient workflow is operational rather than conceptual. No single standard approach consistently combines diagnostic value, repeatability, actionability, and workflow fit required for serial congestion management and discharge-readiness assessment.[1,11]

The gap in today's heart failure patient workflow is operational rather than conceptual. No single standard approach consistently combines diagnostic value, repeatability, actionability, and workflow fit required for serial congestion management and discharge-readiness assessment.[1,11]

Physical signs are useful but variably sensitive and subject to observer dependence. Natriuretic peptides are objective, but interpretation can be affected by comorbidities and they do not always translate neatly into a day-by-day therapeutic target.[1] Chest radiography remains clinically useful for diagnosis but is generally less suited to frequent serial trending during routine inpatient management. Lung ultrasound is promising and clinically meaningful, but in many real-world settings it still depends on training, protocol consistency, device access, and local adoption patterns.[6,7]

What remains is an unmet need for a monitoring approach that is objective enough to be clinically meaningful and simple enough to be used repeatedly during routine inpatient care.

Similarly, common process measures such as urine output, net fluid balance, weight change, or hemoconcentration can be helpful indicators of treatment activity, yet they do not always reflect the underlying hemodynamic state; with published analyses showing substantial discordance between fluid balance and weight loss.[8]

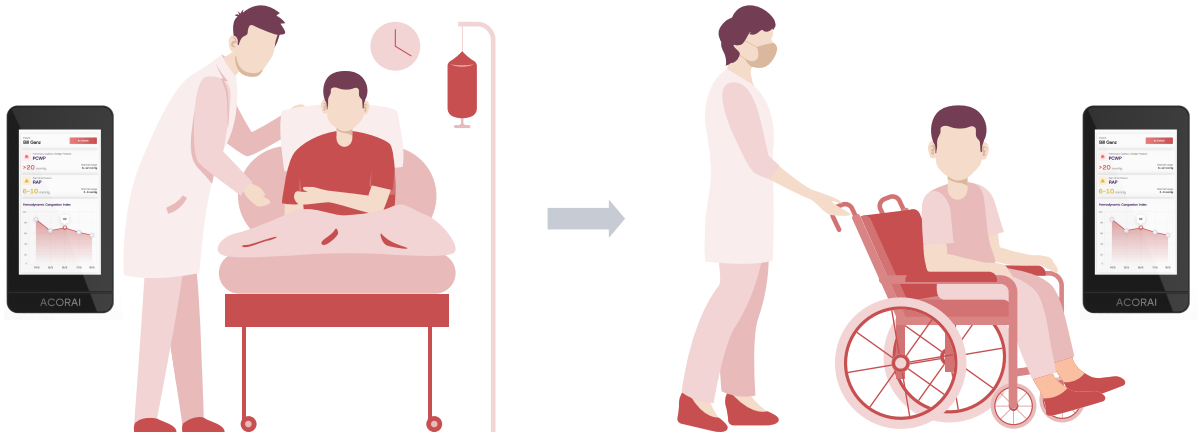
The current unmet clinical need is not that clinicians have no way to assess congestion. It is that they still lack a low-friction way to measure it repeatedly, use it to adjust therapy, and anchor discharge decisions in an objective trend rather than a diffuse clinical impression.[1,11]

The opportunity is therefore not to replace existing tools, but to add a repeatable, low-friction congestion signal grounded in underlying filling pressures that can be integrated into routine inpatient decision points.

Modality	Where it helps	Why it still falls short for serial congestion monitoring and discharge-readiness management
Physical exam	Universal, fast, inexpensive	Subject to observer variability and limited sensitivity for subclinical congestion.
Natriuretic peptides	Objective biomarker signal with intervention literature	Not always a clean day-by-day therapeutic target; can be affected by patient context and interpretation.
Chest x-ray	Familiar and informative for diagnosis	Less suitable as a frequent, low-friction trending tool during routine inpatient management.
Lung ultrasound	Promising bedside congestion assessment with supportive evidence	Adoption depends on training, protocol consistency, device access, and workflow culture.

