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Physicians' Perceptions of the Thrombolysis in Myocardial Infarction (TIMI) Risk Score in Older Adults with Acute Myocardial Infarction

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Abstract

Objectives—To evaluate physician-perceived strengths and limitations of the Thrombolysis In Myocardial Infarction (TIMI) risk scores for use in older adults with acute myocardial infarction (AMI).

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DISCLOSURES

Conflict of interest: None

Background—The TIMI risk scores are risk stratification models developed to estimate mortality risk for patients hospitalized for AMI. However, these models were developed and validated in cohorts underrepresenting older adults (> 75 years).

Methods—Qualitative study using semi-structured telephone interviews and the constant comparative method for analysis.

Results—Twenty-two physicians completed interviews ranging 10–30 minutes (mean = 18 minutes). Median sample age was 37 years, with a median of 11.5 years of clinical experience. TIMI strengths included familiarity, ease of use, and validation. Limitations included a lack of risk factors relevant to older adults and model scope and influence.

Conclusions—Physicians report that the TIMI models, while widely used in clinical practice, have limitations when applied to older adults. New risk models are needed to guide AMI treatment in this population.

Keywords

myocardial infarction; aging; risk factors; older adult; risk stratification model

INTRODUCTION¹

Approximately 30% of adults hospitalized for acute myocardial infarction (AMI) are 75 years of age or older.^{1–3} With changing demographics worldwide, the number of adults in this age group who experience an AMI is expected to grow.^{1, 4} Their high burden of comorbid conditions – including physical and cognitive impairments – and lower physiologic reserve render this group more complex than younger AMI patients. This complexity can complicate AMI clinical care for older adults both acutely, during hospitalization, and in the long-term after hospital discharge.

The use of risk stratification models is endorsed by the American College of Cardiology (ACC) and the American Heart Association (AHA) to assist clinicians' decision-making in AMI care.^{4–5} Based on risk stratification models, patients judged to be at higher risk might receive more intensive treatment or closer surveillance compared with those at lower risk. Risk models are an important part of AMI care because clinicians may underestimate the risk of adverse clinical outcomes when relying on implicit risk assessments alone, particularly in older adults.^{6–8}

The Thrombolysis in Myocardial Infarction (TIMI) risk scores are commonly used risk stratification models developed to estimate short-term risk and guide decisions regarding revascularization for patients with AMI.^{9–11} The TIMI risk score for patients with ST-elevation myocardial infarction (STEMI) was developed in a cohort of patients eligible for fibrinolytic therapy as part of the Intravenous nPA for Treatment of Infarcting Myocardium Early (InTIME) II trial. The model was designed to estimate 30-day mortality risk and was

¹AMI – acute myocardial infarction, ACC – American College of Cardiology, AHA – American Heart Association, TIMI – Thrombolysis in Myocardial Infarction, STEMI – ST-elevation myocardial infarction, InTIME – Intravenous nPA for Treatment of Infarcting Myocardium Early, NSTEMI – Non-ST elevation myocardial infarction, UA – unstable angina, CAD – coronary artery disease, ACS – acute coronary syndrome

validated as part of the TIMI 9A and 9B trials.^{10, 12} An additional version of the model was developed and validated to predict the composite of all-cause mortality, new or recurrent myocardial infarction, or recurrent ischemia requiring urgent revascularization in non-STEMI (NSTEMI) and unstable angina (UA) populations through 14 days.⁹

The TIMI risk scores assign weighted integers based on risk factors assessed at the time of hospital admission. The risk factors in the STEMI model include: age 65 through 74 or 75 years or older; a previous history of angina, diabetes, or hypertension; admission systolic blood pressure less than 100 mmHg; admission heart rate great than 100 beats per minute; admission Killip Heart Failure class II through IV; admission weight less than 67 kg; anterior infarction or left bundle branch block; and time to reperfusion therapy greater than 4 hours among patients who receive reperfusion therapy.¹⁰ The model for UA/NSTEMI has seven risk factors including: age 65 years or older; at least three coronary artery disease (CAD) risk factors; known CAD defined as prior coronary stenosis of at least 50%; aspirin use within the past seven days; at least two anginal episodes within the past 24 hours; ST-segment changes of a least 0.5mm on electrocardiogram at time of initial presentation; and elevation of serum cardiac markers.⁹

