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Access to Care for Patients With Time-Sensitive Conditions in Pennsylvania

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Abstract

Study objective: Collective knowledge and coordination of vital interventions for time-sensitive conditions (ST-segment elevation myocardial infarction [STEMI], stroke, cardiac arrest, and septic shock) could contribute to a comprehensive statewide emergency care system, but little is known about population access to the resources required. We seek to describe existing clinical management strategies for time-sensitive conditions in Pennsylvania hospitals.

Methods: All Pennsylvania emergency departments (EDs) open in 2009 were surveyed about resource availability and practice patterns for time-sensitive conditions. The frequency with which EDs provided essential clinical bundles for each condition was assessed. Penalized maximum likelihood regressions were used to evaluate associations between ED characteristics and the presence of the 4 clinical bundles of care. We used geographic information science to calculate 60-minute ambulance access to the nearest facility with these clinical bundles.

Results: The percentage of EDs providing each of the 4 clinical bundles in 2009 ranged from 20% to 57% (stroke 20%, STEMI 32%, cardiac arrest 34%, sepsis 57%). For STEMI and stroke, presence of a board-certified/board-eligible emergency physician was significantly associated with presence of a clinical bundle. Only 8% of hospitals provided all 4 care bundles. However, 53% of the population was able to reach this minority of hospitals within 60 minutes.

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Author contributions: RAS and BGC conceived the study and supervised the collection, management, and analysis of data. BGC designed the survey and obtained research funding. DFG, RAB, BSA, and BGC reviewed the survey and created the time-sensitive categories. RAS, JME, and BGC drafted the article, and all authors contributed substantially to its revision. BGC takes responsibility for the paper as a whole.

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Conclusion: Reliably matching patient needs to ED resources in time-dependent illness is a critical component of a coordinated emergency care system. Population access to critical interventions for the time-dependent diseases discussed here is limited. A population-based planning approach and improved coordination of care could improve access to interventions for patients with time-sensitive conditions.

INTRODUCTION

Background

Patients presenting to emergency departments (EDs) with critical illness require prompt interventions to achieve optimal outcomes. Previous efforts to organize care for specific disease conditions, especially trauma, have been endorsed by the Institute of Medicine and demonstrated to improve survival.[1–5] The success of these initiatives prompted the institute to call for "coordinated, regionalized, and accountable" systems of emergency care.[6–17] To date, little has been done to proactively and systematically design the emergency care system writ large.

A key first step in designing a system of care is to develop a transparent accounting of hospital resources and capabilities. This has been done for specific disease conditions. Trauma centers meet requirements outlined by the American College of Surgeons[18] and have been demonstrated to reduce injury-related mortality. Burn centers are verified by the American Burn Association.[19] Primary Stroke Centers are certified by The Joint Commission (TJC),[20] and rapid administration of tissue plasminogen activator at stroke centers improves neurologic outcomes in patients with ischemic stroke.[21,22] Patients treated with percutaneous coronary intervention after ST-segment elevation myocardial infarction (STEMI) have decreased morbidity and mortality,[23] and STEMI centers can be identified[20] by the American Heart Association's Mission Lifeline initiative.[24]

Comatose postarrest patients treated with therapeutic hypothermia after return of spontaneous circulation have been shown to have significantly improved neurologic outcomes (16% to 23%) and mortality (14% to 17%),[25,26] and a certification system for cardiac arrest care has been described.[27] Early goal-directed therapy improves survival in patients with severe sepsis and septic shock by 16% to 25%,[28] and national efforts have attempted to improve uptake of evidence-based therapies.[29] Several of these disease conditions have used the population planning perspective to describe the degree to which they serve the needs of the US population.[3,11,24,30–32] National and international guidelines recommend these interventions as standard of care and have built time benchmarks into their endorsement.[33–36] To our knowledge, no central reporting of resources or credentialing system exists that outlines the emergency care capabilities of hospitals in the United States across these different disease domains.

Importance

The strategic development of systems of care to ensure that critically ill patients receive high-quality care has the potential to improve both coordination of care and patient-centered outcomes.

Goals of This Investigation

We sought to describe the proportion of Pennsylvania EDs that provide evidence-based practices for critical illness. We believe that understanding the availability of critical emergency services provides insight into the state's emergency care system. This information can be used for 2 purposes. First, a transparent understanding of a state's emergency care infrastructure allows the strategic development of a statewide system of care for time-sensitive critical illness. Potential system design implications include emergency medical services (EMS) destination protocol development, prenegotiated transfer agreements, and telemedical consultation services. Second, the decisionmaking of educated consumers allows market forces to play a role in the ongoing development of the emergency care system. Because no comprehensive source exists to catalog emergency capabilities, to our knowledge, we offer a snapshot of available resources in Pennsylvania, with an emphasis on the variability in staffing, resources, and management strategies demonstrated to improve outcome for 4 time-sensitive conditions.

