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HEART HEALTH AT A CROSSROADS

ADDRESSING THE PERVASIVE
BURDEN OF DELAYED CARE

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CV BUSINESS WHITE PAPER

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INTRODUCTION

While cardiovascular care has been revolutionized by innovations like minimally invasive procedures and advanced imaging, these tools are only as effective as the systems that support them. When technology isn't fully integrated into clinical workflows or fails to meet patients where they are, its potential to drive better outcomes often falls short. "Technical brilliance means nothing if it never reaches patients."¹

This disconnect is particularly evident in the care of severe aortic stenosis (AS), the most morbid and mortal form of valvular heart disease (VHD),² where, despite effective treatments like TAVR, many patients experience delays in diagnosis and referral. In some cases, early signs of disease go unrecognized or overlooked, and others remain asymptomatic and underdiagnosed until they present to the emergency department, having never been seen by a cardiologist.² The literature continues to support the benefit of earlier treatment and demonstrates that a lack of timely intervention leads to worse outcomes and increased cost of care, even in patients who have not yet developed symptoms.³ To bridge this critical gap, healthcare systems must transition from a reactive model to a proactive, technology-driven and systematic approach to patient identification.



FROM IDEA TO IMPACT

Facing a critical need to improve the monitoring and throughput of structural heart (SH) patients, Cedars-Sinai Medical Center's leadership and a determined team came together to tackle a challenge and pursue a strategic imperative. The team went beyond optimizing a resource and acquiring new technology to forge two separate, vital resources into a powerful, complementary set of tools. This new approach fundamentally transformed how *and* when patients receive care and ultimately saves lives.

This revolutionary care transformation changed internal operations and granted Cedars-Sinai a formidable competitive advantage. This advantage stems from the ability to proactively tap into a patient population within the network but not yet under the supervision of a cardiologist. By offering better, faster and more precise identification, they ensured these patients received necessary and appropriate medical care before presenting in distress and needing emergent cardiac services. This strategic patient identification and management dramatically improved patient outcomes, elevated the standard of care, and helped with better utilization of resources.

Cedars-Sinai implemented a scalable approach using two distinct yet complementary tools: an echocardiographic surveillance platform *and* a structured workflow built within Epic, their electronic health record (EHR). While the surveillance tool operates outside the EHR, it works in parallel with the Epic-based workflow to identify patients who may benefit from aortic valve replacement. Together, these tools create a coordinated system that strengthens referral pathways, supports timely clinical decision-making, and enables the SH program to manage growing volumes without compromising care.

This CV business white paper outlines the modernized approach Cedars-Sinai used to achieve these results. It offers a replicable blueprint for other institutions seeking to enhance their SH programs and adopt a more proactive, data-informed approach to cardiovascular care that benefits both patients and the healthcare system.

CEDARS-SINAI: THE POWER OF PARALLEL SYSTEMS

A key insight from the Cedars-Sinai experience is that the transformation wasn't driven by a single tool, but rather the intentional coordination of two systems working in parallel to improve access to TAVR:

- **Biome Echo Surveillance:** A cloud-based platform that identifies patients with VHD who have not yet been referred to a specialist for further evaluation. It synthesizes quantitative and qualitative data from echocardiogram reports and applies American Society of Echocardiography (ASE) guideline-based logic to flag patients for timely review. The outreach process is handled by a dedicated team, preserving referral relationships and operational flow.
- **Epic EHR Tool:** Designed to streamline patient tracking, clinical documentation and care coordination once a patient has entered the TAVR workflow. Built with frontline feedback, this tool improves quality outcomes by supporting structured follow-up, such as the Kansas City Cardiomyopathy Questionnaire (KCCQ), five-minute walk tests (5MWTs), and 30-day post-procedure follow-up.