Since development, the TIMI risk scores continue to be widely used in AMI care. However, both the STEMI and UA/NSTEMI TIMI risk scores were developed and validated from clinical trials which underrepresented adults over the age of 75 compared to community-based estimates.^{13–16} The lack of older adults within the development and validation cohorts of these models may limit their ability to accurately stratify risk and predict outcomes when applied to older populations. For example, previous studies have found that when applied to older adults with AMI, the STEMI TIMI model has reduced 30- day mortality discrimination¹⁷ and calibration.¹⁸ Despite these potential limitations, little is known about the perceived value or current use of the TIMI risk scores in determining risk among older adults with AMI.

Given the anticipated growth in the number of older adults with AMI, there is a critical need to better understand clinicians' experiences with applying risk stratification models, such as the TIMI risk scores, to this population. Therefore, the purpose of this study was to qualitatively describe physicians' perceptions about the role, strengths, and limitations of the TIMI risk scores in the medical care of older adults hospitalized for AMI.

METHODS

Study Design

We conducted this study as part of an ongoing, multi-center, observational study designed to develop and validate risk stratification models for adults 75 years of age or older with AMI. The purpose of this qualitative study was to describe physician practices and preferences related to the use of existing risk stratification models in older adults with AMI. While respondents discussed several other models used in AMI risk stratification, here we report data on the TIMI risk scores. The Institutional Review Board at Yale University exempted this study.

Sample

Our sample included hospitalist or cardiology physicians. We chose this sample as this population frequently cares for older adults hospitalized with AMI throughout a hospital admission. Study inclusion criteria required that hospitalist or cardiology physicians have self-reported experience caring for older adults with AMI, however we did not specify an explicit number of years of experience. We utilized a snowball technique to identify potential physician respondents. We emailed study site investigators who were participating in the multi-center study and non-study associates and asked for referrals of hospitalist or cardiology physicians with experience caring for older adults with AMI. All contacts were sent a mass email seeking a response from those with experience caring for older adults with AMI and interest in completing a research telephone interview. All cardiology or hospitalist physician respondents who replied to the mass email were invited to participate in the study. Prior knowledge of the TIMI risk scores or other risk stratification models was not required, nor included as exclusion criteria for study participation. Participants were encouraged to refer other physicians with experience caring for older adults with AMI to the study and who might provide insights based on clinical experience. We continued to recruit potential participants until theoretical data saturation was reached, determining the final sample size.

Interview Procedures

Two registered nurses (S.L.F., K.W.) with experience in qualitative interviewing conducted all telephone interviews. Interviews were semi-structured, with general probes based on respondents' responses. Examples of interview questions and probes are included in Table 1. Interview questions were purposively broad in nature without requiring the respondent to specify a particular TIMI model. Interview topics included the general use of risk stratification models such as the TIMI in clinical practice, perceptions of model utility, and perceived strengths and limitations of risk models including the TIMI, when applied to older adults. A professional medical transcription service audio-recorded and transcribed verbatim all telephone interviews.

Data Analysis

We used ATLAS.ti 7 qualitative software (Scientific Software, Berlin, Germany) to facilitate data coding and analysis. Data analysis was inductive, employing the constant comparative method, in which we compared coded units to each other within and across coding categories over successive interviews.¹⁹ Two investigators (S.L.F.; D.S-G) trained in qualitative methods performed independent followed by joint line-by-line review of the transcripts. We identified main coding categories and updated the code list as new codes and categories emerged from the data, keeping memos to document this process. We discussed and resolved any coding discrepancies and continued interviewing, coding, and analysis iteratively until no new concepts emerged and we reached theoretical data saturation.

