What is the Evidence for Existing State Laws to Enhance Pre-hospital Stroke Care?

A Policy Evidence Assessment Report

National Center for Chronic Disease Prevention and Health Promotion
Division for Heart Disease and Stroke Prevention

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The Big Picture

On average, every 40 seconds, someone in the United States has a stroke, and someone dies of one approximately every four minutes.[a] There are life-saving treatments for stroke, but patients must receive them in a timely manner. To improve the timeliness and quality of care for stroke, **stroke systems of care** coordinate and promote patient access to the full range of activities and services associated with stroke prevention, treatment, and rehabilitation.[b]

In stroke systems of care, **emergency medical service systems (EMSS) and EMS providers** are essential in the recognition of suspected strokes and providing timely transport and **pre-hospital care** for patients with suspected stroke. EMSS pre-hospital care could be improved to reduce time to treatment after stroke. **State law could help scale up evidence-based policy interventions shown to improve EMSS response to suspected stroke and related stroke outcomes.**

To prioritize pre-hospital EMSS policy interventions for stroke that could be addressed in state law, CDC's Division for Heart Disease and Stroke Prevention (DHDSP) collected and assessed early, best available evidence. This evidence included evaluation studies of stroke systems of care as well as subject matter expert and practitioner recommendations drawn from the published and grey literature.

Pre-hospital care: includes all emergency medical care, including transitions of care, provided prior to a stroke patient's treatment at an appropriate stroke hospital.

EMSS: refers to the delivery systems for EMS that may be organized on a local, regional, statewide, or nationwide basis using public or private resources.

EMS providers: includes any licensed and/or certified, dispatched responder who provides pre-hospital medical care, such as emergency medical responders, emergency medical technicians, and paramedics.

About This Report

This report assesses the best available evidence for seven pre-hospital EMSS policy interventions for stroke addressed in existing state law. These policy interventions were all a) recommended by experts on stroke systems of care and b) addressed in at least one state's law as of May 31, 2017. For more on the method used, see the Appendix. Future reports by DHDSP will assess the evidence for policy interventions impacting hospital and post-hospital settings.

Evidence associated with each pre-hospital EMSS policy intervention for stroke is assessed here for strength and quality. **Results of this evidence assessment offer public decision makers real-world options for supporting stroke systems of care that are grounded in the best available evidence**. The figure on the next page provides seven pre-hospital EMSS policy interventions for stroke addressed in state law, prioritized by evidence level.

As of May 31, 2017, there are four pre-hospital EMSS policy interventions for stroke found to have "best" evidence, and three found to have "emerging" or "promising" evidence (Figure). State laws that address the policy interventions with **"best" evidence** are expected to have the greatest potential for a positive health and associated economic impact. The policy interventions with "best" evidence bases include:

- **Stroke pre-notification of receiving facility by EMS providers**
- **EMS triage and transport to the most appropriate stroke facility**[c]
- **Air medical transport to the most appropriate stroke facility**
- **Inter-facility transfer to the most appropriate stroke facility**

a. Mozzafarian D, Benjamin EJ, Go AS, Arnett DK, Blaha MJ, Cushman M, et al., on behalf of the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2016 update: a report from the American Heart Association. *Circulation* 2016;133(4):e38–360.

b. Schwamm LH, Pancioli A, Acker JE, et al. Recommendations for the Establishment of Stroke Systems of Care. Recommendations From the American Stroke Association's Task Force on the Development of Stroke Systems. 2005;36(3):690-703.

