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ORIGINAL RESEARCH

Implementing the GWTG-CAD Program in Mexico: Feasibility, Challenges and Lessons Learned for Acute and Secondary Prevention and Management

Leslie Marisol Lugo-Gavidia, MD, MSc, MCM, PhD; Jorge F. Saucedo, MD, MBA; Alexandra Arias-Mendoza, MD; Manuel Odin De los Ríos Ibarra, MD; José L. Leiva-Pons, MD; Pedro Gutierrez-Fajardo, MD, PhD; Arturo Guerra Lopez, MD; Jorge Cosio, MD; Louise Morgan, MSN; Julia Mora, MSHSA, BSN; Eddy Manzo-Berding

BACKGROUND: The American Heart Association's GWTG (Get With The Guidelines) program has demonstrated effectiveness in standardizing and improving cardiovascular care in the United States. This study describes the implementation of the GWTG-CAD (GWTG–Coronary Artery Disease) program in Mexico and evaluates its impact on adherence to guideline-directed medical therapy and key clinical processes.

METHODS: Patients presenting with acute coronary syndrome from 10 hospitals in Mexico were included in the GWTG-CAD registry. Clinical processes and guideline-directed medical therapy use were assessed over the program's first 18 months, grouped into preprogram, 0 to 6 months, 6 to 12 months, and 12 to 18 months.

RESULTS: A total of 2363 patients were analyzed. Mean age was 62.7±12.4 years, and 73.4% were male. ST-segment–elevation myocardial infarction was the initial presentation in 65.4% (n=1546). Substantial improvements were achieved in time-sensitive care. The proportion of patients receiving an ECG within 10 minutes of arrival increased from 61% preprogram to 93% at 12to 18 months (P<0.001), and mean time to first ECG decreased from 23.3±38.7 minutes to 8.5±19 minutes (P<0.001). Guideline-directed medical therapy at discharge (aspirin, beta blockers, angiotensin-converting enzyme inhibitors/angiotensin receptor blockers, statins, and antiplatelet agents) remained consistently >85%. Significant improvements were observed on health processes, including ECG documentation (89%–97.3%), symptom onset recording (79.7%–90.1%), left ventricular ejection fraction assessment (73.4%–87.5%), and lipid profile measurement (42.7%–72%) (all P<0.001).

CONCLUSIONS: Implementation of the GWTG-CAD program in Mexico enabled the identification of critical barriers in cardiac care and supported targeted quality-improvement strategies, resulting in measurable improvements in clinical processes over 18 months.

Key Words: coronary artery disease ■ quality improvement program ■ quality indicators ■ STEMI

Over the past decades, international societies and organizations have developed clinical guidelines to promote standardized, evidence-based health care. However, the integration of guideline-directed medical therapy (GDMT) into routine practice remains challenging and often delayed. There is usually a significant lag between the generation of evidence and its effective translation into day-to-day clinical workflows.[1–3]

Correspondence to: Leslie Marisol Lugo-Gavidia, Mexican Academic Consortium for Clinical Data Acquisition SC, Río Choix 922, Col. Antonio Rosales. Sin., Mexico CP 80230. Curtin University, School of Population Health-Faculty of Health Sciences, Perth, Australia. Email: lugogavidia.cardiovascular@gmail.com

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RESEARCH PERSPECTIVE

What Is New?

- This study demonstrates the first implementation of the American Heart Association's Get With The Guidelines coronary artery disease program in Mexico, resulting in improvements in acute care processes.
- The program identified persistent gaps in emergency medical services use use, transfer pathways, and secondary prevention practices that require continued attention.

What Question Should Be Addressed Next?

- Future research should evaluate quality of care beyond the acute setting, including long-term medication adherence, clinical outcomes, and the scalability of this model across the continuum of care.

Nonstandard Abbreviations and Acronyms

AHA	American Heart Association
GDMT	guideline-directed medical therapy
GWTG	Get With The Guidelines
pPCI	Primary percutaneous coronary intervention

Additionally, with the pace of modern technological and scientific advancements, the rapid evolution of clinical guidelines often surpasses the capacity of health care systems to implement them effectively. This is especially prominent in regions where socioeconomic resources can influence the access and adoption of the latest clinical innovations.

Implementation science (IS) has emerged as a critical field for addressing these translational challenges. Implementation science focuses on understanding and addressing the factors that influence the uptake of evidence-based practices. By identifying system-level, provider-level, and patient-level barriers, implementation science helps quantify adherence to clinical recommendations and provides a framework for data-driven quality improvement strategies.[4,5] These efforts are essential for enhancing both the consistency and the effectiveness of health care delivery.

To address gaps in cardiovascular care, the American Heart Association (AHA) launched the "Get With The Guidelines" (GWTG) program over 20 years ago. This hospital-based quality improvement initiative aims to ensure consistent adherence to evidence-based guidelines across a range of cardiovascular conditions, including coronary artery disease (CAD), stroke, and other cardiovascular conditions.[6–14] The AHA-GWTG program has served to characterize and improve quality care patterns in the United States.[7,10–15] Recently, the program expanded internationally and started a pilot project in Mexico, Asia, and the Middle East. GWTG has demonstrated its utility in improving health care quality in different areas of cardiovascular medicine (CAD, stroke, atrial fibrillation, and heart failure) through the improvement of predefined performance metrics.[6–12]

This article aims to describe our experience implementing the first AHA GWTG program in Mexico focused on CAD (GWTG-CAD). We provide a detailed description of the main obstacles encountered when implementing the GWTG-CAD in Mexico, the strategies implemented to overcome these challenges and health care processes improvements over the first 18 months of the program.

METHODS

GWTG-CAD Mexico Program Components

GWTG-CAD is a quality improvement program led by the AHA focused at improving the quality of care for patients with CAD. In 2022, the AHA launched the GWTG Mexico pilot program, locally named "Calidad con Corazón." This initial pilot was implemented across 5 Mexican states (Mexico City, Sinaloa, San Luis Potosi, Nuevo Leon, and Jalisco) and included 10 high-volume hospitals (5 public and 5 private) with percutaneous coronary intervention (PCI) capabilities. Each participating hospital received either human research approval to enroll cases without individual patient consent under the common rule or a waiver of authorization and exemption from subsequent review by their institutional review board. The details of the GWTG program have been described previously.[6–12] Briefly, GWTG-CAD is a voluntary, ongoing, continuous registry that captures patient-level data using a web-based patient management tool. Additionally, the program incorporates educational activities, including learning sessions, didactic lectures, best practice sharing, and interactive workshops for health care professionals.[6–12] The program was directed by stakeholders, comprising AHA directives, and a local expert panel with representatives from major Mexican cardiology organizations: Sociedad Mexicana de Cardiologia, Asociacion Nacional de Cardiologos de Mexico, and Consorcio Academico Mexicano para la Obtencion de Datos Clinicos. Data for this study are available through the AHA-GWTG registry program. Access to the data is restricted and requires the completion of a formal data request process at the following website: https://pmp.heart.org/gwtg-cad-sdoh-data-resource.

