

Implementation Guide

Implementation Guide: Stroke-Heart Syndrome Protocol

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0.0 Abstract

Following an acute stroke, patients face drastically elevated risk of major adverse cardiac events, yet most clinical settings lack a systematic protocol for screening and post-stroke management, contributing to preventable mortality. To address this gap, we have developed a clinical workflow for acute stroke patients. The 5-phase workflow provides a clear pathway from admission to discharge, integrating two novel scoring systems, the SHS (Stroke-Heart Syndrome)-Early Risk Score for initial stratification and the SHS-Severity Score for guiding escalation of care once a cardiac injury is confirmed. The workflow includes a user-friendly website tool that streamlines score calculation, ensuring rapid and accurate clinical decision-making. By formalizing this process, the workflow aims to shift post-stroke care from a reactive to a proactive model, enabling timely, risk-appropriate interventions. The successful adoption of this protocol is projected to significantly reduce the incidence of preventable cardiac complications, decrease risks of mortality, and optimize the use of specialized cardiology resources. This guide outlines a scalable implementation roadmap with the ultimate goal of establishing a new, safer standard of care for stroke survivors everywhere.

1.0 Introduction

1.1 Problem Statement

A study of 93,000 stroke patients in Ontario found that after a first stroke, the risk of suffering major heart complications increased 23-25 times within the first 30 days. With many studies showing a clear linkage between stroke and cardiac issues, many hospitals and clinicians have not implemented systematic screening for cardiac complications in stroke patients, increasing their risk of mortality by 10-20%.

1.2 Objectives

- **Establish a Standardized Workflow**

To design and implement a 5-phase neurocardiology workflow that standardizes the early identification, risk stratification, and management of cardiac complications for acute stroke patients

- **Streamline Risk Assessment with a Digital Tool**

To develop and deploy a user-friendly digital risk scoring tool that assists for rapid and accurate clinical decision-making. Calculated based on our proposed SHS-Early Score & SHS-Severity Score to warn for preventative actions and ease clinical burden.

- **Improve Patient Outcomes and Optimize Resource Allocation**

To improve post-stroke patient safety by enabling timely, risk-appropriate interventions. Ultimately, our goal is to significantly reduce the preventable incidents of major adverse cardiac events and its associated mortality through optimizing stroke and cardiology resources for high-risk patients.

1.3 Solution Overview

Our team designed a clinical workflow chart that can easily be implemented by hospitals and clinicians, as it integrates with stroke protocols. The clinical workflow allows healthcare workers to predict and monitor stroke patients' risk of experiencing cardiac complications, by using the SHS-Early Risk Score and SHS-Severity Score.

The SHS-Early Risk Score is used for early predictions on potential stroke induced cardiac complications. Whereas the Severity Score tests patients' risk for common heart complications like **Arrhythmia Burden**, basing its results from the risk screen assessments, allowing healthcare workers to properly monitor and prevent severe cardiac complications. We decided to use both scoring systems to accurately predict patients behaviour, making it easier for healthcare workers to prevent and prepare for possible complications when they implement our prototype.

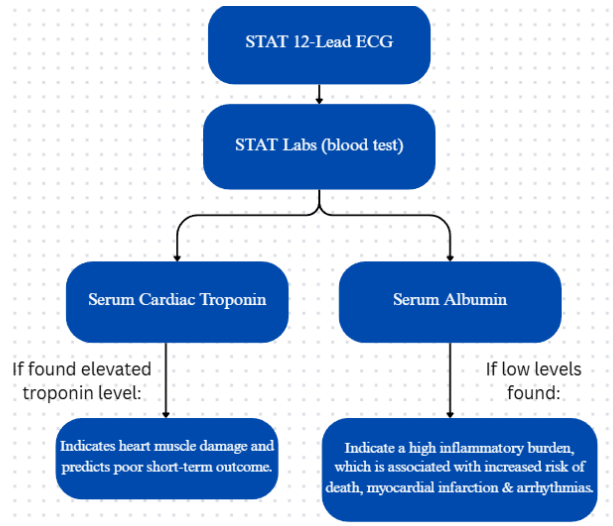
1.4 Scope

As various studies by Universities and healthcare professionals around the world have found stroke patients to be at higher risk of experiencing cardiac complications, the clinical workflow we created is suited for all stroke victims.