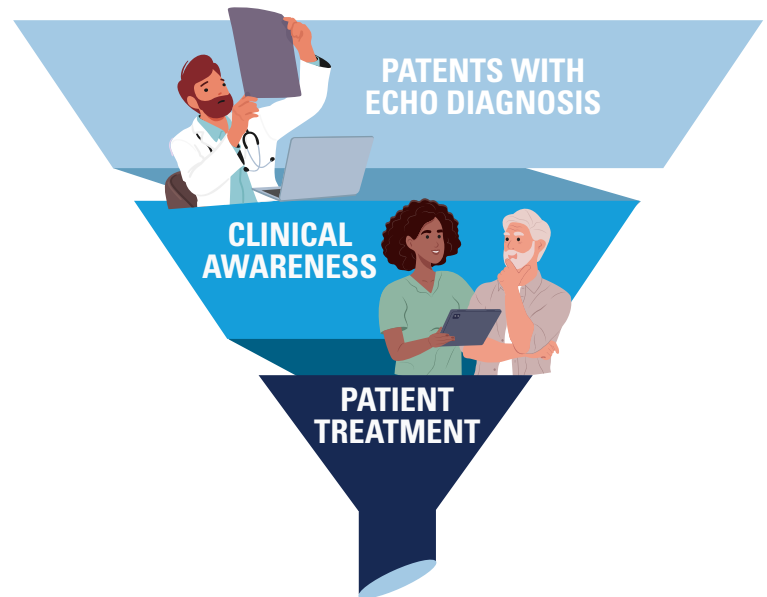


Joseph Ebinger, MD, MS, FACC, director of Clinical Analytics at Cedars-Sinai, notes: “VHD is both underdiagnosed and inefficiently treated. By using novel informatics solutions, we can more rapidly identify patients who require treatment and more quickly move them through the healthcare system to improve their quality of life.”

This coordinated method ensures patients are not only identified earlier but also moved efficiently through the care continuum without overburdening physicians or disrupting existing workflows.

While this dual-system strategy enhances identification and coordination, it was born out of a recognition that traditional care pathways were failing patients due to the complexities of healthcare and an overreliance on labor-intensive handoffs that are often prone to failure (Figure 1).

Figure 1: The Complexities of Traditional Care Pathways



The EHR tool is about efficiency and follow-through. The Biome-enabled echo tool is about finding the patients in the first place.

**THEY'RE DOING TWO DIFFERENT THINGS WITH THE SAME GOAL:
HIGH-VOLUME, HIGH-VALUE VALVE CARE."**

Joseph Ebinger, MD, MS, FACC

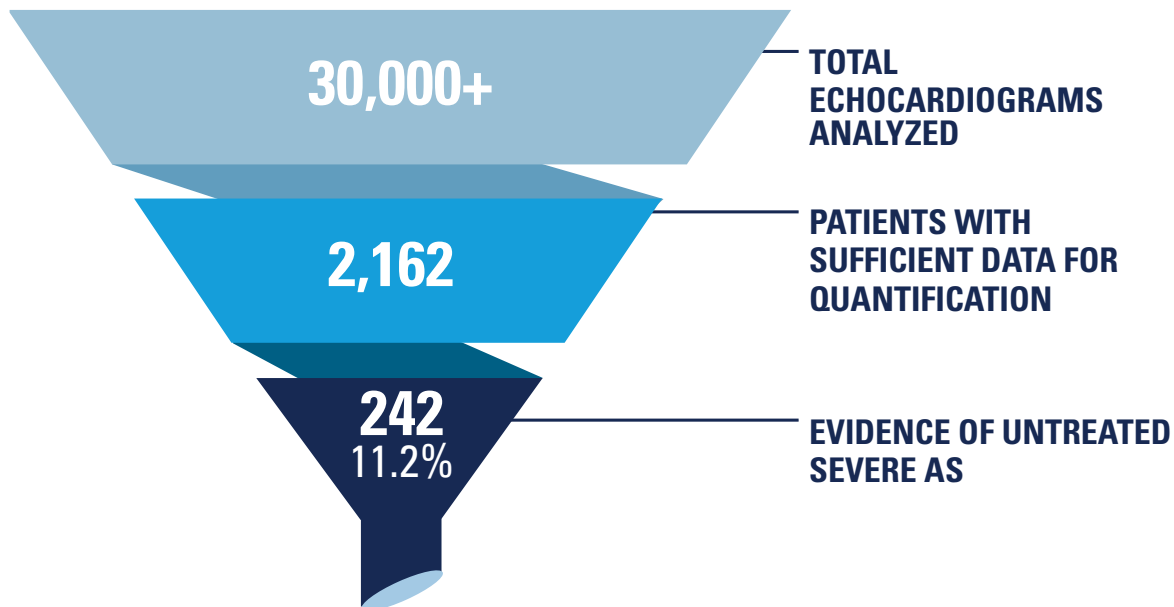
Associate Professor of Cardiology; Director of Cardiac Critical Care;
Director of Clinical Analytics, Cedars-Sinai Medical Center