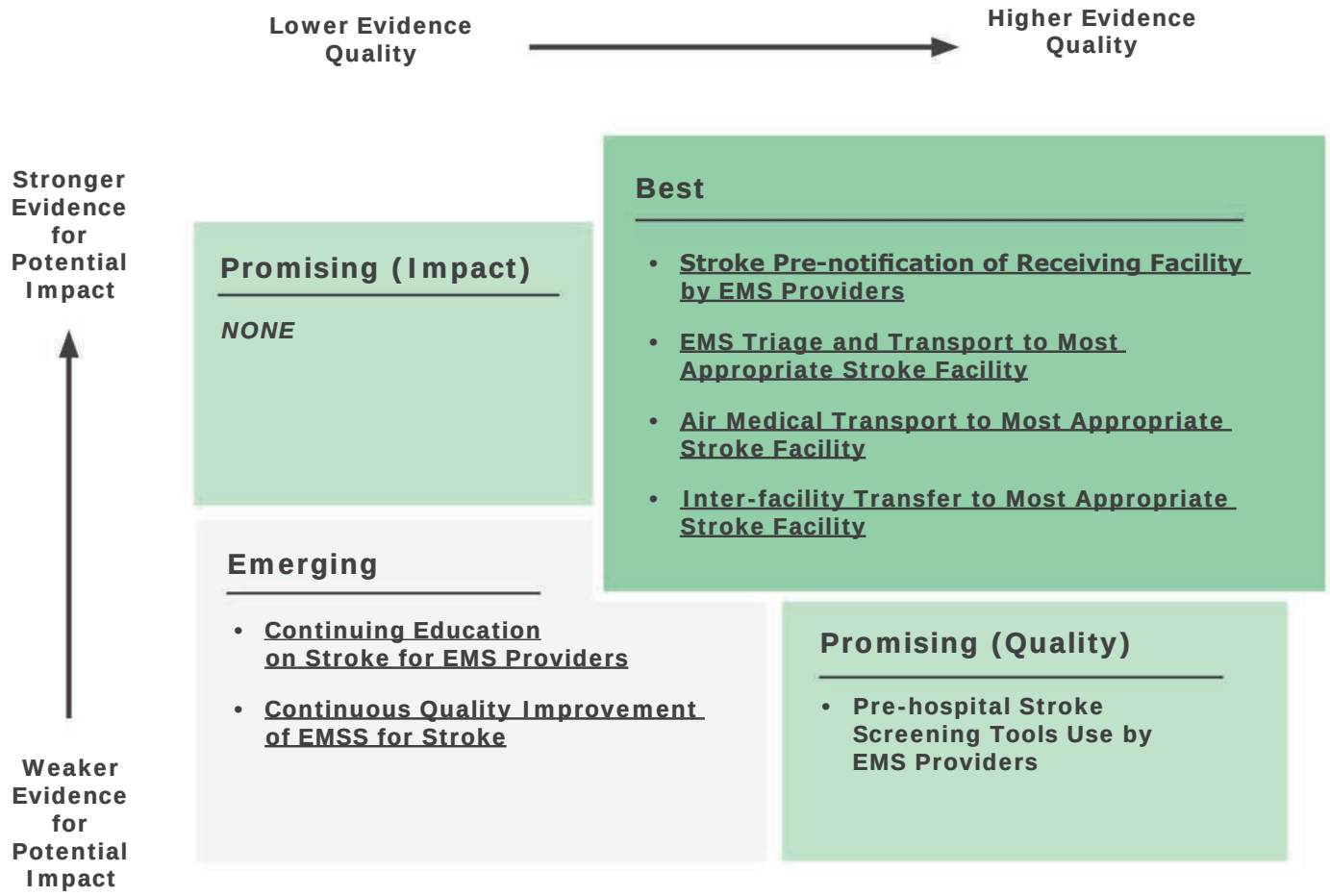
c. The "most appropriate stroke facility" is the clinic, hospital, or stroke center that 1) is best equipped to provide the right treatment for a patient's specific type of stroke and 2) is close enough to reach within the recommended time window for that treatment.

State laws that address the policy interventions with "**promising" or "emerging" evidence** could also have positive impacts, but the quantity and quality of the evidence for them is limited at this time. These policy interventions include:

- **Pre-hospital stroke screening tool use by EMS providers**
- **Continuing education on stroke for EMS providers**
- **Continuous quality improvement of EMSS for stroke**

Researchers and evaluators could help build stronger evidence bases for these "promising" and "emerging" policy interventions. See the Appendix for how each evidence base could be strengthened. The figure below summarizes the results of our evidence assessment

Figure. Seven pre-hospital EMSS policy interventions for stroke addressed in existing state law.
Use the links in this figure to navigate to an evidence summary for each type of intervention.



How To Use this Report

State decision makers and public health organizations may consider presenting this report, along with facts about state stroke rates and existing stroke programs, to the state public health department, Emergency Medical Services Director, health care providers and payers, and others interested in improving stroke outcomes.

