



Published in final edited form as:

J Stroke Cerebrovasc Dis. 2025 February ; 34(2): 108174. doi:10.1016/

j.jstrokecerebrovasdis.2024.108174.

Acute stroke care coordination in the United States: Variation in state laws for Emergency Medical Services and hospitals

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Abstract

Background: Lack of care coordination between Emergency Medical Services (EMS) and hospitals contributes to delay of acute stroke (AS) treatment. In the United States, states have adopted laws to improve the quality of EMS and hospital care; the degree to which these laws create regulatory incentives to promote care coordination between them is less well known. We

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Author Contributions: Study concept and design (all authors), acquisition of subjects and/or data (ZY, JH), data collection and policy coding (SG, NO), analysis and interpretation of data (all authors), preparation of the manuscript (all authors).

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Declaration of competing interest

None of the Authors have any financial conflict of interest. This study had no funding support.

Disclaimer: The findings and conclusions of this study are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. Furthermore, this article is not intended to promote any particular legislative, regulatory, or other action.

Disclosures: None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.jstrokecerebrovasdis.2024.108174](https://doi.org/10.1016/j.jstrokecerebrovasdis.2024.108174).

examined state variation in attributes of laws that may influence AS care coordination between EMS and hospitals.

Materials and Methods: We selected ten law “dyads” across seven domains of EMS and hospital AS care informed by published risk assessments of critical steps for improved door-to-needle time and door-in-door-out time. We assessed concordance in prescriptiveness (degree to which levels were similar) and in adoption (degree to which laws were adopted concurrently) of the laws in effect between January 2002 and January 2018 in the United States.

Results: The proportion of states with prescriptiveness concordance ranged from 47 % (e.g., inter-facility transfer agreements, comprehensive, primary stroke center certification) to 75 % (e.g., Continuous Quality Improvement (CQI) for EMS and hospitals). Adoption concordance ranged from 31 % (e.g., inter-facility transfer agreements, Acute Stroke Ready Hospital certification) to 86 % (e.g., CQI for EMS and hospitals). Laws for EMS triage were less prescriptive than laws for stroke center certification in 22 %–35 % of states adopting both laws, depending on stroke center type.

Conclusions: Subsequent policy implementation and impact studies may benefit from assessing concordance and prescriptiveness in policy intervention adoption, particularly as a foundation for evaluating delays in AS treatment due to inefficient care coordination.

Keywords

Stroke systems of care laws; Emergency medical services; Hospitals; Care coordination

Introduction

Stroke is a leading cause of death, a common cause of long-term disability, and a costly disease.¹ In 2017–2018, annual total stroke care costs reached \$52.8 billion, with the economic burden of stroke increasing with growing stroke incidence among younger adults, improved survival rates among adults >65 years old, and aging of the United States population.¹

Drivers of stroke care costs remain largely unknown, although recurrent stroke^{2,3} and lack of care coordination have been identified.⁶ Re-hospitalization⁷ and “bounce-back” to post-acute care frequently occur after hospital discharge to home.^{5,8} These frequent care transitions are associated with increased adverse events and higher costs⁸ Some adverse events are potentially preventable through improved care coordination, such as Emergency Medical Services (EMS) triage and improved inter-hospital transfer.^{1,9,10}

Most states have adopted laws (statutes, legislation, and regulations) that result in policies and procedures to improve stroke systems of care.¹¹ The laws typically address the type and quality of EMS care as well as in-hospital (heretofore “hospital”) care.^{11,12} The degree to which the laws affect policies and procedures that promote care coordination between EMS and hospitals has not been well studied. For example, according to Gilchrist et al¹¹, while hospitals are required to be accredited by a national accrediting body, such as the Joint Commission,¹³ as an Acute Stroke Ready Hospital (ASRH), Primary Stroke Center (PSC), or Comprehensive Stroke Center (CSC), EMS providers are not always required to transport

patients to the most appropriate stroke center. Furthermore, neither the concordance of the level of law mandates of specific actions that EMS or hospitals must undertake, hereafter *prescriptiveness concordance*, nor the concordance of when laws take effect, hereafter *adoption concordance*, have been examined. Yet, previous research has shown that policy effectiveness varies by *level of prescriptiveness* or authorization.^{14,15} Lack of *adoption concordance* may mitigate the potential positive impact of laws that, when combined, affect EMS and hospital policies and procedures, particularly regarding care coordination.