MATERIALS AND METHODS

Theoretical Model of the Problem

The last half century has seen dramatic medical advancements, including in the realm of emergency care, but the advancement of the delivery system has failed to keep pace with medical advancements, and wide variability in practice and outcomes has resulted. Aside from the conditions that have their own specialty credentialing process, relatively little is known about the capabilities of US hospitals to appropriately treat conditions requiring rapid diagnostics and sophisticated interventions, and little has been done to plan emergency care systems from the population perspective. We illustrate the capability of the emergency care system in Pennsylvania to deliver care for 4 unplanned illnesses that require rapid intervention to inform and improve coordinated planning efforts.

Study Design

We developed a 46-item survey describing hospital staffing, characteristics, resources, and practice patterns pertinent to the practice of emergency medicine, using established survey methods.[37] Multiple choice, Likert scales, and free-form text answers were used for questions on demographics, staffing, resources, and practices of the ED. The initial survey draft was piloted in a focus group composed of academic emergency physicians and experienced health services researchers. The survey instrument was revised according to the feedback of the focus group participants.

The finalized survey was distributed to a compiled list of all hospitals with an ED in the commonwealth of Pennsylvania in 2009. A prenotice letter announcing the survey arrival and orienting participants to the goals of the survey was addressed to the ED director and mailed to each of the hospitals. The survey was mailed 1 week later and addressed in an identical manner. Included with the survey was a cover letter introducing the survey, a self-addressed stamped envelope, and a $2 bill as a token incentive. A reminder postcard was sent 2 weeks after the survey was mailed. Telephone calls and e-mails were made to nonresponders, and surveys were remailed as needed in an effort to increase response rate. Survey responses were received during 6 months, with the exception of 1 hospital that was inadvertently excluded from the initial mailing and subsequently contacted before final data analysis. Additional data on hospital demographics were derived from the American Hospital Association (AHA) 2009 Annual Survey. This study was deemed exempt from review by the institutional review board at the University of Pennsylvania.

Setting

Our initial list of Pennsylvania hospitals was acquired from the Pennsylvania Department of Health's 2006–2007 Annual Hospital Questionnaire. This list was then verified with the Agape Centers list of Pennsylvania hospitals, the Pennsylvania chapter of the American College of Emergency Physicians, and Pennsylvania Health Care Cost Containment Council's information on hospital closures, mergers, and name changes.[38,39] The final list of facilities represented all EDs open in Pennsylvania in 2009.

Methods of Measurement

Information on demographics, staffing, resources, practices, and transfer policies was collected from each participating hospital. Each type of ED staffing, including attending physicians, residents, and nurse practitioners, was assessed as either "regularly available" or "always available" (24 hours a day/7 days a week/365 days a year). Specialist availability was assessed as "never available," "sometimes available," "always available but not always within 1 hour," and "always available within 1 hour." Resources and practice patterns specific to the care of the 4 time-sensitive conditions described were classified as above. Hospitals transfer practices were assessed 2 ways: as an estimate of overall adult and pediatric patients transferred (<5%, 5% to 10%, 10% to 15%, 15% to 20%, 20% to 25%, >25%) and as condition-specific ease of transfer (easy, somewhat easy, moderate, somewhat difficult, difficult, rarely transfer) (Appendix E1, available online at http://www.annemergmed.com).

We identified a bundle of staffing, resource, and practice patterns for each of the 4 conditions that described a required minimum level of care, using a consensus process. Initial bundles of care were created by the core research team according to literature review and were then vetted in a research focus group as described above. The bundles that we used were meant to capture many of the key elements of care for the condition of interest without being overly proscriptive. We defined the bundle necessary to care for STEMI patients as including (1) having access to a cardiac catheterization laboratory with percutaneous coronary intervention capabilities within 1 hour, (2) having access to interventional cardiology within 1 hour, and (3) rarely transferring patients with STEMI. We identified a facility as delivering stroke care if they (1) had access to a computed tomography (CT) scan within 1 hour, (2) had access to a radiology reading for head CT within 1 hour, (3) had access to a neurologist within 1 hour, and (4) rarely transferred patients with acute ischemic stroke. We defined capability to care for patients with return of spontaneous circulation after out-of hospital cardiac arrest if they (1) reported routine induction of TH (ie, more often than not), and (2) had access to an ICU 24 hours a day, 7 days a week. Finally, we described a facility as capable of taking care of patients with severe sepsis and septic shock if they (1) reported routine use of early goal-directed therapy (ie, more often than not) in adult patients with septic shock, and (2) had access to an ICU 24 hours a day, 7 days a week. All clinical bundles included a requirement of attending emergency physician availability 24 hours a day, 7 days a week. Care bundles were also separately evaluated among EDs with board-certified/board-eligible emergency physicians available 24 hours a day, 7 days a week.

