Triage Disposition of Patients with Acute Myocardial Infarction – ACSIS 2000

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Abstract

Background: In the emergency department the physician is often confronted with the decision of where to hospitalize a patient presenting with chest pain and a possible acute myocardial infarction – in the cardiac care unit or in the internal medicine ward.

Objective: To characterize the clinical factors involved in the triage disposition of patients hospitalized with AMI in Israel to either CCUs or IMWs and to determine to what extent the perceived probability of ischemia influenced the disposition decision.

Methods: During a 2 month nationwide prospective survey in the 26 CCUs and 82 of the 94 IMWs in Israel, we reviewed the charts of 1,648 patients with a discharge diagnosis of AMI. The probability of ischemia at admission was determined retrospectively by the Acute Coronary Ischemia Time-Insensitive Predictive Instrument. Co-morbidity was coded using the Index of Coexistent Diseases.

Results: The ACI-TIPI score for patients admitted to CCUs or to IMWs was 76.2% and 57.7% respectively ($P < 0.001$). Multivariate analysis showed that young patients with a high probability of ischemia and low co-morbidity or functional impairment were more likely to be hospitalized in CCUs than in IMWs.

Conclusion: In Israel, the factors that strongly influence the initial triage disposition of AMI patients to CCUs or IMWs are age, perceived probability of ischemia, status of co-morbid conditions and functional impairment.

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Patients presenting with chest pain to emergency departments in Israel are assessed by ED physicians. Those admitted to hospital, including patients with acute myocardial infarction, are then admitted either to cardiac care units or to monitored beds in internal medicine wards. The care of patients in the CCUs is provided solely by cardiologists and in the IMWs by internists.

The initial triage decision potentially has profound implications on immediate treatment and long-term outcome. Although never statistically studied, it is common knowledge that in Israel patients in CCUs are more likely to undergo a greater number of diagnostic procedures including catheterization, and to be treated by thrombolytic therapy or primary percutaneous coronary interventions than are patients in IMWs.

To what extent are AMI patients in Israel admitted to CCUs and to IMWs? Which factors are taken into consideration when making that initial placement decision? We hypothesized that the primary probability of ischemia, based on the clinical presentation and the initial electrocardiograph, is the major determinant of that critical initial decision. Thus, patients with a high probability of ischemia would more likely be admitted to CCUs, and those with a low probability more likely to be admitted to IMWs. If this were the case, then triage based on the probability of ischemia would represent an attempt by the admitting physicians to optimize the use of limited resources. We used the data of the prospective national survey of management and clinical outcome of acute myocardial infarction in Israel (ACSIS 2000) to examine these hypotheses [1].

Methods

The Israel Cardiology Association and the Israel Society of Internal Medicine collaborated in the Sixth Biennial Survey during February and March 2000 [1]. This was a prospective observational survey of all patients with a final diagnosis of AMI hospitalized in 82 of 94 IMWs and in all 26 CCUs in Israel. It was the first study to include patients admitted to IMWs; previous surveys studied only those admitted to CCUs. Each institution's committee on human research approved the study.

The investigators, who underwent a process of standardization, visited the wards regularly during the study period and identified patients with AMI. Clinical data were obtained from the medical charts and recorded in the survey questionnaires and then forwarded to a central coordination center. The diagnosis of AMI based on the usual clinical, ECG and enzymatic criteria was made by the medical staff of each department. Only patients with a definite diagnosis of AMI as reported in the discharge medical summary were included in the final analysis. Patients who survived hospitalization were followed for 30 days post-AMI. The Israeli National Population Registry was used to complete the mortality data. The coordination center completed data collection and assessed quality control.

In order to evaluate the case mix of patients, an analysis tool was introduced – the Index of Coexistent Diseases [2]. The ICED is a compilation of two sub-indices: the Index of Disease Severity, which

AMI = acute myocardial infarction
CCU = cardiac care unit
IMW = internal medicine ward
ACI-TIPI = Acute Coronary Ischemia Time-Insensitive Predictive Instrument
ED = emergency department
ICED = Index of Coexistent Diseases

grades 13 coexistent medical conditions (organic heart disease, ischemic heart disease, primary arrhythmia and conduction problems, congestive heart failure, hypertension, cerebral vascular accident, peripheral vascular disease, diabetes mellitus, respiratory problems, malignancies, hepatobiliary disease, renal disease, and gastrointestinal disease); and the Functional Severity Index, which grades 10 items that assess the impact of all conditions, diagnosed or not, on the patient's functional status (circulatory, respiratory, neurologic, mental, urinary and fecal continence, feeding, vision, hearing, and speech). The unique advantage of the ICED is that it takes into account the severity of the most debilitating coexisting diseases and the most serious functional defect of the patient. This tool has been used in AMI patients hospitalized in three medical centers in the United States [3].