THE HIDDEN BURDEN: CLINICAL AND OPERATIONAL CHALLENGES IN MANAGING UNTREATED SEVERE AS

To understand the magnitude of the issue, it helps to begin with what the data reveals about untreated patients. Severe AS is a progressive and life-threatening condition associated with significant morbidity and mortality if left untreated. Despite the availability of effective therapies such as TAVR, timely intervention remains a persistent challenge across healthcare systems. Many patients with severe AS experience missed or delayed diagnosis or treatment, leading to preventable hospitalizations and even death,³ due to limitations in current surveillance mechanisms and fragmented care coordination pathways.

Cedars-Sinai Medical Center aimed to quantify this gap by retrospectively analyzing echocardiogram data through a custom-developed screening system. Using natural language processing (NLP) and structured data extraction techniques, the team evaluated 2,162 echocardiographic reports performed in 2023. The findings were notable: 242 patients (11.2%) had evidence of untreated severe AS (**Figure 2**). This high rate of unaddressed disease highlights an urgent need for scalable, technology-enabled strategies to identify at-risk individuals early and align care pathways to enable timely intervention. Among the 11.2% of patients identified many were those with non-cardiology referrals or individuals who had echocardiography performed during non-cardiac inpatient stays, emphasizing the previous missed opportunities for crucial intervention.⁴

Figure 2: Echocardiographic Reports Performed in 2023



*"The hardest part of a TAVR is **GETTING THE PATIENT ON THE TABLE.**"*

Mark Russo, MD, MS

Professor of Surgery, Chief of Cardiac Surgery; Director of Structural Heart Disease,
Rutgers-Robert Wood Johnson Medical Center

Operational Inefficiencies: The Limitations of Traditional AS Surveillance

The underdiagnosis and undertreatment of severe AS is not solely a clinical issue. It also reflects underlying operational inefficiencies that hinder timely and effective care delivery. Current workflows often rely on manual chart review, individual provider recall, or non-integrated systems to track echocardiographic findings and follow-up actions. These labor-intensive and error-prone methods contribute directly to delays in triage, incomplete referrals and inconsistencies in documentation.

Key barriers contributing to these challenges include:

- **Unstructured Clinical Data:** Echocardiographic reports are frequently stored as free-text narratives, making automated case identification and large-scale analysis exceedingly difficult. This necessitates time-consuming manual review to glean critical information.
- **Lack of Standardized Workflows:** Significant variability exists in follow-up protocols and referral practices across different providers and departments. This leads to inconsistencies in patient care and potential for patients to fall through the cracks.
- **Limited Interoperability:** Traditional EHR systems may not be optimized for tracking longitudinal care journeys, particularly across the diagnostic, interventional and post-procedure phases. This fragmentation creates data silos and impedes a holistic view of patient progress.
- **Administrative Burden:** A high staff workload and over-reliance on manual processes significantly reduce efficiency and increase the likelihood of missed follow-up appointments or necessary interventions.⁵

These structural challenges collectively contribute to missed opportunities for timely intervention, which can significantly impact patient outcomes, diminish institutional quality metrics, and negatively affect reimbursement under value-based care models.⁴



*“Leading such an exceptional team through the implementation of the patient tracking system showed how **ALIGNING TECHNOLOGY WITH WORKFLOW CAN BREAK DOWN DATA SILOS AND ELEVATE PATIENT CARE ACROSS OUR PROGRAM.**”*

Tracy Salseth, MSN, ACNP-BC, MCSO

Interventional Cardiology Nurse Practitioner, Cedars-Sinai Medical Center

CEDARS-SINAI APPROACH TO ECHO SURVEILLANCE AND WORKFLOW OPTIMIZATION

Pioneering a Solution: Technology-Driven Echo Surveillance

To effectively address the high prevalence of untreated AS and the inherent inefficiencies in traditional follow-up systems, Cedars-Sinai partnered with Biome, a cloud-based clinical intelligence company, to implement an advanced echo surveillance solution. This innovative approach uses a sophisticated NLP engine to extract clinically relevant information from echocardiogram reports. This includes both quantitative parameters, such as aortic valve area (AVA), peak velocity and mean gradient, as well as crucial qualitative interpretations from echocardiographers.