Outcome Measures

Using the definitions outlined above, we determined the proportion of hospitals providing each of the clinical bundles. We also examined the association between additional hospital resources and practices and the presence of essential clinical care bundles for time-critical disease. We then calculated the proportion of the population that could reach each disease-specific clinical bundle within 60 minutes by ground transportation.

Primary Data Analysis

All surveys responses were manually entered into a Microsoft Access 2010 Database (Microsoft, Redmond, WA) and exported into statistical software for analysis (Stata, version 12.0; StataCorp, College Station, TX). Summary statistics were used to describe hospital characteristics and to assess the capability of facilities to provide the described clinical bundles. We examined the association between each clinical bundle and other hospital characteristics such as availability of an ICU, availability of an intensivist, transfer rate, ED size (≥15,000 annual visits), and presence of other clinical bundles. Clinical bundles that shared overlapping definitions were not evaluated for association. Variables were considered associated with a clinical bundle if there was a statistically significant relationship (α=.10). Because of the relatively small sample sizes and the high frequency of exact prediction (ie, cell sizes equal to zero), penalized maximum likelihood logistic regression models were used to estimate measures of association. Penalized maximum likelihood logistic regression methods include a penalty factor into the estimation procedures and thus were deemed more appropriate than ordinary logistic regressions because they have been shown to overfit data with small sample size or exact prediction.[40] To determine the degree to which missing data influenced our results, we performed sensitivity analyses in which we classified all hospitals with missing data as providing the highest level of care for each bundle.

All access calculations were performed with ArcGIS (ESRI, Redlands, CA). To calculate population access to each type of care, we assigned the population of each census block group to the population weighted center point (centroid) of the block group, assessed transport times to the closest facility with each care bundle by using ArcGIS’s network analyst, and then summed the population able to reach each care bundle. We included additional out-of-hospital times including a multiplier of travel time to proxy response time, and on-scene time as we have done previously.[3] We describe 60-minute access because this interval provided stable estimates and represented a reasonable range of transport times that might still permit timely intervention in critical diseases. We did not examine the effect of air ambulances or interfacility transports in our access calculations because the majority of patients with the diseases of interest arrive at the ED by EMS, private vehicle, or other modes of ground transportation.

RESULTS

Characteristics of Study Subjects

We identified 183 24-hour ambulance receiving EDs in the commonwealth of Pennsylvania in 2009. EDs in hospitals that were closed (n=8) before study completion (December 2010) or identified as EDs in children's hospitals (n=3) were excluded. Of the remaining 172 hospitals in Pennsylvania with EDs, we received 137 survey responses (81% response rate). Of the respondents, 82 (60%) were filled out by a department head, 36 (26%) were filled out by a medical director, and 19 (14%) were classified as "other," the majority of whom were current or former ED administrators (13/19). Among these 137 EDs, 125 (91%) were available in the AHA survey. Of the EDs responding to the survey, 80% were located in general hospitals serving both adults and children (Table 1). Missing data were minimal (<5%) for all variables presented. Average number of total hospital beds was 237.4 (SD 240.0). A small number (10%) of hospitals included in our analysis were classified as rural referral centers per the AHA survey. The majority of hospitals reported always having access within an hour to a board-certified/board-eligible emergency physician (56%), CT scanner (83%), ICU (67%), and radiologist (72%). One hospital reported regular presence of board-certified/board-eligible emergency, family, and internal physicians but no type as "always present."

Main Results

For the management of acute ischemic stroke, 20% of respondents reported providing the 4 essential services we identified as our bundle for stroke care (Table 2). Among hospitals without this bundle of stroke care services, however, almost a fifth (17%) reported rarely transferring acute ischemic stroke patients. Just under a third (32%) of hospitals reported having an essential bundle of services required to care for STEMI. Of the hospitals reporting no STEMI bundle, 6% reported rarely transferring STEMI patients.

