Multispecialty stroke services in California hospitals are associated with reduced mortality

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Multispecialty stroke services in California hospitals are associated with reduced mortality

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Abstract—*Objective:* To evaluate whether 1) a dedicated, multispecialty service, 2) a distinct hospital ward, 3) protocols, and 4) a specialist are associated with reduced mortality among patients with stroke. *Methods:* The authors reviewed data (1998 and 1999) from all acute, non-federal hospitals in California, including administrative discharge databases for patient and hospital-level information, mortality data through 1 year post discharge, and a hospital-level survey regarding structural elements of stroke care. The impact of a dedicated, multidisciplinary stroke service and of stroke wards, protocols, and specialists on odds of death among patients with ischemic and hemorrhagic stroke were each examined using logistic regression models. How these elements of care impacted outcome at teaching vs non-teaching hospitals was also examined. *Results:* A 67.5% response rate (257/381) from surveyed hospitals provided data for 61,541 patients with stroke. A dedicated, multispecialty stroke service was available at 7.4% of hospitals. Twelve percent of hospitals had a stroke ward, 62.3% used protocols, and 16% had neurologists with specialty training in stroke. Patients cared for at hospitals with a dedicated stroke service had significantly lower odds for death at 30 days, and reduced mortality was maintained through 365 days after admission. Stroke wards, protocols, and specialists were not associated with reduced mortality. Having a dedicated stroke service was associated with reduced mortality at both non-teaching and teaching hospitals. *Conclusions:* Dedicated, multispecialty stroke services are underutilized despite their association with reduced stroke mortality at both academic and non-academic hospitals.

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Randomized controlled trials (RCT) to evaluate stroke care have shown better outcomes associated with multidisciplinary stroke services or teams, but benefits have been less clear for stroke wards, protocols or pathways, and specialists outside the setting of a stroke team or service.

Stroke units and specialists are recommended as key components of Comprehensive Stroke Centers by the US Brain Attack Coalition.[1] Health care systems changes require some initial investment of resources and one or more local advocates. However, the availability of these kinds of stroke care delivery resources across a broad spectrum of hospitals and their effectiveness in reducing adverse outcomes of stroke in these settings (i.e., outside of clinical trial or teaching hospital settings) is unclear. Efforts to broadly disseminate the implementation of stroke teams into community hospital settings may be hampered by lack of data on whether stroke care delivery provided by stroke specialists or teams is associated with reduced mortality outside of tightly controlled RCT settings.

To evaluate whether recommended components of inpatient stroke care are available at and associated with reduced mortality across hospitals in one US region, we studied adult patients with stroke hospitalized in all acute care, non-federal hospitals in California in 1998 and 1999. Four stroke care resources were each examined because of their potential for incorporation into most hospitals and evidence consistent with their potential association with improved stroke outcomes: a dedicated, multi-specialty stroke service, a distinct ward in the hospital for patients with stroke, stroke protocols, and a stroke specialist.[2-4]

Methods. *Patients.* The 1998 and 1999 California Office of Statewide Health Planning and Development (OSHPD) Patient Discharge Databases (PDD) for all non-federal acute care hospitals in California were used to identify patients age ≥35 years having a primary discharge diagnosis of ischemic or hemorrhagic

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stroke (ICD 9-CM codes 431, 432, 434, and 436). The codes used to identify ischemic stroke were previously reported to have 90% accuracy.[5] For patients with multiple stroke hospitalizations, the first occurrence was selected as the "index" hospitalization for analysis. We excluded post-procedure strokes by excluding the <0.5% of strokes identified by ICD 9 codes but not coded under Diagnosis Related Group (DRG) 014 (stroke). Because of the inability to accurately track out-of-state deaths for non-Californians, we excluded patients with a residence outside of California.

Mortality. Deaths occurring during hospitalization were recorded in the OSHPD PDD. Identification of out-of-hospital deaths via linkage to the California State Vital Statistics Registry Database (VSD) for the years 1998 through 2000 was performed and validated by OSHPD.[6] Deaths were determined for 30, 60, 180, and 365 days after discharge from the index stroke hospitalization. A sensitivity analysis excluding early deaths (within 24 hours of admission) was also conducted.

Hospital characteristics. Hospital size (number of beds), ownership/profit status, and location (rural/non-rural) were obtained from the OSHPD Annual Hospital Financial Database. Teaching hospitals were identified through membership in the Council of Teaching Hospitals (http://www.aamc.org/members/listings/thgeoca.htm). Membership requires documented affiliation agreement with a medical school accredited by the Liaison Committee on Medical Education. Hospital-level measures were linked to the patient-level discharge records using the uniquely assigned OSHPD facility identification number.

