

# Addressing Delays in ECGs During Cardiac Events in the ICU

Author: Timothy Chang, MS4

Mentor: Emily Gottenborg, MD

## Background

ECGs in critical care settings, such as the ICU, are an effective tool to not only diagnose patients with cardiac diseases, but also to predict patient outcomes and manage their care overall. Delays in ECGs for patients, especially in critical care settings, can delay clinical decision-making and may lead to poorer patient outcomes. The objective of this study is to identify contributing factors to delays in ECGs, specifically at the University of Colorado Hospital intensive care units, understand why they occur, and discuss possible interventions that may address these factors.

## Methods

Stakeholders at the University of Colorado Hospital were surveyed in person, including ICU nursing staff (n=9), ECG techs (n=2), and patients (n=3) with both qualitative and quantitative questions. We performed a root cause analysis through an affinity diagram to identify key factors that were most prevalent in our discussions with stakeholders. We also created a flowchart of the problem process to identify where in the process contributing factors occurred and where we could insert these interventions (fig 1).

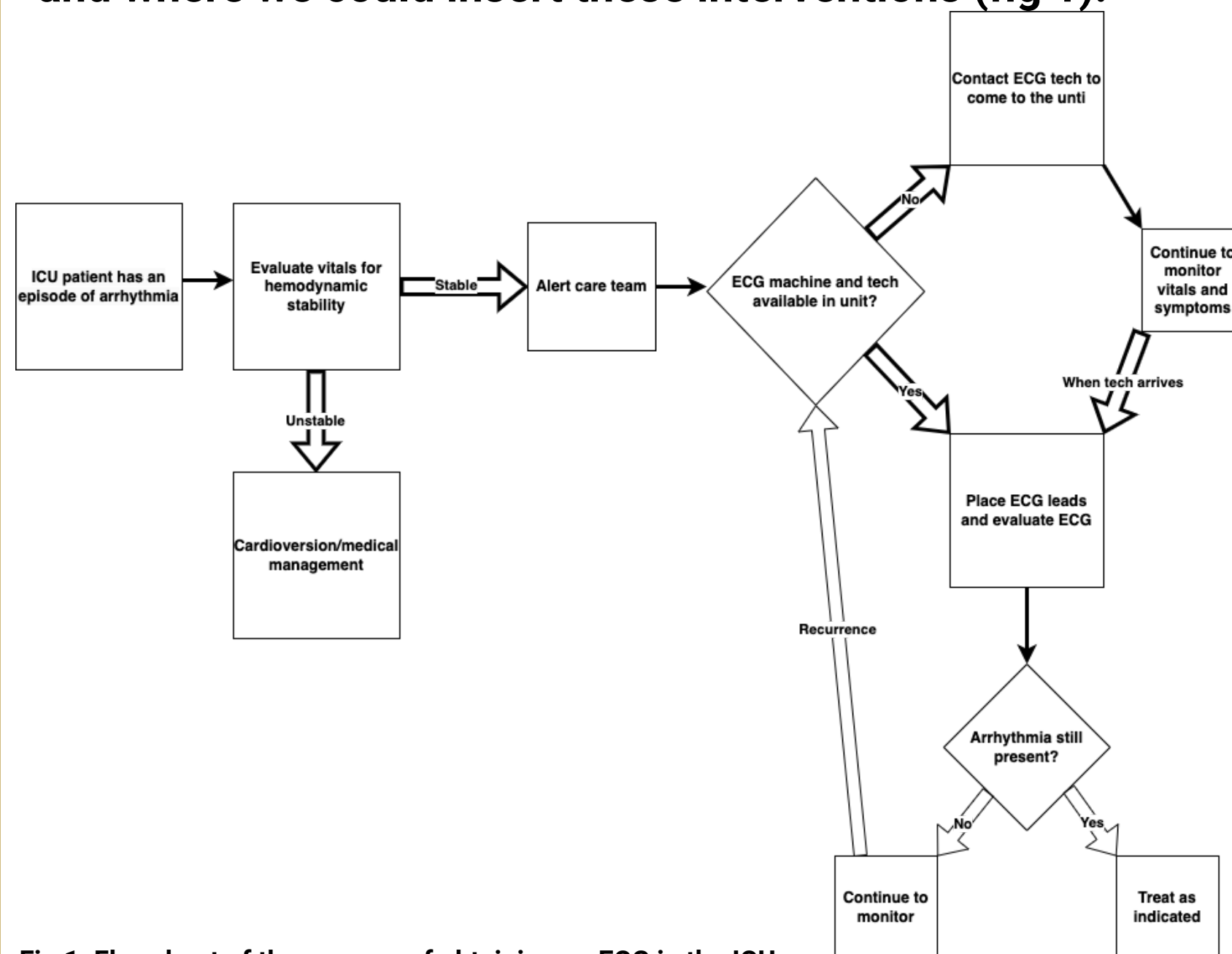


Fig 1. Flowsheet of the process of obtaining an ECG in the ICU.