Just over a third of hospitals (37%) reported routine induction of TH in comatose patients with return of spontaneous circulation after cardiac arrest, and slightly fewer (34%) both reported induction of TH and access to an ICU within an hour. Of EDs not routinely providing TH, 26% described transfer of adult ICU patients as easy, whereas 36.8% reported rarely transferring adult ICU patients.

The majority of hospitals (66%) reported routine use of early goal-directed therapy in cases of severe sepsis and septic shock, but fewer (57%) reported both routine use of early goal-directed therapy and access to an ICU within an hour. Of the EDs not routinely providing early goal-directed therapy, 31% reported not having access to an ICU within an hour, and only 31% described transfer of adult ICU patients as easy. Almost a third (32%) of hospitals without a sepsis bundle reported rarely transferring adult ICU patients.

We observed substantial variability with respect to hospitals' abilities to provide the bundles of care we have described for time-sensitive conditions, with only 8% of hospitals reporting the ability to deliver all 4 of the clinical bundles described (Table 2). Among hospitals reporting none of the 4 bundles of care required to treat these time-sensitive conditions, few reported "rarely transferring" STEMI patients (3%) and stroke patients (8%), but more than a fifth (23%) reported rarely transferring patients requiring adult critical care services. In unadjusted analyses, the presence of an intensivist was consistently statistically significantly associated (at α=.10) with the presence of all care bundles, whereas presence of a board-certified/board-eligible emergency physician was associated with only STEMI and stroke bundles of care (Table 3). For all care bundles except sepsis, an ED census of greater than or equal to 15,000 patients was associated with presence of clinical bundles.

In addition to examining the frequency with which EDs provided the specified clinical bundles, we also assessed the proportion of the overall population that is able to reach these EDs within a 60-minute out-of-hospital interval. In the commonwealth of Pennsylvania, a majority of the population has access to each bundle (71% STEMI, 65% stroke, 71% cardiac arrest, 84% sepsis) (Table 4). Similarly, 53% have access to at least 1 ED providing all bundles within 60 minutes. Of this subgroup, 61% had access to 2 or more EDs providing all 4 clinical bundles (32% of overall population). By comparison, 80.9% of Pennsylvania residents had access to an ED staffed by a board-certified/board-eligible emergency physician at all times.

Sensitivity Analyses

As described above, we recalculated access for each care bundle assuming that all missing hospitals provided the highest level of care. We found that including these hospitals increased population access for each bundle (85% STEMI [versus 71% as above], 83% stroke [versus 65% as above], 89% cardiac arrest [versus 71% as above], 94% sepsis [versus 84% as above]).

Missing hospitals were also compared with included hospitals according to bed size, ED volume, number of annual admissions, and rurality. Of the 35 identified hospitals that did not respond to our survey, 29 (83%) were identified in the AHA annual survey. Missing hospitals were found to be similar in bed size (mean: missing hospitals 223 versus respondents 237), ED visits (mean: missing hospitals 36,042 versus respondents 36,247), total admissions (mean: missing hospitals 10,075 versus respondents 11,415). Missing hospitals were less likely to be rural referral centers than respondents (missing hospitals 3.5% versus respondents 9.6%).

LIMITATIONS

Although our survey was informed by previous work related to evidence-based bundles of care, we acknowledge that the emergency care community has not articulated guidelines or standards related to care that we describe. As a result, we offer these bundles as a straw man starting point and welcome consensus development and transparent communication to patients about what is considered standard of care. Our survey (Appendix E1, available online at http://www.annemergmed.com) was vetted by individuals with research and acute care expertise and was intentionally worded to allow subjective interpretation by the respondent in areas in which no clear guidelines exist. This includes the interpretation of what it means for a specialist to be “available” because we did not specify on the telephone, in person, or level of training (resident, fellow, attending physician), and the use of Likert scales to quantify ease of transfer. This was done to increase the likelihood of ED directors responding, but it introduces uncertainty.

If the emergency care community were to report a public, patient-facing inventory of emergency care capabilities, a simple hospital self-reporting system would be inadequate. Our observations are at 1 interval, and conditions may change. The estimated frequency with which early goal-directed therapy is reported in Pennsylvania is higher than that in previously published literature.[41] This may be an example of interpretation about what it means to perform early goal-directed therapy because we did not specify individual components of the bundle, including central venous pressure measurement, specific catheter use, and mixed venous oxygen saturation measurement. A selection bias may be present in our data. Although we had a high response rate (81%) and performed a sensitivity analysis, we cannot be certain that substantive differences do not exist between respondents and nonrespondents. Finally, because of the missing data and our limitation to a single state, results may not be directly generalizable to all states.