Stroke care resources. A survey was mailed to a physician identified by a hospital representative as knowledgeable about stroke care at each of 381 non-federal, acute care hospitals that discharged at least one patient with stroke in 1998. The survey queried the availability in 1998 of four structural resources for acute stroke care. The specific questions were as follows:

Dedicated stroke service: Was there a dedicated stroke service at this hospital in 1998 (e.g., a multispecialty service including non-physicians)?

Stroke ward: In 1998, were patients with stroke located in a distinct ward of the hospital?

Stroke protocol (hospitals were coded as using protocols if they answered affirmative to either question): Did the hospital routinely employ critical pathways, protocols, or guidelines for stroke care in 1998? or Did the Emergency Department routinely use pathways, protocols, or guidelines for acute stroke?

Stroke specialist(s) (with regard to neurologists serving the hospital): Including yourself, had any of these neurologists completed specialty training in stroke?

Surveys were received from 257/381 (67.5%) of eligible hospitals. Eighty-one percent of survey respondents were neurologists, 16% were internists, and 3% were family medicine physicians.

Analysis plan. Across hospitals that had provided care for one or more eligible patients with stroke in 1998 and 1999, we used a χ^2 test to compare size, number of stroke admissions annually, and teaching status of hospitals with and without survey data. We compared patients with stroke cared for at hospitals for which we had survey data to those for which we did not on age, Charlson Index,[14] sex, race, stroke subtype (hemorrhagic vs non-hemorrhagic), stroke admissions in each of the past 5 years, other admissions in the past 5 years, length of stay, and mortality, using a *t* test or Wilcoxon rank sum test. SAS 8.1 software was used for the analysis.

Stroke care resource availability was examined as the proportion of patients with stroke with access to the resource. If a patient was transferred to a second hospital within 24 hours, we designated the patient as having access to resources within the second hospital rather than the first. The impacts of a dedicated, multidisciplinary stroke service, stroke ward, stroke protocol, and stroke specialist on 30-, 60-, 180-, and 365-day odds of death were each examined using logistic regression models, controlling for age, race, sex, and Charlson Index,[7] whether or not the patient had a hemorrhagic stroke, and variables indicating if the patient had been hospitalized in each of the past 5 years.[8] For each model, a clustering correction was employed to account for within-hospital correlation of outcomes and a robust regression was completed to improve coefficient estimates. Patients admitted and discharged in 24 hours or less were excluded from the analysis because of evidence that these represent TIAs not strokes.[5]

Because having a stroke service and a stroke ward covaried, we also examined the unique associations with mortality of care at hospitals having both a stroke service and a ward, a ward only, and a stroke service only, relative to having neither a dedicated stroke service nor a ward. In addition, because having a stroke service was found to be associated with being a teaching hospital, we further examined the unique associations with mortality of care at teaching and non-teaching hospitals having a stroke service. Finally in 1999, OSHPD added a variable indicating whether patients were on do-not-resuscitate (DNR) status. Since DNR status might impact mortality[9] and could differ at hospitals with and without a dedicated stroke service, we compared the proportion of patients with stroke who were DNR at hospitals with and without dedicated stroke services and conducted a sensitivity analysis adding DNR status to the models for 1999 data.

Given the mortality benefit associated with hospitals having a dedicated, multidisciplinary stroke service, we compared specific resources (such as provider type, availability of imaging, availability of intensive care services) at hospitals that reported having a dedicated multispecialty stroke service vs those that did not. We also estimated the difference in the projected and actual number of deaths if mortality at hospitals without a stroke service was the same as mortality at those having a stroke service over this 2-year period. This was estimated as the sum over all patients of the predicted probability of death at 30 days if the hospital had a stroke service minus the predicted probability of death at 30 days based upon the actual hospital status, accounting for other measured patient and hospital characteristics.

Study procedures were reviewed and approved by the UCLA Office for Protection of Research Subjects.

Results. *Characteristics of patients with stroke.* See table 1. Data for 80,132 patients aged 35 years and older who were discharged from non-federal acute care California hospitals in 1998 or 1999 with a primary diagnosis of acute stroke were obtained. Hospital surveys provided data about stroke care resources for 72% of all California patients with stroke seen during the 2-year period. Among the 61,541 patients with stroke discharged from the 257 survey respondent hospitals, mean age was 73 years, 56% were female, and median length of stay was 4 days (range 1 to 86 days). Only 3.2% of patients were transferred from the admitting hospital to another acute care hospital. Ten percent of patients died during admission, 30% were discharged to home, and 56% were discharged to a non-acute care facility (rehabilitation or chronic care).

