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Characteristics and Outcomes of Hospitalized Patients Undergoing Troponin Testing

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Abstract

Troponin is frequently utilized in diagnosing acute myocardial infarction (AMI). We hypothesized troponin testing might predict increased risk of readmission within 30 days or death during index hospitalization. In total, 54,039 inpatient admissions were reviewed and primary international classification of disease (ICD-10) diagnoses at discharge, troponin I, risk factors, and readmission within 30 days or death during hospitalization were collected. Of all visits, 55.8% underwent troponin testing with 19.9% having an elevated troponin value >99th% (0.1 ng/ml). Troponin testing, even if within normal limits, was associated with increased 30-day readmission (OR 2.24, 95% CI 2.08,2.41, p<0.0001) and death during hospitalization (OR 3.11, 95% CI 2.63,3.71, p<0.00010) while elevated troponin showed increased death compared to those with troponin level within normal limits (OR 4.06, 95% CI 3.49,4.72, p<0.0001). Troponin testing may predict 30-day readmission or death during index hospitalization, however an elevated troponin value >99th% may only predict death. Further research is needed to determine the impact of troponin testing on patient care.

1. Introduction

Troponin testing is employed to diagnose or exclude acute myocardial infarction (AMI), with levels of troponin greater than the 99th percentile considered "positive" and diagnostic for myocardial injury.[1] However, troponin values are commonly elevated in patients without AMI.[2-8] Prior data from our system in 2014 showed that testing was common; occurring during 1 in 4 inpatient admissions.[9] Testing may be encouraged by research suggesting that elevated troponin values predict poor outcomes for non-AMI diagnoses such as sepsis.[2,3,8] We hypothesized the characteristics of patients chosen for troponin testing differ from those not tested, and that selection for troponin testing, itself, might account for a portion of the prognostic power attributed to positive troponin results.

2. Method

We reviewed data from all inpatient admissions for patients aged 40 years or older admitted to nine hospitals in central Texas from January 1, 2017 to December 31, 2018. In total, 54,039 unique admissions were identified. The primary International Classification of Disease (ICD-10) diagnoses at discharge, troponin I (TnI) test data, baseline risk factors, and readmission within 30 days or death during index admission for each patient were collected. Baseline risk factors obtained included gender, race, smoking history, hypertension (HTN), hyperlipidemia (HLD), type 2 diabetes mellitus (T2DM), coronary artery disease (CAD), chronic kidney disease (CKD), chronic obstructive pulmonary disease (COPD), prior cerebrovascular accident (CVA), and prior AMI. Odds ratios were calculated for all patients based on ICD-10 classification at discharge. Bivariate analysis was also performed on the baseline risk factors described above for both troponin testing and troponin positivity.

3. Results

Patients had a median age of 67.3 years. Female patients accounted for 53.1% and 46.9% were male. 81.3% were white. Hypertension was a diagnosis in 72.9%. Of all visits, 30,173 hospitalizations were associated with troponin testing (55.8%). Of these, 6,013 encounters (19.9%) had one or more elevated troponin values >99th percentile (0.1 ng/ml). The

readmission rate within 30 days for all patients was 8.5% while death during index hospitalization for all patients was 1.7%. Bivariate analysis of baseline risk factors showed statistically significant results for troponin testing versus non-testing in all risk factor groups (Table 1).

Table 1. *Baseline patient characteristics*

	Frequency N=54039	TnI Draw, No N=23866	TnIDraw,Yes N=30173	P-Value
Race (White)	43929 (81.3%)			
Smoker	10576 (16.6%)	4507 (18.9%)	6069 (20.1%)	0.0003
Hypertension	39376 (72.9%)	15596 (65.4%)	23780 (78.8%)	<0.0001
Hyperlipidemia	27364 (50.6%)	10900 (45.7%)	16464 (54.6%)	<0.0001
Type II Diabetes	17695 (32.7%)	6466 (27.1%)	11229 (37.2%)	<0.0001
Coronary Artery Disease	12473 (23.1%)	3394 (14.2%)	9079 (30.1%)	<0.0001
Chronic Kidney Disease	8496 (15.7%)	2485(10.4%)	6011 (19.9%)	<0.0001
Chronic Obstructive Pulmonary Disease	8050 (14.9%)	2151 (9.0%)	5899 (19.6%)	<0.0001
Prior Stroke	909 (1.7%)	185 (0.8%)	724 (2.4%)	<0.0001
Prior Myocardial Infarction	3256 (6.5%)	995 (4.2%)	2531 (8.4%)	<0.0001
Died During Index Admission	908 (1.7%)			
Readmission within 30 days	4572 (8.5%)			
Troponin Draw	30173 (55.8%)			
Troponin >99th (0.1 ng/mL)	6013 (19.9%)			