The current unmet clinical need is not that clinicians have no way to assess congestion. It is that they still lack a low-friction way to measure it repeatedly, use it to adjust therapy, and anchor discharge decisions in an objective trend ..

3 What a Clinically Useful Decongestion Tool Must Deliver



A clinically useful discharge-readiness tool must be objective enough to reduce reliance on subjective interpretation and actionable enough to influence therapeutic decisions. It must be repeatable so that clinicians can trend changes in congestion rather than rely on one-off snapshots. It must be easy to use, broadly available, and fast enough to fit real inpatient workflow rather than idealized research conditions.

Just as important, the tool should ideally provide a repeatable signal that can be interpreted against a clinically meaningful decongestion goal rather than merely confirm that congestion exists.[1,11] A targetable output is most useful when it anchors a repeatable protocol: initial assessment, daily trending, pre-discharge confirmation, and structured documentation of the patient's congestion trajectory. That distinction separates a passive measurement from a management instrument. In that model, the goal is not simply to confirm congestion, but to follow a pressure-derived decongestion trajectory that can support daily management and discharge-readiness decisions.

A non-invasive cardiac and pulmonary pressure-sensing approach is most likely to be valuable when it produces a repeatable hemodynamic signal that can be trended over time and interpreted against a therapeutic goal, rather than functioning as a one-off data point.

Finally, the tool should work across the inpatient journey. A measurement that is helpful only at diagnosis or only at discharge will have narrower strategic utility than one that can support triage, daily reassessment, therapy titration, discharge-readiness assessment and post-discharge follow-up.

Objective	Reduces dependence on subjective interpretation and improves consistency across users.	**Actionable**	Supports escalation, continuation, or de-escalation of therapy.
Repeatable	Enables trending over time rather than one-off measurement.	**Available and low-friction**	Can be used across shifts and care settings without excessive workflow burden.
Fast	Fits ED and ward decision-making timelines.	**Targetable**	Helps define and aim for a clinically meaningful decongested zone.
Longitudinal	Adds value at triage, daily management, and discharge - not only at diagnosis.	**Platform-ready**	Can feed documentation, analytics, protocolization, and patient management layers.

4 Beyond Length of Stay: Why Better Discharge Matters More Than Faster Discharge

Clinical takeaway

The real objective is not the shortest admission - **it is the lowest total burden of hospitalization** consistent with safe recovery. Technologies that improve discharge quality can therefore matter even if their value is not fully captured by index length of stay alone.

Many hospital decisions are shaped by a familiar tension: the desire to shorten index length of stay versus the need to achieve adequate decongestion. This is often framed as a trade-off between efficiency and near-term patient risk, but that framing is incomplete. A discharge that occurs before congestion is adequately resolved may reduce the current admission only to increase the total burden of care across the next several weeks or months.

From a health-system perspective, a more useful framework may be to maximize days alive and out of hospital, or how to minimize total hospital days across a defined follow-up period.[12,13] This framing shifts the discussion away from index length of stay alone and toward cumulative hospitalization burden and patient pathway performance over time.

A more relevant economic question is not simply whether a technology shortens length of stay, but whether it reduces cumulative hospital use, supports safer discharge timing, and improves days alive and out of hospital over the follow-up period.

Value is increasingly created when technologies support better decisions at moments of high leverage. Discharge is one of those moments. A tool that improves confidence in discharge-readiness can influence not only one decision, but the trajectory of utilization that follows.

5 The Opportunity for Objective, Longitudinal Decongestion Monitoring

Investigational Device
Limited by Federal (or United States) Law to Investigational Use

There is an unmet need for an objective, repeatable hemodynamic congestion signal that can be obtained quickly at the bedside, trended over time, and interpreted in the context of a therapeutic goal. A better decongestion target may support earlier decision-making and more confident daily management, not simply improved diagnostic accuracy at a single time point. That is especially true when the signal reflects the direction and magnitude of change in cardiac and pulmonary pressure burden rather than relying only on intermittent surrogate markers.