State decision makers and public health organizations may consider planning for a state stroke policy that addresses multiple evidence-based interventions to improve the entire system of stroke care. Many of the interventions presented here are expected to work together to improve stroke outcomes. State law is a tool that could help initiate policy change, reach whole populations, and increase consistency and coordination across a state stroke system. Some states already have laws addressing multiple pre-hospital EMSS policy interventions for stroke found here to have "best" evidence. One example, from Wyoming, is provided below—the bolded policy components align with the policy interventions shown in the Figure to have "best" evidence bases of state laws addressing the evidence-based WHP interventions in this report.

Wyoming's policy approach to support pre-hospital EMSS for stroke.

As of 2015, a Wyoming law authorizes the Wyoming Department of Health (DOH) to designate hospitals as acute stroke ready, primary, or comprehensive stroke centers. In addition, the DOH must develop evidence-based EMS pre-hospital stroke assessment, treatment and transport protocols and work with the office of emergency medical services and EMS providers to develop **stroke triage and transport plans** to the closest most appropriate stroke center. **EMS providers must also issue a "Notification of a Stroke Alert" to the receiving stroke center** as soon as possible for patients with a positive FAST (Facial droop; Arm droop; Slurred speech; and Time to call for help) assessment. Stroke centers must have **inter-facility agreements** with higher level stroke centers as well as written agreements with EMS for ground or **air transport** of stroke patients. Wyo. Stat. Ann. § 35-2-1001 (West, 2017); 13 WYO. CODE R. §§ 1 through 7 (2017); 15 WYO. CODE R. §§ 1 through 6 (2017)

The seven pre-hospital EMSS policy interventions provided in this report are all addressed in existing state law, but some states are implementing these interventions using other policy approaches. In addition, EMSS may be authorized by states to adopt their own evidence-based policies and protocols for stroke.

There are innovations in pre-hospital stroke care which states may choose to address in their laws in the future; for example, clinical innovations that require modifications of EMSS for stroke care as well as technological advances, such as mobile stroke units and telemedicine in ambulances. States may also consider addressing EMS certification requirements for stroke, dispatcher recognition and prioritization of stroke, and health insurance coverage for transportation to stroke centers, among other policy interventions.

Other pre-hospital EMSS policy interventions for stroke were not included in the current report because they were not yet addressed in existing state laws and/or they did not align with a major recommendation by an expert group as of May 31, 2017. This report will be updated as states enact new laws and there is new evidence addressing additional evidence-based pre-hospital EMSS policy interventions for stroke. Future reports about the evidence for hospital and post-hospital policy interventions for stroke, including those addressing stroke center designations as well as stroke registries and data sharing, will be forthcoming from CDC DHDSP.

Evidence Summaries

The next section provides evidence summaries for all of the pre-hospital EMSS policy interventions for stroke included in this assessment. The evidence summaries could help state decision makers and public health organizations determine which pre-hospital EMSS policy interventions for stroke may be useful in their state. The links in the Figure on the previous page can be used to navigate to the evidence summary for each policy intervention.

How to use an evidence summary.

Evidence summaries describe the evidence used to score a policy intervention's evidence base on potential public health impact and quality. Each evidence summary includes a full reference and evidence list and provides the positive outcomes observed in intervention studies, as well the specific states in which these outcomes were found. When there were no intervention studies of a policy intervention, an evidence summary instead includes the rationale for the policy intervention, as described by experts and practitioners. See the Appendix for more on the method used to develop evidence summaries.

As a first step, state decision makers and public health organizations may want to research the health problems in their state. CDC offers many state health facts on its website, including those about stroke. Next, state decision makers and public health organizations may consider using the evidence summaries in this report to identify pre-hospital EMSS policy interventions that may help improve stroke systems of care in their state setting. They may consider reviewing the policy interventions with "best" evidence first. For example, the evidence summary for Stroke Pre-notification of Receiving Facility by EMS Providers provides the studies in which stroke pre-notification (and stroke systems including stroke pre-notification) have been linked to positive health-related outcomes in the general population in several states (Massachusetts, California, Michigan, North Carolina, Pennsylvania, and Illinois) and in one national study. This evidence summary also describes how one state, Wyoming, has addressed stroke pre-notification in its law.[d]

d. There are other states that have addressed stroke pre-notification by EMS in law, but Wyoming was chosen as the example because of the alignment of its law with the evidence base.