Study Population

The program population included patients presenting with acute coronary syndrome identified using hospital admission records, the primary cardiac diagnosis, and corresponding *International Classification of Diseases, Tenth Revision* (*ICD-10*) admission codes, in alignment with GWTG-CAD methodology. Data were collected by trained hospital staff and included information on demographics, medical history, diagnostic testing, in-hospital treatments, in-hospital mortality, and discharge management. The web-based data collection system supports both concurrent (real-time) and retrospective data entry. Predefined logic within the tool ensures that mandatory sections are completed based on case characteristics. To promote data quality, hospitals received individualized feedback and regular reports to identify inconsistencies, improve data completeness, and encourage corrections when needed. The length of participation varied across hospitals; therefore, to account for differences in each hospital's learning curve, data were grouped by participation duration (0–6, 6–12, and 12–18 months) according to the date of acute coronary syndrome occurrence relative to each hospital's start of data collection. To establish a preprogram benchmark, hospitals were also instructed to retrospectively enroll 30 baseline cases randomly selected from the 6 months before program initiation. They were further encouraged to enroll a targeted number of cases per month, tailored to their monthly case volume and operational capacity. This analysis includes both baseline (preprogram) cases and cases from the first 18 months of each hospital's participation, covering the period October 2022 to July 2024.

Guideline Adherence Performance Measurements

As an incentive to promote high-quality care, GWTG-CAD incorporates a hospital recognition program based on adherence to evidence-based guidelines. A national expert panel selected 7 performance indicators for recognition (Figure 1), adapted from the US GWTG-CAD program.[16] Each indicator has specific inclusion and exclusion criteria, and hospital compliance is calculated as the percentage of eligible patients receiving the recommended care.[16] The data collection tool features a real-time reporting dashboard showing compliance rates for each measure, providing immediate feedback to drive continuous quality improvement. Although the primary focus is on secondary prevention, additional "*plus measures*" related to reperfusion management were included to further evaluate the quality of care and hospital performance (Figure 1).

Although the performance measurements are applied to specific populations (eg, ST-segment–elevation myocardial infarction [STEMI]) on a quarterly basis, for the purpose of this analysis, aggregate data on MI are presented where relevant to provide a broader view of quality improvement. STEMI was defined based on ECG characteristics and clinical diagnosis.

Statistical Analysis

Categorical variables are expressed as counts (n) and percentages (%), and continuous variables are reported as mean±SD. For time-dependent measures, additional descriptive statistics, including mean±SE and median with interquartile range (Q1–Q3) are

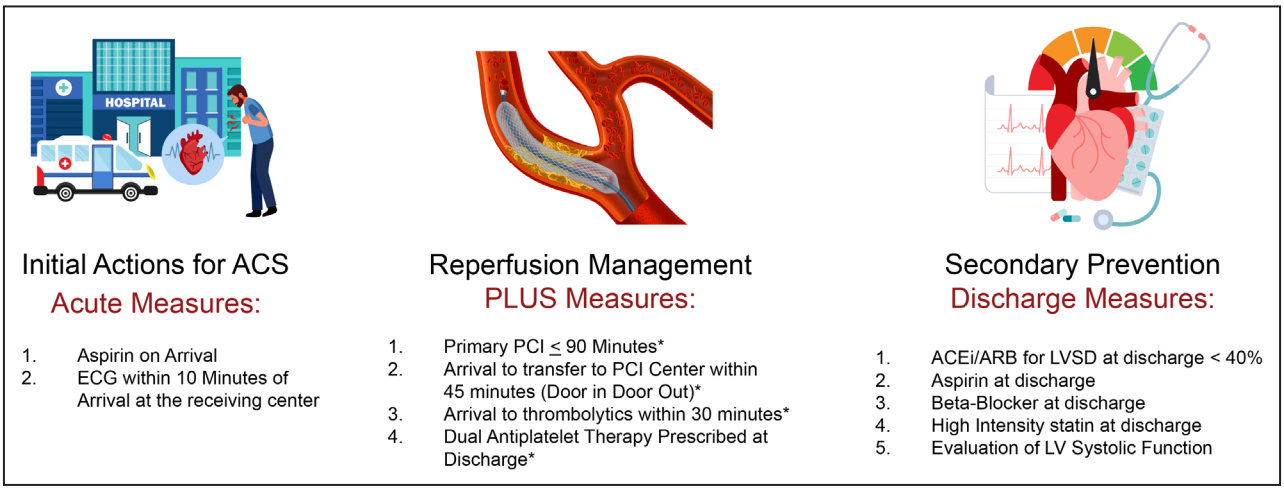

Figure 1. Calidad con Corazón: performance measures for hospital recognition.
GWTG awards require >85% compliance for all standard indicators. PLUS measures are additional reperfusion metrics; the PLUS award is granted when hospitals meet >85% compliance for all standard indicators and achieve ≥2 PLUS metrics. ACEi indicates angiotensin-converting enzyme inhibitors; ACS, acute coronary syndrome; ARB, angiotensin receptor blocker; GWTG, Get With The Guidelines; LV, left ventricular; LVSD, left ventricular systolic dysfunction; and PCI, percutaneous coronary intervention.

provided to enhance interpretation of the precision and distributional characteristics of these time-based outcomes. Quality control procedures using logic checks were applied to ensure data integrity, and cases that failed these checks were excluded from the analysis. Extreme outliers were excluded only for specific time-based process measures (eg, time to ECG) when values were clinically implausible or reflected documentation or system-entry errors (eg, negative times due to prehospital diagnosis or extreme delays resulting from atypical clinical presentations or workflows). Analyses were conducted on available data without imputation for missing values. Because this study is a feasibility and implementation analysis based on real-world registry data, missing data were considered informative and reflective of actual clinical practice rather than a limitation requiring correction through imputation.

