Rural Healthcare Quality Network

Hospital Peer Review

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Hospital Peer Review *is a monthly newsletter sponsored by the Rural Healthcare Quality Network to alert Critical Access Hospitals regarding findings from the Peer Review Program. Summarized are a few of the key findings and best practices that would be helpful for other critical access hospitals to be knowledgeable about. This newsletter is edited by Myron Bloom, Medical Director and he can be reached at drmbloom@msn.com.*

Level One STEMI Transfer Resource Wastage: The Best Response for a "Non-Reassuring STE" Electrocardiogram

Given that a significant portion of the patients identified as requiring emergent transfer for STE expecting primary percutaneous coronary intervention (PPCI) prove to not have a treatable lesion at cardiac catheterization might be considered wasted resources, how precisely can the electrocardiogram be interpreted? The following paragraphs will show the "false positive" call rate, the limitations of electrocardiogram interpretation, confounding diagnoses, increased risk of lytics, and the necessity of tolerating a reasonable "false positive" rate.

The first year of operation of the Spokane Regional Level One program, 3 of 28 patients transferred to Sacred Heart Medical Center without first having received thrombolytics were found to have benign coronaries and 1 patient had cardiomyopathy for a false positive rate of 14.2%. Three patients were taken to CABG after cath and one patient was found to have severe inoperable disease. Of the 28 patients, 28% did not have PCI, but only 10.7% had normal coronaries. During that time, 35 patients went to Deaconess Medical Center. [I do not have the breakdown of their patients except to note that four had been successfully resuscitated prior to transfer]. This was during the first year while in a learning curve, trusting rural physicians and mid-level practitioners to summon a helicopter and cardiologist and the cath lab team to be waiting for the patient's arrival.

A study of 1,335 patients transferred from outlying hospitals to Abbott Northwestern Hospital in Minneapolis (which in a large way was the role model for the RHQN promoted Level One STEMI cardiac transfer protocol) undergoing emergent catheterization found 9.2% had the combination of no apparent culprit artery and negative biomarkers; 14% did not have a clear-cut culprit artery; and 9.5% did not even have significant coronary artery disease. However, in these transferred-in patients, the thirty-day mortality was still 2.7% in those without, compared to 4.6% in patients with a culprit coronary artery. In summary, about 1 in 10 cath lab referrals was a false positive after 40 months of patient transfers. False-positive cath lab activation was especially prevalent in the treatment of women, patients with new left bundle branch block, and those with previous MI or coronary artery bypass surgery.[1] But how many of the following list of false-positive patients would have benefitted from the combination of thrombolytics and heparin? Perhaps the two with a pulmonary embolism, but certainly not the patient with a dissecting aneurism. Doctor, first do no harm.

Etiologies of "no culprit artery" STEMI transfers to Abbott Northwest Hospital (n=187)

With Negative Biomarker (n = 123)		***With Positive Biomarkers (n = 64)***	
Early repolerization	25	Stress cardiomyopathy	17
Non-diagnostic electrocardiogram	21	Myocarditis	15
Pericarditis	20	Previous myocardial infarction	9
Previous myocardial infarction	20	STEMI embolic or spasm	9
Left Bundle Branch Block	11	Left Bundle Branch Block	4
Left sided hypertrophy	8	Non-ST-elevation infarction	2
Vasospasm	4		
Tachycardia	3		
Right Bundle Bunch Block	3		
Pulmonary Embolism	2		
Brugada Syndrome	1		
Drug overdose	1		
Severe Aortic Stenosis	1		
Aortic Dissection	1		
Unknown	3		

While a non-diagnostic ECG or benign early repolerization accounted for a quarter of the "no culprit artery" cases, pericarditis accounted for 18%. A retrospective analysis of 238 patients with a final diagnosis of acute pericarditis evaluated at Mayo Clinic, Rochester, between January 1, 2000 and December 31, 2006, found that on the initial electrocardiogram, 61% (146) had ST-segment elevation. Coronary angiography was performed on 16.8% of the pericarditis patients with the frequency 5 times higher among those with ST-segment elevation (24.7% vs. 4.3%). Characteristics associated with a higher likelihood of coronary angiography included typical anginal chest pain, ST-segment elevation, previous percutaneous coronary intervention, elevated troponin values, diaphoresis, and male sex. Importantly, 7 patients (4.8%) with ST-segment elevation received thrombolytics before being transferred to Mayo.[2] Other studies have reported thrombolytic rates as high as 19% for patients with myopericarditis that was mistaken for myocardial infarction.[3]

