Value of Serial Troponin T Measures for Early and Late Risk Stratification in Patients With Acute Coronary Syndromes

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Background—The baseline cardiac troponin T (cTnT) level strongly predicts short-term mortality in acute coronary syndromes, but the added value of later measures to predict short- and long-term outcome and in the context of baseline clinical characteristics is unclear.

Methods and Results—Relations between baseline, peak, and 8- and 16-hour (late) cTnT results and outcomes were assessed in 734 patients in a GUSTO-IIa substudy. Proportional-hazards models assessed the prognostic information gained from late cTnT when added to a mortality model containing the baseline cTnT result and clinical factors. At baseline, 260 patients were cTnT-positive (>0.1 ng/mL), 323 became positive later, and 151 remained negative (≤0.1 ng/mL). Mortality at 30 days was 10% in the baseline-positive group, 5% in late-positive patients, and 0% in negative patients. After adjustment for baseline characteristics, any positive cTnT result predicted 30-day mortality (baseline, $\chi^2=8.96$, $P=0.0113$; 8-hour, $\chi^2=6.51$, $P=0.0107$; 16-hour, $\chi^2=8.40$, $P=0.0038$). Both the 8- and the 16-hour results added to the strength of the baseline result (baseline+8-hour, $\chi^2=12.04$, $P=0.0072$; baseline+16-hour, $\chi^2=13.52$, $P=0.0036$). Only age and ST-segment elevation were stronger predictors of 30-day mortality than baseline cTnT; results were similar for prediction of 1-year mortality. Most of the mortality difference between cTnT-positive and -negative patients occurred within the first 30 days.

Conclusions—The cTnT level is a strong, independent predictor of short-term outcome in acute coronary syndromes. The addition of later samples to a baseline level is useful to evaluate the risk of serious cardiac events. **(*Circulation*. 1998;98:1853-1859.)**

Key Words: risk factors ■ mortality ■ prognosis ■ ischemia

The acute coronary syndromes represent a gradation of severity of coronary artery disease, from unstable angina through acute myocardial infarction. All share an underlying pathophysiology of acute plaque rupture, with various degrees of platelet and thrombotic vessel occlusion. Although they share this pathophysiology, outcomes and effective management strategies differ by the patient's place on the continuum, and diagnosis and risk stratification of this diverse group are often difficult. As new treatments and management guidelines emerge for care of patients with acute coronary syndromes, accurate diagnosis and risk stratification will become increasingly important to optimize their treatment while maintaining reasonable costs.

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We have reported the strength of the baseline cardiac troponin T (cTnT) result for short-term risk stratification in the Global Use of Strategies to Open Occluded Arteries in Acute Coronary Syndromes (GUSTO-IIa) troponin T substudy.[1] In this study, baseline cTnT was the most important prognostic indicator, independent of presenting ECG changes and serum creatine kinase-MB results. However, in the GUSTO-IIa troponin T substudy, 512 patients (64%) initially had a negative cTnT result. Although lower than in baseline-positive patients, 30-day mortality in this group was 3.9%.[1] The ability of serial cTnT measures to refine short-term prognosis in patients with initially negative results or to add to prognostic ability beyond 30 days is unknown. Likewise, the relative contribution of cTnT measures after baseline clinical characteristics are considered is unclear. Thus, we evaluated the utility of baseline and serial cTnT samples for short- and long-term risk stratification in 734 patients enrolled in this substudy.

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TABLE 1. Baseline Characteristics of Substudy Patients by cTnT Classification

		cTnT (+)*			
	Overall (n=734)	Baseline (n=260)	8 hours (n=308)	16 hours (n=15)	cTnT (−) (n=151)
Age, y	63 (52, 71)	66 (54, 75)	61 (52, 68)	60 (53, 72)	63 (51, 71)
Male, %	70	66	77	80	59
Diabetes, %	21	25	17	33	24
Hypertension, %	50	54	43	53	58
Current smoking, %	50	51	55	60	37
Hypercholesterolemia, %	41	35	43	47	50
Previous angina, %	67	69	56	80	83
Current angina symptoms, %					
Continuous	37	31	50	20	23
Intermittent	63	69	50	80	77
Previous myocardial infarction, %	27	23	23	20	41
Previous angioplasty, %	11	7	9	13	22
Previous bypass surgery, %	11	9	7	40	17
Killip class >I, %	13	20	9	20	12
Symptom duration, min	178 (80, 285)	177.5 (80, 305)	180 (110, 270)	120 (30, 285)	120 (30, 239)
Baseline ECG, %					
ST-segment elevation	58	52	78	67	26
ST-segment depression	11	15	6	13	15
T-wave inversion/normal	22	18	12	20	48
ECG confounders†	9	14	5	0	10