We then reapplied the final code list to all transcripts. We created and analyzed data reports for individual codes and code categories and extracted frequently occurring, principal themes from the data. We collectively examined the final themes and summarized the results. We supported data collection and analysis rigor with written interview instructions,

interview question guides, and coding procedures. Members of the research team met weekly to review the interview and coding process. All interview and coding issues were resolved via group consensus. We facilitated data collection and analysis trustworthiness with data triangulation, by routinely vetting findings with experts in geriatrics and cardiology, as well as study interviewees.

RESULTS

Sample

We summarize sample demographics in Table 2. Twenty-two physicians completed interviews, which ranged in length from 10 to 30 minutes with an average length of 18 minutes. The sample was 68% male, with a median age of 37 years. The sample had a median of 11.5 years of clinical experience after medical school, and 50% reported working more than 40 hours a week in direct patient care. About three-quarters of respondents were cardiologists and one-quarter were hospitalist physicians. Of the sample, 46% worked at health care institutions from the northeast region of the United States. The sample represented 14 different health care institutions (not depicted in the table).

Strengths of the TIMI Risk Scores

Respondents identified several strengths of the TIMI risk scores. These included the models' widespread familiarity among medical professionals, ease of use, and the models' validation and evidence base in initial AMI care (Table 3). Each of these strengths is described below.

Ubiquitous presence among medical professionals—Respondents regarded the TIMI risk scores as ubiquitous, i.e. part of standard curricula taught during medical education and a frequently used model in acute care settings. These models were perceived as commonly recognized and often used among clinicians to stratify risk. Many respondents reported first learning about the TIMI risk scores while in medical school, which often led to a preference for their use that continued into clinical practice. Respondents viewed the TIMI risk scores' meaning and clinical implications as commonly understood across provider types, specialties and patient care settings. This shared understanding among clinicians made the TIMI risk scores useful communication tools due to their capability to portray and categorize patients' risk in a standardized way.

Ease of use—The TIMI risk scores were reported as easy to use. Respondents' appreciated that both scores utilized very few data points, with most required information readily accessible in patients' medical records. Respondents highly valued the rapid completion time of the TIMI risk scores, which was generally reported as less than a minute. Respondents liked that the TIMI risk scores calculators were available through a multitude of electronic platforms including Internet browsers or as applications on handheld electronic devices such as smartphones or tablets.

Development and validation—Respondents perceived the TIMI risk scores as tools supported by a large evidence base of development and validation studies. In addition, respondents viewed the TIMI risk scores as original tools of the risk stratification arsenal in

AMI, remaining fairly relevant and helpful in determining risk in initial AMI care. These qualities contributed to respondents' confidence in the TIMI risk scores' capability to assess risk.

Limitations of the TIMI Risk Score

Respondents also identified significant limitations of the TIMI risk scores. These included the models' lack of risk factors relevant to older adults and the models' limited scope and influence (Table 3).

Lack of risk factors relevant to older adults—Respondents felt that the TIMI risk scores lacked risk factors viewed as important for calculating risk of short-term adverse events in older adults with AMI. Respondents believed the TIMI scores lacked specific risk factors in part because of the TIMI scores' development and validation cohorts. Respondents viewed these cohorts as inclusive of few older adults. Examples of risk factors perceived as important but absent in the TIMI risk scores included comorbid diseases, aging related impairments (e.g. frailty, functional limitations), and social support.

Physician respondents cited several examples of comorbid disease that they felt increased risk of adverse events in older adults with AMI. These included comorbidities such as hypertension, diabetes mellitus, cognitive dysfunction, chronic obstructive pulmonary disease and congestive heart failure present either prior to the index hospitalization or developed as a result of the AMI. While these comorbidities are not unique to older populations, physicians viewed these comorbidities as complicating decision making regarding revascularization and other medical management decisions in older adults. Furthermore, respondents felt that the TIMI risk scores failed to account for the overall complexity of the older adult with AMI, which was often viewed as stemming from multiple comorbid conditions.