Using a rules-based engine that aligns with current guideline definitions of AS severity, the system precisely stratifies patients based on their disease burden. In a validation cohort of 400 manually adjudicated cases, the system demonstrated exceptional accuracy, achieving 100% sensitivity, and 95.4% specificity for identifying moderate or severe AS, with an area under the curve of 0.97.¹

Importantly, this system is designed for practical operational use, primarily by clinical support staff rather than physicians. This strategic design enables efficient case identification, quality flagging and task routing without disrupting established provider workflows. This model significantly streamlines patient identification and substantially reduces the administrative burden traditionally associated with manual chart reviews.



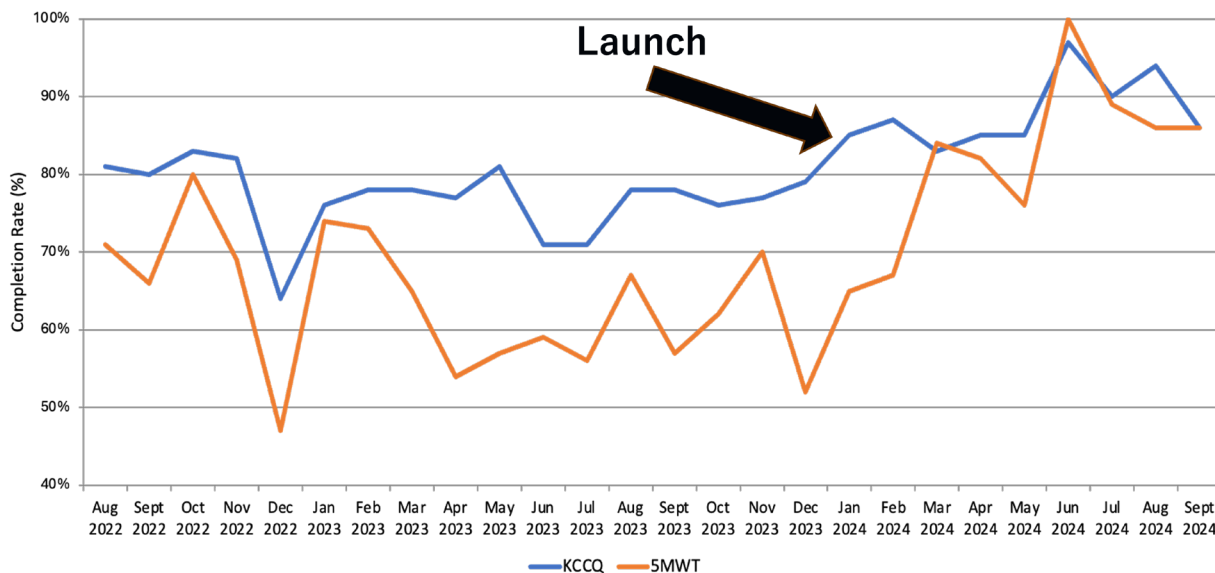
Seamless Integration: Optimizing Workflows Within Epic EHR

Cedars-Sinai developed and deployed a longitudinal patient tracking framework within the Epic EHR in parallel with the echo surveillance system. A functionality available to all Epic users, this feature utilizes the episodes and checklists functions. Leveraging a module designed initially for obstetrics that treated pregnancy as a cohesive “episode of care,” this comprehensive framework was designed to support structured follow-up and episode-based care management for TAVR patients. The workflow itself was developed through close collaboration between a Cedars-Sinai-employed senior application specialist (Epic) and the cardiovascular service line, ensuring a solution that aligns with clinical expectations, operational needs and regulatory standards.

Key workflow features that empower this integrated system include:

- **SmartForms and Dynamic Scripting:** Custom Epic SmartForms dynamically display content based on previous inputs and automatically pull information from the patient’s existing medical record. This auto-population helps ensure consistency across documentation, reduces manual entry errors, and improves patient identification and tracking throughout the care pathway.⁵
- **Automated Task Generation:** Task templates, meticulously tailored to pre-evaluation, intervention and post-procedure phases automatically assign actions, such as diagnostics, KCCQ and 5MWT assessments, and consultations (**Figure 3**). This eliminates manual task assignment and ensures timely completion.
- **Dashboards and Reports:** Real-time dashboards provide immediate summaries of patient status, flag incomplete documentation, and support proactive care coordination across multidisciplinary teams.⁵
- **Other Clinical Decision Support Tools:** Epic’s Our Practice Advisory (OPA) was set up to display prompts and alerts to further support rapid task creation, enhances visibility into key patient milestones, and provides checks and balances within the Structural Heart Navigator module.⁵

Figure 3: Increase in KCCQ and 5MWT Completion Rates



Reproduced from Salseth T, Chugh KL, Bullock G. Improving Structural Heart Outcomes with Epic’s Patient Tracking Tools. Epic XGM Presentation, 2025.

