

Premature Closure: Was It Just Syncope?

November 25, 2020

Maurier D, Barnes DK. Premature Closure: Was It Just Syncope? PSNet [internet]. 2020.

<https://psnet.ahrq.gov/web-mm/premature-closure-was-it-just-syncope>

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Learning Objectives

- Understand how cognitive biases such as framing errors and premature closure may contribute to medical error
- Interpret ECG patterns that may indicate serious non-cardiac illness
- Categorize systemic anticoagulation as a high-risk clinical situation
- Choose and apply systematic interventions such as checklists and forcing functions to mitigate cognitive biases and prevent adverse events

The Case

A 60-year-old man presented to the emergency department (ED) with a chief complaint of syncope. His partner reported he had been exercising when he became dizzy, passed out, then quickly regained consciousness. His initial vital signs in the ED were notable for a systolic blood pressure in the 100s and a heart rate of 56 beats per minute. Twelve-lead electrocardiogram (ECG) demonstrated ST segment and T

wave changes but not ST-elevation myocardial infarction. A computed tomography (CT) scan of the brain was ordered and performed, but it is unclear whether the ordering physician ever reviewed the CT images.

Concerned for a cardiac etiology of syncope, the emergency physician administered aspirin, started the patient on an unfractionated heparin drip, and ordered an echocardiogram to assess cardiac function. However, the patient reported he felt well and wanted to pursue an outpatient workup. As an alternative to admission, the physician discussed the case with a cardiologist who recommended full-dose, therapeutic low molecular weight heparin (Lovenox) and cardiology follow up the next day.

While awaiting the echocardiogram, the patient became somnolent and his heart rate slowed. The emergency physician placed a transcutaneous pacemaker, intubated the patient, and ordered a full-body CT scan which demonstrated a large subdural hematoma with mass effect on the brain and surrounding cerebral edema. In the operating theater, a neurosurgeon performed an emergent craniotomy and placed an external ventricular drain. The patient's condition temporarily improved. However, serial brain imaging demonstrated expansion of the intracranial hemorrhage and ultimately brainstem herniation. He transitioned to comfort care and later died.

A post-mortem review of the patient's medical records indicated he had multiple ED visits with similar episodes of syncope in the preceding months all resulting in falls and head trauma. It was later acknowledged that the first CT scan of the patient's brain showed a small subdural hematoma that was not recognized by his clinical team. Ultimately, the initial ECG changes were retrospectively interpreted as consistent with intracranial hemorrhage.

The Commentary

Several preventable medical errors contributed to this patient's death. First, the emergency physician did not initially elicit a complete history of the patient's recurrent head trauma from the patient, his partner, or the medical record. Had the patient's recurrent head trauma been recognized, immediate anticoagulation may have been avoided and neuroimaging prioritized. Emergency physicians should be mindful in cases where history-taking is challenging and take appropriate steps to gather the best possible history, especially when language barriers exist. Although it is not clear that there was a language barrier in this case, in one study of Spanish speakers presenting for emergency care, nearly one quarter said they were not provided an interpreter when one was necessary.¹ Second, the physician did not recognize the 12-lead ECG abnormalities as consistent with intracranial hemorrhage. This led to a framing error and premature closure around isolated cardiac pathology. Finally, the physician failed to appreciate the high-risk nature of anticoagulation, especially in the setting of head trauma. Although it is a common medical treatment, anticoagulation can be associated with serious adverse events, including death. This commentary will discuss the specific errors highlighted by this case and identify individual and systems-based approaches to preventing such errors.

Background

Framing and Premature Closure

[Framing](#), also known as the framing effect, occurs when decisions are influenced by the way information is presented. For example, presented with the choice between a guaranteed modest monetary gain and an uncertain larger gain with a slightly higher weighted expected value, individuals typically prefer the certain gain.² The framing effect has also been studied specifically in the context of medicine. Patients may be more likely to elect a treatment when it is framed in terms of their likelihood of survival, rather than their likelihood of mortality.³ For example, a patient presented with a cancer treatment survival rate of 95% is more likely to choose the treatment than a patient presented with a treatment mortality of 5%, although both options are identical. Similarly, physicians recommended timelier follow-up for cancer screening when presented with the frequency (e.g. 1 in 167 patients) rather than the percentage probability (e.g. 0.6%) of developing a form of cancer.⁴ Framing may also influence diagnostic reasoning. In one study, nurses participating in a clinical vignette describing a patient presenting with a heart attack were significantly more likely to attribute symptoms to a benign etiology (e.g. emotional upset) if informed the patient was recently unemployed.⁵ In a survey of internal medicine residents, more than half identified a case in which framing adversely influenced their diagnosis.⁶ In the present case, the patient's syncope while exercising, combined with bradycardia and ECG changes, may have caused the clinician to frame the case primarily as a 'cardiac' problem.