Aging-related impairments absent from the TIMI risk scores, such as frailty and functional limitations, were viewed by respondents as key risk indicators of mortality and other adverse events in older adults with AMI. Frailty was often cited as a significant risk factor in decision-making regarding the immediate treatment of an older adult presenting with AMI, including decisions regarding cardiac revascularization. Physicians often assessed patient frailty through implicit means. For example, physicians noted a perceived lack of standardized methods of defining and measuring patient frailty and thus reported relying on implicit assessments of frailty in judging risk. Functional limitations, also cited by physicians as aging-related impairments, included the ability to perform daily activities, stair climbing, gait speed, and level of independence prior to admission.

Inadequate social support was also a reported risk factor in older adults with AMI, though absent in the TIMI risk scores. Respondents cited several types of support, including support from family and other caregivers, and residential support (e.g. independent/assisted living). These support systems were seen as encouraging patients' adherence to follow-up appointments, medications, health regimens, and enhancing medical literacy about AMI and post-AMI care.

Limited model scope and influence—Respondents recognized that the original purpose of the TIMI risk scores was to stratify risk for short-term mortality in hospitalized AMI patients. However, respondents viewed this scope as narrow and desired a model that moved beyond initial AMI care. Others felt that the goal of medical management in AMI had moved beyond short-term mortality, and thus short-term mortality was no longer the primary driver influencing medical management.

DISCUSSION

Respondents' perceptions of the TIMI risk scores for AMI risk stratification were mixed. The TIMI risk scores were perceived as well-known amongst a variety of clinicians, well-developed and validated for many AMI populations, accessible and convenient to complete. However, respondents believed these models lacked risk factors important for clinical decision-making in older adults with AMI, including non-traditional cardiovascular risk factors such as frailty and measures of functional status. Respondents also thought that the TIMI risk scores' scope was narrow, and that in clinical practice decisions regarding revascularization for older adults were not only based on estimates of short-term mortality or other short-term cardiovascular events.

To our knowledge, this is the first study to describe clinicians' perceptions of risk stratification models, such as the TIMI risk scores, for use in older adults with AMI. Previous research has evaluated the TIMI STEMI model's performance in older adults with AMI, uncovering limitations in the model's discrimination¹⁷ and calibration¹⁸ when applied to this population. Risk stratification models may inadequately assign risk or assign risk with varying accuracy amongst models for specific demographic groups such as older adults and women.^{16,20} This may be in part because many models were developed and validated in clinical trials which underrepresent these populations compared to community estimates.^{15, 16} Physicians in our study cited limitations of the TIMI risk scores, which they perceived to stem in part from the models' derivation (e.g. STEMI median age = 62, NSTEMI/UA median age = 66) and validation cohorts.^{9–11,21} However, our study extends this research by suggesting that the lack of geriatric-specific risk factors in the TIMI risk scores also influence physicians' views of model utility in this population.

Our findings have important implications for AMI risk model adoption and use by a variety of clinicians, including nurse practitioners, physician associates and registered nurses, who are at the front lines of providing AMI clinical care. While use of AMI models are recommended by national guidelines,^{4,5} clinicians' views and experiences using existing risk models likely influence the extent to which they rely on the models in therapeutic decisions. This is supported by our finding that physicians often reported using TIMI as an adjunct to implicit clinical assessment, in part because of perceived limitations of the scores when applied to older adults.

