*Jason P. Stopyra, MD, MS*
*Nicklaus P. Ashburn, MD*
*Simon A. Mahler, MD, MS*
*Department of Emergency Medicine, Wake Forest School of Medicine*
*Winston-Salem, NC*

https://doi.org/10.1016/j.annemergmed.2021.09.428

*Funding and support:* By *Annals* policy, all authors are required to disclose any and all commercial, financial, and other relationships in any way related to the subject of this article as per ICMJE conflict of interest guidelines (see www.icmje.org). Dr. Stopyra receives research funding from NCATS/ NIH (KL2TR001421), HRSA (H2ARH39976-01-00), NHLBI (U01HL123027), Roche Diagnostics and Abbott Point of Care. He has provided paid consulting to Roche Diagnostics. Dr Mahler receives funding/support from Roche Diagnostics, Abbott Laboratories, Ortho Clinical Diagnostics, Siemens, Grifols, Pathfast, Quidel, Genetesis, AHRQ, PCORI, NIDA, and NHLBI (1RO1HL118263-01), and HRSA (1H2ARH399760100) and is a consultant for Roche, Abbott, Quidel, Genetesis, and Amgen and the Chief Medical Officer for Impathiq Inc. The other authors have stated that no such relationships exist.

1. Green SM, Schriger DL. A methodological appraisal of the HEART score and its variants. *Ann Emerg Med*. 2021;78:253-266.
2. Cotterill PG, Deb P, Shrank WH, et al. Variation in chest pain emergency department admission rates and acute myocardial infarction and death within 30 days in the Medicare population. *Acad Emerg Med*. 2015;22:955-964.
3. Mahler SA, Riley RF, Hiestand BC, et al. The HEART Pathway randomized trial: identifying emergency department patients with acute chest pain for early discharge. *Circ Cardiovasc Qual Outcomes*. 2015;8:195-203.
4. Hollander JE. Risk stratification of emergency department patients with chest pain: the need for standardized reporting guidelines. *Ann Emerg Med*. 2004;43:68-70.
5. Mahler SA, Lenoir KM, Wells BJ, et al. Safely identifying emergency department patients with acute chest pain for early discharge. *Circulation*. 2018;138:2456-2468.

## Do Not Throw Out the Baby With the Bathwater

*To the Editor:*

We read with great interest the article by Green and Schriger[1] reviewing the methodological aspects of the HEART score. This manuscript provides a wide review of the risk assessment model and emphasizes some of its weaknesses.

The authors have highlighted a lack of sensitivity of the HEART score less than 4 to rule out a major adverse cardiovascular event leading to an unacceptable rate of missed diagnoses. Indeed, the pooled sensitivities of the HEART score were 96% to 97%, with the lower bounds of the 95% confidence intervals of 93% to 94%, "ie, compatible with missing 6% to 7% of major adverse cardiovascular events."[1] The definitions of "miss-rate" and "miss threshold" used in this paper may be confusing for emergency physicians. What emergency physicians need for decisionmaking is the residual risk of the patient in front of them, knowing the result of the test, which corresponds to the negative predictive value (NPV) and the false negative rate. In this purpose, the 1% to 2% rate of "acceptable" errors is commonly understood as the false negative rate (1–NPV) rather than the rate of missed diagnoses among the patients with the disease (1–sensitivity). The false negative rate is widely used for the validation of diagnostic scores and strategies such as the latest accelerated diagnostic protocols for acute coronary syndrome.[2] Considering a worst-case scenario in a high-risk population with a 30-day major adverse cardiovascular event prevalence of 15%, with a sensitivity and specificity of 96% and 42%, respectively, the false negative rate of the HEART score would be 1.6%.[3] Moreover, most recent studies have reported a way lower 30-day prevalence of acute myocardial infarction or death in unselected emergency department patients in the United States (0.6%), corresponding to a 100% NPV and a false negative rate near 0%.[4] In the latest meta-analysis including more than 25,000 patients, the lower bound of the 95% confidence interval of the NPV for the 30-day rate of major adverse cardiovascular event was 98%, leading to a false negative rate lower than the "acceptable 2% threshold."[3] Finally, the safety of the HEART score is supported by a high-quality randomized trial, having confirmed the noninferiority of a HEART score–based strategy compared with usual care.[5]

*Thomas Moumneh, MD*
*Delphine Douillet, MD*
*Département de Médecine d'Urgence, Centre hospitalier universitaire d'Angers, Angers, France*
*Institut MITOVASC, Centre National de Recherche Scientifique 6015 Institut National de la Santé Et de la Recherche Médicale 1083, Université d'Angers, Angers, France*