This study examines the variation in the level of prescriptiveness, prescriptiveness concordance, and adoption concordance of laws governing EMS and hospitals that are part of stroke systems of care. We aim to gauge the regulatory strengths of stroke systems of care laws in promoting acute stroke care coordination.

Methods

This is a retrospective cohort study design and cross-sectional analysis of a legal database of “stroke system of care” laws affecting EMS and hospital stroke systems of care across the United States, in effect between January 1, 2002 and January 1, 2018.

Collection and coding of state laws

We applied legal epidemiology methods to create a state law database, using a coding protocol to code each state’s body of law for the presence and prescriptiveness of 15 evidence-informed policy interventions.¹¹ Two legal analysts used the legal search engine, WestLaw Next, to retrieve statutes, regulations, session laws, and uncodified legislation in effect at any time from January 1, 2002 to January 1, 2018 for the 50 states and Washington, DC. The analysts also reviewed state agency websites to ensure that all relevant laws were collected. A legal database was created in Excel (Microsoft Corp) to capture changes in laws over time, with each law (statute, legislation, or regulation) coded as an individual record. The calendar date when each law took effect was captured. As each law was amended, sunset, rescinded, or repealed, a new record was created with the corresponding date. Next, for each state, a summary record for each year was created with each policy variable coded across the entire body of law in effect on January 1. This approach allowed for direct comparison across states of laws in effect on the same day of each year. If a state had enacted a law that took effect after January 1, it was included in the summary record for the following year, providing that it was still in effect. Collectively, the research team reviewed the individual and state-year summary records, reconciled differences, and recoded after consensus was reached.

Variables

We focused on laws that regulate seven care domains capturing the critical steps that involve care coordination between EMS and hospital stroke centers.^{16–18}, some of which amenable to policy interventions.^{19–24} See Table 1 for the selected laws.

Prescriptiveness Level:

For each state, each policy intervention was coded into four levels: (a) required, (b) required in some circumstances, (c) authorized, or (d) “silent.” Silent indicates that the law does not address the policy intervention. No state prohibited any policy intervention.²⁵

Prescriptiveness Concordance:

Prescriptiveness concordance was measured as the proportion of states with the same level of prescriptiveness for EMS and hospital laws.

Adoption Concordance:

Laws affecting EMS and hospitals were further compared based on the effective date. To determine when a law went into effect, among states that expressly require an executive agency to promulgate regulations to implement EMS and/or hospital care legislation, the first effective date of the relevant regulation was used. For other states, the effective date of the enabling legislation was used. We calculated the lag time in years using the summary record. The proportion of states where a pair of laws affecting EMS and hospitals took effect within the same year was determined.

Analysis

We adopted a dyadic approach to examine concordance (i.e., the systematic patterns of similarity) between two state laws; this is consistent with prior research that used dyads (or pairs) to examine state policy emulation²⁶ and patient-caregiver alignment on care expectations.²⁷

We focused on 10 pairs of laws for EMS and for hospitals (law “dyads”) across the seven domains of EMS and hospital care (Appendix Figure A1). In the first step, we selected law domains based on published risk assessments that identified high priority steps for improved PSC centers door-in-door-out process¹⁷ and door-to-needle process,¹⁶ and based on evidence that shows the effectiveness of individual policy on improved acute stroke treatment performance using a previously published policy assessment process.²⁸ (Appendix Table A1). In the second step, we selected law dyads that have been shown or suggested to have differential effects by the presence of another law domain (Appendix Table A2).

We analyzed the following 10 dyads:^{1–3} EMS triage/ground transportation and standardized assessment, EMS hospital pre-notification, inter-facility transfer agreements;^{4–6} EMS triage/ground transportation and stroke center certification (ARSH, PSC, CSC);^{7–9} Inter-facility transfer agreements and stroke center certification (ARSH, PSC, CSC); and¹⁰ Continuous quality improvement (CQI) data system by EMS and by stroke centers.

We examined the distribution of prescriptiveness and adoption concordance across states, using descriptive statistics in Stata/MP 16.1 (StataCorp LLC).

Results

Level of prescriptiveness

For most laws affecting EMS and hospital care, “required” was more prevalent than other prescriptiveness levels.