Patients with stroke admitted to hospitals for which survey data on stroke care resources were available were less likely to have experienced a stroke-related admission in the past 5 years; their length of stay was shorter; and in-hospital mortality was higher than that of patients (n = 18,591) admitted to hospitals without survey data (see table 1). Patients with stroke across these two categories of hospitals did not differ in age, Charlson Index, sex, race, stroke subtype, or 30-day through 365-day mortality. Compared to hospitals for which survey data were available, hospitals without these data were smaller (average staffed beds 153 vs 198; $p = 0.002$), admitted fewer patients with stroke annually (mean 81 vs 117; $p < 0.0001$), and were less likely to be a teaching hospital (12.0% vs 24.7%; $p = 0.004$).

Stroke care resources. Respondents from 19 (7.4%) hospitals reported having a dedicated, multispecialty stroke service that included non-physicians, which translates into availability of this resource for 9.8% of patients with stroke at respondent hospitals during this period. Respondents at the hospitals with stroke services reported that the team met daily (10/19, 52.6%), weekly (7/19, 36.8%), or monthly (2/19, 10.5%). All hospitals with a stroke service had one or more neurologists available.

Table 1 *Comparison of characteristics of patients with stroke at hospitals for which stroke care resource data were obtained by survey and those hospitals without survey data*

Characteristic	Patients at survey respondent hospitals (n = 61,541)	Patients at hospitals without survey data* (n = 18,591)	*p* Value
Age, y, mean (SD)	73.8 (12.6)	73.9 (12.6)	0.87
Charlson Index, mean (SD)	1.6 (1.6)	1.6 (1.5)	0.35
% Male	44.2	44.3	0.97
Ethnicity, %			0.77
White	67.4	64.2	
Black	9.3	9.5	
Latino	12.4	13.8	
Asian	8.5	9.5	
Other	2.4	3.0	
Hemorrhagic stroke, %	16.1	15.1	0.12
Stroke hospitalization within prior 5 years, %	8.9	10.4	<0.001
Non-stroke hospitalization within prior 5 years, %	22.8	22.0	0.22
Length-of-stay, median days (mean)	4 (4.95)	4 (5.83)	<0.001
Mortality, %			
In-hospital	10.2	9.4	0.03
30 days	16.3	15.2	0.08
60 days	19.3	18.6	0.26
180 days	24.8	24.2	0.40
365 days	29.7	29.2	0.57
Discharged alive in first 24 hours	8.1	6.7	0.03

* Includes patients seen at all non-federal, general acute care hospitals in 1998 or 1999 for an acute ischemic or hemorrhagic stroke, excluding patients seen at 257 respondent hospitals that provided survey data on stroke care resources. In addition to patients seen at hospitals that were included in the survey but were non-respondents (381 – 257 = 124 hospitals), this includes patients seen at 12 other non-federal, acute care hospitals in California caring for one or more patients with stroke in 1999 but not 1998. These 12 hospitals were either small facilities with infrequent patients with stroke or were not yet in operation in 1998.

Thirty-one (12%) hospitals reported that patients with stroke were admitted to a distinct ward of the hospital, which would have meant this resource was available to 17.2% of patients with stroke. Overall, stroke protocols were reported used in 62.3% of hospitals serving 72.8% of patients. Neurologists with specialty training in stroke were available at 16% of hospitals and thus potentially available for 18.8% of patients with stroke.

Mortality. Patients cared for at hospitals with a dedicated stroke service had significantly lower odds for death at 30 days post admission as compared to those hospitals without this resource (table 2), and this association with reduced mortality was maintained beyond 365 days after admission. Stroke wards, protocols, and specialists were not associated with reduced mortality. Exclusion of patients with stroke who died within 24 hours of admission did not impact the findings. The proportion of DNR patients at hospitals with dedicated stroke services (14%) and those without dedicated stroke services (12.9%) was not different ($p = 0.068$). The mortality benefit of a dedicated stroke service was not changed when we repeated the analysis including DNR status in the model (for the subset of 1999 data).

Analysis of the independent contributions of stroke services and stroke wards showed that stroke service rather than ward is associated with reduced mortality (table 3).