To describe the population perspective, we used access to care with 60 minutes as our benchmark. Although this is consistent with previous work, shorter out-of-hospital intervals may be more appropriate for some conditions (cardiac arrest) and longer ones may be appropriate for others (sepsis). In addition, we recognize that our access to care calculations account for the additional out-of-hospital time associated with transport to the hospital by EMS and that many critically ill patients may not arrive in that manner. We performed these calculations in this manner to maintain consistency with previously published literature[3,11,16,42,43] but recognize that they may underestimate access to care. Finally, we describe population access to care and do not describe an association between access to care and improved outcomes. There is substantial work to be done to test the concept of regional networks of care.

DISCUSSION

Initial efforts around coordination of care for unplanned critical illness focused on EMS bypass and transfer of patients to tertiary care facilities. This approach has limitations,[44] and recent work by the National Quality Forum defined regionalization as “an established network of resources that delivers specific care to a defined population of patients or within a defined geography.” This updated approach to coordinating emergency care allows interfacility consultations, including telemedical care delivery, patient preference, and moving the patient only when necessary. But a key building block remains understanding what emergency care capabilities exist at hospitals. Efforts to categorize EDs according to capabilities are part of the Institute of Medicine’s vision to improve emergency care, but previous attempts to categorize EDs have met with modest success regionally and have not been implemented on a national scale.[45,46] Transparently describing the capabilities of hospitals to address time-sensitive conditions would allow market forces to function appropriately. Focusing on gaps in population access to care for these conditions would enable public and private interests, patients, and policymakers to build a better emergency care system.

The development of a coordinated emergency care system will need to take into consideration credentialing mechanisms in addition to market and political forces. For example, trauma centers are often verified by the American College of Surgeons, regional STEMI systems often register with the American Heart Association's (AHA) Mission Lifeline,[17,47] and Primary Stroke Centers[14] are certified by TJC.[20] Although the development of cardiac arrest centers has not reached the point of credentialed centers, the AHA has endorsed the designation of Cardiac Resuscitation Centers,[15] and a regional system of sepsis care is likely on the way.[48] No central entity has ever bridged the many special interest groups building disease-based systems of care, and the current scheme is unlikely to be easily navigated by patients.

Wide variability exists in the capabilities of Pennsylvania hospitals to care for 4 key emergency care–sensitive conditions. Although the majority of the Pennsylvania population can access a facility reporting an ability to deliver optimal care for unplanned critical illness within an hour, only a fraction of hospitals provide all 4 of these evidence-based bundles of care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Editor's Capsule Summary

What is already known on this topic

Many believe that certain emergency conditions require rapid, resource-intensive bundled care to optimize outcomes.

What question this study addressed

Do potential patients have access to a hospital declaring the ability to deliver acute care bundles for stroke, ST-segment elevation myocardial infarction, cardiac arrest, and sepsis?

What this study adds to our knowledge

In a structured, qualitative survey of emergency department directors of all acute care hospitals in Pennsylvania in 2009, only 8% reported an ability to deliver all 4 care bundles, with ranges for each bundle between 20% and 57%. Despite the small number of full-service-capable sites, 53% of the commonwealth population could reach such a site within an hour.

How this is relevant to clinical practice

The number and location of specialty centers may need to be adjusted if more patients are to have 1-hour access to problem-specific intensive emergency care and this access is demonstrated to improve clinical outcomes.

Table 1.

Description of characteristics, resources, and practices in Pennsylvania EDs.*

ED Characteristic	% of Pennsylvania EDs (n = 137)
Type of ED	
ED in adult-only hospital	18.4
ED in general hospital serving adults and children	80.2
Freestanding ED	1.5
TJC accreditation†	74.4
Trauma centers†	20.6
Rural referral center†	9.6
ED size (annual census ≥15,000)	71.5
ED staff (always present) ‡	
Any attending physician	48.9
BC/BE EM attending physician	56.2
Any non-EM attending physician	9.5
Physician available from inside hospital	0.7
Physician extender or physician available from home	0
ED resources (always available within 1 h)	
Cardiac cath lab (capable of PCI)	35.8
CT scanner	83.1
ICU	67.2
Interventional cardiologist	43.8
Radiologist	71.5
Neurologist	36.5
Transfer practices	
Overall frequency of adult transfers, %	
<5	74.5
5–10	17.5
10–15	7.3
15–20	0
20–25	0
>25	0.7
Rarely transfer	
STEMI	36.6
Acute ischemic stroke	33.1
Adult ICU	43.8
Routine treatment practices	
Early goal-directed therapy	66.4
Therapeutic hypothermia	36.5

BC/BE, Board-certified/board-eligible; *ICU*, intensive care unit; *PCI*, percutaneous intervention.

