






RESEARCH LETTER

Utility of Echocardiography in Patients With Suspected Acute Myocardial Infarction and Left Bundle-Branch Block

Thomas Nestelberger , MD; Jasper Boeddinghaus , MD; Pedro Lopez Ayala, MD; Juliane Gehrke , MD; Raphael Twerenbold , MD; Louise Cullen, MD; Christian Mueller , MD; on behalf of the APACE, ADAPT, TRAPID-AMI Investigators*

Patients with suspected acute myocardial infarction (AMI) in the setting of left bundle-branch block (LBBB) present an important diagnostic and therapeutic challenge to clinicians, as altered ventricular depolarization might mask changes in ventricular repolarization associated with AMI.^{1,2} We hypothesized that the use of early echocardiography may provide value in the differentiation of AMI from other causes of acute chest pain.^{1–4} This hypothesis is based on the assumption that patients with LBBB and AMI would exhibit relevant wall motion abnormalities (WMA), particularly in the anterior wall, while patients with other causes of acute chest pain would not exhibit these WMA. Unfortunately, this assumption has never been verified in an appropriate diagnostic study.³

written informed consent. The data that support the findings of this study are available from the corresponding author upon reasonable request. Final diagnoses were centrally adjudicated by 2 independent cardiologists according to the fourth universal definition of AMI based on all available information including the ECG, serial measurements of cardiac troponin, echocardiography, magnetic resonance imaging, and coronary angiography performed both after as well as before the index event to verify that abnormalities were causally related to the chest pain episode leading to ED presentation (eg, if in a patient with LBBB the acute chest pain episode did not lead to a rise and/or fall in cardiac troponin, during serial sampling, AMI was ruled out). Patients underwent echocardiography if considered clinically indicated by the treating physician. Echocardiography was performed by specifically trained cardiologists or echocardiographic sonographers following current echocardiographic guidelines. A WMA was reported only if imaging quality was good enough and if it was clearly distinguishable from paradoxical septum motion. For this analysis, patients were only eligible for this analysis if echocardiography was performed in the ED before revascularization to exclude the possible confounding of revascularization on

See Editorial by Birnbaum et al

The aim of our study was to evaluate the diagnostic accuracy of echocardiography among patients presenting with suspected AMI and LBBB to 26 emergency departments (EDs) in 3 international, prospective, diagnostic studies.⁵ Ethics approval was obtained by local ethics committee and patients provided

Key Words: acute coronary syndrome ■ echocardiography ■ left bundle-branch block

Correspondence to: Christian Mueller, MD, Department of Cardiology, University Hospital Basel, Petersgraben 4, CH-4031 Basel, Switzerland. E-mail: christian.mueller@usb.ch

*A complete list of the APACE, ADAPT, and TRAPID-AMI Investigators can be found in the Appendix at the end of the article.

For Sources of Funding and Disclosures, see page 4.

© 2021 The Authors. Published on behalf of the American Heart Association, Inc., by Wiley. This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

JAHA is available at: www.ahajournals.org/journal/jaha

WMA. Unfortunately, data on preexisting LBBB and/or WMA were not available in most patients.

Among 10 959 patients presenting with acute chest pain to the ED, LBBB was recorded in 286 (2.6%) patients. Transthoracic echocardiography had been performed in 35% (100/286) of patients with LBBB in the ED. AMI was the final diagnosis in 41% (41/100) of these patients. Among 59 patients without AMI, there were 29 with noncardiac causes of chest pain, 23 with cardiac but noncoronary causes, and 7 with unstable angina. WMAs were documented in 77 (77%) patients, with a similar prevalence in patients

with versus patients without AMI (33 [80%] and 44 [75%], $P=0.49$, Figure). The same finding emerged when specifically evaluating WMA of the anterior wall. In patients with LBBB, the prevalence of WMA of the anterior wall (54% versus 54%, $P=0.95$) and WMA of the septum (66% versus 58%, $P=0.41$) was comparable in patients with adjudicated AMI versus patients with other final diagnosis. Furthermore, other structural and/or functional abnormalities assessed did not differ for patients with versus without adjudicated AMI (eg, left atrium dilation 67% versus 66%, $P=0.885$, left ventricular hypertrophy 56% versus