2.0 Workflow Overview

Phase 1: Admission Screening

This phase occurs **upon patient arrival** and is for those with confirmed or suspected acute stroke (say goal). In this phase, patients will go through Immediate Initial Assessments, including:



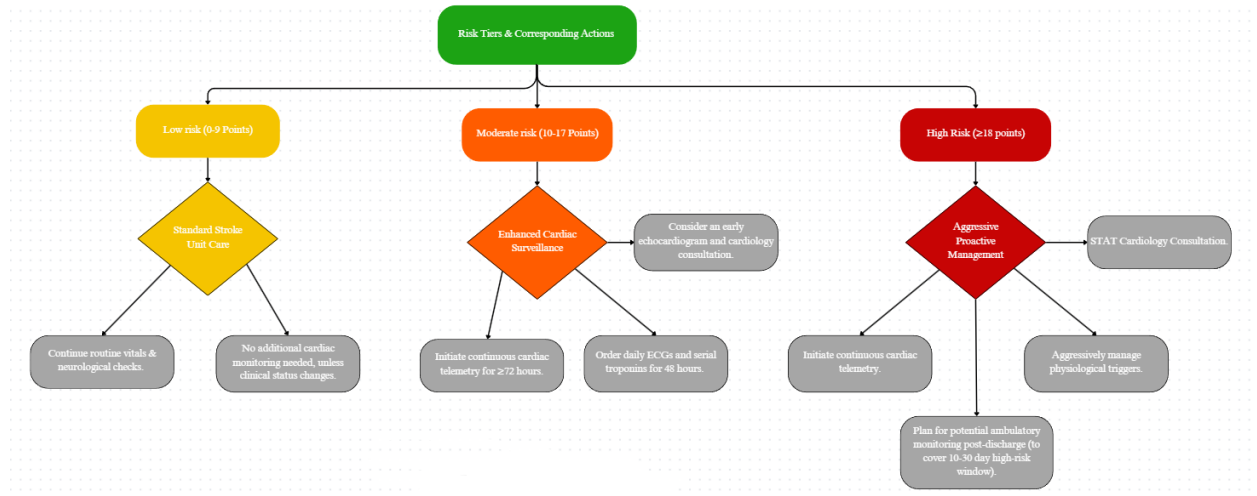
Phase 2: Initial Risk Stratification (SHS-EARLY Score)

The next phase happens **within the first 60 minutes of patient arrival** and is performed by the primary clinical team, which can either be ED or the Stroke Team. The objective of this phase is to **predict a patient's risk for developing a major heart complication** within 72 hours to 30 days, by using the patient's initial clinical data, imaging results, and lab values to calculate SHS-EARLY Score.

The SHS-Early Score uses a point system, based on a combination of the patient's: demographic (sex & age), stroke phenotype, NIH Stroke Scale (refers to severity of patient's stroke), neuroanatomy, physio "trigger" burden, ECG (recording of heart's electric activity), cardiac biomarkers, echocardiogram, lab test results (completed in Phase 1) and patient's past medical history.

Phase 3: Tiered Action & Monitoring Pathways

The third phase focuses on how the primary clinical team should respond to results of the SHS-Early Score. By the end of this phase, the team should be able to match intensity of cardiac monitoring and intervention directly to the patient's calculated risk, optimizing resources and improving outcomes:



The results are split into three categories: Low, Moderate and High risk, as seen on the image above. Based on the patient's classification, the team will adapt and customize cardiac monitoring.