[Premature closure](#) — the acceptance of a diagnosis before it has been objectively established and alternative diagnoses have been fully investigated — is closely related to the framing effect and provides an additional conceptual framework for analyzing this case.⁷ In an effort to establish a diagnosis and treatment plan more efficiently, emergency physicians often close on the diagnosis that is first conceived, the most common diagnosis, the most dangerous diagnosis (also known as ROWS, or "Rule Out Worst Case Scenario), or simply the one for which it is easiest to justify the hospital admission, despite lack of supporting evidence or even evidence to the contrary. In the current case, although neuroimaging (CT) was ordered, the clinician did not review the results before initiating anticoagulation. This suggests that the clinicians initially considered trauma but prematurely narrowed their focus to cardiac pathology and excluded other possible diagnoses.

In summary, multiple common cognitive errors may have contributed to the patient's outcome. Bradycardia and the history of syncope while exercising likely primed the clinician to view the case in a cardiac frame, and that impression may have been reinforced by the presence of non-specific ECG changes. Chart review or additional history-taking may have revealed the patient's recent history of falls with repeated closed head injuries and prompted the clinician to re-frame the case as recurrent head trauma in addition to possible cardiac pathology. The heuristics typically applied to cases of head trauma should have caused the clinician to consider the necessity and advisability of anticoagulation under these circumstances. Additionally, had the clinician not closed on a cardiac diagnosis prematurely, they likely would have prioritized neuroimaging results before administering anticoagulation.

ECG Changes in Intracranial Hemorrhage

The 12-lead ECG is one of the most common diagnostic studies in medicine with more than 300 million performed annually in the United States.⁸ Physicians most frequently obtain an ECG for patients with chest pain to evaluate the possibility of myocardial ischemia, but emergency physicians may fail to consider other potential diagnoses associated with various ECG patterns. In the current case, the clinician did not

consider that the ECG changes could be secondary to intracranial hemorrhage rather than primary cardiac pathology. In addition to the classic finding of deep, inverted T-waves ('cerebral T-waves'), intracranial hemorrhage frequently presents with other non-specific ECG changes that can mimic patterns seen in acute coronary syndromes. In a study of patients with confirmed intracranial hemorrhage, 25% demonstrated ST-segment depression, and 1 in 5 showed T-wave inversion.⁹ Intracranial hemorrhage can also cause ST-segment elevation or cardiac arrhythmias.¹⁰ Cardiac troponin may be elevated with intracranial hemorrhage reflecting secondary myocardial damage due to activation of the sympathetic nervous system and catecholamine release.¹¹ Because life-threatening, non-cardiac pathology can be associated with non-specific ECG changes, clinicians must maintain vigilance and a broad differential when interpreting ECGs. ST-segment abnormalities in a patient with a recent history of head trauma and no chest pain should prompt consideration of intracranial hemorrhage.

High-risk medications: Anticoagulation

Because the clinician was concerned for a cardiac etiology of syncope, they initiated anticoagulation with unfractionated heparin and, after consulting with a cardiologist, low molecular weight heparin. Both [anticoagulants](#) are identified by the [Institute for Safe Medication Practices](#) as "high-alert" medications that are particularly dangerous when administered in error.¹²

Contraindications to heparins include active major bleeding, a history of heparin-induced thrombocytopenia, and hypersensitivity to the drug's constituents of enoxaparin (in the case of Lovenox), benzyl alcohol, or pork products.¹³ Even in the absence of those contraindications, anticoagulants are associated with significant [adverse events](#). In one study, 1.5% of patients in whom anticoagulation was initiated for atrial fibrillation suffered a major hemorrhage, defined as bleeding requiring admission, transfusion of at least two units of blood, or intracranial bleeding, within the first year of starting therapy.¹⁴