When troponin was tested versus not tested, odds of 30-day readmission was increased (OR 2.24, 95% CI 2.08,2.41, p<0.0001) as was risk of death (OR 3.11, 95% CI 2.63,3.71, p<0.0001). Further, the presence of TnI values >99th percentile was associated with a risk of death 4.06 times that seen in hospitalization of patients with TnI values below the 99th percentile [(OR 4.06, 95% CI 3.49,4.72, p<0.0001) Table 2].

Table 2. *Comparison of troponin testing and troponin positivity*

Troponin Drawn				
	Odds Ratio	95% Confidence Interval	p-value	C-statistic
Died During Index Admission	3.11	2.63, 3.71	<0.0001	0.65
Readmission within 30 days	2.24	2.08, 2.41	<0.0001	0.64
Troponin >0.1 ng/mL				
	Odds Ratio	95% Confidence Interval	p-value	C-statistic
Died During Index Admission	4.06	3.49, 4.72	<0.0001	0.64
Readmission within 30 days	1.04	0.95, 1.14	0.4006	0.54

Elevated troponin was not associated with a difference in 30-day readmission (OR 1.04, 95% 0.95,1.14, p = 0.4006).

4. Discussion

There were significant differences in patient characteristics between patients who had troponin testing and those who did not. Tested patients were older and more likely to be male. They were more likely to have cardiovascular risk factors (smoking, hypertension, diabetes, hyperlipidemia), known cardiovascular disease (CAD, prior CVA, prior MI), CKD or COPD. Race was not associated with testing, though our patient population was >80% white, and minority groups were underrepresented in our data.

Troponin testing, independent of result, was associated with both death during hospitalization and 30-day readmission. Yet, it is implausible testing plays a causal role in either mortality or readmission. It is likely that differences in the characteristics of patients selected for testing are responsible for this association. Older patients with more comorbidities and known cardiovascular disease are likely to have worse outcomes. Testing, in and of itself, does not make such outcomes more likely.

Patient selection appears to contribute to the predictive power of troponin testing. After all, only through testing are elevated values identified. A growing body of work has reported associations between elevated troponin values and worsened outcomes in a variety of cardiac and non-cardiac disease states. [2-8] However, few have controlled for patient selection. Our data suggests the decision to test carries an important predictive value.

We find that detection of troponin values > 99th percentile was associated with increased risk for

inpatient mortality. This association has been previously reported by other researchers. [10-11] Though developed as a test to diagnose AMI, many other disease processes are associated with elevated troponin. [4,5,8,12-13] The power of elevated troponin to predict inpatient mortality is likely not attributable to selection alone. However, the finding that 30-day readmission was associated with testing alone not the result of that testing highlights the role that selection alone may play in predicting outcomes.

Our data demonstrate a significant increase in testing as rates of testing increased from 25.2% in 2014 to 55.8% by 2018 in our nine-hospital system. Most hospitalized patients now undergo testing. Increased testing is occurring at a time when the frequency of AMI in our hospitalized patient population has remained stable at 2-3%.[14] It is likely that addition of troponin to order sets in our electronic medical record has played a role. Troponin testing has a high negative predictive value for excluding AMI. Troponin testing could become universal. Should this occur, however, patient selection will be lost and with it some of the prognostic power of testing. This testing will come at a cost as data from our system shows testing is associated with an increased cost of care.[15]

Our study is a broad overview of troponin testing, and several limitations exist. We did not look comprehensively at all patient variables, choosing instead to specify those such as age and smoking status that are well known to predict outcomes. In addition, we looked at troponin results in a binary fashion, either greater than 99th percentile or not. The impact of specific troponin values and the timing of such values was not investigated. In addition, we did not determine the weight each co-morbid risk factor may contribute to death or readmission. Finally, our data cannot be extrapolated to hospitalized patients younger than 40.

5. Conclusion

We observed significant differences in patient characteristics between patients tested and those not tested for troponin during hospitalization. Testing, independent of result, was associated with death and 30-day readmission during hospitalization. Elevated troponin >99th percentile was associated only with mortality. Further research is needed to determine the value of troponin testing to predict outcomes for hospitalized patients.

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