Mandates regarding stroke center certification and EMS use of a standardized assessment tool tended to have a higher proportion of “required”, whereas mandates regarding EMS hospital pre-notification of a suspected stroke patient, EMS triage/ground transportation, and the use of a CQI data system tended to have a higher proportion of “authorized” (Table 2). In 2018, among the 30 states that passed laws regulating CSC certification, the regulation was “required” in 26 (86.7 %) and “authorized” in 4 (13.3 %) states. Among the 20 states that passed laws regulating EMS triage/ground transportation, the regulation was “required” in 13 (65 %) and “authorized” in 7 (35 %) states.

During 2002–2018, the share of “required” remained largely unchanged for most laws. However, laws addressing inter-facility transfer agreements and hospitals’ use of CQI data systems tended to become less prescriptive, as shown by the diminishing share of “required” over time (Appendix Figure A2).

Variation in prescriptiveness concordance

In 2018, the proportion of states with the same level of prescriptiveness ranged from 47 % for inter-facility transfer agreements and PSC or CSC certification to 75 % for CQI for EMS and hospital care (Table 3). EMS triage/ground transportation laws were less prescriptive than stroke center certification laws in 22 %–35 % of states that adopted both laws. Inter-facility transfer agreement laws were less prescriptive than stroke center certification laws in 35 % to 51 % of states with both laws (Table 3). Among law dyads that addressed EMS care only, EMS triage/ground transportation tended to be the most prescriptive (Table 3).

Variation in adoption concordance

The proportion of states that adopted each law dyad within the same year ranged from 31 % (inter-facility transfer agreement and ASRH certification) to 86 % (CQI for EMS and hospitals) (Table 4). Stroke center certification and EMS triage/ground transportation laws were adopted concordantly within the same year in 44 % to 70 % of states, depending on the certification level. Similar results were found when assessing adoption concordance between stroke center certification and inter-facility transfer agreement laws (Table 4).

For dyads that address EMS care and patient triage, the proportion of states in which EMS triage/ground transportation laws took effect before, within the same year, and after inter-facility transfer agreement laws took effect, was 43 %, 36 %, and 21 %, respectively (Table 4).

Discussion

We found substantial variation across states in adoption concordance and prescriptiveness concordance between laws affecting EMS and hospitals. Overall, laws affecting EMS were

less prescriptive than those affecting hospitals. However, adoption concordance was high. To our best knowledge, our analysis is among the first to examine the variation in state concordance in adopting laws regulating stroke systems of care. Findings from this study are especially relevant for stroke care delivery system redesign and have policy implications for improving care coordination between EMS and hospitals.

We found that, despite variation across states in the presence of law dyads,¹¹ in states that adopted laws regulating both EMS and hospital care, most laws were adopted concordantly, revealing that most states used a “bundled” legislative approach.^{29,30} Our results are consistent with prior research, which shows that the development, implementation, and modification of EMS policies often occur shortly after the designation and establishment of a stroke center.^{19,20} Such a “bundled” legislative approach has been shown to improve uptake of evidence-based practices, such as increased tissue plasminogen activator or alteplase delivery¹⁹ and increased endovascular therapy utilization.²⁰

For patients to be assessed, triaged, and transferred to the most appropriate stroke center, both EMS and hospitals may be simultaneously motivated through regulatory practices. We found two areas where the extant regulatory efforts for EMS and hospitals are less synchronized. On one hand, only one-third of states that adopted laws for both EMS triage and inter-facility transfer agreements did so concordantly, with inter-facility transfer agreements adopted later than EMS triage nearly half of the time.

Transfer between hospitals continues to be critical,^{9,18,31} especially for more severe patients.^{31,32} Multiple care steps of inter-hospital transfers may benefit from the establishment of formal agreements.^{17,18} For instance, key strategies to streamline the inter-hospital transfer process include early transfer decisions made at the referring hospital, digital updates during transport, electronic transmission of patient records between hospitals, and standardized workflow by paramedics.¹⁸ We found that inter-facility transfer agreements typically specify the criteria for transfer, standardize the procedures of patient transport and acceptance, and remove administrative barriers through mutual agreements. Additionally, inter-facility transfer agreements may facilitate implementation of patient triage laws. These agreements would especially benefit states without EMS triage of patients with severe stroke where transport directly to the most appropriate stroke center may not be feasible.