This integrated system enables Cedars-Sinai to oversee the full spectrum of TAVR care with a single, unified platform, eliminating the need for external spreadsheets, disparate databases or fragmented communication. Rather than relying on an individual, it follows a transparent and reliable process.

“THIS TRULY STOOD OUT AS A UNIQUE NEED – *no existing solution could manage the longitudinal view of a patient’s journey through pre- and post-intervention care.*”

Kirti Chugh, MS, BTech

Sr. Application Specialist, Enterprise Information Services, Cedars-Sinai Medical Center

Tangible Results: Measurable Impact on TAVR Program Performance and Patient Outcomes

The strategic introduction of the echo surveillance system and the Epic-based workflow at Cedars-Sinai has yielded significant and measurable operational improvements across its TAVR program. These enhancements highlight the profound benefits of integrating advanced technology with a robust EHR system, including:

- **Increased TAVR Volume:** Following the launch of the integrated system in February 2024, Cedars-Sinai observed a notable rise in the number of TAVR procedures performed. This increase directly reflects the earlier identification and activation of eligible patients, broadening the reach of interventional therapies.⁵
- **Improved Follow-up Compliance:** Post-procedure metrics demonstrated significant improvement, reversing prior declines observed in the NCDR® STS/ACC TVT Registry™. Specifically, adherence to 30-day follow-up visits, KCCQ completion and 5MWT documentation showed marked improvement. This higher compliance ensures continuous monitoring and optimizes long-term patient health.⁵
- **Enhanced Operational Efficiency:** Care teams reported increased clarity in tracking responsibilities, reduced reliance on manual systems, and notably improved interdisciplinary communication. This was particularly evident in managing cases referred from outside cardiology or those discovered during inpatient stays, showcasing the system’s ability to streamline complex care pathways.⁵
- **Helped Support Research:** The tracking system has also assisted in identifying patients who meet the eligibility criteria for research trials. Eliminating traditional labor-intensive chart reviews.

Together, these enhancements provide a robust and replicable framework for other institutions actively seeking to improve their SH disease programs. The Cedars-Sinai experience illustrates how a data-driven, integrated approach can lead to better patient care and more efficient and cost-effective operations.

Biome's Unique Value: Data Mart Integration

Biome excels at unifying data across platforms. Echo reads from picture archiving and communication systems are processed and merged with Epic data, financials and registry inputs, such as transcatheter valve therapy, to provide a 360-degree view.

This flexibility and customization have made Biome indispensable compared to traditional EHRs. Future integration of an echo surveillance tool into Epic's workflows could automate patient identification and simplify task management, further enhancing clinical efficiency.

"WE'RE OPEN TO INTEGRATING WITH ARTIFICIAL INTELLIGENCE, BUT WE ALSO DON'T WANT TO SIT IDLE. *We're building bridges – getting metrics into dashboards and acting on them now.*"

Kirti Chugh, MS, BTech

Sr. Application Specialist, Enterprise Information Services, Cedars-Sinai Medical Center

"Biome builds custom data marts that allow us to see the clinical, operational and financial picture of a patient in one place.

THAT'S WHAT MAKES IT SO POWERFUL."

Joseph Ebinger, MD, MS, FACC

Associate Professor of Cardiology; Director of Cardiac Critical Care;
Director of Clinical Analytics, Cedars-Sinai Medical Center

BEYOND OPERATIONS: STRATEGIC IMPLICATIONS AND ENDURING VALUE

Advancing Population Health Through Proactive Identification

The Cedars-Sinai experience highlights the importance of moving from reactive to proactive models of care delivery, particularly within the complex landscape of SH disease. By integrating advanced surveillance systems, the institution established a systematic method for identifying asymptomatic or undertreated patients with severe AS who were already within the health system's care continuum. This innovative approach supports broader population health goals by:

- **Detecting High-Risk Patients Earlier in the Disease Trajectory:** This allows for intervention before symptom onset or disease progression, improving prognosis.
- **Facilitating Timely Specialist Referral and Evaluation:** This refines the path from identification to expert assessment.
- **Supporting Equitable Access to Interventional Therapies Such as TAVR:** This ensures that all eligible patients, regardless of their initial point of contact with the health system, can receive life-saving treatment.