The Acute Coronary Ischemia Time-Insensitive Predictive Instrument was used retrospectively to determine the probability of ischemia [4]. This tool, developed to prospectively or retrospectively evaluate the appropriateness of admission to CCUs [5], showed excellent diagnostic performance in the validation study [4] and in other settings [6,7]. It utilizes seven clinical features that are reliably ascertainable in the ED setting. These are patient history and ECG Q wave, ST segment, and T wave changes. The ACI-TIPI expresses a patient's probability of having acute ischemia as a score between 0 and 100%. Though the ACI-TIPI index is a continuous scale it can be used to stratify patients into discrete groups by probability of ischemia: high probability (score above 55%), two intermediate probabilities (27–55% and 11–26%), and low probability (0–10%) [4].

We present here the probability of ischemia score at admission in all patients who were eventually discharged with a diagnosis of AMI. The ED physician while formulating his or her triage disposition decision did not use the ACI-TIPI score. We use this tool retrospectively to evaluate the ED physician's decision.

Data analysis

Multivariate stepwise logistic regression was used to estimate the odds ratios of referral to CCUs or IMWs. These odds ratios are adjusted for covariates associated with this triage and were calculated by taking the exponent of the coefficient estimated through the maximum likelihood method in the logistic regression procedure in SPSS.

Results

Overall, we identified 1,648 patients with a discharge diagnosis of AMI. Of them, 1,088 had been admitted directly to CCUs (66%) and the remaining 560 were initially admitted to IMWs. Table 1 shows the differences between the populations hospitalized in CCUs and in IMWs. Men were admitted to CCUs more frequently than women, 79% versus 62%. Women with AMI were on average a decade older than men with AMI.

Relevant data to enable assessment of the ACI-TIPI probability of ischemia was found in 1,230 of the 1,648 patients included in the survey (74.6%). The 418 patients with incomplete data did not differ significantly from the rest of the patients regarding age, gender and clinical presentation. The average ACI-TIPI score for the 1,230 patients was 70.1%. Approximately 76% of the patients had a score above 55%, indicating a high probability for ischemia, and 92% of the patients had a probability score of above 25% [Table 2]. Eight percent of these AMI patients had a less than intermediate probability of ischemia (score below 25%) at presentation. Table 1 shows that the decision to admit patients to CCUs or IMWs correlated with the degree of probability of ischemia. Patients

Table 1. Comparison of demographic and coexisting diseases in patients admitted to CCUs or IMWs

			Internal Medicine Ward			
Variable	**All**	**CCUs**	**IMW only**	**IMW-CCUs**	**IMW overall**	***P* value**
Patients (N)	1,648	1,088	342	218	560	
Age: All patients	66 ± 14	62 ± 13	75 ± 13	69 ± 12	73 ± 13	< 0.01
Male	63 ± 14	60 ± 13	72 ± 13	67 ± 13	70 ± 13	
Female	73 ± 12	70 ± 13	79 ± 11	74 ± 10	77 ± 11	
Male (%)	73	79	61	64	62	< 0.01
History and IHD risk factors						
Previous MI	27	23	37	34	36	< 0.01
Angina syndrome	33	27	44	48	45	< 0.01
S/P CABG	5	4	7	7	7	0.063
Heart failure	10	5	24	14	20	< 0.01
PVD	10	8	15	17	15	< 0.01
Stroke	10	6	18	12	16	< 0.01
Diabetes	32	29	35	38	36	0.060
Hypertension	47	40	59	62	60	< 0.01
Hyperlipidemia	46	46	44	52	47	0.421
Family history	20	22	17	15	16	0.017
Current smoker	35	41	20	29	24	< 0.01
Coexisting morbidity						
Renal failure	9	7	16	12	14	< 0.01
COPD	9	7	14	10	13	0.002
Killip class						
Stage I	75	82	59	67	62	< 0.01
Stage II	14	10	24	20	23	
Stage III	7	5	15	9	12	
Stage IV	3	32.3	3	4	3	
ICED						
Normal	29	36	15	28	20	< 0.01
Mild	10	13	6	6	6	
Moderate	34	30	42	32	38	
Severe	28	21	38	34	36	
ACI-TIPI prob (%)	70 ± 25	76 ± 22	54 ± 26	64 ± 23	58 ± 25	< 0.01

IHD = ischemic heart disease, CABG = coronary artery bypass graft, PVD = peripheral valve disease.
IMW-CCU = patients admitted to IMWs and later transferred to CCUs.