The differential diagnosis between acute myocardial infarction and acute pericarditis is important because it markedly affects treatment and prognosis. Given the risk of pericardial effusion and tamponade after fibrinolytic and heparin therapy in patients with pericarditis, such therapy should be avoided. Thus, the risk vs. benefit profile of patients with suspected ACS versus pericarditis may well favor cardiac catheterization.

So how precisely can an ST Elevation on an electrocardiogram be interpreted?

Fifteen experienced cardiologists were asked to decide, based on 116 consecutive ECGs (assuming that the patient had compatible infarction symptoms), whether they would send each patient for PPCI. Of the 116 patients, only 8 had STEMI. The percentage of ECGs for which PPCI was recommended for the patient by the individual readers varied widely (7.8% to 33%) and there was not a significant difference between the North American and readers from other counties. The sensitivity of the individual readers for diagnosing STEMI-ACS ranged from 50% to 100% (average of 75%) with a 73% to 97% specificity (average 85%). If a diagnosis of non-ischemic STE was chosen, the reader was asked to select 1 or more of 12 possible explanations

for making their choice, finding that there were marked inconsistencies among the readers in the chosen reasons used to classify the cases as non-ischemic STE.[4]

Simply stated, STE may be benign or pathological. Studies have shown STE of 1 to 3 mm in one or more precordial leads (most commonly in lead V_2) to be prevalent in otherwise healthy men. The prevalence gradually declines with increasing age, from over 90% in men 17 to 24 years old ,dropping to 30 percent in men over 75 years of age. In contrast, only about 20 percent of normal electrocardiograms from women have ST-segment elevation of 1 mm or more, irrespective of age.[5]

There are several clinically significant non-infarction pathologic causes of STE. Hyperkalemia causes STE and the other electrocardiographic features (such as widened QRS, tall peaked T waves, and low-amplitude or absent P waves) which may not be present. When the acute inflammatory reaction of pericarditis is localized to a relatively small area of the ventricular wall, it may cause a pseudo-infarction pattern closely mimicking myocardial infarction on an electrocardiogram. Pulmonary embolism electrocardiographic features may include STE and T-wave inversion. In Prinzmetal's angina, an epicardial artery is "pinched off" by spasm and the ST segment will become elevated in the leads facing the affected area; if the spasm lasts long enough, a true infarction will result. Similar to Prinzmetal's angina, emotionally triggered STE of Takatsubo cardiomyopathy was described in the December 2009 Hospital Peer Review.

The ACC/AHA/Core Measure reperfusion guidelines recommend a "door to needle" time of 30 minutes and a "door-to-balloon" time of 90 minutes, resulting in an "acceptable PCI-related delay" of "door to balloon" minus "door to needle" of 60 minutes [very much a one size boot to fit all feet perhaps poorly]. PPCI is associated with higher patency rates of the infarct vessel and better survival when compared with fibrinolytic therapy for whom about 1/3 will not reperfuse and 1/3 of those who do will re-thrombose. An analysis by the Primary Coronary Angioplasty versus Thrombolysis (PCAT), 2 investigators of studies that have compared primary PCI with in-hospital fibrinolysis, suggested that a survival benefit of primary PCI may still be present with PCI-related delays of up to 2 hours or longer, depending on the circumstances. Data from the large National Registries of Myocardial Infarction (NRMI) 2, 3, and 4 indicate that when selecting a reperfusion treatment, the time delays and the individual characteristics of the patients presenting with a STEMI should both be taken into account.

Pinto et al. analyzed data from 192,509 patients treated between June 1994 and August 2003 at 645 hospitals in the United States. The effect of the PCI-related delay in specific subgroups of patients stratified by age, infarct location, and time from symptom onset to hospital arrival was examined.[6] The PCI-related delay beyond which the survival benefit of primary PCI was lost varied considerably, depending on the patients' characteristics.