Respondents viewed the TIMI risk scores' exclusion of geriatric-specific risk factors, other than age, as a limitation. While age is a powerful predictor of risk in older adults with AMI, there is much heterogeneity among older adults that chronological age may not accurately capture. This heterogeneity underscores the need for risk stratification models that include

not just chronologic age, but also likely geriatric-specific risk factors such as markers of physiologic “age.” Physiological age may be better characterized by risk factors such as frailty and functional status.^{22,23} For example, frailty is associated with increased morbidity and mortality in acute coronary syndrome (ACS), yet frail patients are less likely to receive aggressive treatment than their less-at-risk counterparts.²⁴ Thus while there is an emerging interest in geriatric risk factors and their prognostic relevance in the cardiovascular literature, these risk factors have not yet been incorporated into available AMI risk stratification tools.^{25,26}

While it may be argued that geriatric assessments may be impractical in inpatient settings, a growing body of research has underscored the importance of these assessments in risk stratification, and has shown the ability to perform these assessments during hospitalization.^{24, 25, 27–29} The practicality of including geriatric assessments may also differ between STEMI and UA/NSTEMI populations given the variety in acuity of these AMI subtypes as well as the wide clinical spectrum of the UA/NSTEMI diagnosis that lends itself more to risk stratification. Therefore these studies and review papers highlight the importance of ongoing research into the significance of these risk factors and the practicality of their measurement in inpatient settings for older adults with AMI.

There are limitations to this study. First, although a small sample size is appropriate for qualitative research when data saturation is reached,¹⁹ our results are not representative of all clinicians, practice settings, or institutional cultures. For example, our study sample did not include non-physician clinicians such as nurse practitioners, physician associates, or registered nurses, or other physician specialties such as geriatricians. These providers may contribute from their perspectives unique insights into the use of risk stratification models for older adults with AMI. In addition, chest pain units, emergency departments, and other inpatient settings, are often largely staffed by non-physician providers, suggesting that additional research evaluating perceptions in this population is warranted. Second, most respondents were younger and likely less experienced, reporting a median of 11.5 years of clinical experience after medical school. While we found that participants viewed the TIMI risk scores as widely familiar and commonly used, this finding may represent the frequency with which the TIMI risk scores are integrated into current medical education. Another potential limitation is the grouping of both TIMI risk scores together (in participants’ responses) without differentiation between the STEMI and UA/NSTEMI models. The application of risk stratification tools for STEMI and UA/NSTEMI could likely differ given the sharp contrast in acuity and the heterogeneousness of the latter diagnosis. However, both of these models were developed to predict short-term cardiovascular outcomes and neither included the more geriatric-specific risk factors identified as important in risk stratification by our respondents. This suggests that concerns raised by the respondents regarding the TIMI risk scores should indeed apply to both models.

An important final consideration is that although respondents reported limitations of the TIMI risk scores, these limitations reflect changing demographics of the AMI population, as well as evolutions in the practice of risk stratification in older adults with AMI. The TIMI risk stratification models were primarily developed to determine short-term cardiovascular outcomes to guide decisions about revascularization. Thus, criticisms of the TIMI risk

scores should be placed within the framework of the models' original intent. While our respondents perceived the models to have limitations when applied to older adults, this does not suggest that these models are inappropriate for application in this population within the context of the TIMI risk scores' original purpose. Rather these perceptions offer opportunity for future risk model and risk stratification research and development.

The results of our study have several implications for future research. Physicians', as well as other clinicians' perceptions of the limitations of existing risk stratification models may drive their dependence on implicit risk assessments in older adults with AMI. Research is needed to evaluate these relationships. Future research should evaluate a wider spectrum of clinicians' perceptions of risk model use and risk stratification in older adults with AMI. Additional research is also needed to evaluate the prognostic importance of non-traditional risk factors such as frailty, functional and cognitive impairments, as well as social support and the relationship between these "gero-centric" risk factors and AMI outcomes.

Results from this study will inform our ongoing quantitative research focused on developing risk stratification models specifically for use in older adults with AMI. In order to maximize uptake, new risk models should build on the TIMI models' strengths, including widespread availability on multiple electronic platforms and use of information that is readily available and easily collected (Table 3).