When clinicians have an objective target, congestion may be identified earlier in the acute-care pathway, and therapeutic response may be assessed more frequently. Lack of progress may be recognized sooner, enabling earlier escalation or modification of decongestive therapy and/or guideline-directed medical therapy optimization. As the patient approaches a defined low-congestion zone, the discharge discussion can shift from symptom improvement alone toward a more structured readiness assessment.

Novel congestion monitoring tools will sit at the intersection of bedside measurement, clinical workflow, patient management software, analytics, and pathway standardization. These tools need to capture data repeatedly and be translated into documentation, decision logic, analytics, and patient pathway planning.

Strategic implication

Objective, longitudinal congestion monitoring is an opportunity for patient pathway optimization, not just a point-diagnostic opportunity. A clinically useful solution is one that becomes part of routine inpatient decision-making and creates a bridge to software, analytics, and future care-continuum expansion.

6 Illustrative Workflow: From ED Triage to Discharge-Readiness

...early evaluation when congestion is suspected, once-daily trending during decongestion, and a pre-discharge check interpreted alongside the broader clinical picture

At presentation in the emergency department or acute admissions setting, non-invasive cardiac and pulmonary pressure sensing could complement the initial clinical evaluation and help shorten the time from suspected symptoms to a clearer management decision. During the inpatient stay, the same pressure-derived measurements could be repeated daily to show whether the patient is moving toward or away from the intended decongestion target.

A useful tool will support defined inpatient protocol: early evaluation when congestion is suspected, once-daily trending during decongestion, and a pre-discharge check interpreted alongside the broader clinical picture. Non-invasive cardiac and pulmonary pressure sensing has the potential to be sufficiently low-friction to be repeatable across triage, daily reassessment, and pre-discharge review without requiring a specialist workflow for successful long-term implementation.

These emerging workflows can allow for therapy to be adjusted with greater confidence. If the patient is not progressing toward the target, clinicians may intensify or adapt decongestive strategy. If the patient is improving but has not yet entered a low-congestion range, discharge can be delayed or planned more cautiously. If both the objective signal and the overall clinical picture converge, the team may gain greater confidence that discharge is occurring from a more stable physiologic position.

Looking forward, these tools can naturally be extended to the broader heart failure care continuum with early follow-up, transitional care, or recongestion detection.

Illustrative Workflow for Inpatient Heart Failure Management

Step 1 **ED triage**	Add an objective congestion signal to early evaluation to support faster recognition and earlier decongestion decisions.
Step 2 **Daily inpatient trending**	Repeat measurements during the admission to assess whether the patient is moving toward or away from a target state.
Step 3 **Therapy adjustment**	Use the trajectory to support escalation, modification, or continuation of decongestive therapy.
Step 4 **Discharge-readiness**	Combine the objective trend with the broader clinical picture to determine whether the patient has reached a more stable low-congestion zone.

7 Requirements for Clinical Adoption and Workflow Integration

Operational simplicity and strong health economic data will remain key to successful adoption and implementation of any new tool.

Improving discharge-readiness in heart failure addresses clear hospital pain points, and a growing pressure to improve care pathway efficiencies. Non-invasive cardiac and pulmonary pressure sensing aligns with broader care trends of extending monitoring beyond vital signs and better linking these measurements to existing workflows.

A solution built around a repeatable, non-invasive, pressure-informed congestion signal can become embedded in how hospitals triage heart failure patients, manage inpatient decongestion, document readiness for discharge, and plan for patient follow-up.

Operational simplicity will remain key to successful adoption and implementation of any new congestion tool. Adoption will depend not only on accuracy, but also on training requirements, time required per measurement, device availability, integration with existing monitoring infrastructure, and clarity about how device outputs trigger action.

A tool with low workflow friction, high repeatability, a clear operational protocol, and a clinically interpretable target state is required to be adopted consistently and support pathway integration. The opportunity is not only to add another diagnostic input, but to move heart failure management from spot assessment toward longitudinal, pressure-informed decongestion management.