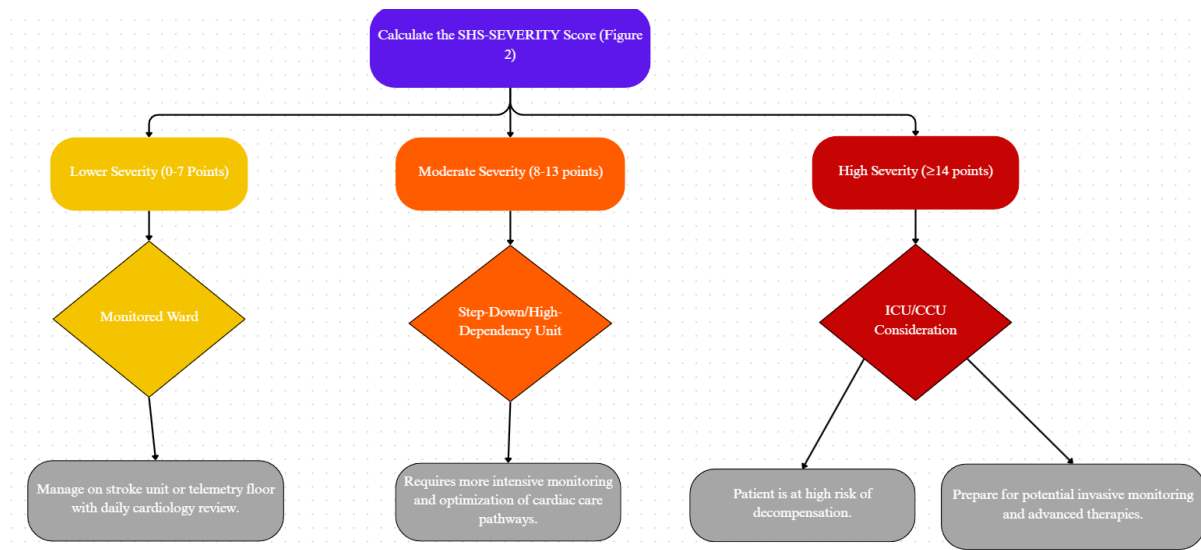
Phase 4: Escalation of Care (SHS-SEVERITY Score)

If a patient develops a confirmed cardiac complication, including but not limited to: elevated troponin, new atrial fibrillation or heart failure, the primary team and cardiology will work together to investigate its severity of cardiac injury and predict the risk of mortality, allowing them to give appropriate level of care (ex. Putting patients into a ward or ICU).

First, the primary team will evaluate the items below and calculate their Severity Score:

Domain	Predictor	Points
Cardiac Injury	hs- Troponin >5x URL or dynamic rise $\geq$ 50%	4
	ST depression/Q waves	3
Arrhythmia Burden	Severe ventricular arrhythmia (VT/VF)	5
	AF/flutter with RVR or recurrent episodes	3
Pump Function	LVEF <40% or cardiogenic pulmonary edema	5
	LVEF 40-49%	3
	Mid-ventricular WMA	4
Systemic Stress	Ongoing respiratory failure or shock	4
Host Factors	Albumin <35g/L	2
	Age $\geq$ 75	2
Neuroanatomy	Right insular involvement	2

Once the score is calculated, the patient's severity will be split into three categories: Low, Moderate and High severity, where the team will place patient in appropriate ward:



Phase 5: Discharge Planning & Post-Acute Risk Mitigation

Before patients get discharged, they are required to do a Risk Re-assessment, where the team will re-calculate the patient's SHS-Early Score to determine any potential risks. For patients that stratified in the High Risk Category (≥ 18 / ≥ 14) at any point from admission, or who suffered a cardiac complication must have cardiology follow-up. For patients in the High-Risk tier, consider prescribing an ambulatory heart monitor to cover the high-risk 10-30 day post stroke window.

Family education:

Before discharge, ensure that patients family/caregivers understand the following:

- People who previously suffered from stroke have higher risk of having another one:
Should feed them a healthy diet, enforce exercise, properly take prescribed medication and regularly visits with healthcare provider
- Patient should consider assistance from an occupational or physical therapist if they experience: dizziness, inability to walk for six minutes without stopping, cannot complete daily activities
- If serious falls occur and cause bruising, bleeding and severe pain, take the patient to hospital.
- If there were more than two minor falls within the first six months, ensure that the patient is taken to a physical therapist or physician.

