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A Novel Survey Tool to Quantify the Degree and Duration of STEMI Regionalization Across California

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Introduction: California has been a global leader in regionalization efforts for time-critical medical conditions. A total of 33 local emergency medical service agencies (LEMSAs) exist, providing an organized EMS framework across the state for almost 40 years. We sought to develop a survey tool to quantify the *degree* and *duration* of ST-elevation myocardial infarction (STEMI) regionalization over the last decade in California.

Methods: The project started with the development of an 8-question survey tool via a multi-disciplinary expert consensus process. Next, the survey tool was distributed at the annual meeting of administrators and medical directors of California LEMSAs to get responses valid through December, 2014. The first scoring approach was the Total Regionalization Score (TRS) and used answers from all 8 questions. The second approach was called the Core Score, and it focused on only 4 survey questions by assuming that the designation of STEMI Receiving Centers must have occurred at the beginning of any LEMSA's regionalization effort. Scores were ranked and grouped into tertiles.

Results: All 33 LEMSAs in California participated in this survey. The TRS ranged from 15 to 162. The Core Score range was much narrower, from 2 to 30. In comparing TRS and Core Score rankings, the top-tertiles were quite similar. More rank variation occurred between mid- and low-tertiles.

Conclusion: This study evaluated the *degree* and *duration* of STEMI network regionalization from 2004 to 2014 in California, and ranked 33 LEMSAs into tertiles based upon their TRS and their Core Score. Successful application of the 8-item survey and ranking strategies across California suggests that this approach can be used to assess regionalization in other states or countries around the world.

Key words: ST-elevation myocardial infarction, regionalization, STEMI Receiving Centers, Total Regionalization Score, Core Score, Emergency Medical Services, networks

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Regionalization, organized networks, and systems of care all promote the widespread dissemination of guideline-based evidence into actual practice. Current policy statements from the American Heart Association advocate for the creation of regional systems of care for several time critical diagnoses, including ST-elevation myocardial infarction (STEMI), out-of-hospital cardiac arrest (OHCA) resuscitation, and acute stroke.[1–3] Creation of these regional networks requires multi-disciplinary collaboration to implement 5 mutually reinforcing core elements: (1) designating certain hospitals as Receiving Centers, (2) destination protocols for emergency medical services (EMS), (3) organized interhospital transfers, (4) real-time 2-way digital communication, and (5) quality improvement (QI) registry participation (Fig. 1).

California has been a global leader in regionalization efforts for time-critical medical conditions. A total of 33 local EMS agencies (LEMSAs) exist, providing an organized EMS framework across the state for almost 40 years. Some LEMSA have single-county jurisdictions (usually major urban areas) whereas other jurisdictions include several adjacent rural counties. Because each LEMSA independently plans, implements, and evaluates its EMS system, we sought to develop a survey tool to quantify the *degree* and *duration* of STEMI regionalization over the last decade across California. Moreover, this assessment tool may serve as a model for other EMS agencies and health-care administrators that wish to quantify regionalization in their emergency care systems.

METHODS

The project started with development of an 8-question survey tool (appendix, supplemental material, available at http://links.lww.com/HPC/A202) via a multidisciplinary expert consensus process. Four pairs of questions focused on the following attributes: EMS devices and destination protocols, the designation of certain percutaneous coronary intervention (PCI) hospitals as STEMI Receiving Centers (SRCs), inter-hospital transfer protocols for non-PCI referral hospitals, and the region's quality improvement process. The degree of utilization for each variable was assessed by multiple-choice format for each LEMSA region: A—none (0%), B—some (<50%), C—most (50–94%), D—all (≥95%), and E—unknown. The duration was evaluated by asking participants for the calendar year that choice C or D was true for each of the 8 questions.

Next, the 8-question survey tool was distributed at the annual meeting of administrators and medical directors of California LEMSAs to get responses valid through December, 2014. Incomplete or inconsistent survey response received e-mail follow-up for clarification by the study coordinator. Published ranking was deidentified, but each LEMSA confidentially received their scores.

The first scoring approach was the Total Regionalization Score (TRS). Points were assigned for each selected answer in the survey (A = 0 point, B = 1 point, C = 2 points, and D = 3 points) and multiplied by the number of years that each choice was true. This calculation was repeated for all 8 questions in the survey and summed to yield the TRS for each LEMSA. The 33 LEMSAs were then ranked from highest to lowest TRS on an Excel spreadsheet.

An example of TRS calculations comes from a hypothetical region that first equipped at least 50% of its paramedic units with prehospital electrocardiogram (PH-ECG) devices in the year 2010, and then was able to equip all their ambulances in 2011. Thus, the "C" choice in 2010 would equal 2 points (2 points × 1 year) and a "D" choice from 2011 to 2014 would equal 12 points (3 points × 4 years), resulting in 14 total points for question #1. Repeat these steps for Questions #2 to #8 and sum to find the TRS for this hypothetical LEMSA.