Comparisons of clinical process measures were conducted using proportion tests, with differences between program phases evaluated using the chi-square test or Fisher's exact test when appropriate. Differences in time-dependent continuous variables were compared across program implementation phases preprogram, 0 to 6, 6 to 12, and 12 to 18 months using ANOVA. Homogeneity of variance was assessed using Levene's test. When this assumption was violated, Welch's ANOVA was applied. Post hoc pairwise comparisons between phases were conducted using pairwise Welch -tests with Holm adjustment to control for multiple comparisons. Effect sizes were estimated using omega-squared (ω^2), which provides a less biased estimate of explained variance and is appropriate for heteroscedastic and unbalanced designs. All statistical analyses were conducted using R version 4.5 (The R Project for Statistical Computing). A 2-sided *P* value <0.05 was considered statistically significant.

RESULTS

Patient Characteristics

This report includes a total of 2363 cases, comprising both preprogram cases and cases from the first 18 months of the GWTG-CAD Mexico pilot program. The cohort involved 69.3% (n=1638) patients from the public health system and 30.7% (n=725) from private health care institutions. Mexico City had the largest number of recruitment with 55.1% of the cases, followed by 26.5% in the north, and 18.4% in the west/center region.

The mean age of the cohort was 62.7±12.4 years, with 73.4% (n=1735) of patients being male. Overall, 57.8% (n=1365) had known hypertension, 41.8% (n=988) had diabetes and 13.8% (n=326) had dyslipidemia (0.6% with familial hypercholesterolemia). Cardiovascular preexisting comorbidities included 11.5% (n=271) MI, 1.8% (n=43) cerebrovascular disease (1.5% stroke and 0.2% transient ischemic attack), 0.7% (n=16) peripheral artery disease, and 1.6% (n=37) atrial fibrillation. Previous PCI was present in 7.7% (n=182) of cases, and 1.3% (n=30) had a previous coronary artery bypass graft. The mean creatinine level was 1.24±1.58 mg/dL with 1.1% (n=25) of patients on dialysis.

Clinical presentation was predominantly STEMI in 65.4% (n=1546), followed by non-STEMI (NSTEMI) (19.2%, n=454). Patients with unstable angina, chest pain, or nonspecific diagnosis (eg, *ICD-10* acute MI, unspecified) were grouped as others (n=363). Complications at first medical contact were more common in patients with STEMI than NSTEMI (heart failure: 12.2% versus 9.7%; cardiogenic shock: 4.9% versus 2.4%). The baseline characteristics of the study cohort by diagnosis are summarized in Table 1.

One third of the cohort (n=786) was transferred from another health care facility (non-PCI capable). The use of emergency medical services (EMS) was low (6% by ambulance; 1% by air), with the majority (89.7%) arriving via private vehicles, including 82 patients with cardiogenic shock. Importantly, among patients with MI, the mean time from symptom onset to arrival at a PCI-capable center (excluding interhospital transfers) was 435.1±538.5 minutes (NSTEMI: 602.5±724.9 minutes; STEMI: 380.9±449.9 minutes). Only 15.2% of patients with STEMI arrived within 90 minutes of symptom onset.

A prehospital 12-lead ECG was performed in 33.7% of cases (n=797). Among patients arriving directly to PCI centers, 78.9% had their first ECG within 10 minutes, with a mean time of 14.1±28.7 minutes (NSTEMI: 18.7±37.9 minutes; STEMI: 10±20.4 minutes). Nearly all patients with MI (97.6%) received aspirin at or within 24 hours before arrival.

Overall, 79.5% of the patients underwent PCI and coronary artery bypass graft was required in 8.3%. Among patients with STEMI, 552 (35.7%) received fibrinolysis, the majority subsequently undergoing pharmacoinvasive PCI (n=486). More than half of the patients who received fibrinolysis were transferred from another health care facility (58.7%). Primary PCI (pPCI) was performed in 703(45.5%) of the cases with STEMI, mainly on those arriving directly to the PCI center (n=519). Of those receiving pPCI, 54.9% achieved a door-to-balloon time of <90 minutes, with a mean time of 113.8±105.2 minutes.

Mean hospital length of stay was similar for STEMI (6.22±6.39 days) and NSTEMI (6.16±5.97 days). The mean left ventricular ejection fraction (LVEF) was 46.4±12.1%, with 22.1% having LVEF <40%. Most patients (90.1%) were discharged home, and 5.3% were