Table 2. Comparison of demographics and AMI characteristics according to the ACI-TIPI probability

	ACI-TIPI probability, % range (category)				
Variable	**0–10 (low)**	**11–25 (interme-diate-low)**	**26–55 (interme-diate-high)**	**56–100 (high)**	***P* value**
No. (%)	23 (1.9)	70 (5.7)	203 (16.5)	934 (75.9)	
Male (%)	56.5	55.7	63.1	78.1	<0.001
Age group					<0.001
<56	8.7	18.8	28.9	29.7	
56–75	34.8	33.4	35.0	47.4	
>75	56.5	47.8	36.1	22.9	
AMI type					<0.001
Q wave	30.4	35.7	43.3	67.9	
Non-Q wave	69.6	64.3	56.7	32.1	
Location					<0.001
Anterior	19.0	36.8	39.5	44.0	
Inferior	23.8	30.9	34.4	42.1	
Lateral	9.5	13.2	9.2	9.4	
Posterior	4.8	–	1.0	1.5	
Undetermined	42.9	19.1	15.9	3.0	
Killip class					<0.001
1–2	77.0	68.6	87.7	94.5	
3–4	23.0	31.4	12.3	5.7	
ICED score					0.001
Normal-mild	23.5	20.0	29.5	44.6	
Moderate-severe	76.5	80.0	70.5	55.4	
Admission symptoms					<0.001
Typical pain	–	12.9	54.2	89.5	
Atypical pain	–	5.7	14.3	6.3	
Triage					<0.001
IMWs	73.9	65.7	49.3	25.7	
CCUs	26.1	34.3	50.7	74.3	
Thrombolysis	4.3	1.4	7.9	38.5	<0.001
Primary percutaneous coronary intervention	–	2.9	3.6	9.3	0.008
30 day mortality	21.7	15.7	12.8	8.0	0.007

Table 3. Multivariate analysis of the triage decision to admit to CCUs or IMWs

Model 1: All patients

	Odds ratio of admission to CCU instead of IMW	**95% Confidence interval**
Age (each year)	0.95	0.94, 0.96
TIPI prob. (% point)	1.03	1.02, 1.04
ICED score	0.79	0.68, 0.92

Variables included in the model: gender and Killip class.

Model 2: Female patients

	Odds ratio of admission to CCU instead of IMW	**95% Confidence interval**
Age (each year)	0.95	0.93, 0.97
ST elevation	9.35	5.72, 15.26
Stroke	0.21	0.10, 0.43

Variables included in the model: Killip class, old AMI, past CABG, CHF, chronic obstructive pulmonary disease, renal failure, hypertension and diabetes.

Model 3: Male patients

	Odds ratio of admission to CCU instead of IMW	**95% Confidence interval**
Age (each yr.)	0.95	0.94, 0.97
ST elevation	8.85	6.52, 12.07
CHF	0.58	0.35, 0.98

Variables included in the model: Killip class, old AMI, past CABG, stroke, chronic obstructive pulmonary disease, renal failure, hypertension and diabetes.

admitted directly to CCUs had a higher ACI-TIPI score than those admitted to IMWs, and patients who were transferred from IMWs to CCUs had a higher ACI-TIPI score than those who remained in IMWs during the entire course of their hospital stay.

Gender, age, and type of infarction are factors that define ACI-TIPI and, as expected, they determine the probability of ischemia [Table 2]. The average ACI-TIPI score for males was 72% vs. 64% for females ($P < 0.001$). Age was inversely related to the probability of ischemia as determined by the ACI-TIPI score. As expected, patients with typical chest pain had a higher ACI-TIPI score than those with atypical chest pain or those with no chest pain at all. Patients with Q wave AMI had a higher ACI-TIPI score than patients with non-Q wave AMI. A similar relationship existed between patients with an AMI with ST elevation (high probability) compared with those without ST elevation (low probability). An inverse relationship was seen between Killip class at admission and ACI-TIPI probability groups. Similarly, there was an inverse relationship between co-morbidity/degree of functional impairment (ICED) and the probability of ischemia on admission (ACI-TIPI) [Table 2].

Multivariate analyses of the factors influencing admission in CCUs are presented in Table 3. In the first model, three independent factors account for admission to CCUs. These are young age (an increase of 1 year decreases the probability of admission to the CCUs by approximately 5%), the ACI-TIPI score (every percent increases the chance by 3%), and the ICED score (increase in one point decreases the chance by approximately 20%). Gender and Killip class did not contribute independently to this model.

When the ST elevation on the admission ECG and the individual co-morbid conditions were included, a strong interaction between gender and co-morbid conditions became apparent. Therefore, the models for females (model 2) and males (model 3) were separated. These two models are similar in the effect of increasing age (decreasing probability) and ST elevation (increasing probability) on the admission to CCUs. The independent co-morbid conditions in these models differed by gender, including stroke for females and congestive heart failure for males – both reducing the chance of admission to CCUs. The two models by gender did not account for functional status, which is part of the ICED score in model 1.