The true value of non-invasive cardiac and pulmonary pressure sensing will be realized when it is trended across emergency, inpatient and outpatient settings, extending beyond single inpatient encounters, enabling an end-to-end heart failure care pathway to emerge.

References

1. McDonagh TA, Metra M, Adamo M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J. 2021;42(36):3599-3726. doi:10.1093/eurheartj/ehab368.

2. Greene SJ, Fonarow GC, Vaduganathan M, et al. The vulnerable phase after hospitalization for heart failure. Nat Rev Cardiol. 2015;12(4):220-229. doi:10.1038/nrcardio.2015.14.

3. Rubio-Gracia J, Demissei BG, Ter Maaten JM, et al. Prevalence, predictors and clinical outcome of residual congestion in acute decompensated heart failure. Int J Cardiol. 2018;258:185-191. doi:10.1016/j.ijcard.2018.01.067.

4. Rattarasarn I, Yingchoncharoen T, Assavapokee T. Prediction of rehospitalization in patients with acute heart failure using point-of-care lung ultrasound. BMC Cardiovasc Disord. 2022;22(1):330. doi:10.1186/s12872-022-02781-9.

5. Maw AM, Hassanin A, Ho PM, et al. Diagnostic Accuracy of Point-of-Care Lung Ultrasonography and Chest Radiography in Adults With Symptoms Suggestive of Acute Decompensated Heart Failure: A Systematic Review and Meta-analysis. JAMA Netw Open. 2019;2(3):e190703. doi:10.1001/jamanetworkopen.2019.0703.

6. Platz E, Jhund PS, Girerd N, et al. Expert consensus document: Reporting checklist for quantification of pulmonary congestion by lung ultrasound in heart failure. Eur J Heart Fail. 2019;21(7):844-851. doi:10.1002/ejhf.1499.

7. Gargani L, Girerd N, Platz E, et al. Lung ultrasound in acute and chronic heart failure: a clinical consensus statement of the European Association of Cardiovascular Imaging (EACVI). Eur Heart J Cardiovasc Imaging. 2023;24(12):1569-1582. doi:10.1093/ehjci/jead169.

8. Testani JM, Brisco MA, Kociol RD, et al. Substantial Discrepancy Between Fluid and Weight Loss During Acute Decompensated Heart Failure Treatment. Am J Med. 2015;128(7):776-783.e4. doi:10.1016/j.amjmed.2014.12.020.

9. McLellan J, Bankhead CR, Oke JL, et al. Natriuretic peptide-guided treatment for heart failure: a systematic review and meta-analysis. BMJ Evid Based Med. 2020;25(1):33-37. doi:10.1136/bmjebm-2019-111208.

10. Li Y, Ai H, Ma N, Li P, Ren J. Lung ultrasound-guided treatment for heart failure: An updated meta-analysis and trial sequential analysis. Front Cardiovasc Med. 2022;9:943633. doi:10.3389/fcvm.2022.943633.

11. Pena DL, Iliesiu AM, Aurelian J, et al. Assessment of Decongestion Status Before Discharge in Acute Decompensated Heart Failure: A Review of Clinical, Biochemical, and Imaging Tools and Their Impact on Management Decisions. Medicina (Kaunas). 2025;61(5):816. doi:10.3390/medicina61050816.

12. Chen Y, Lawrence J, Stockbridge N. Days alive out of hospital in heart failure: Insights from the PARADIGM-HF and CHARM trials. Am Heart J. 2021;241:108-119. doi:10.1016/j.ahj.2021.03.016.

13. Ariti CA, Cleland JGF, Pocock SJ, et al. Days alive and out of hospital and the patient journey in patients with heart failure: Insights from the Candesartan in Heart failure: Assessment of Reduction in Mortality and morbidity (CHARM) program. Am Heart J. 2011;162(5):900-906. doi:10.1016/j.ahj.2011.08.003.