In 2000, the Brain Attack Coalition proposed an organized stroke system of care, which promoted routing acute patients to Primary Stroke Centers (PSCs), and Comprehensive Stroke Centers able to provide proven stroke care reliably and rapidly. Hospitals began to apply voluntarily for PSC certification from the Joint Commission in 2003. Hospitals face multiple incentives and disincentives to becoming PSCs. Incentives include improving patient care and outcomes, reputation enhancement in the community, and continued access to patients once a regional preferential routing system is implemented. Disincentives include capital and operational costs, increased regulatory oversight, and potentially disruptive changes in internal processes. The relative importance of these factors in determining hospital decisions has been little studied. We hypothesized that continued access to patients is a key driver. To investigate, we analyzed the association of conversion of hospitals to PSC status with adoption of Emergency Medical Service (EMS) preferential routing protocols in the state of California from 2003 to 2012.

**Methods**—Dates of PSC certification were obtained through The Joint Commissions Website and confirmatory calls to stroke coordinators. Starting date of county EMS PSC routing policies was obtained from county EMS agencies. We provide descriptive analysis of number of hospitals achieving PSC designation relative to implementation of EMS routing policies for all counties with PSCs.

**Results**—By June 2012, there were 131 California PSCs in 27 counties, and 22 of 58 counties had implemented EMS routing policies. The greatest number of PSCs was in Los Angeles (30) followed by San Diego (11), Orange (9), and Santa Clara (9) counties. Achievement of PSC designation occurred more frequently immediately before and after EMS routing: 51 PSCs (39%) within 1 year; 85 PSCs (65%) within 2 years. The yearly rate of eligible hospital conversion to PSC designation accelerated concurrent with EMS diversion policy adoption from 3.8% before to 16.2% during and decelerated afterward to 7.6%.

**Conclusions**—Implementation of EMS routing policies may be an important factor driving PSC certification. National adoption of stroke routing policies may lead to more PSCs, positively impacting patient care. (Stroke. 2013;44:3584-3586.)

**Key Words:** certification ■ health policy ■ prehospital emergency care ■ stroke, acute
we calculated the rate of conversion of PSCs compared with the number of potential converting hospitals in EMS routing counties.\textsuperscript{8} Only facilities with 24-hour emergency departments were considered potential converting hospitals.\textsuperscript{7} A background annual rate of PSC conversion independent of EMS routing policy implementation was calculated for comparison.

We averaged annual PSC conversion rates for time periods pre-EMS, concurrent, and after EMS policy enactment. The pre-EMS routing policy period included the dates from 2003 until 1 year before implementation of a routing policy in the county of the facility. The concurrent with EMS routing policy period was defined as the 2-year period beginning 1 year before and continuing 1 year after the enactment of EMS routing policy. The post-EMS policy implementation period was defined as >1 year after EMS routing policy enactment.

To evaluate further, we used a nested Poisson regression model to test the time trends before or after EMS routing protocols. In the following model, phase is defined as either before or after EMS routing protocols.

Differences-in-Differences is represented by the following interaction term Year*Phase:

\[
\log(\text{Conversion Rate}) = \text{Intercept} + \beta_1 \text{Phase} + \beta_2 \text{Year} + \beta_3 \text{Year*Phase}.
\]

**Results**

From December 2003 to July 2012, 131 of the 303 (43.2\%) hospitals in California with 24-hour physician staffed emergency departments received PSC certification.\textsuperscript{6–8} Also during this period, 22 of the 58 (37.9\%) counties in California implemented preferential routing protocols. The greatest number of PSCs was in Los Angeles (30), followed by San Diego (11), Orange (9), and Santa Clara (9) counties. Counties adopting EMS routing policies had larger populations than those not doing so; the 38\% of counties implementing EMS stroke routing policies contained 75\% of the total population of California.\textsuperscript{10}

From 2003 to 2008, the annual PSC conversion rate independent of EMS routing polices was 3.5\%. The conversion rate accelerated to 14.0\% and 15.0\% for the years 2009 and 2010, respectively, and then decelerated to 9.2\% in 2011 and 9.4\% in 2012 (Figure 1). During 2009 and 2010, Los Angeles, San Diego, Sacramento, and Orange counties implemented PSC routing policies impacting 50.8\% of all PSCs in California, of which 37.4\% converted simultaneously (19.0\% of all PSCs in California).