The second approach was called the Core Score, and it focused on only 4 survey questions by assuming that the designation of SRCs must have occurred at the beginning of any LEMSA's regionalization effort. The Core Score then evaluated the evolution of either

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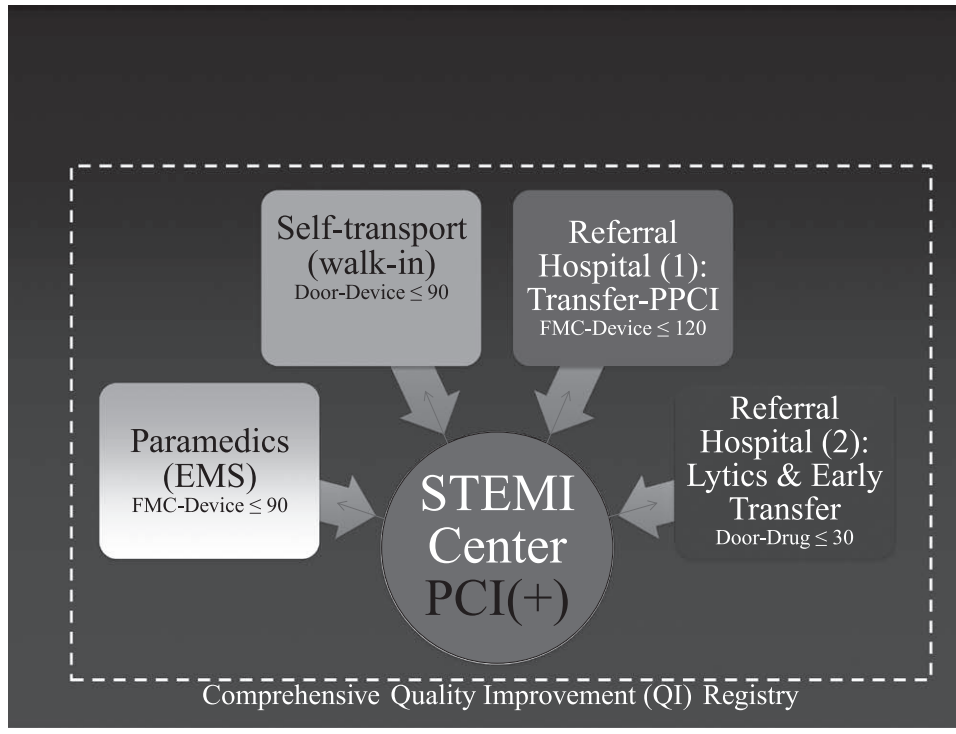

FIGURE 1. The 4 express lanes of a regional STEMI network.

PH or interhospital networks as a spectrum: none, partial, substantial, or complete and scored as 0, 1, 2, and 3 points, respectively, for each year that a given threshold was achieved. Core elements of any PH network are the presence of PH-ECG devices and Destination Protocols to the SRC (survey questions 1 and 2). Similarly, interhospital transfer primarily depends on identifying the 2 types of non-PCI hospitals: type 1 Referral Hospitals are urban/suburban and transfer directly to an SRC for primary PCI (question 5), whereas type 2 Referral Hospitals are too far away (rural/remote) to meet guideline-based PCI metrics and need to provide pretransfer fibrinolytics to eligible patients (question 6).

With the Core Score, partial regionalization was defined as the occurrence of "C" status for either PH (both questions #1 and #2) or interhospital survey items (either questions #5 or #6), whereas substantial regionalization occurred in the calendar year that "C" applied for both PH and interhospital questions. Complete regionalization in LEMSA occurred in the calendar year that "D" (≥95%) was selected both for questions #1 and #2, as well as the highest choice from either question #5 or #6.

A Core Score calculation example comes from the following hypothetical region. In 2008, this region equipped more than 50% of the ambulances with PH-ECG devices and simultaneously instituted destination protocols. Next, in 2010, it got most referral hospitals transferring to their nearest SRC, and then in 2012 got all (≥95%) of the EMS vehicles fully equipped and all of their referral hospitals transferring. This scenario would be quantified as follows: 2 years (2008 to 2009) of partial regionalization would yield 2 points, 2 years (2010 to 2011) of substantial regionalization would yield 4 points, and 3 years (2012 to 2014) of complete regionalization would yield 9 points, for a total core score of 15 points.

