

# SIGNAL 1

## Using machine learning to streamline the hospital discharge process

### **Executive Summary**

Machine learning holds great potential to unlock efficiencies in the complex hospital discharge process and address the patient flow challenges being experienced by hospitals worldwide.

In consultation with hospital leaders and frontline clinicians, Signal 1 identified that discharge efficiencies could be realized if hospital staff could predict in advance which patients are approaching the end of their hospital stay. Signal 1's Discharge Solution is based on a machine learning model that uses common EMR data to identify patients who are approaching the end of their hospital stay and could be prioritized for discharge assessment and planning. These predictions, along with information about patients' discharge barriers, are seamlessly shared with relevant clinicians with their existing workflows.



## Signal 1's Discharge Solution streamlines the discharge process to help patients get out of hospital sooner.

### **A Universal Challenge: Managing Patient Flow**

With 33.3 and 2.9 million annual hospitalizations in the United States and Canada, respectively,<sup>1,2</sup> many hospitals are struggling to optimally manage patient flow. Patient flow is the movement of patients through a healthcare facility. It is the process of getting patients from the point of admission to the point of discharge.

Efficient and effective flow means constantly matching every patient's care needs to the human and physical resources necessary to address those needs.<sup>3</sup> Since hospital resources are generally constrained (hospitals cannot quickly create beds or increase nursing staff), doctors and nurses are largely specialized (an obstetrician cannot perform an emergency appendectomy), and patient volumes and care needs are hard to predict, this is quite a challenging task.

Poorly managed patient flow results in adverse health outcomes for patients, extra stress for hospital staff, and capacity problems including overcrowded emergency departments (EDs) and/or cancelled procedures.<sup>4</sup> The challenges associated with effectively managing flow are magnified in the current post-COVID environment where hospitals are experiencing higher patient volumes, struggling with significant staffing shortages (in the US, 52% of nurses said they considered leaving their position due to insufficient staffing and burnout<sup>5</sup>) and facing both political and financial pressure to reduce a large surgical backlog that accumulated during the pandemic.

# 52%

of nurses said they considered leaving their position due to insufficient staffing and burnout.<sup>5</sup>

## Patient Discharge: A ‘Pressure Valve’ for Many Hospitals

While flow problems may be most visible in long ED wait times, challenges in the ED are often a symptom of barriers elsewhere in the hospital.<sup>5</sup> When patients do not efficiently flow out of a hospital, beds and staff are not available for new patients who are flowing into the hospital, resulting in excessive waits for newly admitted patients. When discharges are safely accelerated, not only do patients get out of hospital sooner, but beds and staff are more quickly available for the next patient, taking pressure off other parts of the hospital.

Discharge coordination and execution is a complex task and hospitals have been trying to improve discharge processes for decades.<sup>6</sup> Yet, while numerous discharge checklists, processes, and tools have been developed and piloted, challenges associated with efficient discharge persist.<sup>2</sup> Average length of stay, a common indicator of hospital throughput and efficiency, is increasing across many OECD countries,<sup>7</sup> including Canada<sup>8</sup> and the United States.<sup>9</sup>

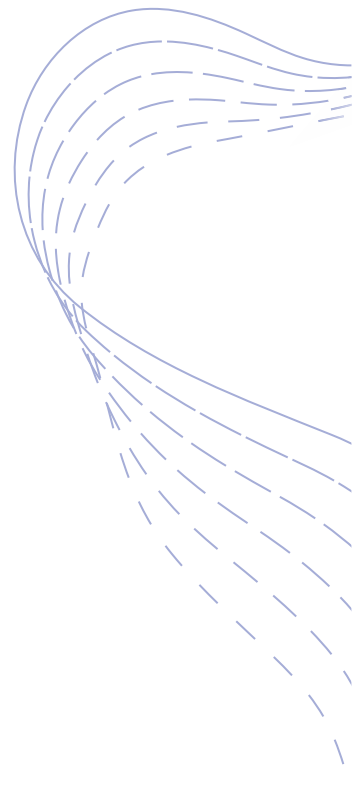
### The Opportunity: Using Machine Learning to Predict Readiness for Discharge Assessment and Planning

Over the past year, we at Signal 1 have talked with staff at multiple hospitals to understand the challenges they face around discharge.

All of them zeroed in on a key point in the patient journey: **the time when a patient transitions out of their acute phase of care.**

They explained that, ideally, discharge planning occurs while a patient is approaching the end of their acute phase so that the patient is ready to leave the hospital shortly after reaching clinical stability.