Intracranial hemorrhage is the most feared and most lethal adverse event associated with anticoagulation. In a study of patients with a hemorrhage secondary to anticoagulation, 76% of patients with intracranial hemorrhage had permanent disability or died, compared to only 3% of patients with extracranial hemorrhage.¹⁵ In one Swedish study, patients treated with oral anticoagulants were found to have a 10-fold increase in the risk of hemorrhagic stroke.¹⁶

In the present case, the patient's age and chief complaint of syncope correctly prompted concern for the possibility of intracranial hemorrhage and brain imaging was initially ordered. However, the study was not interpreted prior to the administration of anticoagulation and the intracranial hemorrhage, representing a clear contraindication to the administration of heparin and Lovenox, was not recognized. Even in the absence of a demonstrable intracranial hemorrhage or knowledge of the patient's recurrent closed head trauma, the history initially gathered from the patient may have warranted re-examination of the plan to discharge on therapeutic low molecular weight heparin.

While it is clear in hindsight that anticoagulation was contraindicated in this patient, it is less clear whether anticoagulation was indicated in the first place. Syncope is not an indication for systemic anticoagulation. Syncope with ECG changes may have caused the clinician to suspect a pulmonary embolism, but no other elements of the history support that diagnosis. Alternatively, the clinician may have suspected acute coronary syndrome, however there were no clinical criteria present to support a diagnosis of unstable

angina or myocardial infarction (MI) and therefore anticoagulation was not indicated. According to the Fourth Universal Definition of Myocardial Infarction, an acute MI is diagnosed when there is a detected rise of cardiac troponin values with at least one value above the 99th percentile and at least one of the following:

- Symptoms of myocardial ischemia
- New ischemic ECG changes
- Development of pathologic Q waves
- Imaging evidence consistent with new myocardial damage secondary to ischemia¹⁷

Although there were non-specific ECG changes present that in the right setting could have been concerning for myocardial ischemia, there was no history of chest pain or other ischemic symptoms to suggest the presence of an acute coronary syndrome. Without a clear indication for anticoagulation, these high-risk medications should not have been administered.

Approach to Improving Safety and Systems Change Needed

To help clinicians avoid similar errors, hospitals should adopt systemic changes to ensure each patient is screened for absolute contraindications to high risk medications like anticoagulants and antiplatelet agents, and that there are clear indications for their use. To achieve these goals, we suggest implementing cognitive aids which are “prompts designed to help users complete a task or series of tasks”.¹⁸ Two such aids are checklists and forcing functions.

Checklists

Checklists are cognitive aids that have been shown to prevent errors in several high stakes organizations and domains. For example, checklists are used widely in commercial aviation; federal regulations effectively mandate them for most cockpit procedures.¹⁹ Checklists also have demonstrated efficacy as tools that can prevent medical error. One of the first studies of medical checklists involved the World Health Organization’s (WHO) Guidelines for Safe Surgery checklist to reduce surgical complications. The checklist detailed 19 steps (e.g. “Confirm the patient’s identity, surgical site, and procedure” and “Anesthesia staff review concerns specific to the patient”) that should be performed before, during, or after an operation. In a multi-center international study, the WHO surgical checklist decreased mortality from 1.5% to 0.8% and decreased the rate of inpatient complications from 11.0% to 7.0%.²⁰

Using checklists to reduce complications related to anticoagulants is particularly appealing given the potential adverse effects. One simple monitoring checklist developed by an expert panel utilized the mnemonic ABCDEF: A (adherence), B (bleeding), C (creatinine clearance), D (drug interactions), E (examination), and F (follow-up) to specifically reduce complications associations with these medications.²¹ Although not explicitly designed for use in the emergency department, this checklist may have prevented administration of anticoagulants in the current case. Alternately, if the clinician had simply reviewed an abbreviated list of absolute and relative contraindications to anticoagulation prior to ordering the medication (e.g. “Has this patient suffered recent head trauma or is this patient at increased risk of head trauma?”), they may have reconsidered their order.

In an emergency department setting, where the pace of clinical work is rapid and diagnostic uncertainty and distraction are both common, cognitive aids such as checklists may be especially helpful. However, providers may not remember to use the checklists. They may also avoid using checklists because they feel their use imposes an additional cognitive burden or demand on their time. One solution to ensure checklists are utilized or acknowledged is to implement checklists into the Electronic Health Record (EHR) as a type of forcing function.