Importantly, many of these patients were often referred by non-cardiology providers or identified during unrelated inpatient stays, highlighting the system's remarkable ability to capture previously missed opportunities for intervention. This has profound implications for improving long-term outcomes and significantly reducing preventable adverse events among older adults with VHD.⁵

Enhancing Program Value and Operational Efficiency

Timely intervention for severe AS is associated with improved survival and quality of life, and national registries such as the STS/ACC TVT Registry track multiple post-procedure metrics tied to reimbursement and public reporting. Cedars-Sinai's demonstrated improvements in 30-day follow-up visit completion, KCCQ scores and functional testing adherence directly showcase the value of structured workflow systems in driving superior performance on these crucial measures.^{3,5}

Beyond clinical quality, the integration of echo surveillance and Epic EHR capabilities also supports program sustainability and accountability by:

- **Increasing Procedural Volume Through Improved Patient Identification:** Provides a direct pipeline of eligible patients leads to more procedures.
- **Enhancing Staff Efficiency and Expanding Capacity:** By reducing manual tracking and streamlining workflows, the program has been able to manage a larger volume of patients without adding staff. This approach minimizes administrative burden, frees up valuable clinical resources, and allows the existing team to focus more on patient care rather than documentation and follow-up coordination.
- **Supporting Comprehensive Documentation for Accreditation and Payer Reporting:** Ensures compliance and optimizes reimbursement.
- **Reducing Length of Stay and Readmission Risk Through Structured Follow-up:** Promotes better post-procedure care and prevents complications.

The Cedars-Sinai model presents a high-value pathway to achieve clinical quality, operational scalability and cost-effectiveness simultaneously to improve their SH program.



"The goal is to grow in a resource-constrained world."

Mark Russo, MD, MS

Professor of Surgery, Chief of Cardiac Surgery; Director of Structural Heart Disease,
Rutgers-Robert Wood Johnson Medical Center

A BLUEPRINT FOR SUCCESS: REPLICABILITY AND BROADER APPLICATIONS

The Cedars-Sinai initiative offers a replicable framework based on implementation science for other institutions seeking to enhance their SH programs. Key success factors underpinning this model include:

- **Strong Alignment Between Clinical Leaders and Informatics Teams:** A collaborative approach is vital for successful implementation.
- **Purposeful EHR Customization With Standardized Episodes, Tasks and Forms:** The EHR should be tailored to specific clinical workflows.
- **Comprehensive Staff Training and Engagement With Clearly Defined Workflows:** This ensures user adoption and proficiency.

The underlying surveillance and tracking system is not limited to AS and can be adapted for use in other critical areas and other conditions for which guideline-directed medical therapy and precise procedural timing are critical to optimal patient outcomes. As SH volumes grow and disease management becomes increasingly complex, scalable systems that significantly enhance data visibility, care coordination and accountability will become essential components of program success.

EXPANDING BIOME'S POTENTIAL: BEYOND AS

Initially focused on AS, Biome's NLP capabilities are highly adaptable for other disease states:

- **Mitral and Tricuspid Valve Disease:** Extraction of valve area and regurgitation severity supports earlier detection.
- **Heart Failure Indicators:** Identification of diastolic dysfunction and reduced ejection fraction ensures timely specialist intervention.
- **Pulmonary Hypertension:** Elevated right ventricular pressures and tricuspid regurgitation jet velocity tracking aids early management.
- **VHD Progression:** Monitoring moderate disease patients ensures timely escalation of care.



A PHASED APPROACH: RECOMMENDATIONS FOR IMPLEMENTATION AND PROGRAM ENHANCEMENT

Health systems seeking to enhance their TAVR programs through technology-enabled echo surveillance and EHR integration can draw directly on Cedars-Sinai's successful experience to guide their application. The following phased framework outlines key elements required for effective adoption, scalability and implementation.

PHASE I: Establishing Data Infrastructure and Surveillance Logic

The first step involves establishing the data infrastructure to support comprehensive surveillance. By leveraging the lessons learned from Cedars-Sinai's implementation, facilities can adopt a proven workflow built in Epic, avoiding the need for extensive local validation and testing.