Values are medians (25th, 75th percentiles).
*cTnT (+) indicates >0.1 ng/mL; cTnT (−), ≤0.1 ng/mL.
†Left bundle-branch block, left ventricular hypertrophy, or paced rhythm.

Methods

Study Population

Our study population included 734 patients who were part of the troponin T substudy of the GUSTO-IIa trial. The methods of GUSTO-IIa have been described.[2] In brief, 2564 patients with suspected acute coronary syndromes were randomized to either intravenous heparin or desirudin if they presented within 12 hours of symptom onset, met baseline ECG criteria (transient or persistent ST-segment elevation or depression >0.5 mm or persistent, definite T-wave inversion >1 mm), and had no protocol-specified contraindications to enrollment.

The troponin T substudy of GUSTO-IIa enrolled 855 patients and was designed to evaluate cTnT measures for risk stratification of this population.[1] Serum samples for cTnT were collected at baseline (as close to randomization as possible), at 8 hours, and at 16 hours. Of these, 50 patients lacked a baseline sample, and another 71 lacked an 8- or 16-hour sample, only 7 because they had died within 8 hours. The remaining 734 patients, the cohort analyzed, had serial samples drawn as follows: 39 patients had samples drawn only at baseline and 8 hours, 20 had samples drawn only at baseline and 16 hours, and 675 had samples at all 3 points. The median times of sampling were 8.4 (25th, 75th percentiles, 7.7, 9.0) hours for the 8-hour samples and 16.5 (15.8, 17.1) hours for the 16-hour samples.

Analytical Methods

The methods of sample collection, storage, and analysis for this substudy have been described.[1] In brief, cTnT samples were col-

TABLE 2. Troponin T Status at Different Sampling Times by ECG Category

	Overall (n=734)	ST-Segment Elevation (n=425)	ST-Segment Depression (n=82)	T-Wave Inversion (n=161)	ECG Confounding Factors (n=66)*
Proportion positive cTnT (>0.1 ng/mL), %					
Baseline	35.4	31.8	48.8	29.8	56.1
8 h	77.5	88.7	68.0	52.6	75.4
16 h	76.8	89.4	64.1	50.3	75.4
Absolute value, ng/mL					
Baseline	0.04 (0.01, 0.27)	0.04 (0.01, 0.22)	0.1 (0.02, 0.34)	0.02 (0.01, 0.2)	0.17 (0.02, 0.51)
8 h	2.02 (0.17, 10.75)	7.09 (1.08, 16.3)	0.36 (0.04, 2.91)	0.17 (0.01, 1.21)	0.64 (0.17, 2.88)
16 h	2.88 (0.17, 10.21)	7.64 (1.44, 13.8)	0.51 (0.04, 3.41)	0.15 (0.01, 1.93)	0.79 (0.12, 3.35)

Values are medians (25th, 75th percentiles).
*Left bundle-branch block, left ventricular hypertrophy, or paced rhythm.

TABLE 3. Adverse Events by cTnT Classification

	cTnT (+)*		
	Baseline (n=260)	Late (n=323)†	cTnT (−) (n=151)
30-Day mortality, %	10	5	0
Myocardial (re)infarction, %			
Early‡	85	91	3
Late	5	6	5
Shock, %	7	2	1
Congestive heart failure, %	13	8	6
Angioplasty, %	28	41	19
Bypass surgery, %	19	16	15
Composite end point, %§	54	59	33
Length of stay, d			
Critical care unit	3 (2, 4.5)	3 (2, 4.5)	2 (1, 4)
Stepdown/intermediate unit	4 (2, 6)	4 (2, 6)	2.5 (1, 4.5)
Overall	8 (6, 11)	7 (6, 10)	5 (4, 9)

Values are medians (25th, 75th percentiles).
*cTnT (+) indicates >0.1 ng/mL; cTnT (−), ≤0.1 ng/mL.
†Late refers to patients who became troponin T–positive at 8 or 16 hours.
‡Within 18 hours of enrollment.
§Death, late infarction, angioplasty, or coronary artery bypass surgery.