In counties with preferential EMS routing policies, hospitals were far more likely to achieve PSC status concurrent with EMS implementation of a policy than before or after. The average annual rate of conversion to PSC status was substantially higher in the concurrent period, 16.2\%, than in the preperiod, 3.8\%, or the postperiod, 7.6\%. Overall, 32 PSCs were certified >1 year in advance of EMS implementation of a routing policy; 51 were certified within the 2-year period concurrent with EMS routing policy implementation, 31 were certified >1 year after the policy took effect. The rate of conversion of nonstroke hospitals to PSCs accelerated before EMS diversion policy adoption and decelerated in the years after (Figure 2).

The nested Poisson regression model showed a statistically significant Differences-in-Differences ($P<0.01$). Before EMS routing, for any given year, the conversion rate increased 69\% (95\% confidence interval [26\%–127\%]) from the previous year; whereas after EMS routing, for any given year, the conversion rate decreased 40\% (95\% confidence interval [2\%–63\%]) from the previous year. When restricting to 5 years before or after EMS routing, the trend remained the same, but slopes were slightly steeper.

**Discussion**

This study indicates that implementation of EMS policies preferentially routing acute stroke patients to designated receiving facilities is an important factor driving hospital attainment of PSC certification. In California, the rate of hospital conversion to PSCs concurrent with EMS routing protocol implementation was 4-fold higher than before and 2-fold higher than after. The potent effect of EMS routing policies on hospital certification status is likely mediated by several factors, including financial incentives, quality of care, and prestige. Implementation of a County or State routing policy is generally

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**Figure 1.** Annual Primary Stroke Center (PSC) conversion in California from 2003 to 2012 independent of emergency medical services routing policy adoption.
accompanied by regional planning meetings, community publicity, and enhanced physician and provider interest.

Also the reimbursement for the treatment of patients with ischemic stroke undoubtedly is an incentive for hospitals to become a PSC, with potential loss of revenue attributable to loss of EMS-transported patients unless PSC status is attained. This incentive was strengthened in 2005 when Medicare increased the reimbursement for patients with ischemic stroke treated with thrombolytic agents from \( \approx 6000 \) to \( \approx 12000 \) per patient. Where previously stroke care had been relatively revenue neutral or negative for hospitals, the improved reimbursement rates from 2005 forward could have created a financial incentive to continue to provide care to this large population of patients.

The findings of this study are consonant with previous studies demonstrating increasing, but regionally variable, access to PSC care among US populations during the observation period. As far as we are aware, this study is the first to describe the association of regional adoption of EMS routing policies with hospital pursuit of PSC certification. Further studies are warranted to evaluate this association in other jurisdictions.

This study has several limitations. We examined the association of PSC adoption with only the single variable of EMS routing policy implementation. We cannot determine from our data the extent to which conversion to PSCs was driven by other unmeasured variables besides EMS diversion policy. A more detailed analysis of additional variables would be of interest, including changing regional demographics and fluctuations in the local supply of neurology specialists. In addition to formal changes in EMS routing policies, marginal informal evolutions also occur because prehospital personnel have some freedom to select among equidistant destination facilities even when policies direct routing to the nearest facility. The impact of informal preferential routing of patients with stroke by prehospital providers on the pursuit of PSC status was not evaluated. Official records documenting date of PSC certification and EMS policy implementation often were unavailable; nonetheless, extensive efforts were made to verify obtained dates from multiple sources, including the Joint Commission Quality Check Website and direct conversations with Stroke Coordinators from each hospital.

We conclude that EMS adoption of stroke center preferential routing policies is a major stimulus to hospital attainment of PSC status and improvement of stroke care throughout a region. Adoption of preferential EMS routing policies for stroke in all US states and counties and internationally has the potential to substantially improve care for patients with stroke.

Disclosures

None.

References

Impact of Emergency Medical Services Stroke Routing Protocols on Primary Stroke Center Certification in California
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