

uniquely positioned to participate in integration of this evidence-based but underutilized class of cardiometabolic therapies to advance comprehensive cardiovascular care.

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<https://doi.org/10.1016/j.jacc.2019.01.029>

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Please note: Dr. Vaduganathan is supported by the KL2/Catalyst Medical Research Investigator Training award from Harvard Catalyst, The Harvard Clinical and Translational Science Center (National Institutes of Health/National Center for Advancing Translational Sciences Award UL1TR002541); and has served on advisory boards for AstraZeneca, Bayer AG, and Baxter Healthcare. Drs. Patel and Qamar are supported by NHLBI T32 postdoctoral training grants (T32HL069771 and T32HL007604). Dr. Qamar is supported by the American Heart Association Strategically Focused Research Network in Vascular Disease grant (18SFRN3390085). Dr. Januzzi is supported in part by the Hutter Family Professorship; has received grant support from Abbott, Cleveland Heart Labs, Singulex, and Prevencio; has received consulting income from Roche Diagnostics, Critical Diagnostics, and Novartis; and has participated in clinical endpoint committees/data or safety monitoring boards for Novartis, Amgen, GE, Janssen, Pfizer, and Boehringer Ingelheim. Dr. Scirica has received research grants via Brigham and Women's Hospital from AstraZeneca, Eisai, Novartis, and Merck; has received consulting fees from AstraZeneca, Biogen Idec, Boehringer Ingelheim, Covance, Dr. Reddy's Laboratories, Eisai, Elsevier Practice Update Cardiology, GlaxoSmithKline, Lexicon, Merck, Novo Nordisk, Sanofi, and St. Jude's Medical; and has equity in Health [at] Scale. Dr. Butler has received research support from the National Institutes of Health and European Union; and has served as a consultant for Amgen, Array, AstraZeneca, Bayer, Boehringer Ingelheim, Bristol-Myers Squibb, CVRx, G3 Pharmaceutical, Innolife, Janssen, Luitpold Pharmaceuticals, Medtronic, Merck, Novartis, Novo Nordisk, Relypsa, StealthPeptide, SC Pharma, Vifor Pharma, and ZS Pharma. Dr. Cannon has received research grants from Amgen, Boehringer Ingelheim, Bristol-Myers Squibb, Daiichi-Sankyo, Janssen, and Merck; and has received consulting fees from Alnylam, Amgen, Boehringer Ingelheim, Bristol-Myers Squibb, Eisai, Janssen, Kowa, Merck, Pfizer, Regeneron, and Sanofi. Dr. Bhatt has served on the Advisory Board of Cardax, Elsevier Practice Update Cardiology, Medscape Cardiology, and Regado Biosciences; has served on the Board of Directors of Boston VA Research Institute, Society of Cardiovascular Patient Care, and TobeSoft; has served as Chair of the American Heart Association Quality Oversight Committee, NCDR-ACTION Registry Steering Committee, and VA CART Research and Publications Committee; has served on the Data Monitoring Committees for Baim Institute for Clinical Research (formerly Harvard Clinical Research Institute, for the PORTICO trial, funded by St. Jude Medical, now Abbott), Cleveland Clinic, Duke Clinical Research Institute, Mayo Clinic, Mount Sinai School of Medicine, and the Population Health Research Institute; has received honoraria from the American College of Cardiology (Senior Associate Editor, *Clinical Trials and News*, ACC.org); Vice-Chair, ACC Accreditation Committee), Baim Institute for Clinical Research (formerly Harvard Clinical Research Institute; RE-DUAL PCI clinical trial steering committee funded by Boehringer Ingelheim), Belvoir Publications (Editor-in-Chief, *Harvard Heart Letter*), Duke Clinical Research Institute (clinical trial steering committees), HMP Global (Editor-in-Chief, *Journal of Invasive Cardiology*), *Journal of the American College of Cardiology* (Guest Editor; Associate Editor), Population Health Research

Institute (COMPASS clinical trial steering committee funded by Bayer), Slack Publications (Chief Medical Editor, *Cardiology Today's Intervention*), Society of Cardiovascular Patient Care (Secretary/Treasurer), and WebMD (CME steering committees); has served as Deputy Editor of *Clinical Cardiology*; has received research funding from Abbott, Amgen, AstraZeneca, Bayer, Boehringer Ingelheim, Bristol-Myers Squibb, Chiesi, Eisai, Ethicon, Forest Laboratories, Idorsia, Ironwood, Ischemix, Lilly, Medtronic, PhaseBio, Pfizer, Regeneron, Roche, Sanofi, Synaptic, and The Medicines Company; has received royalties from Elsevier (Editor, *Cardiovascular Intervention: A Companion to Braunwald's Heart Disease*); has served as site co-investigator for Biotronik, Boston Scientific, St. Jude Medical (now Abbott), and Svelte; is a Trustee of the American College of Cardiology; and has performed unfunded research for FlowCo, Merck, Novo Nordisk, PLX Pharma, and Takeda. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose. Prakash Deedwania, MD, served as Guest Editor for this paper.

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Administrative Billing Codes for Identifying Patients With Cardiac Arrest



Administrative data that utilize International Classification of Diseases-Ninth Revision (ICD-9) diagnosis and procedure codes are increasingly used to study patterns of care and outcomes in patients with out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA). However, the validity of diagnosis and procedure codes to identify true cases of OHCA and IHCA, respectively, remains uncertain. In a recent study, we found that the sensitivity of ICD-9 procedure codes to identify confirmed cases of IHCA in a national registry was only 37.2% (1). However, an important but unanswered question in these studies is the positive predictive value (PPV) of ICD-9 codes: that is, what proportion of included patients truly have IHCA or OHCA?