*All data are presented as valid percentages unless otherwise noted.

[†]Variables drawn from the AHA annual survey.

[‡]The question was presented as "select all that apply" and thus percentages may not add to 100%.

Table 2.

Frequency of available condition-specific clinical bundles in Pennsylvania EDs.*

Resource	% of Pennsylvania EDs (n = 137)
Bundles among all EDs	
Acute ischemic stroke	*19.7*
CT scanner (within 1 h)	83.1
Radiologist (within 1 h)	71.5
Neurologist (within 1 h)	36.5
Rarely transfer acute ischemic stroke patients	33.1
STEMI	*32.1*
Cardiac cath lab (capable of PCI)	35.8
Interventional cardiologist (within 1 h)	43.8
Rarely transfer STEMI patients	36.6
Cardiac arrest	*33.6*
Routine therapeutic hypothermia	36.5
Access to ICU (24 h/7 days)	67.2
Septic shock	*56.9*
Routine early goal-directed therapy	66.4
Access to ICU (24 h/7 days)	67.2
All clinical bundles	*8.0*
Bundles among EM-staffed EDs	
Acute ischemic stroke	16.1
STEMI	24.8
Cardiac arrest	19.7
Septic shock	32.1
All clinical bundles	6.6

*All data are presented as valid percentages.

Table 3.

Hospital-level factors predictive of clinical bundles (unadjusted).[*†]

ED Characteristic	OR	(95% CI)
Stroke		
ED size (≥15,000)	30.4	(1.8–511.7)
ICU	1.7	(0.3–10.0)
BC/BE emergency physician	4.1	(1.5–11.2)
Intensivist	6.8	(2.5–18.7)
Transfer rate (≤5%)	4.4	(1.1–17.2)
Cardiac arrest bundle	2.6	(1.1–6.0)
STEMI bundle	47.9	(11.9–191.7)
Sepsis bundle	3.1	(1.2–8.0)
STEMI		
ED size (≥15,000)	64.5	(3.9–1,079.2)
ICU	3.3	(0.6–19.0)
BC/BE emergency physician	3.8	(1.7–8.5)
Intensivist	16.4	(6.3–42.4)
Transfer rate (≤5%)	6.3	(1.9–20.2)
Cardiac arrest bundle	3.8	(1.8–8.1)
Stroke bundle	47.9	(11.9–191.7)
Sepsis bundle	2.7	(1.2–5.7)
Cardiac arrest [‡]		
ED size (≥15,000)	4.5	(1.7–12.1)
ICU	12.4	(0.7–217.2)
BC/BE emergency physician	1.2	(0.6–2.4)
Intensivist	3.8	(1.8–8.0)
Transfer rate (≤5%)	1.9	(0.8–4.6)
STEMI bundle	3.8	(1.8–8.1)
Stroke bundle	2.6	(1.1–6.0)
Sepsis [‡]		
ED size (≥15,000)	1.2	(0.6–2.5)
ICU	35.5	(2.0–619.1)
BC/BE emergency physician	1.0	(0.5–2.0)
Intensivist	1.9	(1.0–3.9)
Transfer rate (≤5%)	1.6	(0.7–3.4)
STEMI bundle	2.7	(1.2–5.7)
Stroke bundle	3.1	(1.2–8.0)

[*] Unless otherwise noted, all variables are defined as "always available."

[†] As described in the "Materials and Methods," penalized maximum likelihood estimates are used here to account for instances of exact prediction. The very wide confidence intervals for some odds ratios (eg, ED size) suggest that there are cells with very small numbers and consequently the model may be overfit. Nevertheless, whether the true OR is 64.5, 40, or 80, the conclusions are unchanged.

[‡] Cardiac arrest and sepsis bundle associations are not shown as they contain similar items.

Table 4.

Population access to EDs providing condition-specific clinical bundles in Pennsylvania in 2009.

Clinical Bundle	% of Pennsylvania Population
STEMI	70.8
Acute ischemic stroke	65.4
Cardiac arrest	71.2
Septic shock	83.8
All clinical bundles	52.8