## Results

After discussions with the stakeholders, common concerns included reported delay times up to 40-50 minutes, dissatisfaction from nursing staff who were able to perform ECGs at other institutions, challenges with transporting ECG machines throughout the hospital, and families concerned with alarms coming from the vitals monitor that they did not understand. Through our root cause analysis (fig 2), we identified that common contributing factors at our institution included nonavailability of machines on the ICU floors, provider limitations based on hospital regulations, and ECG techs being responsible for several units.

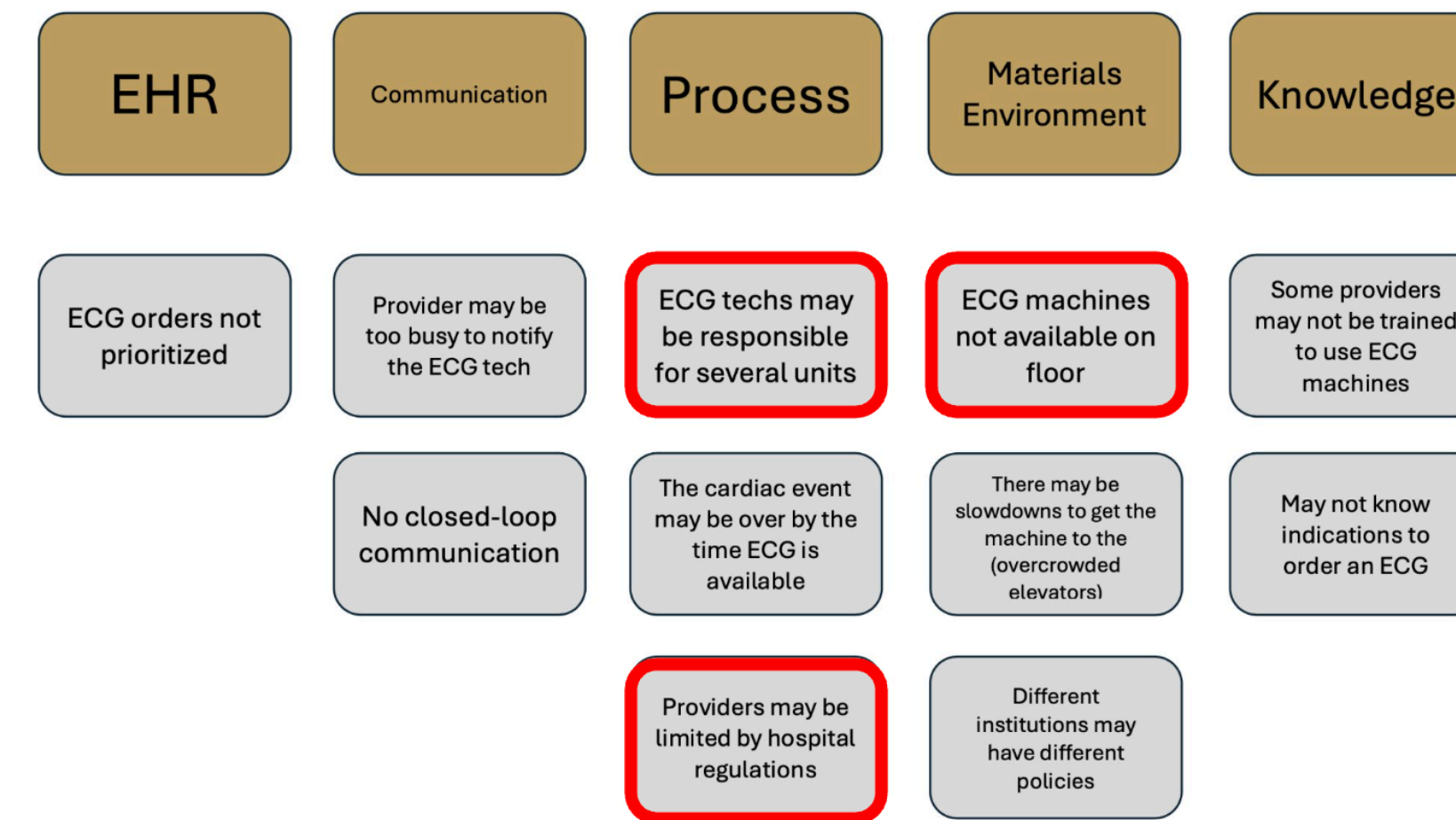
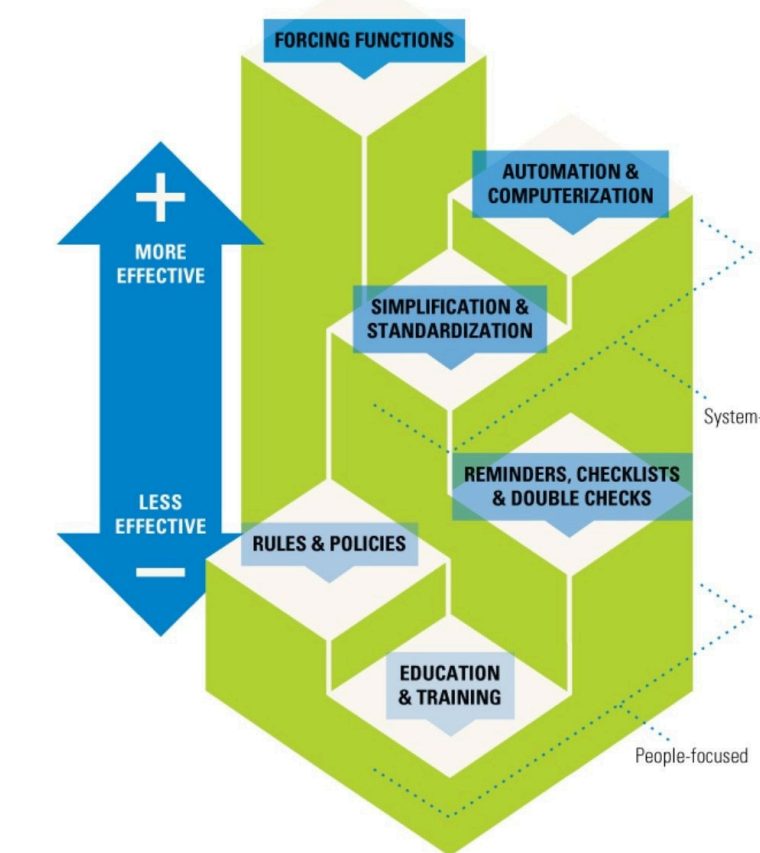