Forcing Functions

[Forcing functions](#) are automatic, built in features of systems designed to minimize or avert errors. Forcing functions are common in non-medical settings. Some auto manufacturers install car doors that won't lock until the driver removes the key from the ignition thus preventing the driver from locking the keys in the car. [22](#) Modern bank ATMs won't dispense cash until the user removes their card from the machine, thus preventing leaving the bank card behind.

Various medical forcing functions are already in use. For example, in order to avoid the administration of the wrong medication during an anesthesia procedure, inhalation gas canister connectors are constructed with unique fittings that physically prevent the connection of a gas cylinder to the wrong hose. [23](#)

Forcing functions do not have to be physical. Electronic forcing functions are increasingly integrated into electronic medical record systems. One example, currently in use at our hospital, requires providers ordering an MRI study to complete a contraindication screening checklist before the order can be completed. Although such functions can impose additional cognitive load and burdens of documentation on clinicians, they also help avoid errors and improve identification and treatment of life-threatening conditions. In another example, an informatics team developed an EHR alert that, when triggered, sends a page to the treating physician when elements consistent with sepsis are entered into the patient's record. This forces the physician to acknowledge the potential diagnosis of sepsis. Prior to implementing this alert, 23% of patients did not receive intravenous antibiotics and more than 40% did not receive intravenous fluids. A subsequent analysis showed that the alert was triggered at "clinical time zero" in 41% of cases and before a positive nursing sepsis screen in 96% of cases. [24](#)

Because anticoagulants and antiplatelet agents are inherently high-risk medications, this class of drug is particularly well-suited to forcing functions. One healthcare system implemented an alert whenever a patient taking an anticoagulant or antiplatelet agent is scheduled for an elective endoscopic gastrointestinal procedure. The alert recommends referral to an anticoagulation clinic; the ordering provider can accept or decline the recommendation. After implementing the alert, there were significantly fewer cancellations of planned endoscopic procedures as a result of antithrombotic medication mismanagement and a majority of clinicians reported that the alert was both easy to use and helpful. [25](#)

In an emergent setting, a forcing function or alert could prevent providers from inappropriately ordering antiplatelet or anticoagulation therapy for patients at increased risk of bleeding. For example, a provider ordering anticoagulation for a patient with recent head imaging could be alerted to those imaging results before accepting the order. In the current case, if the physician had been alerted to the recent imaging from his visits related to head trauma, they may have avoided anticoagulation altogether. Moreover, if anticoagulation is ordered on a patient awaiting the results of neuroimaging or other critical tests, this same

system might also raise an alert. It seems probable that with either system in place, the error highlighted by this case may have been averted.

Conclusion

With a thorough history, the clinician may have constructed a different frame around the patient's presentation, instead considering the case as both "head trauma" and "syncope." This more inclusive frame may have prevented premature closure around an isolated cardiac etiology as the sole cause for the patient's presentation. This may also have helped the provider appreciate that the ECG changes could be consistent with intracranial hemorrhage. Early identification, and even consideration, of intracranial hemorrhage would likely have prevented the administration of anticoagulation and ultimately the patient's death.

Systems-level changes like checklists and forcing functions, when integrated into the EHR, provide additional measures of safety and reduce the risk of patient harm. Even if the clinician failed to elicit the history of recent head trauma, together these interventions may have prevented a sequence of events that lead to this patient's death by calling attention to the high-risk nature of anticoagulation and forcing consideration of contraindications to high-risk medications.

Take Home Points

- Inaccurate framing and premature closure are two common cognitive biases that can contribute to diagnostic error.
- ECG changes are not always ischemic and do not always indicate primary cardiac pathology. "Cerebral" T-waves may mimic ischemia.
- Anticoagulants and antiplatelet agents are high-risk medications and should always prompt a thorough consideration of indications and contraindications prior to administration.
- Checklists and forcing functions are two tools that healthcare providers can use to mitigate cognitive traps and avoid medical error.

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This project was funded under contract number 75Q80119C00004 from the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services. The authors are solely responsible for this report's contents, findings, and conclusions, which do not necessarily represent the views of AHRQ. Readers should not interpret any statement in this report as an official position of AHRQ or of the U.S. Department of Health and Human Services. None of the authors has any affiliation or financial involvement that conflicts with the material presented in this report. [View AHRQ Disclaimers](#)