EMS laws tend to be less prescriptive than those affecting hospital care, although the effectiveness of a policy has been shown to depend on the level of prescriptiveness.^{14,15} Health care organizations that must implement laws “without exceptions” (mandatory) demonstrate greater quality improvement.^{15,15} Before a policy becomes mandatory, low-performing organizations in a market tend not to participate.¹⁵ Laws that are less prescriptive may miss opportunities to improve care quality, especially among lower-performing organizations.¹⁵ Empirical evidence about the heterogeneity in law effectiveness by level of prescriptiveness is largely absent for stroke care. With ongoing data collection of EMS performance measures,³³ future research may be needed to examine the degree to which variation in prescriptiveness of EMS laws affect EMS utilization and care coordination outcomes.

We further found discordance among laws affecting EMS care delivery. Evidence has suggested that EMS use of standardized stroke assessments^{17,34–36} and pre-notification of hospitals^{23,24,37} are associated with better outcomes and are rated among the strongest evidence-based EMS practices.^{11,28} We found that laws regulating these actions generally lagged. Without the use of a standardized screening, EMS may delay the transfer of a suspected stroke patient or fail to triage. Failure to detect severe stroke, potentially due to suboptimal standardized assessment, has been recently recognized as an underlying root cause for delayed door-in-door-out time¹⁷ and a leading cause of diagnostic errors in the emergency department.³⁵

At the center of the debate regarding inter-hospital transfers is the tradeoff between improved access to advanced treatment and delay in treatment due to transfer.^{17,18,38} Laws requiring EMS pre-notification could potentially mitigate the delay effects. For example, prehospital notification is associated with shorter door-to-CT time,^{24,37} a known contributing factor to prolonged door-in-door-out time.³⁹ In addition, EMS pre-notification appears to have synergistic effects with other related EMS policies, which is consistent with the findings from other fields related to chronic disease management.¹⁴ For example, according to a study in Chicago, the effectiveness of EMS triage laws is stronger among EMS-transported patients with pre-notification, compared to those without pre-notification.¹⁹ Inadequate pre-notification requirements might further lead to missed opportunities to improve the implementation of related EMS and hospital laws.

Despite the proliferation of empirical evidence, laws regulating pre-notification and other critical aspects of EMS stroke care tend to be less frequent and less prescriptive than laws regulating hospital stroke care. Studies report that EMS systems in the United States are largely decentralized, in part due to federal initiatives that support regionalized approaches to trauma, cardiac, and stroke emergency care⁴⁰ as well as local financial support for EMS services.⁴¹ Examination of alternative strategies may be undertaken if formal legislative actions are not feasible. Certain EMS policies disproportionately affect patients transported by EMS.¹⁹ Given the substantial proportion of patients transported through private ambulance, and the suboptimal use of EMS among privately insured patients,³³ decision-makers might consider partnering with local communities to increase public awareness of stroke symptoms and partnering with private insurers to increase coverage of EMS ambulance use for stroke. Given the increasing number of patients who need inter-hospital transfer for advanced treatment,⁹ leveraging resources at stroke centers through innovative models, such as telestroke, might be alternative and feasible approaches.^{42–44}

This study has several limitations. First, our study analyzes laws at the state level. We did not collect information about policies and protocols developed within hospital networks. The conclusions regarding the presence of regulatory discordance between EMS and hospitals should still be valid, as protocols at the local level are developed typically under medical direction in accordance with state EMS agency guidance.^{45,46} Second, because we compared state laws on the first day of each calendar year, laws established in the middle of a year were considered as taking effect in the following year. This may overestimate the adoption discordance of certain dyads. Third, the analysis about variation in prescriptiveness

concordance is cross-sectional. Laws for EMS and hospitals that are less synchronized in prescriptiveness might change over time.

In conclusion, states demonstrate greater concordance in adoption than in prescriptiveness of laws that affect EMS and hospital stroke care. To promote care coordination, additional laws might be considered to strengthen the regulation of EMS stroke care, especially pre-notification and use of standardized screening – two evidence-based practices but lagged in regulatory strengths. Utilizing a novel approach, this study provides a foundation for further exploration of the role of concordance in prescriptiveness and policy intervention adoption in assessing delays in AS treatment due to lack of coordination between EMS and hospitals.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Policy and Practice Implications

The role of concordance and prescriptiveness of laws in policy intervention is understudied—particularly in assessing the creation of stroke systems of care and delays in AS treatment. This research acts as an initial translation tool that decision-makers can reference to implement effective and synergistic policies across states for stroke systems of care. These findings might also address lags in treatment based on lack of care coordination.