Fig 2. Affinity diagram showing concerns brought up by stakeholders that they believed contributed to the problem process, with the most common factors highlighted

Given these common factors, we brainstormed several possible interventions while considering their feasibility based on resource availability and effectiveness. Using the Hierarchy of Intervention Effectiveness, we were able to better understand the effectiveness of each intervention proposed compared to the resources it would take.



One possible intervention included changes in hospital policy allowing trained ICU nurses to use dedicated ECG machines (fig 3), which would address both the factors of providers being limited by hospital policies and non-availability of ECGs on the ICU floor. This intervention may be less effective, as it is a change in policy and would also require resources including dedicated ECG machines and the process of making a policy change at an administrative, hospital level.

Another intervention that was considered was automation of the ECG process with the use of the vital signs monitor and artificial intelligence (fig 4). This intervention may be more effective, as it falls into the automation & computerization category, but would take a significantly higher amount of resources to implement, especially if vitals monitoring machines needed to be replaced with newer ones capable of performing the task of capturing and reading ECGs. There is also the question of whether or not ECGs that are read by artificial intelligence would have the accuracy needed for patients and providers to be comfortable trusting them, as well as the resources needed in order to train these models.

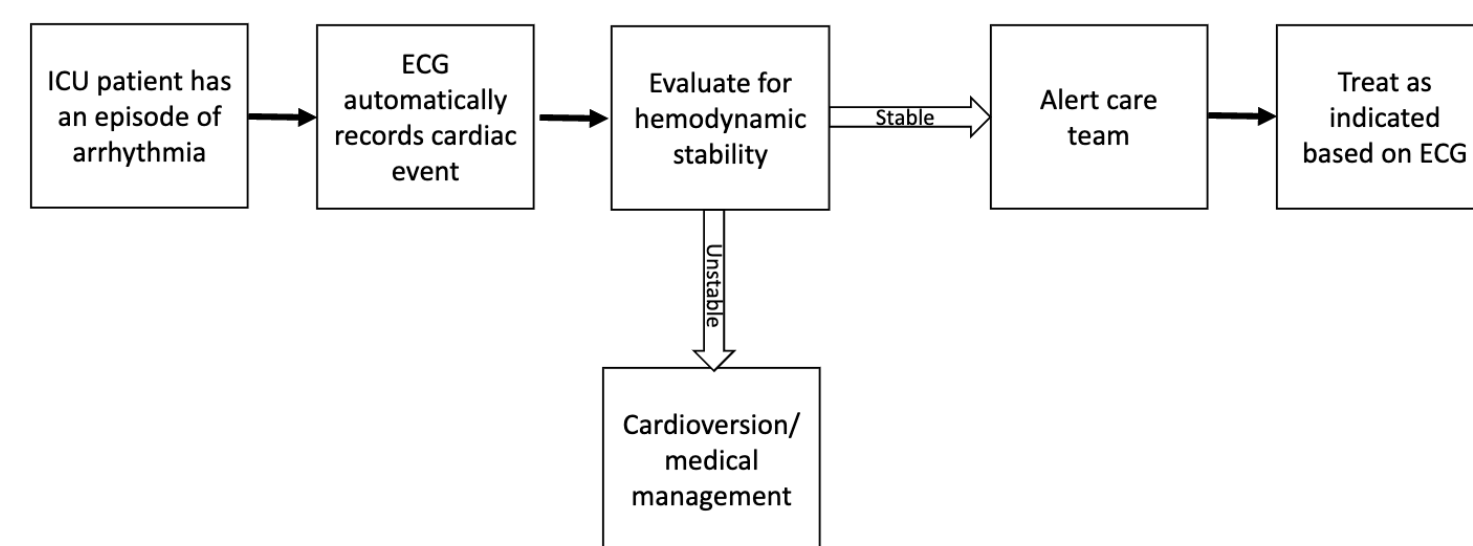
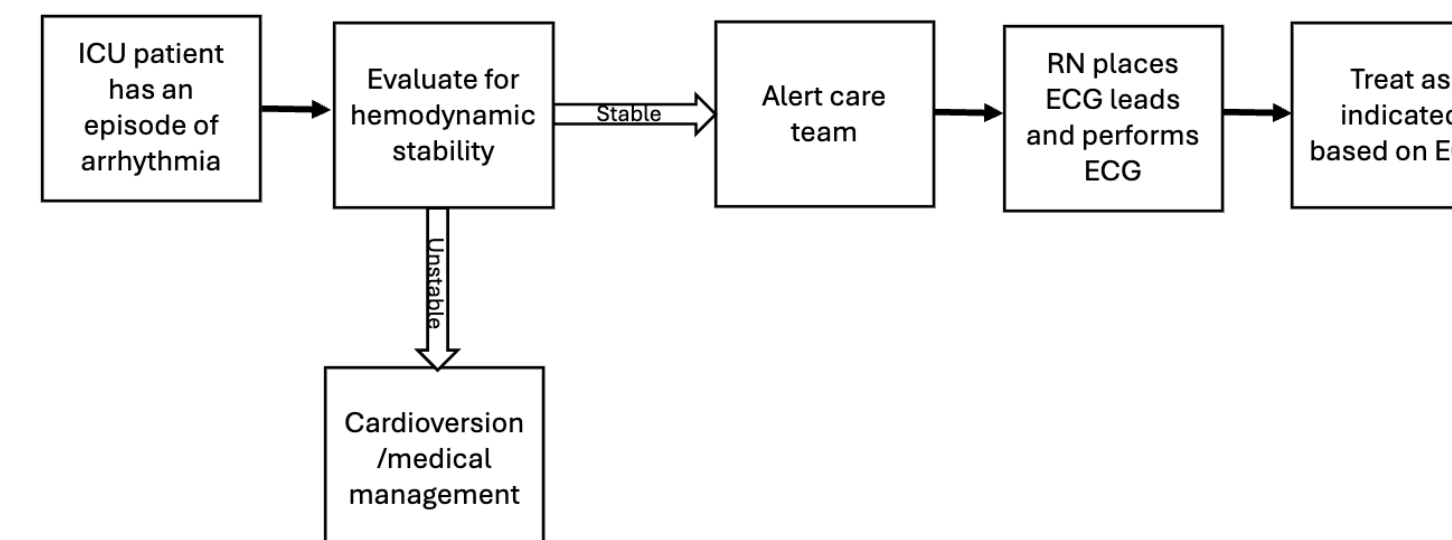


Fig 3. Flowsheet of proposed intervention with policy change allowing RNs to perform ECGs.

Fig 4. Flowsheet of proposed intervention with automation of ECG capture and read.



## Conclusions and Next Steps

Studies show the importance of ECGs for diagnosing and managing patients who are critically-ill, such as in ICU settings. Delays in ECGs can lead to worse patient outcomes. This project demonstrated common factors that led to delays in ECGs at the University of Colorado Hospital from stakeholder reports. Through evaluations of possible interventions, such as changes in hospital policy, implementation of automation through AI, and changes in workflow and resource allocation, it is possible that there can be an improvement in these delays. It is also important to consider the varied interests of different stakeholders and limitations in resource availability and allocation.

Given the small sample size of stakeholders from the same institution, the results presented may not be applicable to a wider patient population. We are also limited in being unable to assess how much exact improvement there is for each proposed possible intervention without preliminary trials, which would take more resources. Next steps would include greatly increasing the sample size of the stakeholders involved, possibly including other sites or institutions who face the same problem process, and performing preliminary studies specific to certain interventions to determine if implementing a quality improvement project for that specific intervention would lead to improved outcomes with reasonable resource management.

## References