Evidence Summaries

Stroke Pre-notification of Receiving Facility by EMS Providers

Evidence Level: BEST

States can encourage EMS providers to pre-notify receiving facilities of a suspected stroke patient; for example, by incorporating pre-notification into EMS protocol algorithms and checklists, including pre-notification as a component of EMS training and continuing education, and reviewing the use of pre-notification as a part of continuous quality improvement activities within stroke systems of care[33]

Example of state law addressing this policy intervention

A Wyoming regulation requires EMS providers to issue a "Notification of Stroke Alert" to the receiving Stroke Center as soon as possible for patients with a positive FAST (Facial droop; Arm droop; Slurred speech; and Time to call for help) assessment. [15 WYO. CODE R. HLTH EMS §§ 1 through 6 (2017)]

Evidence for Potential Public Health Impact:

Effectiveness: ●●●●
Equity & Reach: ●●○○
Efficiency: ●●○○
Transferability: ●●●●

Weaker=●○○○ ◄► ●●●●=Stronger

For more on how evidence for potential impact was assessed, see the Appendix

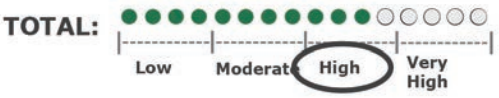
SCORE: STRONG

Evidence Quality:

Evidence Type: ●●●○
Source: ●●●○
Evidence from Research: ●○○○
Evidence from Translation & Practice: ●●●●

Lower=●●●● ◄► ●●●●=Higher

For more on how evidence quality was assessed, see the Appendix



SCORE: HIGH

Reported health-related outcomes

Pre-notification was linked with improved stroke recognition,[2-8] and increased access to appropriate stroke treatment.[2-9] Stroke systems that included pre-notification were also linked to improved stroke recognition[10-12] and increased access to appropriate stroke treatment. [10-12]

Groups studied

Studies reporting positive health-related outcomes examined the general population.[2-12]

Economic highlights

No economic outcomes January 1, 2007 to May 31, 2017

Settings

There was one national study in the evidence base.[5] Additional studies were set in local or state stroke systems in California,[3] Illinois,[11] Massachusetts,[2,4,9,12] Michigan,[7] North Carolina,[8] and Pennsylvania.[10]

Evidence base on Potential Public Health Impact

Research-based studies

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Practice-based reviews

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Narratives and Commentaries

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EMS Triage and Transport to Most Appropriate Stroke Facility

Evidence Level: **BEST**

*Emergency medical services (EMS) providers play a vital role in the rapid triage and transportation of suspected stroke patients. Pre-hospital EMS care protocols for stroke triage and transport to the closest stroke facility by ambulance may improve outcomes for patients with stroke.[1]**

**The following analyses include ground transport studies only.*

Example of state law addressing this policy intervention

In collaboration with the District of Columbia Fire and EMS Department (FEMS), the Department of Health (DOH) is to establish standardized pre-hospital care protocols for stroke triage assessment, treatment, and patient transport to the closest most appropriate facility, which could be an Acute Stroke Ready Hospital (ASHR), Primary Stroke Center (PSC), or Comprehensive Stroke Center (CSC). "DOH is directed to encourage the three levels of stroke care (ASRH, PSC, and CSC) to enter into written agreements (including open communication and transfer agreements) to ensure stroke patients are offered appropriate levels of care. DC CODE §§ 44-1151 to 44-1159 (2017)

Evidence for Potential Public Health Impact:

Effectiveness: ●●●●
Equity & Reach: ●●●●
Efficiency: ●○○○
Transferability: ●●●●

Weaker=●●●● ◄► ●●●●=Stronger

For more on how evidence for potential impact was assessed, see the Appendix

TOTAL: ●●●●●●●●●●●●○○○

Weak | Moderate | Strong | **Very Strong**

SCORE: VERY STRONG

Evidence Quality:

Evidence Type: ●●○○
Source: ●●●○
Evidence from Research: ○○○○
Evidence from Translation & Practice: ●●●●