Table 1. Baseline Characteristics

	STEMI (N=1546)	NSTEMI (N=454)	Others (N=363)	Overall (N=2363)
Male sex	1181 (76.4%)	327 (72.0%)	227 (62.5%)	1735 (73.4%)
Age, y	62.5±11.8	64.5±12.5	61.2±14.5	62.7±12.4
Medical history				
Smoking	875 (56.6%)	215 (47.4%)	105 (28.9%)	1195 (50.6%)
Hypertension	867 (56.1%)	289 (63.7%)	209 (57.6%)	1365 (57.8%)
Diabetes	638 (41.3%)	207 (45.6%)	143 (39.4%)	988 (41.8%)
Dyslipidemia	176 (11.4%)	79 (17.4%)	71 (19.6%)	326 (13.8%)
Familiar hypercholesterolemia	12 (0.8%)	1 (0.2%)	2 (0.6%)	15 (0.6%)
Prior myocardial infarction	120 (7.8%)	105 (23.1%)	46 (12.7%)	271 (11.5%)
Prior PCI	70 (4.5%)	77 (17.0%)	35 (9.6%)	182 (7.7%)
Prior CABG	10 (0.6%)	13 (2.9%)	7 (1.9%)	30 (1.3%)
Prior cerebrovascular disease	24 (1.6%)	11 (2.4%)	8 (2.2%)	43 (1.8%)
Stroke	19 (1.2%)	9 (2.0%)	7 (1.9%)	35 (1.5%)
Transient ischemic attack	1 (0.1%)	3 (0.7%)	1 (0.3%)	5 (0.2%)
Unspecified	3 (0.1%)	0 (0%)	0 (0%)	3 (0.1%)
Prior peripheral artery disease	4 (0.3%)	7 (1.5%)	5 (1.4%)	16 (0.7%)
Atrial fibrillation	16 (1.0%)	12 (2.6%)	9 (2.5%)	37 (1.6%)
Dialysis	12 (0.8%)	9 (2.0%)	4 (1.1%)	25 (1.1%)
Symptoms onset to FMC	380.9±449.9	602.5±724.9	493.2±675.9	557.7±603.9
Transferred from another health care facility	658 (42.6%)	87 (19.2%)	41 (11.3%)	786 (33.3%)
Means of arrival to the health care facility				
Ambulance	93 (6.0%)	26 (5.7%)	23 (6.3%)	142 (6.0%)
Air	24 (1.6%)	0 (0%)	0 (0%)	24 (1.0%)
Walk-in	1375 (88.9%)	420 (92.5%)	325 (89.5%)	2120 (89.7%)
No documented*	54 (3.42%)	8 (1.7%)	15 (4.1%)	77 (3.2%)
In-hospital examinations and laboratory data				
Height, cm	166±11.0	166±10.4	166±11.0	166±10.9
Weight, kg	77.8±15.8	77.7±16.5	78.7±18.2	77.9±16.3
Systolic blood pressure, mm Hg	132±27.3	133±26.6	136±23.8	133±26.7
Heart rate, bpm	81.7±20.0	81.2±22.1	78.1±18.7	81.0±20.3
Heart failure documented at FMC	189 (12.2%)	44 (9.7%)	24 (6.6%)	257 (10.9%)
Cardiogenic shock documented at FMC	75 (4.9%)	11 (2.4%)	1 (0.3%)	87 (3.7%)
Creatinine, mg/dL	1.23±1.67	1.33±1.40	1.11±1.31	1.24±1.58
Low-density lipoprotein cholesterol, mg/dL	105±60.9	100±58.0	88.6±47.8	103±59.6
LVEF	44.4±10.8	49.0±13.2	53.4±13.7	46.4±12.1
LVEF <40%	396 (25.6%)	91 (20.0%)	36 (9.9%)	523 (22.1%)
PCI performed	1350 (87.3%)	328 (72.2%)	201 (55.4%)	1879 (79.5%)
CABG performed	114 (7.4%)	53 (11.7%)	28 (7.7%)	195 (8.3%)
In-hospital stay, d	6.22±6.39	6.16±5.97	3.68±5.02	5.83±6.19
In-hospital death	63 (4.1%)	6 (1.3%)	3 (0.8%)	72 (3.0%)

Data are shown as mean±SD for continuous variables and frequencies and percentages for categorical variables. CABG indicates coronary artery bypass graft; FMC, first medical contact; LVEF, left ventricular ejection fraction; NSTEMI, non–ST-segment–elevation myocardial infarction; PCI, percutaneous coronary intervention; and STEMI, ST-segment–elevation myocardial infarction.

*"Not documented" indicates either missing documentation at a PCI-capable hospital or, for transferred patients, absence of documentation regarding the mode of arrival to the initial health care facility.

transferred to other facilities. The in-hospital mortality rate was 3% (n=72), mostly in patients with STEMI (n=63). Discharge medication use is summarized in Table 2. In patients with STEMI, GDMT was prescribed in the vast majority (>85%)of cases, including aspirin in 97.4%, beta blockers in 88.4%, angiotensin-converting

Table 2. Prescribed Medications in Patients Discharged to Home Care

	STEMI (N=1410)	NSTEMI (N=413)	Others (N=306)	Overall (N=2129)
Aspirin	1374 (97.4%)	390 (94.4%)	231 (75.5%)	1995 (93.7%)
Beta blocker	1247 (88.4%)	325 (78.7%)	175 (57.2%)	1747 (82.1%)
Angiotensin-converting enzyme inhibitors/angiotensin receptor blockers	1210 (85.8%)	329 (79.7%)	185 (60.5%)	1724 (81.0%)
Antiplatelets*	1370 (97.2%)	372 (90.1%)	189 (61.8%)	1931 (90.7%)
Statin	1384 (98.2%)	391 (94.7%)	230 (75.2%)	2005 (94.2%)
Anticoagulant	148 (10.5%)	50 (12.1%)	25 (8.2%)	223 (10.5%)

*P2Y12 inhibitors (clopidogrel, prasugrel, or ticagrelor).
NSTEMI indicates non–ST-segment–elevation myocardial infarction; and STEMI, ST-segment–elevation myocardial infarction.

enzyme inhibitors or angiotensin receptor blockers in 85.8%, and statins in 98.2% of patients.

Barriers and Impact on Health Care Quality Over Time

The program identified key barriers to guideline-directed cardiac care, particularly in documentation and timeliness of care. Early in the program, missing data were frequent: First ECG date/time was missing in 7.7% of cases (mostly preprogram: 11%), with higher rates among transferred patients. After implementing systematic documentation protocols, ECG documentation improved from 89% (preprogram) to 97.3% at 12 to 18 months (P<0.001) (Figure 2). Other important timeline information presented the same problem. Symptom onset time was initially missing in 17.7%, data acquisition improved from 79.7% preprogram to 90.1% at 12 to 18 months (P<0.001). Among transferred patients, recording of arrival time at the first facility improved from 57.7% to 81.9% over time (P<0.001).

Importantly, in patients arriving directly to PCI centers, ECG within 10 minutes improved from 61% (preprogram) to 93% at 12 to 18 months (P<0.001) (Figure 3). The main documented reasons for the delay were emergency department delay, equipment-related issues, and atypical presentation. The arrival-to-ECG time decreased from a 23.3±38.7 minutes (median 8.5 [interquartile range, 5–20.25] minutes) preprogram to 8.5±19 minutes (median 5 [interquartile range, 4–7] minutes) at 12–18 months. Differences across program phases were statistically significant (P<0.001), with a small-to-moderate effect size (ω^2=0.045). Arrival to pPCI time showed no significant change over time (P=0.81), with 54.9% of eligible patients achieving PCI within the recommended 90 minutes. Delays were attributed to procedural, system, or patient-related factors.

GDMT was prescribed in >85% of MI cases. The overall use of angiotensin-converting enzyme inhibitors/angiotensin receptor blockers at discharge increased slightly from 83.9% to 90.4% at 12 to 18 months, whereas in patients with LVEF <40%, angiotensin-converting enzyme inhibitor/angiotensin receptor blockeruse ranged from 90.4% to 92.9% over the same period. No significant differences were observed between time points for other discharge medications (Table 3).