Post-Discharge:

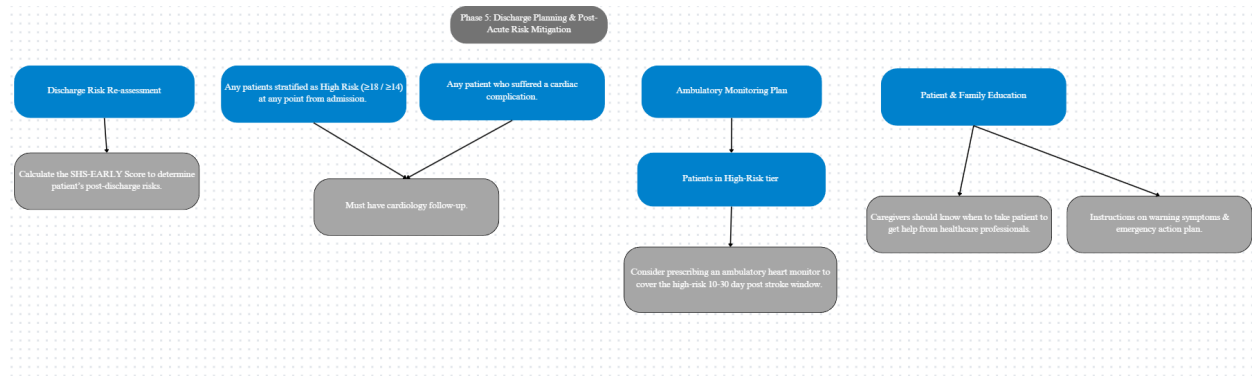
Healthcare workers should regularly check-up on patients via phone call, minimum of 30-45 days post-discharge and should call again 90-105 days post-discharge if the patient suffered a hemorrhagic stroke.

Each call should include information regarding:

- Patient Status
- Resources for more assistance

Each call should take place on certain days and times discussed with patient's family

- Should attempt to call with minimum of 3 attempts (including different days and times)



3.0 Digital Integration

As the World Health Organization aims to integrate digital technology into the healthcare system, the website tool will target hospitals and clinics around the world. The tool calculates patients' scores of both the SHS-Early Score and SHS-Severity Score, as healthcare workers checkbox items that align with the patient's condition.

By using this tool, it makes it faster and easier to store patients' data. Additionally, it is very accessible, easy-to-use and environmentally friendly, as it reduces paper waste. Therefore, the online tool we created makes it easier for healthcare professionals to calculate patients' scores and ensure the earliest needed treatment.

4.0 Implementation Roadmap

Our implementation strategy is a phased, data-driven approach designed to test, refine, and scale the neurocardiology workflow from a single pilot site to a national standard of care. Each stage will be improved based on the previous one to ensure clinical effectiveness, user adaption and system integration before broader expansion of the application.

Stage 1: Pilot Testing (0-3 Months)

We will begin by selecting one dedicated stroke unit in a partner hospital for initial implementation. The Emergency Department and stroke unit staff will receive comprehensive training on the 5-phase workflow, supported by simplified procedural guides in their workspace. The website tool will be deployed as a decision-support aid.

Success will be measured by performance indicators, including patient screening times (i.e. % of patients screened within 60 minutes) and direct staff usability feedback on its accessibility and user-friendliness. This initial feedback will also guide the development roadmap for the tool, prioritizing future upgrades such as a secure feature for saving patient information to allow for longitudinal tracking.

Stage 2: Multi-Centre Integration (3-12 Months)

Following a successful pilot, we will expand the protocol to multiple hospitals and clinics. This stage will focus on assessing the workflow's generalizability and scoring accuracy across

diverse settings. A standardized digital training module will be developed for consistent training. Furthermore, this multi-centre data collection will provide the foundation for our ongoing clinical research. We will use this data to refine the protocol and investigate additional risk factors, such as the impact of family history or how the workflow can be adapted for patients with other concurrent brain injuries.

Stage 3: Regional Standardization (12-24 Months)

In this stage, we will collaborate with regional stroke programs to establish the SHS pathway as a recommended best practice. A key technical goal will be the full integration of the enhanced digital tool, including its risk calculators and patient tracking features, directly into hospital Electronic Medical Record (EMR) systems. To monitor progress, we aim to develop a regional dashboard to track compliance rates, patient outcomes, and the equity of care across participating institutions.