Lower=●●●● ◄► ●●●●=Higher

For more on how evidence quality was assessed, see the Appendix

TOTAL: ●●●●●●●●○○○○○○○

Low | Moderate | **High** | Very High

SCORE: HIGH

Reported health-related outcomes	The utilization of EMS triage and transport protocols is linked to increased access to appropriate stroke treatment;[2,3] decreased time to hospital admission;[2] and improved stroke recognition.[2] A stroke system of care including EMS triage and transport protocols were linked with increased access to appropriate stroke treatment[4-6] and decreased time to hospital admission.[6]
Groups studied	Studies reporting positive health-related outcomes examined the general population.[2-3,4-6]
Economic highlights	*No economic outcomes January 1, 2007 to May 31, 2017*
Settings	There was one national study in the evidence base.[3] Additional studies of local stroke systems were set in Arizona,[5] California,[4] Illinois,[2] and Michigan.[6]

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Evidence Base on Potential Public Health Impact

Research-based studies

No research-based studies January 1, 2007-May 31, 2017

Practice-based studies

2. Prabhakaran S, O'Neill K, Stein-Spencer L, Walter J, Alberts MJ. Prehospital triage to primary stroke centers and rate of stroke thrombolysis. JAMA Neurology. 2013;70(9):1126-1132
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Narratives and commentaries

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e. No outcome – The study reported no differences in community bypass rates or overall transport, and on-scene times, suggesting that the overall impact of hospital bypass protocols may be limited

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35. Southerland AM, Johnston KC, Molina CA, Selim MH, Kamal N, Goyal M. Suspected large vessel occlusion: Should emergency medical services transport to the nearest primary stroke center or bypass to a comprehensive stroke center with endovascular capabilities? Stroke. 2016;47(7):1965-1967.
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Air Medical Transport to Most Appropriate Stroke Facility

Evidence Level: **BEST**

Air transport of stroke patients allows for the shortening of time to treatment, improvements in patient survival rates, potential lowering of the incidence of stroke in patients, improvements in access to interventional stroke care in rural settings. States could authorize air medical transport in stroke transport protocols.[1-4, 13]

Example of a state law addressing this policy intervention

A Missouri rule establishes protocols for "transporting suspected stroke patients by severity and time of onset to the stroke center where resources exist to provide appropriate care." Suspected stroke transport protocol requirements include: all ground and air ambulances must use the state protocol (with some exceptions) that assesses presence of life threatening conditions for stabilization prior to transport to stroke center; timing of symptoms and therapeutic window for transport to level I, II, III or IV and out of state facility. MO. CODE REGS. ANN. tit. 19, § 30-40.790 (2017)

Evidence for Potential Public Health Impact:

Effectiveness: ●●●●
Equity & Reach: ●●●●
Efficiency: ○○○○
Transferability: ●●●●

Weaker=●●●● ◄► ●●●●=Stronger

For more on how evidence for potential impact was assessed, see the Appendix

TOTAL: ●●●●●●●●●●●○○○○

Weak | Moderate | **Strong** | Very Strong

SCORE: STRONG

Evidence Quality:

Evidence Type: ●●●○
Source: ●●●○
Evidence from Research: ○○○○
Evidence from Translation & Practice: ●●●●

Lower=●●●● ◄► ●●●●=Higher

For more on how evidence quality was assessed, see the Appendix

TOTAL: ●●●●●●●●●○○○○○

Low | Moderate | **High** | Very High

SCORE: HIGH

Reported health-related outcomes	Air medical transport to most appropriate stroke facility was linked with decreased time to treatment[8,10] and increased access to appropriate stroke treatment.[5,8]
Groups studied	Studies reporting positive health-related outcomes examined the general population[5,10] or urban and rural populations.[8]
Economic highlights	*No economic outcomes January 1, 2007 to May 31, 2017*
Settings	There were two national studies in the evidence base[5,8] and a study of regional stroke systems in the following states: Delaware, the District of Columbia, Maryland, Pennsylvania, and West Virginia.[10]

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3. Thomas SH, Kociszewski C, Schwamm LH, Wedel SK. The evolving role of helicopter emergency medical services in the transfer of stroke patients to specialized centers. Prehosp Emerg Care. 2002; 6: 210–214
4. Silliman SL, Quinn B, Huggett V, Merino JG. Use of a field-to-stroke center helicopter transport program to extend thrombolytic therapy to rural residents. Stroke. 2003; 34: 729–733.