During the program, 2 critical gaps in care processes were identified. First, LVEF was not measured in 16.9% of patients with STEMI during the index admission. However, LVEF assessment improved over time, increasing from 73.4% preprogram to 87.5% at 12 to 18 months (P<0.001) across the overall population. Second, LDL measurement was missing in 40.8% of cases. Among those tested, 9.5% had low-density lipoprotein (LDL) ≥160 mg/dL. LDL measurement improved significantly from 42.7% preprogram to 72% at 12 to 18 months (P<0.001) (Figure 4).

DISCUSSION

This report represents the first experience of implementing AHA-GWTG in a Latin-American country, where socioeconomic factors significantly influence access to therapies and the quality of health care delivery. Through the implementation of the program in Mexico, we identified several key gaps in health care processes that affected the achievement of performance measures. These findings are particularly relevant, as limited data exist on the quality of cardiovascular care within the Mexican population. To date, most available information comes from Hispanic populations treated in the United States, which represent <10% of the GWTG-CAD database.[8,13]

The principal finding of this study is that the implementation of a quality improvement program is feasible in a Latin American setting. This was made possible through the establishment of partnerships between the American Heart Association, the main national cardiovascular societies (Sociedad Mexicana de Cardiologia, Asociacion Nacional de Cardiologos de Mexico, Consorcio Academico Mexicano para la Obtencion de Datos Clinicos), and key local organizations and stakeholders. The program successfully led to measurable

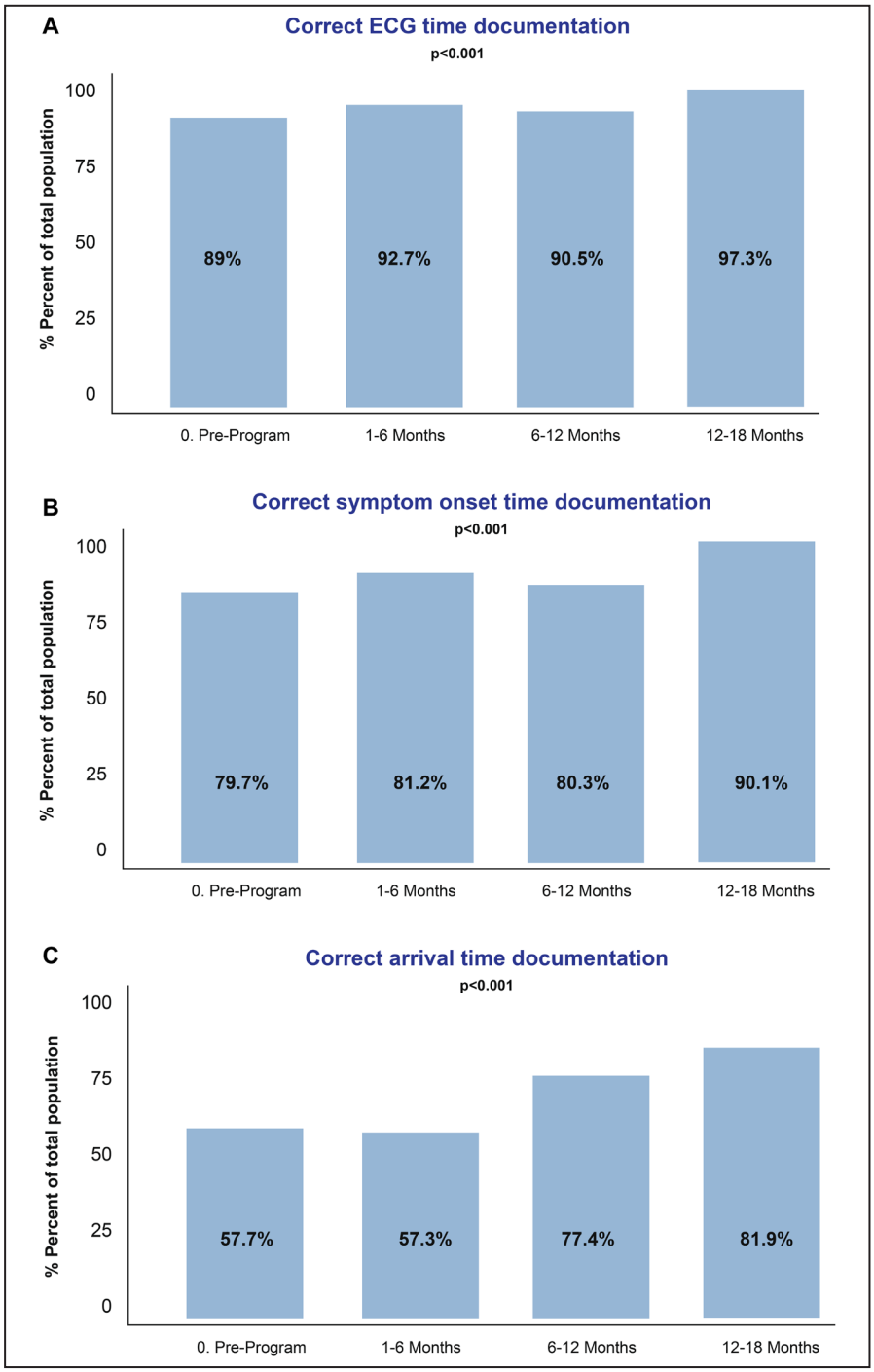

Figure 2. Improvements in appropriate documentation protocols.
A, Improved accuracy in ECG time documentation, **B**, Improved accuracy in symptom onset time documentation, **C**, Improved accuracy in hospital arrival time documentation for transferred patients (arrival at referring hospitals). Proportion differences were tested using chi-square, with significance defined as $P<0.05$.

improvements in health system processes. Notably, there was a substantial increase in the proportion of patients receiving an ECG within 10 minutes of arrival, which translated into an absolute reduction in door-to-ECG time. One of the major challenges encountered early in the program was the high rate of missing or incomplete documentation, particularly concerning the exact dates and times of symptom onset, hospital arrival, and first ECG. Although many cases had event dates recorded, the absence of precise times made it impossible to evaluate key performance measures such as time to ECG, time to treatment, and total ischemic time.