lected, prepared, and stored for later analysis by individuals blinded to treatment assignment, patient characteristics, and outcomes. cTnT was measured with the ES 300 automated analyzer (Boehringer Mannheim). The lower detection limit was 0.04 ng/mL and the reference range 0 to 0.1 ng/mL. Patients were classified as cTnT-positive if the cTnT value was >0.1 ng/mL. They were further classified as "baseline-positive" if the first sample was >0.1 ng/mL, "late-positive" if the samples were first positive at 8 or 16 hours, and "negative" if all values were ≤0.1 ng/mL.

Statistical Methods

We assessed the relations of baseline, serial, and peak cTnT measures with death, (re)infarction, congestive heart failure, shock, performance of angioplasty or bypass surgery, and a composite of death, (re)infarction, angioplasty, or bypass surgery. Continuous baseline characteristics and outcomes were described as medians with 25th and 75th percentiles; discrete variables were summarized as percentages. Kaplan-Meier estimates were used for overall 1-year mortality and that in 30-day survivors. Differences between groups were tested with the likelihood-ratio χ^2 test for 30-day mortality and the log-rank test for 1-year mortality.

Cox proportional-hazards modeling was used to identify baseline predictors of time to death during the first 30 days and during the first year (among 30-day survivors). The relation between each continuous variable and time to death was tested for linearity by restricted cubic-spline functions. After graphical assessment, appropriate transformations were applied for continuous variables that had a nonlinear relation with either outcome. A backward-elimination function was used to determine significant predictors (elimination criterion $P>0.05$). The predictive ability of each model was internally validated with bootstrapping techniques (100 bootstrap samples).

In these models, the predictive ability of the baseline, 8-hour, 16-hour, and peak cTnT measures was determined after adjustment for significant baseline predictors. Some baseline predictors were no longer significant after the various troponin levels were included. Because of the small number of events, these were dropped from the adjusted models. Baseline variables included in the 30-day mortality model were age, ECG stratum, and previous angina. Age, ECG stratum, chronic renal insufficiency, previous bypass surgery, and severe chronic obstructive pulmonary disease were included in the adjusted 1-year mortality modeling.

Time-dependent Cox models were created to determine the significance of each troponin level after adjustment for angioplasty and bypass surgery. Because of the small number of events, baseline predictors were not included in these models. Candidate predictors were tested by the likelihood-ratio χ^2 test.

Results

Of 734 patients studied, 260 (35.4%) had a positive cTnT result at baseline, 323 (44%) became positive by 8 or 16 hours, and 151 (20.6%) remained negative. Of the 675 patients who had results for all 3 intervals, only 8 first became positive at the 16-hour sample; 7 of the 20 patients with only baseline and 16-hour samples became positive at 16 hours. The baseline characteristics of the 734 patients analyzed did not differ from those of the 855 patients in the overall substudy. Baseline characteristics of patients within each cTnT group (baseline, 8-hour, or 16-hour positive or persistently negative) and of the 734-patient analysis population are shown in Table 1. Table 2 displays the relationships between baseline ECG characteristics and troponin T status at the different sampling times.

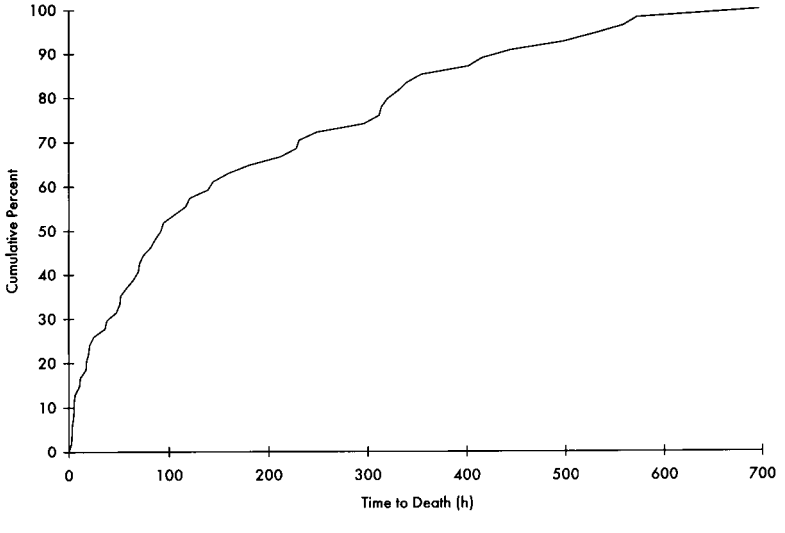

Figure 1. Cumulative distribution of time to death in GUSTO-IIa troponin T substudy.