*Dominique Savary, MD*
*Département de Médecine d'Urgence, Centre hospitalier universitaire d'Angers, Angers, France*
*Ecole des Hautes Etudes en Santé Publique, Institut de*

*Recherche en Santé Environnement et Travail, Institut National de la Santé Et de la Recherche Médicale S1085, Université de Rennes, Angers, France*

*Pierre-Marie Roy, MD, PhD*
*Département de Médecine d'Urgence, Centre hospitalier universitaire d'Angers, Angers, France*
*Institut MITOVASC, Centre National de Recherche Scientifique 6015 Institut National de la Santé Et de la Recherche Médicale 1083, Université d'Angers, Angers, France*

https://doi.org/10.1016/j.annemergmed.2021.09.429

*Funding and support:* By *Annals* policy, all authors are required to disclose any and all commercial, financial, and other relationships in any way related to the subject of this article as per ICMJE conflict of interest guidelines (see www.icmje.org). The authors have stated that no such relationships exist.

1. Green SM, Schriger DL. A methodological appraisal of the HEART score and its variants. *Ann Emerg Med*. 2021;78:253-266.
2. Chapman AR, Lee KK, McAllister DA, et al. Association of high-sensitivity cardiac troponin I concentration with cardiac outcomes in patients with suspected acute coronary syndrome. *JAMA*. 2017;318:1913-1924.
3. Laureano-Phillips J, Robinson RD, Aryal S, et al. HEART score risk stratification of low-risk chest pain patients in the emergency department: a systematic review and meta-analysis. *Ann Emerg Med*. 2019;74:187-203.
4. Sharp AL, Wu YL, Shen E, et al. The HEART score for suspected acute coronary syndrome in U.S. emergency departments. *J Am Coll Cardiol*. 2018;72:1875-1877.
5. Poldervaart JM, Reitsma JB, Backus BE, et al. Effect of using the HEART score in patients with chest pain in the emergency department: a stepped-wedge, cluster randomized trial. *Ann Intern Med*. 2017;166:689-697.

*In reply:*

We read with interest these comments from the creator of the HEART pathway and others. Importantly, we note that they do not dispute the foremost concerns raised in our methodological appraisal, ie, that the HEART score was not formally derived, that its key components display weak interrater reliability, that its 0, 1, and 2 score weights do not align with their known predictivities, that it omits consideration of the timeliness or likelihood of meaningful physician follow-up, and that there is no compelling evidence that it is superior to or improves the risk judgments that emergency physicians make without the score, ie, their clinical gestalt.[1] The HEART pathway is effectively the HEART score plus a second troponin and, thus, fully shares its fundamental structural limitations. As noted in our article, the HEART score and HEART pathway are noncompliant with *Annals*' methodologic standards for such clinical decision rules.[2]

Much of the presumed success of the HEART score is based on "miss rates" misleadingly calculated from negative predictive values rather than sensitivity, as repeated by these correspondents. Unlike sensitivity, predictive values vary based on disease prevalence, and, in populations with low disease prevalence (eg, most HEART studies), this exaggerates the apparent score performance. What emergency physicians mostly care about is how well HEART identifies patients at actual risk, and for this, sensitivity is the only appropriate benchmark. The lower confidence interval bounds for pooled HEART score sensitivities from 3 meta-analyses are 93% to 94%, ie, compatible with missing up to 7% or 1 in 14 occurrences of major adverse cardiac events. As discussed in our article, this summary performance is below that which emergency physicians state a willingness to accept, below the 98% sensitivity exhibited by baseline practice without the score, and below the 1% to 2% acceptable miss threshold specified by the American College of Emergency Physicians in their chest pain policy.

The assertion by Stopyra et al that emergency physicians have historically admitted "up to 80% of their patients with chest pain" is not supported by the reference they cite, which reports a 63% mean admission rate. Also, notably, this was measured in a nonrepresentative, higher-risk sample consisting of elderly Medicare patients (average age, 71 years) with frequent comorbidities, and only included patients with nonspecific chest pain diagnostic codes—thus excluding those evaluated for chest pain but ultimately discharged with apparent noncardiac diagnoses (eg, gastrointestinal and musculoskeletal).

The mention by Stopyra et al of "Standardized Reporting Guidelines" references an editorial rather than any such guideline; moreover, the document we presume they mean proposes only coding recommendations for typical chest pain charting variables and excludes decision rule methodology.[3] They characterize the history component of the HEART pathway as "objective," when this element showed the overall lowest interrater reliability in the numerous studies we detail—a finding further confirmed in the subsequent, largest such study by Soares et al.[4] They propose one reason why sex might be omitted from a chest pain risk score—itself debatable—but raise no response regarding the numerous other established predictor variables excluded from HEART. They argue