To accomplish our study objective, we identified all patients (age ≥ 18 years) discharged from University of Iowa (UI) medical center during 2014 with ICD-9 diagnosis codes 427.5 (cardiac arrest), or 427.41 (ventricular fibrillation) that are commonly used to identify OHCA (2), and ICD-9 procedure codes 99.60 (cardiopulmonary resuscitation, not otherwise specified) or 99.63 (closed chest cardiac massage) that are commonly used to identify IHCA (3). We excluded 15

patients transferred after initial treatment at another hospital because medical records from transferring facilities were not consistently available. After approval by the UI Institutional Review Board, 2 independent reviewers performed a structured chart review to determine whether included patients met the Utstein definition for cardiac arrest (4). Reviewers included the first 3 study authors. If a patient met the definition of cardiac arrest, we classified cardiac arrests as OHCA or IHCA based on whether the first episode of arrest occurred prior to or after arrival at UI hospital. For ICD-9 diagnosis codes, analyses were carried out separately if the code was present as any diagnosis or only the primary diagnosis.

A total of 261 patients (mean age 60.9 years, 40.6% women, 85.8% Caucasian) constituted the study cohort. Of these, 244 (93.5%) had an ICD-9 diagnosis code (427.5 or 427.41), 163 (62.5%) had an ICD-9 procedure code (99.60 or 99.63), and 146 (55.9%) had both a diagnosis and procedure code. On chart review, 155 (59.3%) patients were classified as IHCA, 60 (23.0%) patients were classified as OHCA, and 46 patients (17.6%) did not have an arrest.

Table 1 shows the proportion of patients with ICD-9 codes who were classified as IHCA, OHCA, or no arrest. Among patients with an ICD-9 diagnosis code as a primary or secondary diagnosis, only 24.2% (n = 244) were correctly classified as OHCA. For individual codes, the PPV for identifying OHCA was 28.4% for 427.5 (n = 208) and 10.1% for 427.41 (n = 69). More patients with an ICD-9 diagnosis code had an IHCA instead of OHCA. When restricting diagnosis codes to only the primary diagnosis, the PPV for identifying OHCA was 100% for 427.5 (n = 7) and 12.5% for 427.41 (n = 8). However, this approach identified only 11.6% (n = 46) of patients with OHCA in our data. Among ICD-9 procedure codes, 83.3% of patients with 99.60 were correctly classified as IHCA (n = 162). Of the remainder, 13% of patients with OHCA and 3.7% without an arrest were erroneously identified. The PPV of ICD-9 code 99.63 was 0%; however, that code was present in only 1 patient.

We found that the PPV of ICD-9 codes 427.5 or 427.41 as the primary or secondary diagnosis was <30% for identifying OHCA and identified more cases of IHCA than OHCA. Although the PPV of ICD-9 diagnosis codes, especially 427.5, improved markedly when restricted to only the primary diagnosis, this approach missed nearly 90% of OHCA cases in our data. The ICD-9 procedure code 99.60 had a high PPV for identifying IHCA, but still erroneously identified 13% of OHCA patients. Moreover, in prior work, we found a low sensitivity of ICD-9 procedure codes for identifying

TABLE 1 Positive Predictive Value of Individual ICD-9 Diagnosis and Procedure Codes for Cardiac Arrest

	n	Cardiac Arrest		
		In-Hospital	Out-of-Hospital	No Arrest
ICD-9 diagnosis code (primary or secondary diagnosis)	244	142 (58.2)	59 (24.2)	43 (16.5)
427.5 (cardiac arrest)	208	132 (63.5)	59 (28.4)	17 (8.1)
427.41 (ventricular fibrillation)	69	36 (52.2)	7 (10.1)	26 (37.7)
ICD-9 diagnosis code (primary diagnosis only)	15	2 (13.3)	8 (53.3)	5 (33.3)
427.5	7	0 (0.0)	7 (100.0)	0 (0.0)
427.41	8	2 (25.0)	1 (12.5)	5 (62.5)
ICD-9 procedure code	163	135 (82.8)	22 (13.5)	6 (3.7)
99.60 (cardiopulmonary resuscitation, NOS)	162	135 (83.3)	21 (13.0)	6 (3.7)
99.63 (closed chest cardiac massage)	1	0 (0.0)	1 (100.0)	0 (0.0)

Values are n or n (%).

ICD-9 = International Classification of Diseases-Ninth Revision; NOS = not otherwise specified.

IHCA (1). Thus, our findings raise concerns regarding the use of ICD code-based approaches for resuscitation research, especially ICD-9 diagnosis codes for OHCA.

Limitations of our study include use of data from a single center, which may not reflect billing practices at other institutions. Moreover, our findings do not apply to ICD-10 codes. Finally, despite the use of a pre-specified definition and using 2 independent reviewers, the potential for misclassification of cardiac arrest diagnosis remains.

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<https://doi.org/10.1016/j.jacc.2019.01.030>

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Please note: Dr. Khera is supported by the National Heart, Lung, and Blood Institute (NHLBI) (5T32HL125247-02) and the National Center for Advancing Translational Sciences (UL1TR001105) of the National Institutes of Health. Dr. Chan is supported by funding from the NHLBI (R01HL123980). Dr. Girotra is supported by funding from the NHLBI (K08 HL122527) and the Veterans Health Administration (L21HX002365). The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication. The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the

Department of Veterans Affairs or the United States government. The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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