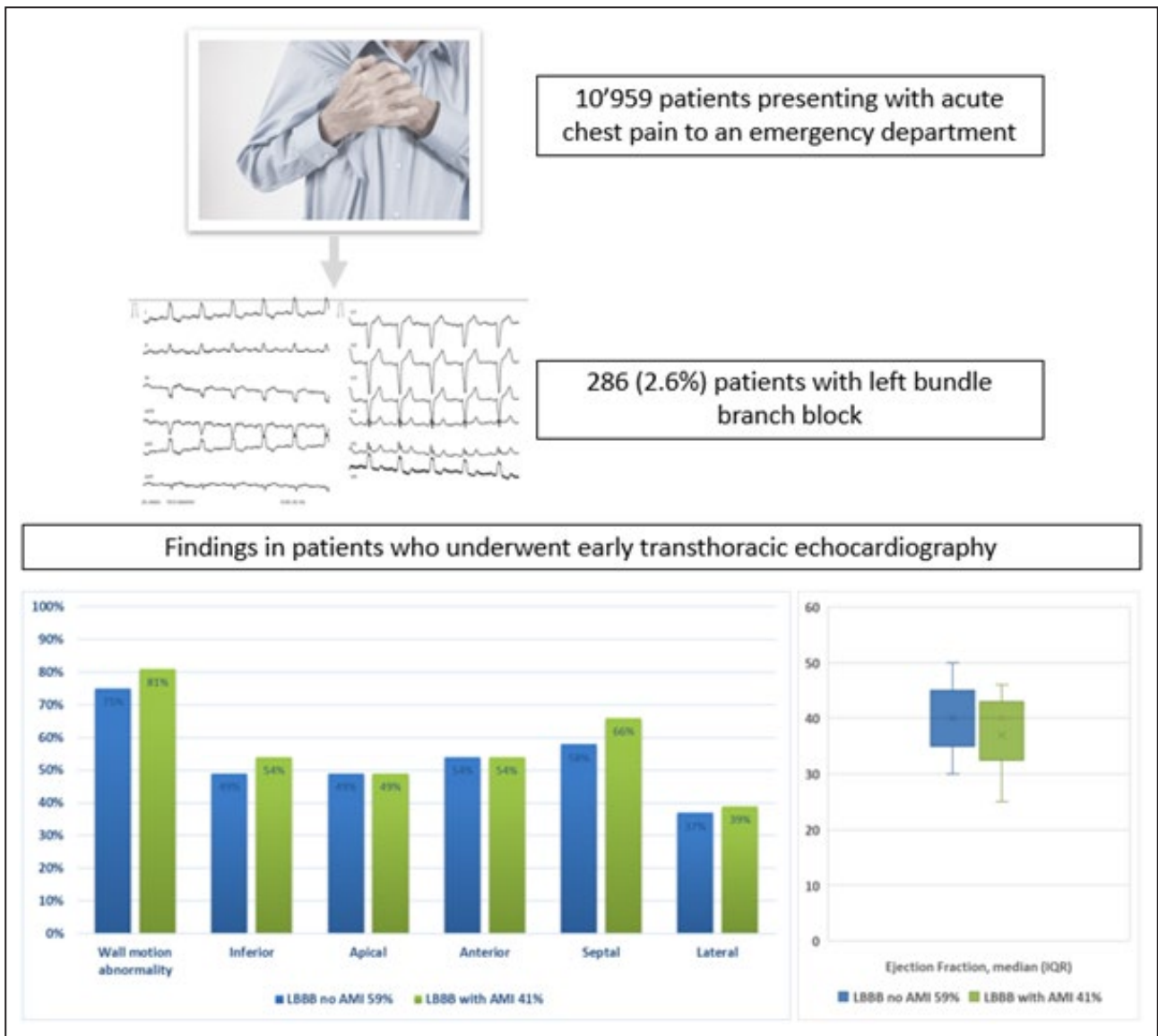


Figure 1. Patient flow chart and echocardiographic findings.

Flow chart of patients presenting with acute chest pain to an emergency department and LBBB. Bar charts and box plot for ejection fraction (with IQR) represent echocardiographic findings in patients with LBBB and adjudicated diagnosis of AMI vs patients with LBBB with an adjudicated diagnosis of no AMI. All P values for comparison are not statistically significant. Data are expressed as medians and IQR for continuous variables, and as numbers and percentages (%) for categorical variables. All variables between T1MI and T2MI were compared by the Mann–Whitney U test for continuous variables or the Pearson χ^2 or Fisher exact test for categorical variables, as appropriate. AMI indicates acute myocardial infarction; IQR, interquartile range; and LBBB, left bundle-branch block.

54, $P=0.822$, and left ventricular dilation 37% versus 44%, $P=0.507$).

These findings have important and immediate clinical consequences, as they falsified the assumption underlying our hypothesis regarding the utility of echocardiography in patients with suspected AMI and LBBB as recommended in current guidelines.^{1,2} As these data were derived from large international diagnostic studies using central adjudication by independent cardiologists, their validity and generalizability seem high. These surprising findings seem well explained by 3 aspects. First, in most patients presenting with LBBB and AMI, LBBB is pre-existing (known or unknown) and not the consequence of the current AMI.² Second, many patients with LBBB have prior AMIs resulting in persistent WMA, which often cannot be reliably differentiated from new WMA related to a new AMI. Third, most AMIs in patients with LBBB are small to moderate in size, and not the catastrophic very large AMI phenotype resulting in LBBB as a consequence of the very large ischemic territory. As only a subgroup of patients with LBBB underwent transthoracic echocardiography in the ED, it is important to highlight that selection bias would be expected to have favored a positive finding.