The mortality benefit of PPCI may be lost when the time to accomplish it exceeds:

	Before 2 hours of Symptoms		After 2 hours of Symptoms	
Under 65	Anterior	40 min	Anterior	43 min
	Non-anterior	58 min	Non-anterior	103 min
Over 65	Anterior	107 min	Anterior	148 min
	Non-anterior	168 min	Non-anterior	179 min
Hospital delays in reperfusion for ST-elevation myocardial infarction: implications when selecting a reperfusion strategy. *Circulation 2006;114(19):2019-2025*				

Advanced age, low body weight, prior cerebrovascular disease, adjunctive agents used, hypertension, systolic and diastolic BPs, and interaction between age and hypertension are independent predictors of ICH. In the Assessment of the Safety and Efficacy of a New Thrombolytic Agent (ASSENT)-2 trial, the overall 30-day intracranial hemorrhage (ICH) rate for tenecteplase (TNK) as well as alteplase was 0.9%, and the highest risk of ICH was observed in females weighing ≤67 kg; and there was 4.7% rate of major noncerebral bleeds and 21% minor bleeds. In the pooled analysis of the ASSENT-3 and ASSENT-3 PLUS studies in which TNK was evaluated with UFH or LMWH, old age was a risk factor for ICH, especially in the group treated with LMWH. Female sex was an independent risk factor for ICH in ASSENT-3 and ASSENT-3 PLUS. Females also had a higher risk of non-cerebral major bleeds. In ASSENT-3, the rates by age were as follows:

	≤65 y	66-75 y	76-85 y	>85 y	P
30-d stroke	0.25	0.99	0.99	4.83	<.0001
Inhospital ICH	0.61	1.56	2.21	2.07	<.0001
Inhospital major bleed	1.9	4.0	7.3	11.0	<.0001
Inhospital transfusion	2.8	5.7	10.2	16.7	<.0001

ASSENT-3 Complication Rates

In summary, bleeding is the most serious and potentially fatal complication of thrombolysis for ACS with intracerebral bleeding rates of 0.6% to 2%, depending on age. Comparing angioplasty to thrombolysis, there is at least a ten fold increased hemorrhagic stroke rate with lytics.

To illustrate the risk analysis, let's compare 2 patients with a STEMI presenting to a non-PCI capable hospital. For a 55 year old man with a negative medical history presenting with 4 mm tombstone ST-segment elevations in the precordial leads within 90 minutes of symptom onset, immediate thrombolytics may save more myocardium. PPCI will only be superior to fibrinolytic therapy if it can be performed well under 1 hour after arrival at the first hospital, meaning he would need to be delivered to the cath lab by a half hour. But, if a 75 year old woman presents more than 5 hours after the onset of symptoms and has just 1 mm in the inferior leads, although the guidelines may suggest that she should get lytics, the risks of thrombolytics outweigh probable benefit, and PPCI is perhaps preferred even after a delay of a couple more hours.[7] Quoting Tarantini, "thrombolytic without delay may provide maximal advantage in a young patient at low risk of hemorrhage and mortality presenting earlier, whereas high-risk patients might benefit from primary PCI, even with longer delays."[8]

Lastly, let's consider the issue of wasted resources and compare it to a couple other expensive invasive procedures. Although a rate for "false positive" emergency cesarean section for non-reassuring fetal heart rate tracings (or sections performed for breech presentation or prematurity) has not been estimated, with the assistance of CT imaging, the "normal" appendectomy rate has been pushed under 10%. However, a multicenter Swedish study of 252 men aged 18-50 with a high clinical probability of non-perforated appendicitis found that about 88% of carefully managed cases can be effectively treated by antibiotics initially avoiding abdominal surgery (subsequently 15% of the medically treated cases underwent appendectomy in the following year for recurrent symptoms).[9] Ironically, cardiologists have called pericarditis "appendicitis of the heart".[10]

Without tolerating false-positives, given the limitations of diagnostic specificity and sensitivity and the potential for adverse outcome, patients who would benefit from PPCI may go untreated or be subjected to risky or inferior alternative therapy.

So, perfect your Level One STEMI protocol and transfer agreements, and monitor your outcomes.

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Please also see:

Hospital Peer Alert – August 2009

Cardiac Level 1 Protocol Sheet

Questions for facilities that are not PCI capable