In a multivariable model, the only hospital characteristic uniquely associated with having a dedicated stroke service was teaching hospital status ($p = 0.013$). Subsequent analysis of the associations of teaching hospital status and of stroke service with mortality showed that having a dedicated stroke service remained uniquely associated with reduced mortality, independent of teaching hospital status (which was also associated with reduced mortality; table 4).

Compared to hospitals without a multidisciplinary stroke service, those that reported such a service were more likely to have neurologists with specialty training in stroke, stroke care nurses, a neuro-ICU, and a stroke ward, as well as being more likely to utilize stroke protocols (all $p < 0.005$) (table 5). There was no significant difference in the availability of general neurologists, MRI, or angiography. If all California patients with stroke admitted in 1998 and 1999 had been cared for at hospitals with the same mortality odds as those hospitals having a dedicated stroke service, the projected number of deaths is 1,071 lower than the actual number of deaths over this 2-year period.

Discussion. Having a dedicated, multispecialty stroke service is linked to reduced mortality in a broad spectrum of acute care hospitals, outside of clinical trial settings. The beneficial associations of

Table 2 *Associations of mortality and availability of stroke care resource at hospitals (n = 56,556)**

Stroke care resource	% Patients with stroke who died: hospital had resource (unadjusted)	% Patients with stroke who died: hospital did not have resource (unadjusted)	Adjusted OR for mortality (95% CI)
Stroke service	n = 5,357	n = 51,199	
30 days	15.3	17.6	0.84 (0.77–0.92)
60 days	18.5	20.8	0.87 (0.79–0.95)
180 days	23.9	26.5	0.88 (0.80–0.96)
365 days	28.4	31.5	0.87 (0.79–0.96)
Stroke ward	n = 9,612	n = 46,944	
30 days	17.2	17.4	1.02 (0.91–1.14)
60 days	20.2	20.6	1.01 (0.91–1.11)
180 days	25.3	26.5	0.97 (0.88–1.06)
365 days	30.1	31.4	0.96 (0.88–1.06)
Stroke protocols	n = 40,947	n = 15,609	
30 days	17.4	17.2	1.03 (0.94–1.12)
60 days	20.7	20.3	1.03 (0.94–1.13)
180 days	26.2	26.3	1.00 (0.91–1.10)
365 days	31.1	31.5	0.98 (0.90–1.07)
Stroke specialist	n = 10,175	n = 46,381	
30 days	17.1	17.4	0.97 (0.88–1.07)
60 days	20.2	20.6	0.97 (0.88–1.06)
180 days	25.6	26.4	0.95 (0.87–1.03)
365 days	30.4	31.4	0.95 (0.87–1.03)

* Covariates include age (5-year increments), race, Charlson Index, stroke subtype (hemorrhagic vs non-hemorrhagic), prior stroke admission in past 5 years, other prior admission in past 5 years, and cluster adjustment for within hospital correlation of outcomes. Excludes patients discharged within 1 day of admission.

Table 3 *Subgroup analysis of stroke mortality among patients hospitalized at a facility having a dedicated stroke service and a stroke ward (n = 10 hospitals), stroke ward only (n = 21 hospitals), or dedicated stroke service only (n = 9 hospitals) relative to hospitals having neither (n = 217 hospitals)*

Stroke care resource	% Patients with stroke who died: hospital had resource (unadjusted)	% Patients with stroke who died: hospital did not have resource (unadjusted)	Adjusted OR for mortality (95% CI)
Service and ward*	n = 3,098		
30 days	18.8		0.88 (0.78–0.99)
60 days	24.0		0.90 (0.80–1.01)
180 days	28.2		0.88 (0.78–0.99)
365 days	35.3		0.85 (0.75–0.97)
Ward only	n = 6,514		
30 days	20.8		1.08 (0.94–1.23)
60 days	25.9		1.05 (0.92–1.19)
180 days	30.9		1.00 (0.89–1.12)
365 days	38.2		1.01 (0.91–1.13)
Service only	n = 2,259		
30 days	18.1		0.82 (0.73–0.91)
60 days	23.8		0.84 (0.74–0.96)
180 days	28.6		0.88 (0.77–1.00)
365 days	35.9		0.90 (0.80–1.02)
Neither ward nor service		n = 44,685	
30 days	—	20.8	1.00
60 days	—	26.6	1.00
180 days	—	31.6	1.00
365 days	—	39.0	1.00

* Default group had no stroke service and no stroke ward.