A “bundled” legislative approach may be useful in creating more coordinated and ultimately more efficient stroke care delivery systems. Future exploration of the effect of this approach on policy intervention may be beneficial for public health practitioner and decision-makers.

These results can help policy decision-makers to strengthen EMS care coordination regulations at the state-level.

Table 1.

Operational Definitions of Stroke Systems of Care Laws

Laws	Definition
EMS Triage/Ground Transportation	Laws that expressly authorize or require statewide and/or regional/local EMS use of an acute stroke assessment tool or triage protocol, and EMS use of stroke transport protocols to the most appropriate stroke center using ground transport.
Standardized Stroke Assessment	Laws that expressly authorize or require the use of a standardized stroke assessment tool [e.g., BE-FAST: Balance, Eyes, Face, Arm, Speech, Time;(38) CPSS: Cincinnati Prehospital Stroke Scale(49)] or protocol for EMS to assess suspected stroke victims.
Pre-notification	Laws that expressly authorize or require pre-notification (direct communication) between EMS and the receiving hospital to which a suspect stroke victim is being transported by ground or air.
Inter-facility Transfer Agreements	Laws that expressly authorize or require inter-facility transfer agreements or protocols between hospitals or freestanding emergency clinics and receiving hospitals for transfer of patients to the most appropriate stroke center. If a law requires some, but not all, stroke centers to have transfer agreements or protocols, it was coded as "required in part."
Stroke Center Certification	State laws that recognize a facility for acute stroke treatment and expressly authorizes or requires designation or recognition of national accreditation as a CSC, PSC, ASRH, respectively.
CQI for Stroke Centers	Laws that establish or authorize a statewide stroke data reporting system and requires or authorizes stroke centers and hospitals to participate in CQI stroke performance monitoring using the data system.
CQI for EMS system	Laws that establish or authorize a statewide and/or regional EMS System CQI plan, process, program, system evaluation, system performance monitoring (or measurement), or system quality assurance that expressly addresses stroke.

Note: CSC = Comprehensive Stroke Center; PSC = Primary Stroke Center; ASRH = Acute Stroke Ready Hospital; EMS = Emergency Medical Services; EMSS = EMS System; CQI = Continuous Quality Improvement.

Table 2.

Distribution of Level of Prescriptiveness of Stroke Systems of Care Laws, 2018

Laws	Prescriptiveness			
	Required	Required in some circumstances	Authorized	Silent
EMS Care Laws				
EMS triage/ground transportation	13	0	7	31
EMS pre-notification	3	0	3	45
EMS stroke standardized tools	12	0	1	38
CQI for EMSS	7	0	4	40
Hospital Care Laws				
CSC certification	26	0	4	21
PSC certification	28	0	4	19
ASRH certification	21	0	2	28
Inter-facility transfer agreements	6	9	3	33
CQI for stroke centers	6	2	7	36

Note: CSC = Comprehensive Stroke Center; PSC = Primary Stroke Center; ASRH = Acute Stroke Ready Hospital; EMS = Emergency Medical Services; EMSS = EMS System; CQI = Continuous Quality Improvement.

Table 3.

Distribution of Prescriptiveness Concordance Between Each Policy Dyad Across States, 2018