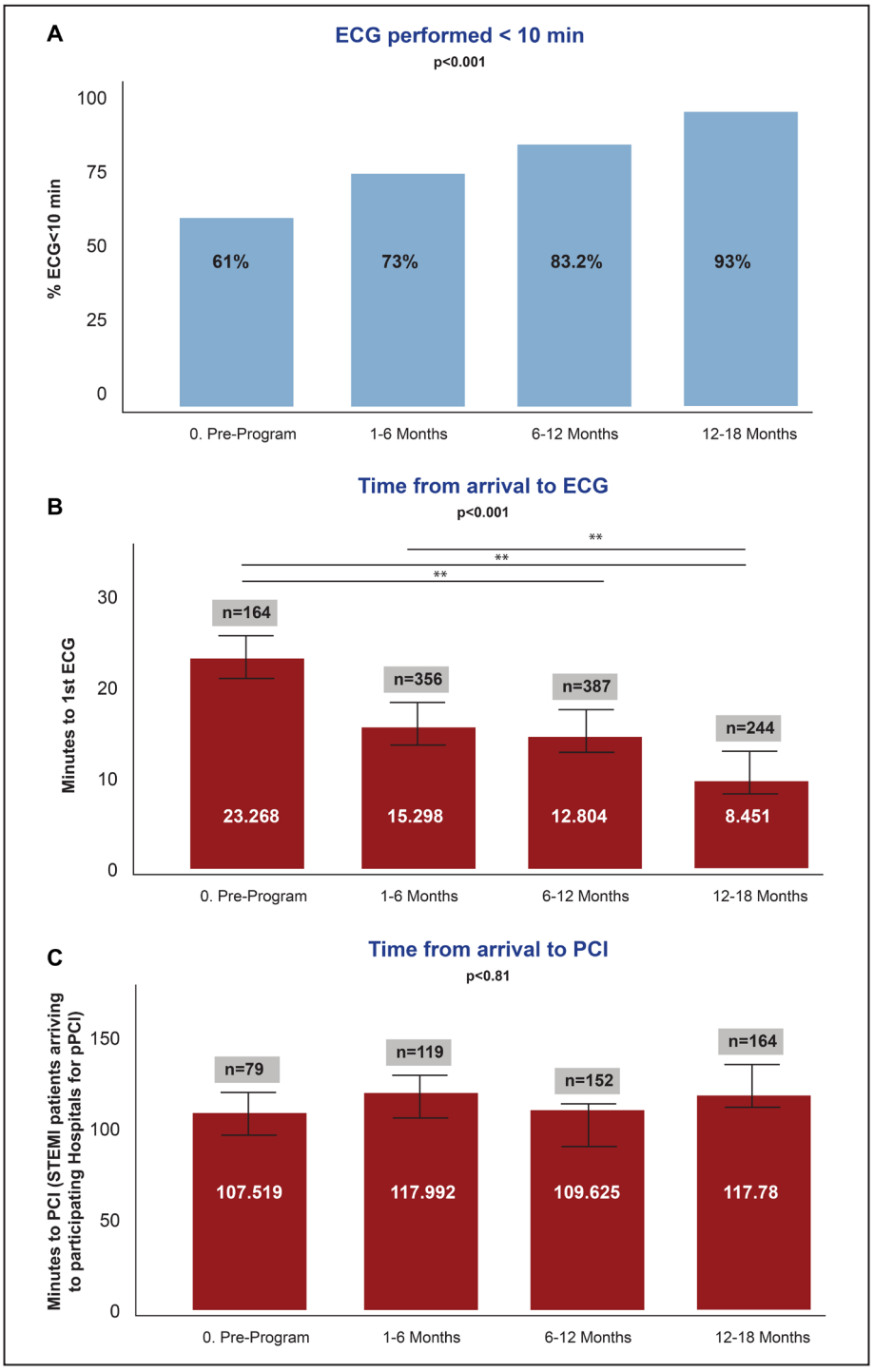

Figure 3. Trends in time metrics.
A, Percentage of patients receiving an ECG in <10 min of arrival(based on cases with available data), **B**, Mean time from arrival to ECG (mean±SE), **C**, Mean time from arrival to PCI (mean±SE). Preprogram refers to historic cases occurring before each hospital's program start date (~30 cases per hospital). Data represent patients arriving directly at the participating hospital. Continous data were evaluated using a Welch ANOVA, followed by post hoc comparisons adjusted with the Holm correction to account for multiple testing. Asterisks indicate statistically significant differences in post hoc tests between groups (*P<0.05; **P<0.01). Proportion differences were tested using chi-square, with significance defined as P<0.05.PCI indicates percutaneous coronary intervention; pPCI, primary percutaneous coronary intervention; and STEMI, ST-segment–elevation myocardial infarction.

Table 3. Trends in Discharge Medications in Patients Presenting With Myocardial Infarction (Data Include Aggregated STEMI and NSTEMI Cases)

Discharge medications	0 Pre-program	1–6 mo	6–12 mo	12–18 mo	Overall	*P* value
Aspirin	98.0%	99.1%	98.8%	98.7%	98.8%	0.5
ACE inhibitor or ARB at discharge	83.9%	86.3%	85.0%	90.4%	86.4%	0.1
ACE inhibitor or ARB (left ventricular ejection fraction <40%)	90.4%	85.7%	88.6%	92.9%	88.7%	0.4
Beta blocker	86.4%	86%	89.7%	86.2%	87.2%	0.2
Statins	98.2%	97.8%	98.7%	97.4%	98.1%	0.5
High-intensity statins	97.8%	96.5%	96.7%	93.9%	96.2%	0.1

The percentage was calculated based on the total number of cases with recorded data for each medication (excluding cases that had contraindications for the specific medication) Proportion differences were tested using chi-square, with significance defined as $P<0.05$. ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker; NSTEMI. non–ST-segment–elevation myocardial infarction; and STEMI, ST-segment–elevation myocardial infarction.