RESULTS

All 33 LEMSAs in California participated in this survey. Questions were answered from the inception of each STEMI program (the earliest was 2004) through the end of 2014. The majority (27 of 33) LEMSAs reported that all (≥95%) of their EMS providers could now bypass nearby non-PCI hospitals when transporting PH-ECG identified STEMI patients to the SRC, whereas only a minority (2) had no EMS destination protocols. Similarly, most (21 of 33) LEMSAs now had a ≥95% proportion of non-PCI hospitals with interhospital transfer protocols to an SRC, but 6 LEMSAs still had no known interfacility transfers in 2014.

The TRS ranged from 15 to 162 (Table 1). The low-tertile scores ranged from 15 to 41, the mid-tertile from 42 to 96, and the top-tertile from 112 to 162. Because 2 LEMSA had identical scores, the low-tertile contains 12 regions (rather than 11).

The Core Score range was much narrower, from 2 to 30 (Table 1). The low-tertile scores ranged from 2 to 8, the mid-tertile from 9 to 15, and the top-tertile from 16 to 30. Because 4 LEMSAs had identical core scores, the low-tertile contains 14 regions (rather than 11).

In comparing TRS and Core Score rankings, the top-tertiles were quite similar. Only 1 LEMSA went from the TRS top-tertile to the Core Score mid-tertile. In contrast, 4 LEMSAs in the mid-tertile for TRS were demoted to the Core Score low-tertile, and 2 LEMSAs in TRS low-tertile were promoted to Core Score mid-tertile.

Comments

Several key findings exist. First, this study demonstrates that it is possible to quantify the *degree* and *duration* of STEMI network regionalization across an entire state. Second, two novel ranking strategies are introduced and compared: the TRS and the Core Score. The 8-question TRS approach provided more discriminatory power to rank the 33 LEMSA, whereas the 4-question Core

TABLE 1. TRS and Core Score of California LEMSAs

LEMSA	TRS	LEMSA	Core Score
Region 1	162	Region 3	30
Region 2	156	Region 1	27
Region 3	153	Region 5	26
Region 4	147	Region 2	25
Region 5	145	Region 6	24
Region 6	144	Region 7	24
Region 7	144	Region 8	21
Region 8	126	Region 11	18
Region 9	115	Region 4	17
Region 10	113	Region 9	16
Region 11	112	Region 16	15
Region 12	96	Region 13	15
Region 13	90	Region 14	15
Region 14	90	Region 15	15
Region 15	84	Region 10*	14
Region 16	83	Region 12	11
Region 17	77	Region 18	10
Region 18	52	Region 31†	10
Region 19	48	Region 24†	9
Region 20	45	Region 28	8
Region 21	42	Region 30	8
Region 22	41	Region 29	8
Region 23	41	Region 17*	8
Region 24	39	Region 26	7
Region 25	39	Region 21*	6
Region 26	37	Region 20*	6
Region 27	30	Region 19*	6
Region 28	29	Region 32	5
Region 29	26	Region 33	5
Region 30	25	Region 25	5
Region 31	24	Region 22	5
Region 32	24	Region 23	4
Region 33	15	Region 27	2

Top-tertile
Mid-tertile
Low-tertile
*Tertile decreased from TRS.
†Tertile increased from TRs.

Score involved fewer survey calculations. Third, these 2 ranking strategies provide a quantitative framework for an ongoing study across California (funded by the *National Institutes of Health* and *National Heart, Lung, and Blood Institute*, grant #1R56HL121108-01A1) that seeks to evaluate the impact of regionalization over the last decade on STEMI patient clinical outcomes. Fourth, successful application of the 8-item survey and ranking strategies across California (population over 38 million) suggests that this approach can be used to assess regionalization in other states or countries around the world.

Several limitations also exist for this study. First, misclassification bias by survey participants was a concern. Some LEMSAs were able to provide policy documents that substantiated their answers, but others could not. Second, leadership changes occurred in some LEMSAs, whereas others had the same leader across the study period (2004 to 2014) with better knowledge of key start points. Third, question misinterpretation did occur and was noted by answers that did not follow a logical timeline (e.g., active EMS destination protocols or interhospital transfers before designating SRCs within the LEMSA). The study coordinator followed up via e-mail to clarify discrepancies. In addition, a prior geospatial mapping study[4] of California provided another database for comparison. Fourth, the annual multiplier gives more weight to the *duration* as compared to the *degree*. Fifth, this study did not evaluate quality (time to reperfusion), efficiency (inappropriate Cath Lab activations), financial considerations, or each LEMSA's impetus to start regionalizing STEMI care.

Although Table 1 has detailed ranking of the 33 LEMSAs, the ranking by tertiles seems more appropriate given the various factors described in limitations earlier. Moreover, there is often a time lag between LEMSA policy approval and actual real-world implementation.

In conclusion, this study evaluated the *degree* and *duration* of STEMI network regionalization from 2004 to 2014 in California and ranked 33 LEMSAs into tertiles based upon their TRS and their Core Score.

DISCLOSURES

Nothing to declare.

DISCLAIMER

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