Law Dyads	N	%
EMS triage/transportation – Stroke Assessment by standardized tools		
EMS triage less prescriptive than assessment	5	9.8
Same level	37	72.6
EMS triage more prescriptive than assessment	9	17.7
EMS triage/transportation – Pre-notification		
EMS triage less prescriptive than pre-notification	2	3.9
Same level	32	62.8
EMS triage more prescriptive than pre-notification	17	33.3
EMS triage/transportation – Inter-facility Transfer		
EMS triage less prescriptive than inter-facility transfer	8	15.7
Same level	32	62.8
EMS triage more prescriptive than inter-facility transfer	11	21.6
EMS triage/transportation – PSC national		
EMS triage less prescriptive than PSC	18	35.3
Same level	32	62.8
EMS triage more prescriptive than PSC	1	2.0
EMS triage/transportation – CSC national		
EMS triage less prescriptive than CSC	17	33.3
Same level	32	62.8
EMS triage more prescriptive than CSC	2	3.9
EMS triage/transportation – ASRH national		
EMS triage less prescriptive than ASRH	11	21.6
Same level	35	68.6
EMS triage more prescriptive than ASRH	5	9.8
Inter-facility Transfer – PSC national		
Inter-facility Transfer less prescriptive than PSC	26	51.0
Same level	24	47.1
Inter-facility Transfer more prescriptive than PSC	1	2.0
Inter-facility Transfer – CSC national		
Inter-facility Transfer less prescriptive than CSC	25	49.0
Same level	24	47.1
Inter-facility Transfer more prescriptive than CSC	2	3.9
Inter-facility Transfer – ASRH national		
Inter-facility Transfer less prescriptive than ASRH	18	35.3
Same level	27	52.9
Inter-facility Transfer more prescriptive than ASRH	6	11.8
CQI_EMSS – CQI_In-hospital		

Law Dyads	N	%
EMSS CQI less prescriptive than stroke center/hospital CQI	9	17.7
Same level	38	74.5
EMSS CQI more prescriptive than stroke center/hospital CQI	4	7.8

Note: CSC = Comprehensive Stroke Center; PSC = Primary Stroke Center; ASRH = Acute Stroke Ready Hospital; EMS = Emergency Medical Services; EMSS = EMS System; CQI = Continuous Quality Improvement.

Table 4.

Distribution of Adoption Concordance Between Each Policy Dyad Across States

Law Dyads	Mean (range), years	N	%
EMS Triage/Transportation – Standardized Tool	-0.6 (-5, 0)		
EMS triage adopted earlier than assessment		2	18.1
Same year		9	81.8
EMS triage adopted later than assessment		0	0.0
EMS Triage/Transportation – Pre-notification	-0.5 (-2, 0)		
EMS triage adopted earlier than pre-notification		1	25.0
Same year		3	75.0
EMS triage adopted later than pre-notification		0	0.0
EMS Triage/Transportation – Inter-facility Transfer	-1.0 (-7, 8)		
EMS triage adopted earlier than inter-facility transfer		6	42.9
Same year		5	35.7
EMS triage adopted later than inter-facility transfer		3	21.4
EMS Triage/Transportation – PSC National	0.3 (-5, 8)		
EMS triage adopted earlier than PSC		2	10.0
Same year		14	70.0
EMS triage adopted later than PSC		4	20.0
EMS Triage/Transportation – CSC National	-1.6 (-7, 3)		
EMS triage adopted earlier than CSC		7	36.8
Same year		9	47.4
EMS triage adopted later than CSC		3	15.8
EMS Triage/Transportation – ASRH National	-3.3 (-13, 3)		
EMS triage adopted earlier than ASRH		8	50.0
Same year		7	43.8
EMS triage adopted later than ASRH		1	6.2
Inter-facility Transfer – PSC National	0.9 (0, 6)		
Inter-facility Transfer adopted earlier than PSC		0	0.0
Same year		13	72.2
Inter-facility Transfer adopted later than PSC		5	27.8
Inter-facility Transfer – CSC National	-1.5 (-8, 5)		
Inter-facility Transfer adopted earlier than CSC		6	35.3
Same year		9	52.9
Inter-facility Transfer adopted later than CSC		2	11.8
Inter-facility Transfer – ASRH National	-3.7 (-11, 0)		
Inter-facility Transfer adopted earlier than ASRH		9	69.2
Same year		4	30.8
Inter-facility Transfer adopted later than ASRH		0	0.0
CQI_EMSS – CQI_In-Hospital	-1.1 (-8, 0)		

Law Dyads	Mean (range), years	N	%
EMSS CQI adopted earlier than stroke center/hospital CQI		1	14.3
Same year		6	85.7
EMSS CQI adopted later than stroke center/hospital CQI		0	0.0

Note: CSC = Comprehensive Stroke Center; PSC = Primary Stroke Center; ASRH = Acute Stroke Ready Hospital; EMS = Emergency Medical Services; EMSS = EMS System; CQI = Continuous Quality Improvement.