Table 4 *Subgroup analysis of stroke mortality among patients hospitalized at a facility having a stroke service and is a teaching hospital (n = 6 hospitals); dedicated stroke service only (n = 13 hospitals), or teaching hospital only (n = 12 hospitals) relative to non-teaching hospitals without a stroke service (n = 226 hospitals)*

Stroke care resource	% Patients with stroke who died: hospital had resource (unadjusted)	% Patients with stroke who died: hospital did not have resource (unadjusted)	Adjusted OR for mortality (95% CI)
Service and teaching hospital*	n = 1,830		
30 days	0.16		0.91 (0.79–1.05)
60 days	0.18		0.86 (0.77–0.97)
180 days	0.24		0.88 (0.76–<1.00)
365 days	0.27		0.85 (0.76–0.96)
Service only	n = 3,527		
30 days	0.15		0.79 (0.72–0.88)
60 days	0.19		0.85 (0.76–0.95)
180 days	0.24		0.85 (0.76–0.96)
365 days	0.29		0.86 (0.77–0.96)
Teaching hospital only	n = 4,043		
30 days	0.15		0.83 (0.69–1.00)
60 days	0.17		0.81 (0.65–<1.00)
180 days	0.21		0.79 (0.64–0.97)
365 days	0.26		0.81 (0.67–0.99)
Neither teaching hospital nor service		n = 47,156	
30 days		0.18	1.00
60 days		0.21	1.00
180 days		0.27	1.00
365 days		0.32	1.00

* Default group had no stroke service and no stroke ward.

having a stroke service were independent of teaching hospital status. No associations with reduced mortality were evident where stroke protocols or stroke care specialists were in place without having a dedicated stroke service.

Several characteristics of care provided by stroke services may mediate the mortality benefits of care in this setting. Stroke services have been found to be more aggressive in imaging patients within 24 hours, more aggressive with mobilization, and more likely to use IV fluids, antipyretics, and antibiotics than general medical services.[10,11] The use of stroke care protocols and involvement of stroke care specialists could potentially increase the provision of such care, but we found that these individual elements were not associated with improved mortality when provided outside of the realm of a dedicated, multidisciplinary stroke service.

Table 5 *Resources at hospitals with and without a stroke team**

Resources	With stroke team, n = 19	No stroke team, n = 224
Neurologists	78.9	87.5
Stroke neurologist*	42.1	13.8
Stroke nurses*	42.1	9.8
Radiologist 24/7	86.7	72.6
ICU	94.7	91.5
NICU*	31.6	6.3
Stroke ward*	52.6	9.4
Stroke protocols*	78.9	41.5
MRI	78.9	74.5
Angiography	73.7	72.8

* $p < 0.005$.

ICU = intensive care unit; NICU = neurologic ICU.

This study utilized a combination of administrative data and survey data. There may be unmeasured patient or hospital characteristics that impact our findings. Although we included stroke admissions in the past 5 years and the Charlson Comorbidity Index, no measure of index stroke severity was available. Furthermore, the aspects of patient care that we obtained through the physician survey reflect the response of a single physician (usually a neurologist). Our definition/question regarding a "dedicated, multispecialty stroke service" did not delineate precisely what a hospital had to provide to claim that such a team existed. At the time of the survey, no specific recommendations existed as to what serves and personnel were required for such a team.

Fewer than 8% of California hospitals had a stroke service in 1998, and this stroke care resource would have been available to only 1 out of 10 patients with stroke during this period. While we do not have data on current availability of stroke services in California or trends since 1998, the levels of stroke resources available in California hospitals in 1998 that we report are very similar to resource availability reported for North Carolina[12] and Illinois[13] during the same time period. A follow-up hospital survey in North Carolina comparing stroke care resources in 1998 to 2003 found no change in the proportion of hospitals with acute stroke teams or stroke acute care units, with each organizational feature existing in fewer than 20% of hospitals.[14] Among respondents to our survey, 40% reported that changes in stroke care at their hospital occurred between 1998 and 2000. Given the mortality benefits associated with multidisciplinary stroke services, one could argue that implementation of such services should be the priority for quality improvement.

Recent observational studies of stroke care in the United Kingdom indicate that acute stroke units improve in-hospital mortality.[15,16] Our data indicate that the mortality benefit associated with acute stroke team availability is maintained through 1 year post stroke and further support the need to increase stroke service availability in community-based, non-academic hospitals (as well as academic medical centers), as it appears to be an effective hospital resource for decreasing mortality for stroke. Having a dedicated, multidisciplinary stroke service should be considered as a potential quality indicator measure for acute care hospitals.

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