Accordingly, an integrated triage algorithm including specific ECG criteria (Sgarbossa or modified Sgarbossa criteria) with high specificity, as well as high sensitivity cardiac troponin/I concentrations at presentation and their 0/1-hour or 0/2-hour changes should be used in the selection of patients for immediate and/or early coronary angiography.⁵ It is important to highlight that these findings only apply to patients stable enough to provide written informed consent, which was required for this study. They should not be extrapolated to patients after cardiac arrest or in cardiogenic shock, for which immediate echocardiography should definitely remain the standard of care.¹

In conclusion, in hemodynamically stable patients with suspected AMI and LBBB, standard echocardiographic assessment provides only limited diagnostic value regarding the presence or absence of AMI.

APPENDIX

APACE Investigators

Cardiovascular Research Institute Basel (CRIB) and Department of Cardiology, University Hospital Basel, University of Basel, Basel, Switzerland and GREAT network, Rome, Italy: Ivo Strebel, PhD; Alexandra Prepoudis, MD; Danielle M. Gualandro, MD, PhD; Christian Puelacher, MD PhD; Jeanne du Fay Lavallaz, MD PhD; Simon Martin Frey, MD; Paul David Ratmann, MD; Ketina Arslani, MD; Joan Elias Walter, MD PhD;

Michael Freese, RN; Samyut Shrestha, MD; Maria Belkin, MD; Luca Koechlin, MD.

Department of Anesthesiology, University Hospital Innsbruck, Innsbruck, Austria: Petra Hillinger, MD.

Division of Internal Medicine, University Hospital Basel, University of Basel, Switzerland: Eliska Potlukova, MD.

Division of Laboratory Medicine University Hospital Basel, University of Basel, Switzerland: Katharina Rentsch, PhD; Sandra Mitrovic, PhD.

2nd Department of Cardiology, School of Medicine with the Division of Dentistry in Zabrze, Medical University of Katowice, Poland: Damian Kawecki, MD; Beata Morawiec, MD; Piotr Munz, MD.

Emergency Department, Kantonsspital Liestal, Switzerland: Nicolas Geigy, MD.

Department of Cardiology, Inselspital, Bern University Hospital, University of Bern, Switzerland: Tobias Reichlin, MD.

Emergency Department, Hospital Clinic, Barcelona, Catalonia, Spain: Gemma Martinez-Nadal, MD; Carolina Isabel Fuenzalida Inostroza, PhD; Òscar Miró, MD.

Servicio de Urgencias, Hospital Clínico San Carlos, Madrid, Spain: José Bustamante Mandrión, MD; Javier Martín-Sánchez, MD.

Laboratory Medicine, University Hospital Zürich, Zürich, Switzerland: Arnold von Eckardstein, MD.

Blood Transfusion Centre, Swiss Red Cross, Basel, Switzerland: Andreas Buser, MD.

Department of Cardiac Surgery, University Hospital Basel, University of Basel, Switzerland: Luca Koechlin, MD.

ADAPT Investigators

Royal Brisbane & Women's Hospital, Herston, Australia: Jaimi Greenslade, PhD.

TRAPID-AMI Investigators

Department of Emergency Care, Lucerne General Hospital, Lucerne, Switzerland: Michael Christ, MD.

Department of Cardiology, Universitätsklinikum Heidelberg, Heidelberg, Germany: Evangelos Giannitsis, MD.

Department of Medical Sciences, University of Uppsala, Uppsala, Sweden: Bertil Lindahl, MD.

ARTICLE INFORMATION

Received February 10, 2021; accepted July 13, 2021.

Affiliations

Department of Cardiology and Cardiovascular Research Institute Basel (CRIB), University Hospital Basel, University of Basel, Switzerland (T.N., J.B., P.L.A., J.G., R.T., C.M.); GREAT Network, Rome, Italy (T.N., J.B., P.L.A., J.G., R.T., L.C., C.M.); Division of Cardiology, Vancouver General Hospital, University of British Columbia, Vancouver, British Columbia, Canada (T.N.); and Emergency and Trauma Centre Department, Royal Brisbane and Women's Hospital, Brisbane, Queensland, Australia (L.C.).

Acknowledgments

We thank the patients who participated in the study, the staff of the EDs, the research coordinators, and the laboratory technicians for their most valuable efforts.