TABLE 4. Short- and Long-Term Mortality by Baseline and Serial cTnT Results

	cTnT (+)*	cTnT (−)	*P*
Mortality by baseline sample result, %			
30 d	10.4 (27/259)	3.2 (15/474)	0.0001§
31 to 365 d‡	4.1	1.3	0.0230‖
1 y‡	14.1	4.5	<0.0001‖
Mortality by any sample result, %†			
30 d	7.2 (42/582)	0 (0/151)	<0.0001§
31 to 365 d‡	2.3	2.0	0.8345‖
1 y‡	9.4	2.0	0.0029‖

Values are percentages; (deaths/total patients) shown for 30 days.
*cTnT (+) indicates >0.1 ng/mL; cTnT (−), ≤0.1 ng/mL.
†Any sample refers to samples at any of the baseline, 8-hour, or 16-hour time points.
‡Kaplan-Meier estimates.
§*P* value based on likelihood ratio χ^2 test.
‖*P* value based on log-rank test.

For patients with baseline-positive cTnT, the 30-day mortality rate was 10%, versus 5% for late-positive and 0% for cTnT-negative patients (Table 3). Shock and congestive heart failure also occurred more often in baseline-positive patients than in late-positive or negative patients.

The median time to death in the 805 patients who had at least a baseline sample was 3.1 (0.8, 8.8) days (Figure 1). Of the 734 patients in the serial-sample cohort, 4 died within 24 hours. Mortality did not differ significantly from 31 to 365 days by cTnT status when the result of any sample was considered (Table 4). There was, however, a significant relation between the baseline result and mortality between 31 and 365 days. Kaplan-Meier survival analysis showed that most of the mortality difference between baseline cTnT-positive and -negative patients occurred early (Figures 2 and 3). The relation of cTnT level with both 30-day and 1-year mortality remained highly significant after adjustment for surgical or percutaneous intervention.

In an unadjusted model including only the 675 patients who had cTnT results at all 3 intervals, the baseline cTnT result provided strong individual ability to predict 30-day mortality (χ^2=15.04; P=0.0005), as did results at 8 (χ^2=15.27, P=0.0001) or 16 (χ^2=23.73, P<0.0001) hours. The addition of either later result to the baseline result contributed significantly to risk stratification (baseline+8-hour samples, χ^2=28.83, P<0.0001; baseline+16-hour samples, χ^2=36.41, P<0.0001). Little additional information was provided by including both late samples. The predictive value of the peak cTnT sample was intermediate to that of the 8- and 16-hour results but, like both, added significantly to the baseline value in the mortality model. These results were similar in the prediction of 1-year mortality. After adjustment for baseline characteristics, cTnT measures at any point remained significant prognostic indicators (Table 5). For both 30-day and 1-year mortality, the addition of a sample at 8 or 16 hours (but not both) added to the predictive ability of the models.

Tables 6 and 7 show the relative importance of cTnT results and clinical predictors of risk. At both 30 days and 1 year, age and ST-segment elevation were the strongest independent predictors of mortality. The baseline cTnT result added significantly in both models (hazard ratios, 1.51 and 1.44 for 30-day and 1-year mortality, respectively).

Discussion

This analysis of serial measures of cTnT in patients presenting with acute coronary syndromes suggests that the best strategy for both short- and long-term risk stratification is to obtain 2 samples within 24 hours after presentation. In addition, cardiac morbidity, like mortality, appears to be rare among patients who remain negative on serial testing. Thus, a strategy of cTnT sampling at baseline and at 8 hours may provide a powerful tool for early identification of patients at risk for short-term complications, who might benefit from early intervention. Conversely, the group with persistently negative results appears to be at very low risk, which might allow targeting of less intensive, cost-saving management.