In practice, however, it is difficult to predict when a patient will reach the point of clinical stability. While doctors may be able to anticipate clinical stability, their attention is often (appropriately) focused on their most acute patients, resulting in delays identifying and/or communicating about the more stable patients. The result: discharge planning is often delayed, beginning only after a patient has been designated clinically stable.



## The power of machine learning

Machine learning is a type of artificial intelligence that involves training computer algorithms to learn patterns from past data to make predictions about future events - events such as when a patient is approaching the end of their hospital stay. Once the patterns have been learned, the model can be deployed on current patients to predict which patients are - and are not - approaching the end of their acute phase care in the coming days.

Signal 1's Discharge Solution does exactly that. Running automatically in the background, our algorithm predicts which patients will receive a discharge order or be discharged within the next 3 days. We combine those predictions with information about patients' discharge barriers in a daily Discharge Priority Report which shared directly with relevant staff through existing technical and communication systems.

**Our algorithm surfaces over 75% of all patients to prioritize for discharge assessment and planning, with over half surfaced in the 3 days prior to their actual discharge.**

## Benefits

1. Our solution surfaces patients often before busy clinical teams have had the time or opportunity to assess the patient's progression towards discharge readiness.
2. With earlier identification of patients approaching the end of their hospital stay, discharge activities can be better coordinated and, importantly, can begin sooner.
3. With visibility into each patient's specific discharge barriers, the barriers become more quickly actionable by the multidisciplinary team.





# About Signal 1

Founded in 2022, Signal 1 is building the technology platform to accelerate the AI revolution in healthcare. Signal 1 offers a fully-integrated AI platform built specifically for the healthcare industry. Our Health AI platform provides the technical infrastructure and tools to enable and accelerate a health system's AI program. The platform consists of three components:

1. AI Infrastructure: Secure data pipelines and an award-winning AI engine to easily deploy AI models into production ensuring industry-leading software and machine learning practices.
2. AI Control Center: A single 'pane of glass' to enable management and monitoring of all AI models deployed via the platform.
3. AI App Suite: Library AI applications that address key operational and care management decisions including discharge planning, ED prioritization and unexpected deterioration.

What this means for hospitals we work with:

- Streamlined AI model development and deployment with a faster time-to-value
- Automated model validation and real-time monitoring to ensure models remain accurate and safe to use
- Lower costs of ongoing model management and maintenance
- Up to 10X the output and ROI of existing data science and machine learning teams

To learn more about Signal 1's Discharge Solution, please contact us at:

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## References

1. American Hospital Association. Fast Facts on U.S. Hospital, 2022 (Available at: <https://www.aha.org/statistics/fast-facts-us-hospitals>)
2. Canadian Institute for Health Information. Hospital Stays in Canada. (Available at <https://www.cihi.ca/en/hospital-stays-in-canada>)
3. What is patient flow? Patient flow - a critical component of process management in hospitals and other healthcare facilities. NEJM Catalyst 2018. (Available at [catalyst.nejm.org/doi/full/10.1056/CAT.18.0289#](https://catalyst.nejm.org/doi/full/10.1056/CAT.18.0289#))
4. Rutherford, P.A. et al. Achieving Hospital-wide Patient Flow (Second Edition). IHI White Paper. Boston, Massachusetts: Institute for Healthcare Improvement; 2020. (Available at [www.ihl.org](http://www.ihl.org))
5. American Nurses Foundation. Pulse on the Nation's Nurses Survey Series: COVID-19 Two-Year Impact Assessment Survey. 2022. (Available at <https://www.nursingworld.org/~4a2260/contentassets/872ebb13c63f44f6b11a1bd0c74907c9/covid-19-two-year-impact-assessment-written-report-final.pdf>)
6. Preyde M, Macaulay C, Dingwall T. Discharge planning from hospital to home for elderly patients: a meta-analysis. J Evid Based Soc Work 2009; 6(2):198-216.
7. OECD (2023), Length of hospital stay (indicator). doi: 10.1787/8dda6b7a-en (Accessed on 20 March 2023)
8. Fekri, O. et al. Associations between hospital deaths (HSMR), readmission and length of stay (LOS): a longitudinal assessment of performance results and facility characteristics of teaching and large-sized hospitals in Canada between 2013–2014 and 2017–2018. BMJ Open 2021;11:e041648.
9. Dharmarajan, K. et al. Diagnoses and timing of 30-day readmissions after hospitalization for heart failure, acute myocardial infarction, or pneumonia. JAMA 2015; 315(20): 2165-2175.