CONCLUSION

While respondents identified several significant strengths of the TIMI risk scores, they also perceived the models to have several limitations that could potentially diminish use and prognostic value in older adults with AMI. These findings underscore the need for additional evaluation of pertinent risk factors for older adults with AMI. This work can inform the development of new AMI risk stratification models that can more thoroughly and accurately assess risk and guide treatment in this population.

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The Institutional Review Board at Yale University exempted this study.

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Highlights

- We examine physicians' perceptions of the TIMI risk scores in older adults with AMI.
- The models' strengths included familiarity, ease of use, and validation.
- The models' limitations included a lack of geriatric-specific risk factors and scope.
- New AMI risk models that incorporate geriatric-specific risk factors are needed.

Table 1

Examples of Interview Questions and Probes

Question	Probe
Can you tell me about any of the risk stratification models you use in your clinical care of patients with AMI?	<ul style="list-style-type: none"> • What do you like/dislike about this model? • Are there any theoretical or practical strengths or limitations of the model you use and if so what are they? • If you don't use risk models – why?
Can you tell me about any of the risk stratification models you use in your clinical care of adults > 75 with AMI?	<ul style="list-style-type: none"> • What do you like/dislike about this model? • Are there any theoretical or practical strengths or limitations of the model and if so what are they? • If you don't use risk models – why?
Regarding the TIMI Risk scores, do you use these models for adults > 75 with AMI?	<ul style="list-style-type: none"> • How do you use them? • Are there any specific reasons why you do not use them? • What do you like/dislike about these models? • Are there any theoretical or practical limitations of these models and if so what are they?

Table 2

Characteristics of Study Respondents (n = 22)

Characteristic	Median (Range)
Age, years	37 (32–62)
Years of clinical experience after medical school	11.5 (5–36)
	N (%)
Male	15 (68.2)
White race	16 (72.7)
Hours per week spent in clinical practice	
<20	5 (22.7)
20–40	6 (27.3)
>40	11 (50)
Practice location	
Urban	17 (77.3)
Suburban	4 (18.2)
Urban and Suburban	1 (4.5)
Practice setting	
Academic medical center	19 (86.4)
Non-academic medical center	3 (13.6)
Clinical specialty	
Cardiology	17 (77.3)
Hospitalist	5 (22.7)
United States geographic region	
Northeast	10 (45.5)
Southeast	3 (13.6)
Midwest	4 (18.2)
West	5 (22.7)
Southwest	0 (0)

Table 3

Reported Strengths and Limitations of the TIMI Risk Score

Theme	Illustrative Quotes
Strengths	
Ubiquitous presence among medical professionals	<p>"I'm familiar with it. We learned about it during med school, during our training."</p> <p>"It's ubiquitous. I can say, 'Well, their TIMI score is this,' and everybody knows exactly what it means."</p> <p>"Everyone buys into it for the most part."</p>
Ease of use	<p>"It's very easy. Click on it [the website] and get the results."</p> <p>"I like its simplicity."</p> <p>"It's easy to use. You don't have to sit down and memorize all of the risk factors. It's an easy interface."</p>
Valid and evidence-based tool	<p>"I think the validations have been good in study after study."</p> <p>"It's got a large evidence base behind it. It's probably one of the most, from an evidence point of view, robustly validated score out there."</p>
Limitations	
Lack of risk factors relevant to older adults	<p>"It doesn't take frailty into account."</p> <p>"Can they ambulate well by themselves or do they use a walker? Are they completely bed bound? And their cognitive capabilities are important predictors. Those are not captured in the TIMI risk score."</p> <p>"The TIMI study didn't take into account the complexity of the geriatric patient as people at that age are likely to have more comorbid disease."</p>
Limited scope and influence	<p>"I guess I'm not convinced that it's gonna change my management if I use the model."</p> <p>"It doesn't really help me to tell the patient what to expect like a year from now."</p>