This retrospective analysis using criteria available at admission to determine the ACI-TIPI score identified subgroups of patients with different prognoses. Patients with a low probability for ischemia had a higher 30 day mortality rate than those with a high probability for ischemia [Table 2]. Patients with a high probability of ischemia were admitted to CCUs and subsequently received intensive monitoring and treatment. On the other hand, the group of patients with a less than high probability of ischemia was older and had more severe co-morbid conditions, and was less likely to be admitted to CCUs. These patients received less thrombolytic and invasive treatment compared with those with a high probability for ischemia at admission.

Discussion

The limited accessibility of intensive care beds makes the ED physician's triage disposition decision on patients with acute coronary syndrome very difficult. The physician needs to assess the clinical severity, cardiac history, coexisting illness, the patient's level of function and compatibility for critical care. All these factors must be considered in the context of the logistics and constraints of bed availability. This study shows that the initial probability for ischemia is a major, though not the sole factor in that placement decision. The other two considerations are the patient's age and the severity of the accompanying illnesses or the functional impairments.

In a previous retrospective study in Israel, patients with acute ischemia were found to have an average ACI-TIPI score of 58% while patients without ischemia had a score of 26% [7]. In the same study the average ACI-TIPI for patients with AMI was 72%, similar to our present findings. In the current study we did not attempt to revalidate the ACI-TIPI but rather to use the ACI-TPI retrospectively to determine the probability of risk of ischemia at admission based on the clinical and ECG data. As expected, the average ACI-TIPI score for the whole group of AMI patients was high, 70%, and a score of more than 55% was found in three-quarters of these patients. On average, patients admitted to the CCU had a higher probability of ischemia than those admitted initially to IMWs [Table 2].

As for our initial hypothesis, the multivariate analysis confirms that the probability of ischemia as perceived by the ED physician based on clinical and ECG data was indeed an important and independent factor in the placement decision. It also indicates that young patients with fewer co-morbid conditions and a better functional status were more likely to be admitted to the CCUs. Whether the current triage pattern represents the ED physicians' view on the best use of the resources, or that some other, unaccounted factors may have influenced the triage decision cannot be determined from the current study.

Women, being older, with more severe co-morbid conditions and/or functional impairment, and with a lower probability of ischemia at presentation, tended to be admitted less to the CCUs than men. Was there gender discrimination? The first multivariate model suggests this was not the case. In this model, age, the co-morbidity/functional status and the probability of ischemia, but not gender, were the factors driving the triage decision. Interestingly enough, if we include in the multivariate analysis the ST elevation status instead of the ACI-TIPI score and the individual co-morbidities, leaving out the functional status, the models do differ by gender. One cannot dismiss the possibility that the differences in co-morbidity between the sexes were due solely to random chance. We assume that these differences in the results of the models emphasize the role of functional status in these patients, with a decade difference in average age separating the genders (70 years of age for women and 60 for men). Other investigators have also shown that functional status per se is an important determinant of outcomes of hospitalizations in elderly patients [8].

An interesting finding in this study was the inverse relationship between 30 day mortality and ACI-TIPI score [Table 2]. It is not possible to determine from the current study whether the more prevalent co-morbid conditions and lower functional status or the lower level of care in IMWs was the major determinant of the poor outcome.

A limitation of this observational study was the fact that in this national multicenter survey the diagnosis of AMI was based on usual clinical, ECG and enzymatic criteria and made by the medical staff of each department. Though only patients with a definite diagnosis of AMI as reported in the discharge medical summary were included in the final analysis, no attempt was made to standardize either the diagnosis or the treatment of AMI. Another factor that could limit the validity of the results is that although not different from the group as a whole in other aspects, for 418 patients (25% of the cohort) with a discharge diagnosis the ACI-TIPI score could not be determined due to lack of relevant data.

It should be noted that at the time the study was conducted, the routine use of the newer biomarkers of ischemia, such as troponins, in the diagnosis of acute coronary syndrome was still rare in Israel. It is possible that when these biomarkers do become widely available, the addition of biochemical information such as troponin levels might further improve triage decisions in the emergency room [6,9].

We conclude that when physicians in the emergency room treat patients who are subsequently diagnosed with AMI, their decision as to where to admit these patients is based implicitly on the perceived probability of ischemia according to clinical and ECG data, despite the fact that they do not routinely use a formal tool to estimate this probability. Co-morbid conditions and functional status also seemed to be important factors in the ED physicians' triage decision.

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