Stage 4: National Endorsement and Policy Integration (24+ Months)

With two years of robust data and refined protocols from our regional partnerships, the ultimate goal is to engage with national guideline bodies and health ministries. By presenting strong evidence of improved patient outcomes and system efficiencies, we will seek national endorsement to integrate the workflow into the standard of care for all acute stroke patients across the country.

Future Direction: Global Adaptation

Beyond national implementation, our long-term vision is to adapt this workflow for global use, which will involve translation and collaboration with international partners to align the protocol with different medical systems and resources worldwide.

Throughout the entire process, we will continuously update the scoring system based on the latest scientific findings regarding the connections between strokes and cardio complications, adding new risk factors or warning signs that healthcare workers should be aware of, and educating the public regarding such connections.

5.0 Training & Education

A comprehensive training and education is essential for the safe and effective use of the Standardized Neurocardiology Workflow. Our approach is designed to be practical and continuous, ensuring that all clinical staff are confident and competent in applying the protocol.

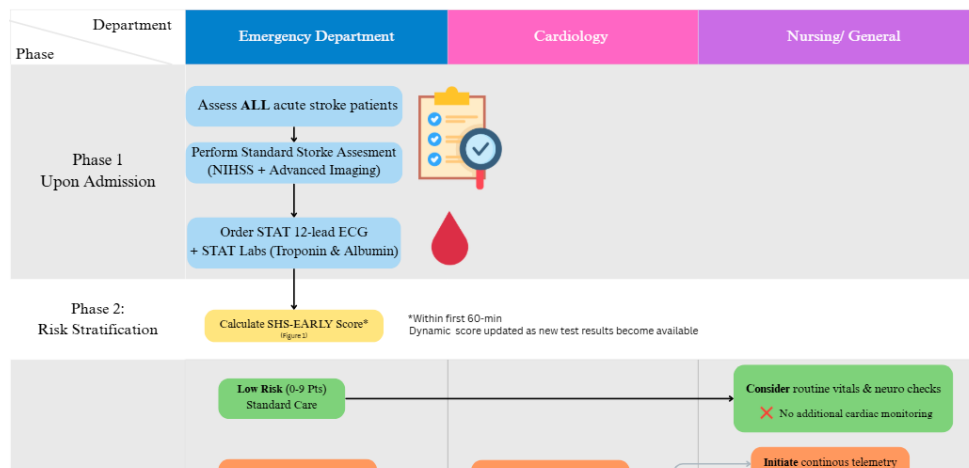
1. Simulation Based Training

Our educational program will include mandatory simulation drills for all relevant clinical teams, including Emergency Department (ED) staff, the Stroke Team, and nursing units. These hands-on sessions will use realistic, case-based scenarios to guide staff through the entire 5-phase workflow in a controlled environment.

2. At-a-Glance Resources

To reinforce the training and provide ongoing support, we will develop clear, accessible reference materials to be placed in key clinical areas.

- **Clinical Workflow Poster:** A large-format, laminated poster featuring a simplified **swim-lane diagram** of the 5-phase workflow will be displayed in high-visibility areas such as nursing stations, the ED, and the stroke unit. This visual aid will serve as a quick and easy reference for all healthcare team members, outlining key steps, decision points, and responsibilities.



3. Patient & Family Education

Recognizing that this new and enhanced monitoring may raise questions, a separate handout will be created for patients and their families. This will include educating patients and their families, explaining the process of the workflow in simple words, the purpose and the urgent need for bridging the gap between stroke-heart complications and prepare them on what they can expect within their hospital stay. This helps manage patient anxiety and promotes partnership in their care.

6.0 Conclusion

The well-documented link between stroke and cardiac complications represents a critical but often overlooked gap within the healthcare system. Our proposed Neurocardiology Protocol directly addresses the challenge by providing a clear, evidence-based pathway for risk identification and management. This project transitions patient care from a reactive model to a proactive and preventative one, empowering clinical teams to intervene before severe complications arise.

References

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