Importance of Serial cTnT Testing

An initial serum marker measure may be negative in a patient with ultimately higher risk because of complex interactions

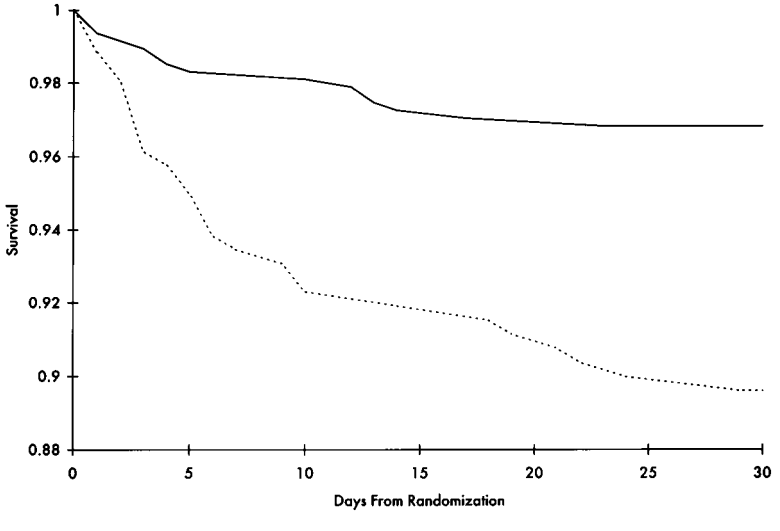

Figure 2. Kaplan-Meier estimates of survival during first 30 days for baseline cTnT-positive (dashed line) and -negative (solid line) patients.

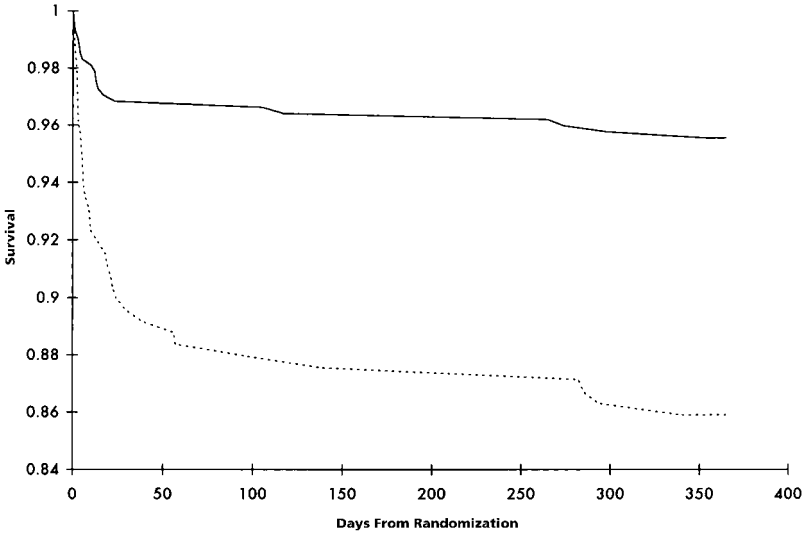

Figure 3. Kaplan-Meier estimates of survival during first year for baseline cTnT-positive (dashed line) and -negative (solid line) patients.

between the timing of the sample relative to symptom onset, the sensitivity of the assay, and the release and clearance kinetics of the marker. Therefore, a marker result may be negative initially in an otherwise high-risk patient. Of the 474 patients (65%) who were cTnT-negative at baseline, 68% later had a positive result, with the attendant increased risks of death and nonfatal complications relative to patients who remained negative.

Pattern of Sampling

The peak cTnT level within 24 hours of presentation can predict adverse events.[3–6] Furthermore, the FRagmin In unStable Coronary Artery Disease (FRISC) investigators showed how the peak cTnT level within 24 hours might be used to identify subgroups that could benefit from specific therapeutic interventions.[7] However, multiple sampling to determine the peak cTnT may be impractical. We showed that the cTnT value at presentation with symptoms of acute coronary ischemia is a strong, independent predictor of short-term mortality and serious cardiac events.[1] In the present study, even after adjustment for baseline characteristics, a positive cTnT result within the first 24 hours strongly predicted mortality.