Sources of Funding

APACE was supported by research grants from the Swiss National Science Foundation, the Swiss Heart Foundation, the European Union, the Cardiovascular Research Foundation Basel, the University Hospital Basel, the University of Basel, Abbott, Beckman Coulter, Roche, Ortho Clinical Diagnostics, Quidel, Siemens, and Singulex. ADAPT was supported by Queensland Emergency Medicine Research Foundation, Christchurch Heart Institute and Health Research Council and Heart Foundation of New Zealand, Christchurch Emergency Care Foundation. TRAPID-AMI was sponsored by Roche.

Disclosures

Dr Nestelberger has received research support from the Swiss National Science Foundation (P400PM_191037/1), the Swiss Heart Foundation, the Prof Dr Max Cloëtta Foundation, the Margarete und Walter Lichtenstein-Stiftung (3MS1038), the University of Basel and the University Hospital Basel as well as speaker honoraria/consulting honoraria from Siemens, Beckman Coulter, Bayer, Ortho Clinical Diagnostics, and Orion Pharma, outside the submitted work. Dr Boeddinghaus has received research grants from the University of Basel, the University Hospital of Basel and the Division of Internal Medicine, the Swiss Academy of Medical Sciences, and the Gottfried and Julia Bangerter-Rhyner-Foundation; and has received speaker honoraria and/or consulting honoraria from Siemens, Roche Diagnostics, Ortho Clinical Diagnostics, and Quidel Corporation, outside the submitted work. Dr Lopez-Ayala has received research support from the Swiss Heart Foundation, outside the submitted work. Dr Koechlin received a research grant from the University of Basel, the Swiss Academy of Medical Sciences, and the Gottfried and Julia Bangerter-Rhyner Foundation, as well as the "Freiwillige Akademische Gesellschaft Basel," outside the submitted work. Dr Twerenbold reports research support from the Swiss National Science Foundation (Grant No P300PB_167803), the Swiss Heart Foundation, the Swiss Society of Cardiology, the Cardiovascular Research Foundation Basel, the University of Basel, and the University Hospital Basel and speaker honoraria/consulting honoraria from Abbott, Amgen, Astra Zeneca, Roche, Siemens, Singulex, and Thermo Scientific BRAHMS, outside the submitted work. Dr Cullen reports grants from Roche and from Abbott, during the conduct of the study. Grants from Roche, grants and personal fees from Abbott Diagnostics, grants from Siemens, grants from Radiometer, personal

fees from AstraZeneca, grants from Alere, outside the submitted work. Dr Lindahl has served as a consultant for Roche Diagnostics, Beckman Coulter Inc., Siemens Healthcare Diagnostics, Radiometer Medical, bio-Mérieux Clinical Diagnostics, Philips Healthcare, and Fiomidiagnostics AB, outside the submitted work. Dr Mueller has received research support from the Swiss National Science Foundation, the Swiss Heart Foundation, the KTI, the European Union, the University of Basel, the University Hospital Basel, the Stiftung für kardiovaskuläre Forschung Basel; Abbott, Beckman Coulter, Biomerieux, Idorsia, Ortho Clinical Diagnostics, Quidel, Roche, Siemens, Singulex, Sphingotec, as well as speaker honoraria/consulting honoraria from Acon, Amgen, Astra Zeneca, Boehringer Ingelheim, Bayer, BMS, Idorsia, Novartis, Osler, Roche, Sanofi, outside of the submitted work. The remaining authors have no disclosures to report.

REFERENCES

1. O'Gara PT, Kushner FG, Ascheim DD, Casey DE, Chung MK, de Lemos JA, Ettinger SM, Fang JC, Fesmire FM, Franklin B, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2013;61:e78–e140.
2. Collet J-P, Thiele H, Barbato E, Barthélémy O, Bauersachs J, Bhatt DL, Dendale P, Dorobantu M, Edvardsen T, Folliquet T, et al. 2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. *Eur Heart J*. 2021;42:1289–1367. doi: 10.1093/eurheartj/ehaa575
3. Neeland IJ, Kontos MC, de Lemos JA. Evolving considerations in the management of patients with left bundle branch block and suspected myocardial infarction. *J Am Coll Cardiol*. 2012;60:96–105. doi: 10.1016/j.jacc.2012.02.054
4. Manfredonia L, Lanza GA, Crudo F, Lamendola P, Graziani F, Villano A, Locorotondo G, Melita V, Mencarelli E, Pennestrì F, et al. Diagnostic role of echocardiography in patients admitted to the emergency room with suspect no-ST-segment elevation acute myocardial infarction. *Eur Rev Med Pharmacol Sci*. 2019;23:826–832. doi: 10.26355/eurrev_201901_16897
5. Nestelberger T, Cullen L, Lindahl B, Reichlin T, Greenslade JH, Giannitsis E, Christ M, Morawiec B, Miro O, Martín-Sánchez FJ, et al. Diagnosis of acute myocardial infarction in the presence of left bundle branch block. *Heart*. 2019;105:1559–1567. doi: 10.1136/heartjnl-2018-314673