Missing data are a well-known limitation in clinical research, especially in registry-based studies, often resulting from the absence of standard operating procedures or inconsistent adherence to protocols. Additionally, the MI management involves multiple departments (eg, EMS, admissions, emergency care, cardiology, and the catheterization laboratory), making the standardization of care processes complex. The fragmented nature of Mexico's public health care system, composed of distinct federal, regional, and local institutions with separate

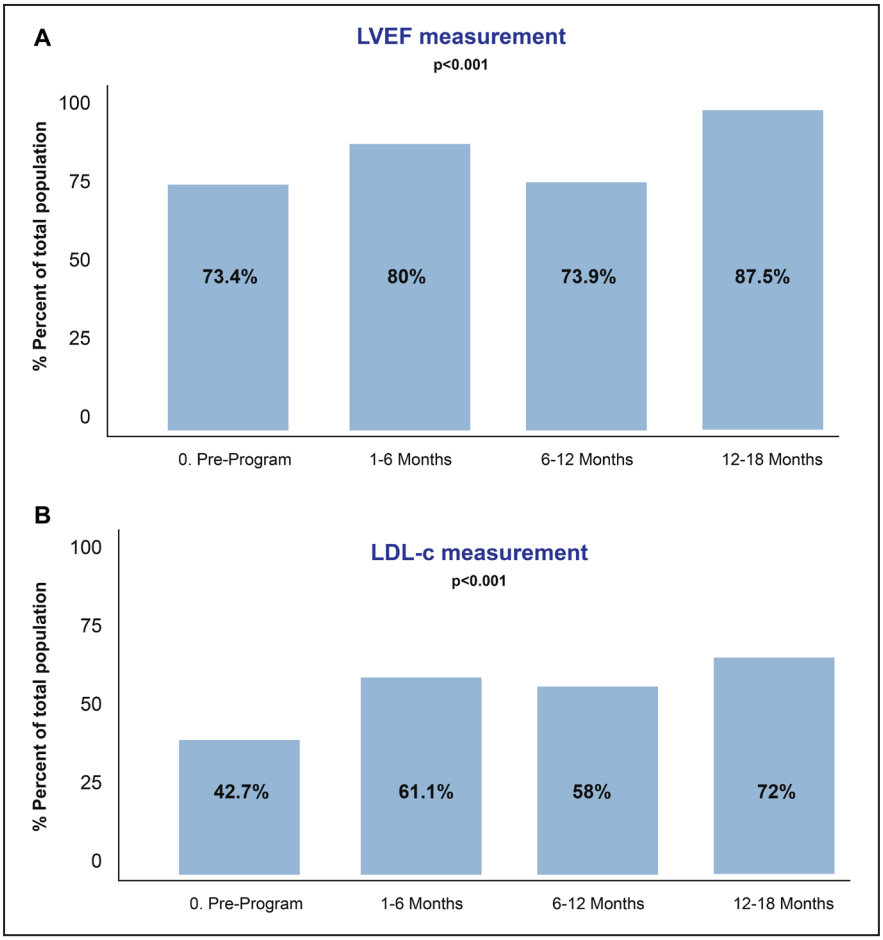

Figure 4. Improvements in health care processes before discharge.
A, Proportion of patients with LVEF measurement performed during the index admission. **B**, Proportion of patients with LDL-c measurement performed during admission. Proportion differences were tested using chi-square, with significance defined as $P<0.05$. LDL-c indicates low-density lipoprotein cholesterol; and LVEF, left ventricular ejection fraction.

organizational structures, further complicates the delivery of cardiovascular care. The absence of a shared electronic medical record system also contributes to critical information gaps, especially when patients are transferred between facilities.

The GWTG-CAD program helped implement standardized data collection tools across participating hospitals, allowing better tracking of the patient journey not only within institutions but also across referring centers (Figure S1). Program champions in each hospital provided training for emergency department teams and main referring facilities, which helped improve documentation compliance and expanded the network effect of the program. Importantly, the program identified equipment-related issues (eg, lack of ECG machines, technical delays) as a common factor for delays in obtaining timely ECGs. This led to infrastructure improvements, such as acquiring new or additional equipment, ensuring technical support, and relocating equipment closer to emergency departments, which contributed to the observed improvements in door-to-ECG times.

In terms of secondary prevention, guideline-recommended therapies were consistently prescribed in >0% of cases throughout the program. This is notably higher than the rates reported in other Mexican national registries, such as RENASCA 2018 (National Registry of the Acute Coronary Syndromes) and RENASICA III 2016 (Third National Registry of Acute Coronary Syndromes), where lower prescription rates for statins (62.7%–79.9%), beta blockers (50.9%–68.8%), and angiotensin-converting enzyme inhibitors (49.4%–69.4%) were observed.[17,18] The higher adherence in our cohort likely reflects both the selection of tertiary care centers for the pilot and the influence of more recent guideline updates, which emphasize comprehensive secondary prevention. The greater use of statins in the GWTG-CAD cohort may also reflect the stricter recommendations for cholesterol management in acute coronary syndrome. However, despite these improvements, nearly half of the cases lacked LDL-cholesterol (LDL-c) measurements. This is consistent with findings from other GWTG-CAD studies, such as the analysis by Qien et al., which reported LDL-c data in only 66% of cases. This highlights a persistent gap in care, as lipid assessment remains underused in the acute setting despite guideline recommendations to obtain lipid profiles within 24 hours of admission or from prior records.[19] Although lipid evaluation may seem less urgent during the acute MI phase, measuring LDL-c before discharge is essential to identify patients who may require high-intensity lipid-lowering therapy to achieve target LDL-c goals. Another area of incomplete assessment was the evaluation of LVEF. Because LVEF is crucial for guiding evidence-based therapies such as beta blockers and renin-angiotensin-aldosterone system inhibitors in patients with reduced systolic function, the absence of this information can lead to missed therapeutic opportunities. The GWTG-CAD program encouraged hospitals to systematically assess LDL-c and LVEF before discharge, which helped reduce the proportion of missing assessments and may have contributed to the observed increase in renin-angiotensin-aldosterone system inhibitors prescription rates over time.

Remaining Challenges and Future Directions

GWTG-CAD program led to important improvements in care processes and demonstrated good compliance with secondary prevention measures; however, achieving timely reperfusion remains a significant challenge in our setting. Reperfusion is the cornerstone of STEMI management, and although pPCI is the preferred strategy, its success is highly time dependent. Achieving the recommended PCI-mediated reperfusion time (<90 minutes for direct arrivals or <120 minutes when transfer is required)[20] remains difficult, particularly in emerging economies where health care systems face challenges such as delayed patient presentation, resource limitations, location-based constraints, and fragmented STEMI networks.[21–24]

In this study, only 54.9% of eligible patients achieved PCI within 90 minutes, similar to early GWTG-CAD data from 2003 to 2008 (~52%)[10] but notably lower than more recent reports showing compliance rates as high as 84.6% in other populations (GWTG 2015–2021 data).[13] Importantly, arrival-to-pPCI times in our cohort did not show significant improvement during the 18-month program. This is consistent with previous studies, which have demonstrated that improvements in reperfusion quality metrics often require 5 years or more to become evident.[9,10] This reflects the complexity of the processes involved and suggests that longer-term strategies and sustained interventions will be necessary before significant progress can be achieved on this indicator.