The baseline cTnT result is critical for early risk stratification and decision-making. The fact that later samples are also powerful predictors of the risk for serious cardiac complications suggests that should a baseline sample be missed, a single later measure would be useful. When added to a model that already contained the baseline result, the 8- and 16-hour results each added similarly to the prognostic ability of the model, but more than 1 "late" sample provided no additional prognostic information. Because in-hospital morbidity drives hospital length of stay and costs and because morbidity correlates with mortality in its relation with cTnT status, it would be most useful to know the cTnT status of a patient as early as possible. Our results suggest that a strategy

TABLE 5. Ability of Various Troponin T Measures to Predict 30-Day and 1-Year Mortality*

	30-Day Model			1-Year Model		
Marker Variables	χ^2	*df*	*P*	χ^2	*df*	*P*
Baseline troponin T result alone	8.96	2	0.0113	10.00	2	0.0067
8-h troponin T result alone	6.51	1	0.0107	14.47	1	0.0001
16-h troponin T result alone	8.40	1	0.0038	16.94	1	<0.0001
Peak troponin T level	7.24	1	0.0071	15.24	1	0.0001
Baseline+8-h results	12.04	3	0.0072	20.05	3	0.0002
What 8-h result adds	3.08	1	0.0792	10.05	1	0.0015
Baseline+16-h results	13.52	3	0.0036	22.40	3	0.0001
What 16-h result adds	4.56	1	0.0382	12.40	1	0.0004
Baseline+8-h+16-h results	13.95	4	0.0075	22.42	4	0.0002
What 8-h result adds to baseline+16-h results	0.43	1	0.5144	0.02	1	0.8802
What 16-h result adds to baseline+8-h results	1.90	1	0.1679	2.37	1	0.1233
Baseline result+peak level	12.58	3	0.0056	20.71	3	0.0001
What peak level adds	3.62	1	0.0571	10.71	1	0.0011

*30-day model adjusted for differences in age, ST-segment elevation, and previous angina; 1-year model adjusted for differences in age, ST-segment elevation, previous bypass surgery, chronic renal insufficiency, and severe chronic obstructive pulmonary disease.

TABLE 6. Effects of Baseline Characteristics and cTnT on 30-Day Mortality

Characteristic	χ^2	*df*	*P*	Hazard Ratio (95% CI)
Age	39.39	1	<0.0001	2.86 (1.98, 4.14)*
ST-segment elevation	17.09	1	<0.0001	5.05 (2.08, 12.22)
Baseline cTnT	8.96	2	0.0113	1.51 (1.15, 1.98)†
Previous angina	8.20	1	0.0042	3.20 (1.23, 8.28)

*Hazard ratio is for an increase of 10 years.
†Hazard ratio is for an increase of 0.1 ng/mL.

TABLE 7. Effects of Baseline Characteristics and cTnT on 1-Year Mortality

Characteristic	χ^2	*df*	*P*	Hazard Ratio (95% CI)
Age	55.02	1	<0.0001	3.04 (2.19, 4.22)*
ST-segment elevation	15.24	1	0.0001	3.42 (1.77, 6.61)
Previous bypass	11.96	1	0.0005	3.80 (1.93, 7.48)
Baseline cTnT	10.00	2	0.0067	1.44 (1.15, 1.81)†
Chronic renal insufficiency	7.11	1	0.0077	4.73 (1.82, 12.29)
Severe COPD	5.64	1	0.0176	3.88 (1.49, 10.11)

COPD indicates chronic obstructive pulmonary disease.
*Hazard ratio is for an increase of 10 years.
†Hazard ratio is for an increase of 0.1 ng/mL.

of baseline sampling followed by 8-hour sampling would provide the greatest opportunity for early intervention in high-risk, positive patients; would enhance decision-making in persistently negative patients; and would miss relatively few patients.

These findings support a recent report that the combined baseline and 4-hour results of troponin I or troponin T testing at the bedside improved the sensitivity and negative predictive value of troponin testing in patients with acute chest pain.[8] Furthermore, the result for either marker after 2 tests in 4 hours was a strong, independent predictor of 30-day death or infarction.[8]

cTnT-Negative Patients

Remaining negative on serial cTnT testing also appears to be important; short-term mortality was 0% and nonfatal events were rare in the group that remained negative. Patients with T-wave inversion or normal baseline ECGs made up the largest proportion of the persistently negative group, but 26% of these patients had ST-segment elevation, and 25% were in the highest-risk ECG categories (confounding ECG factors or ST-segment depression). Thus, across all ECG groups, serial cTnT sampling provides early identification of patients at increased risk and those at ultimately lower risk, regardless of other presenting features.