- **Echo Data Mapping:** Identify where quantitative and qualitative echocardiographic data reside within the system and confirm their accessibility for automated extraction. Cedars-Sinai's successful model demonstrates that capturing relevant information in structured formats is achievable.
- **Rules Engine Adoption:** Utilize established algorithms based on guidelines for grading AS severity, incorporating both objective measures (e.g., AVA, mean gradient) and interpretive findings. The validated rules engine at Cedars-Sinai offers a high-confidence template for consistent clinical accuracy and workflow integration.^{6,7}
- **Validation Confidence:** Cedars-Sinai's experience with a rigorous manual review of 400 cases demonstrated 100% sensitivity and 95.4% specificity for identifying moderate or severe AS, giving new adopters confidence in the system's reliability. Additional local validation may be optional but is not required, given the proven accuracy of the established system.⁴

Institutions should also ensure that data governance policies are in place to comply with patient privacy and security standards when implementing any automated surveillance system.

PHASE II: Seamless EHR Workflow Integration

Building a functional, user-friendly interface within the EHR is key to ensuring widespread adoption and sustainability. Facilities should leverage Epic SmartForms, Episodes, tailored task templates and real-time dashboards to streamline data entry, automate workflows, and enhance care coordination. Partnering closely with informatics teams and frontline users is essential to developing intuitive, efficient and sustainable workflows.⁵



PHASE III: Ensuring Operational Readiness and Robust Governance

Implementation should be accompanied by a well-defined change management strategy that effectively aligns stakeholders and prepares the care environment for the new system:

- **Training and Communication:** Educate support staff, physicians and administrators comprehensively on new workflows and documentation requirements. Emphasize the positive impact on quality metrics, patient outcomes and efficiency to foster engagement and buy-in.
- **Governance Structure:** Clearly define roles for task oversight, exception management and ongoing workflow updates. Cedars-Sinai, for instance, utilized a multidisciplinary leadership team to ensure accountability across its program.
- **Integration With Overarching Goals:** Position the initiative within broader service line strategies, including growth targets, value-based care metrics, and active participation in national registries (e.g., STS/ACC TVT Registry).⁸

PHASE IV: Continuous Monitoring, Optimization and Future Expansion

Ongoing success necessitates continuous measurement, refinement and strategic expansion of the system:

- **Performance Monitoring:** Track key performance indicators (e.g., number of patients identified, intervention timelines, 30-day follow-up compliance) and adjust workflows accordingly based on the data.
- **Feedback Loops:** Actively engage users to identify pain points, gather suggestions for improvement, and refine scripting or task logic where needed, fostering a culture of continuous improvement.
- **Program Expansion:** Evaluate opportunities to extend the tracking model to other patient populations. Scalable application is best achieved by starting with a high-impact use case (e.g., severe AS) and then leveraging the established system for broader application.

By starting with a high-impact use case (e.g., severe AS) and then leveraging established system for broader application, health systems can scale the application.

CONCLUSION

The effective management of severe AS requires not only clinical quality and unparalleled operational precision but also financial accountability and justification. The Cedars-Sinai experience demonstrates that strategic integration of echo surveillance technology (Biome), with enterprise EHR systems, (Epic) can fundamentally improve how SH programs identify, track and treat patients. By leveraging NLP and a rules-based engine grounded in established clinical guidelines, Cedars-Sinai successfully uncovered a significant cohort of patients with untreated AS who were already present within the health system. This data-driven approach enabled earlier identification, facilitated timely intervention, and led to improved compliance with critical post-procedural metrics, collectively contributing to both enhanced patient outcomes and superior operational efficiency,⁵ and optimized resource allocation for systems and staff.

Without requiring external resources, these impressive improvements were achieved by using existing modules and tools within Epic and fine-tuning current applications. This approach offers a reproduceable framework that other health systems can readily adopt immediately.

With increasing pressure on SH programs to boost patient throughput despite limited resources for infrastructure expansion, the ability to seamlessly embed surveillance and tracking into routine workflows becomes a strategic advantage. This approach enables programs to scale without adding staff, leveraging processes rather than personnel. Institutions seeking to elevate their SH programs by controlling throughput, managing cost, and improving outcomes should consider echo surveillance and EHR integration essential to ensuring timely, equitable and high-quality care for all patients.

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Learn more about Biome Analytics at [Biome.io](https://biome.io).

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