A key barrier identified was the mode of patient arrival. In Mexico, the vast majority of patients (89.7%) arrive at hospitals as walk-ins using private transportation, with EMS used in only 7% of cases, markedly lower than the ~50% EMS arrival rates in the United States.[8] This low EMS use delays early diagnosis and treatment because EMS not only provides prehospital ECGs but also facilitates direct transfer to PCI-capable centers, bypassing lower-level facilities. Several factors contribute to this pattern: out-of-pocket costs for ambulance transport can be substantial, stable patients often prefer to first present to primary care or regional hospitals without PCI capacity, and ambulance services are limited, primarily used for unstable patients. Consequently, timely transfer to pPCI centers is often

hindered by limited ambulance availability, geographic barriers, a shortage of trained personnel, and lack of 24/7 catheter laboratory access. These limitations likely explain the higher use of fibrinolysis (35.7%) in our population, compared with only ~5% reported in the US-based GWTG data set.[8,13]

There is compelling evidence that delays >1 hour between first medical contact and PCI are associated with increased mortality in patients with STEMI, likely due to higher rates of severe heart failure at discharge.[21,22] This reinforces the relevance of the "golden hour" concept even in the context of pPCI. In response to these challenges, several programs in Mexico have sought to improve STEMI care. For example, the PHASE-MX registry (Pharmacoinvasive Strategy Versus pPCI in STEMI Patients) showed that pharmacoinvasive strategies can achieve similar outcomes to pPCI when response times are optimized and patient selection is carefully considered.[21,25] These findings support the notion that pharmacoinvasive strategies are a viable, effective, and safe reperfusion option for patients with STEMI in settings where timely pPCI is not feasible.[15,21,25]

Our study also revealed that prolonged symptom onset to first medical contact times remain a critical issue, highlighting barriers that extend beyond the health care system itself. This underscores the need for public health initiatives to raise cardiovascular awareness, emphasizing symptom recognition and the importance of early medical attention.

Finally, despite the high adherence to GDMT at discharge, several challenges remain in long-term secondary prevention. Although the program measured GDMT during the acute phase of care, prescription patterns and adherence after discharge were not captured, limiting visibility into patients' longitudinal treatment across different levels of care. Medication adherence is particularly challenging in this setting due to socioeconomic factors, including limited access, out-of-pocket costs, polypharmacy, and side effects. Although the public health system provides basic cardiovascular medications, supply is constrained by annual budgets and eligibility criteria. Newer, guideline-recommended therapies are often unavailable outside highly specialized centers and are not included in public insurance plans. Furthermore, private insurance coverage is limited, leaving the majority of patients to bear out-of-pocket costs for essential medications, posing a significant obstacle in middle-income countries. To address these gaps, a second phase of the program has been developed to incorporate follow-up data collection, which will help identify both system- and patient-level barriers to long-term adherence and clinical outcomes.

This analysis has several inherent limitations that must be acknowledged. First, the data were self-reported by participating hospitals as part of a voluntary quality improvement initiative, and the program does not conduct systematic file cross-checks or external data audits. As such, the accuracy of some data elements may be limited. Second, the participating sites primarily represent tertiary care hospitals, which excludes other patient populations, such as those managed in regional hospitals, less specialized clinics, or primary care settings. Additionally, the recruitment rate was higher in public hospitals from the major specialized cardiology institutes in Mexico, which may introduce convenience sampling bias. As a pilot project, the overall sample size is smaller than that of the US GWTG-CAD registry, limiting the statistical power of the analyses and reducing the generalizability of the findings. Thus, these results do not represent a nationally representative sample of the Mexican population. Finally, although the study included both public and private health care centers, some important contextual differences must be considered. Public hospitals often face patient overload, infrastructure constraints, and limited budgets, all of which can severely impact guideline adherence. In contrast, private health care settings may offer faster care, but access is frequently restricted by out-of-pocket costs, which can influence clinical decision-making based on the patient's financial capacity. A formal comparison of the program's impact between the public and private sectors was beyond the scope of this initial analysis and would require a dedicated evaluation. Nevertheless, this study represents the first multicenter data set focused on quality-of-care measurements and health care process evaluation in the Mexican cardiovascular population.

CONCLUSIONS

In conclusion, this study demonstrates the feasibility of implementing a quality improvement program in Mexico for patients with acute coronary syndromes. Over 18 months, the GWTG-CAD pilot program achieved meaningful improvements in health care processes. Through interactive workshops, open-ended discussions, continuous feedback, and real-time data collection, participating hospitals were encouraged to identify local challenges and develop tailored strategies to address them. This collaborative approach, combined with the insights provided by the web-based tool, fostered a deeper understanding of the socioeconomic and structural barriers limiting the implementation of guideline-recommended care. The program facilitated the design and execution of targeted actions that contributed to the observed improvements in several health care processes. This study underscores the value of quality improvement initiatives in low- and middle-income countries and highlights both the context-specific limitations and the opportunities for

implementation science to drive health care advancements in resource-constrained settings. Moving forward, larger, longitudinal studies incorporating clinical outcomes will be essential to fully assess the long-term impact of quality improvement programs in developing countries and to inform strategies for a sustainable, system improvement.

ARTICLE INFORMATION

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Affiliations

Mexican Academic Consortium for Clinical Data Acquisition, Culiacán, México (L.M.L., M.O.D.I., J.L.L.); Curtin University, School of Population Health-Faculty of Health Sciences, Perth, Australia (L.M.L.); University of Arkansas for Medical Sciences, Little Rock, AR (J.F.S.); Instituto Nacional de Cardiología, Mexico City, México (A.A.); Centro para el Desarrollo de la Medicina y Asistencia Médica Especializada, Culiacán, México (M.O.D.I.); Grupo Intervencion San Luis, San Luis Potosí, México (J.L.L.); Hospital de Especialidades San Francisco de Asis. Cardiotest. Laboratorio de Ecocardiografia, Guadalajara, Jalisco, México (P.G.); Hospital Excel Tijuana, Tijuana, México (A.G.L.); Sociedad Mexicana de Cardiología, Ciudad de México, México (J.C.); and American Heart Association, Dallas, TX (L.M., J.M., E.M.).

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Supplemental Material

Figure S1
STROBE checklist

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