Baseline demographic and clinical characteristics have been described that predict short- and long-term mortality for patients with acute coronary syndromes.[6,9–11] Baseline characteristics also might be used to guide initial triage decisions and in-hospital resource use.[12,13] Furthermore, we have described a group of patients without clinical complications 4 days after thrombolysis, who had very low risk for 30-day mortality or in-hospital complications.[14] Early discharge of these patients could confer reductions in length of stay of 4 days and in hospital costs of more than $6000.[15]

In the cTnT-negative group in the present study, the median hospital stay was 5 (4, 9) days, 2 days in the critical care unit. Because serial cTnT status within 24 hours is a strong predictor of later in-hospital events and short-term mortality, it may be advantageous to incorporate it with clinical risk stratification to improve early management and resource use and to facilitate early discharge decisions across all acute coronary syndromes.

In a predictive model that included significant baseline clinical characteristics, only age and the baseline ECG stratum were stronger predictors of 30-day mortality than the baseline cTnT level. Furthermore, the degree of elevation of the baseline cTnT was important in predicting risk (increased hazard ratio of 1.51 for each 0.1-ng/mL increase), which suggests that quantitative assessment of cTnT may be ideal for risk stratification.

Thus, in combination with clinical indicators of risk, cTnT may have utility in delineating low-risk patients, who may be candidates for more conservative management (including early discharge), from high-risk patients, who would be candidates for more intensive therapy and longer in-hospital observation. Further prospective study will be needed to confirm this potential.

Long-Term Risk Stratification in Acute Coronary Syndromes

The FRISC study group showed a significant relation between long-term (150-day) outcomes and the peak cTnT within 24 hours of presentation.[6] Stubbs and colleagues[16,17] noted a significant relation between cTnT status within 6 hours of presentation and outcomes at a median of 3 years in patients presenting with ST-segment-elevation infarction or unstable angina. Similarly, we found a significant relation between long-term mortality and cTnT measures at baseline or serially within 24 hours. Even after adjustment for baseline clinical predictors, cTnT remained a strong predictor of long-term mortality. Only increasing age, ECG stratum, and previous bypass surgery were stronger predictors of 1-year mortality.

None of the previous studies addressed early versus late risk stratification, however. When we assessed the contribution of early (within 30 days) versus late (between 31 and 365 days) mortality to 1-year mortality by troponin T status, we found that most of the risk stratification by cTnT measures was for events within 30 days (Figure 3). Although most of the mortality difference between baseline-positive and -negative patients occurred within 30 days, the baseline cTnT result also identified a group of patients with an increased risk of late mortality (4.1% for cTnT-positive patients versus 1.3% for cTnT-negative patients, $P=0.0230$).

Thus, the greatest potential of cTnT for risk stratification may be to link the baseline and serial cTnT results to early interventions, which could reduce short-term morbidity and mortality and, in the process, affect long-term outcome. The fact that there is a correlation between late mortality and the baseline cTnT result suggests that efforts directed at chronic treatment guided by troponin result also may be useful.

Limitations

The GUSTO-IIa patients used for this analysis were a relatively high-risk group with a high prevalence of coronary artery disease. Whether the results apply to the evaluation, diagnosis, and triage of patients with lower-risk clinical presentations is unclear. However, when we evaluated patients with normal ECGs or nonspecific ECG changes, the value of the baseline cTnT result was undiminished.[1] We would not expect this to differ for serial sampling, and Hamm's report on serial bedside troponin testing lends support for such a practice in a broad range of chest-pain patients.[9]

Conclusions

The utility of the baseline cTnT level for risk stratification of patients with acute coronary syndromes seems clear and has important implications for their initial level of care and strategies for management and treatment. On the basis of serial cTnT measures, patients with acute coronary ischemia can be categorized into those who never become positive (who have a very low risk of later serious cardiac events) and those who do become positive (who incur increased risk). The use of baseline and 8-hour cTnT sampling in combination with key clinical characteristics could provide the information needed for early risk stratification and management, which could improve outcome and reduce costs of care in this diverse group of patients.

Acknowledgments

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Value of Serial Troponin T Measures for Early and Late Risk Stratification in Patients With Acute Coronary Syndromes

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