

Referral Regions for Time-Sensitive Acute Care Conditions in the United States

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Study objective: Regional, coordinated care for time-sensitive and high-risk medical conditions is a priority in the United States. A necessary precursor to coordinated regional care is regions that are actionable from clinical and policy standpoints. The Dartmouth Atlas of Health Care, the major health care referral construct in the United States, uses regions that cross state and county boundaries, limiting fiscal or political ownership by key governmental stakeholders in positions to create incentive and regulate regional care coordination. Our objective is to develop and evaluate referral regions that define care patterns for patients with acute myocardial infarction, acute stroke, or trauma, yet also preserve essential political boundaries.

Methods: We developed a novel set of acute care referral regions using Medicare data in the United States from 2011. For acute myocardial infarction, acute stroke, or trauma, we iteratively aggregated counties according to patient home location and treating hospital address, using a spatial algorithm. We evaluated referral political boundary preservation and spatial accuracy for each set of referral regions.

Results: The new set of referral regions, the Pittsburgh Atlas, had 326 distinct regions. These referral regions did not cross any county or state borders, whereas 43.1% and 98.1% of all Dartmouth Atlas hospital referral regions crossed county and state borders. The Pittsburgh Atlas was comparable to the Dartmouth Atlas in measures of spatial accuracy and identified larger at-risk populations for all 3 conditions.

Conclusion: A novel and straightforward spatial algorithm generated referral regions that were politically actionable and accountable for time-sensitive medical emergencies. [Ann Emerg Med. 2018;■:1-9.]

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INTRODUCTION

Regionalized care is a system-level public health strategy in which patients are routed to specific hospitals according to diagnosis, illness severity, and hospital capability.^{1,2} For time-sensitive conditions such as acute myocardial infarction,^{3,4} acute stroke,⁵ and major trauma,^{6,7} regionalization has the potential to save lives by concentrating complex care in high-volume, high-quality centers. More than 10 years ago, a National Academy of Medicine report endorsed coordinated, regional, accountable systems as an approach to improve health care quality for severe acute conditions related to trauma and emergency care.⁸ Despite this recommendation, implementation efforts face barriers, including a lack of accountable geographic referral regions to organize or evaluate these systems of care.

The Dartmouth Atlas of Health Care, a set of geographic regions based on Medicare and Medicaid hospital discharge claims, is used epidemiologically for comparing the cost,⁹ quality,¹⁰ and consumption¹¹⁻¹³ of health care in different parts of the country. Unfortunately, the hospital referral regions of the Dartmouth Atlas are not actionable from either fiscal or political standpoints, with almost all regions crossing county and state borders,¹⁴ and therefore lack accountability. Consequently, Dartmouth Atlas regions do not engender ownership, do not have clear stakeholders, and are not well suited for organizing or evaluating regionalized care.

We sought to develop actionable referral regions for 3 time-sensitive acute care emergencies—acute myocardial infarction, acute stroke, and trauma—and then compare these regions with the Dartmouth Atlas. We hypothesized that a set of accountable referral regions for time-sensitive

Editor's Capsule Summary*What is already known on this topic*

To improve the quality of emergency and trauma care provided in the United States, we need a regional system.

What question this study addressed

The authors used 2011 Medicare fee-for-service inpatient claims for 3 time-sensitive conditions to identify distinct geographic regions based on where the majority of residents in each county received their care and the preservation of county and state boundaries.

What this study adds to our knowledge

The Pittsburgh Atlas consists of 326 emergency and trauma referral regions for emergency and trauma care that uphold political boundaries.

How this is relevant to clinical practice

The Pittsburgh Atlas provides a framework for the development of an integrated and coordinated emergency and trauma care system in the United States.

medical emergencies could be developed with an iterative data-driven spatial algorithm.

MATERIALS AND METHODS**Data Collection and Processing and Selection of Participants**

We performed a geospatial analysis using data from the Medicare Provider Analysis and Review (MedPAR) file from 2011. MedPAR contains inpatient hospital records for all fee-for-service Medicare beneficiaries. We identified patients with acute myocardial infarction, acute stroke, and trauma, using previously validated *International Classification of Diseases, Ninth Revision, Clinical Modification* codes (see [Appendix E1](#), available online at <http://www.annemergmed.com>).¹⁵⁻¹⁷ We chose these conditions because they are time-sensitive acute care emergencies that require coordination between out-of-hospital providers, emergency departments, specialist teams, and special hospital resources. These conditions are also subject to ongoing regionalization efforts in which patients are transported to specific centers according to patient condition and hospital capabilities. We elected to pool all 3 conditions, rather than create separate referral regions for each condition, because condition-specific

referral regions would be more difficult to implement and would emphasize silos of care delivery rather than coordination. To construct regions, we used maps of US ZIP codes, counties, and state boundaries for 2011, obtained from the United States Census Bureau,¹⁸ and a map of Dartmouth Atlas hospital referral regions¹⁴ for comparison.

Details about the development of candidate sets of referral regions are provided in [Appendix E1](#), available online at <http://www.annemergmed.com>. Briefly, we developed candidate sets of referral regions by aggregating counties in the United States, using patient home locations and treating hospital locations. We used counties as unit of aggregation because they are accountable political and fiscal units (unlike individual or groups of ZIP codes), and they frequently coordinate local public health activities. The process involved 3 sequential steps. First, we calculated the frequency and location of hospital referrals (ie, where patients were treated) for each residential county (ie, where patients live) in the United States. Second, we joined each residential county to the most frequent hospital referral county, allowing for multiple residential counties to join to a single hospital referral county. Third, in accordance with a decreasing threshold of relatedness, we combined the aggregated groups of counties from the second step. This process resulted in progressively smaller overall numbers of referral regions. We performed these steps twice: with and without a restriction that regions could cross state lines. This process resulted in 6 total candidate sets of regions.

Primary Data Analysis

We compared our 6 candidate sets of regions to one another and the Dartmouth Atlas Hospital Referral Regions, using a conceptual framework, which holds that useful hospital referral regions should delineate where patients live and receive their health care, and that valid hospital referral regions should foster collaboration between hospitals, physician organizations, and public health agencies.⁸ To evaluate the potential utility of each set of regions and the Dartmouth Atlas, we used separate measures of accountability and accuracy. For a region to engender accountability from stakeholders, it should not intersect political boundaries because this creates fragmented constituencies with potentially unclaimed political ownership. As a fundamental construct, a region must also accurately define where patients live and receive care.

To assess accountability, we summarized the number of referral regions that intersected county or state boundaries for each set of referral region builds and for the Dartmouth Atlas.

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