Evidence Base on Potential Public Health Impact

Research-based studies

No research-based studies January 1, 2007-May 31, 2017

Practice-based studies

5. Albright KC, Branas CC, Meyer BC, et al. ACCESS: acute cerebrovascular care in emergency stroke systems. Archives of Neurology. 2010;67(10):1210-1218.
6. Golden AP, Odoi A. Emergency medical services transport delays for suspected stroke and myocardial infarction patients. BMC Emergency Medicine. 2015;15:34.
7. Gropen T, Magdon-Ismail Z, Day D, Melluzzo S, Schwamm LH, Group NA. Regional implementation of the stroke systems of care model: recommendations of the northeast cerebrovascular consortium. Stroke. 2009;40(5):1793-1802.
8. Hutton CF, Fleming J, Youngquist S, Hutton KC, Heiser DM, Barton ED. Stroke and Helicopter Emergency Medical Service Transports: An Analysis of 25,332 Patients. Air Medical Journal. 2015;34(6):348-356.
9. Kesinger MR, Sequeira DJ, Buffalini S, Guyette FX. Comparing National Institutes of Health Stroke Scale among a stroke team and helicopter emergency medical service providers. Stroke. 2015;46(2):575-578.
10. LaMonte MP, Bahouth MN, Magder LS, et al. A regional system of stroke care provides thrombolytic outcomes comparable with the NINDS stroke trial. Annals of Emergency Medicine. 2009;54(3):319-327.
11. Prabhakaran S, Ward E, John S, et al. Transfer delay is a major factor limiting the use of intra-arterial treatment in acute ischemic stroke. Stroke. 2011;42(6):1626-1630.
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18. DeSousa KG, Haussen DC, Yavagal DR. Strategies for streamlining emergency stroke care. Current Neurology & Neuroscience Reports. 2014;14(11):497.
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22. Saler M, Switzer JA, Hess DC. Use of telemedicine and helicopter transport to improve stroke care in remote locations. Current treatment options in cardiovascular medicine. 2011;13(3):215-224.
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Inter-Facility Transfer to Most Appropriate Stroke Facility

Evidence Level: **BEST**

*Policies encouraging: (1) written inter-facility transfer agreements to ensure appropriate, timely acute stroke care at appropriate facilities;[12, 22] (2) strategies to improve efficiency including 'drip and ship' protocols to allow t-PA infusion immediately before or during transport to endovascular-capable centers;[12, 21] and (3) reimbursement that covers costs for both transferring and receiving facilities.[21]**

**The following analyses include ground transport studies only. Air transport is addressed separately.*

Example of state law addressing this type of intervention

The Louisiana Emergency Response Network Board and the Department of Health and Hospitals are required to recognize four levels of stroke facilities: Comprehensive Stroke Center (CSC), Primary Stroke Center (PSC), Acute Stroke Ready Hospital (ASRH) and non-stroke hospitals. An ASRH is expected to provide timely acute stroke care in areas where transportation and access are limited using "drip-and-ship", telemedicine and other delivery models. A non-stroke hospital is only authorized to accept suspected stroke patients when clinically necessary, provided it has written transfer agreements with an ASRH, PSC or CSC. LA. ADMIN CODE. TIT. 48, PT. I, §§ 18701 THROUGH 18709 (2017)

Evidence for Potential Public Health Impact:

Effectiveness: ●●○○
Equity & Reach: ●○○○
Efficiency: ●●●○
Transferability: ●●○○

Weaker=●○○○ ◄► ●●●●=Stronger

For more on how evidence for potential impact was assessed, see the Appendix

TOTAL: ●●●●●●●●●○○○○○○○

Weak | Moderate | **Strong** | Very Strong

SCORE: STRONG

Evidence Quality:

Evidence Type: ●●●○
Source: ●●●○
Evidence from Research: ○○○○
Evidence from Translation & Practice: ●●●●

Lower=●○○○ ◄► ●●●●=Higher

For more on how evidence quality was assessed, see the Appendix

TOTAL: ●●●●●●●●●○○○○○○○

Low | Moderate | **High** | Very High

SCORE: HIGH

Reported health-related outcomes

Inter-facility transfer to the most appropriate stroke facility was linked with decreased time to treatment and increased access to appropriate stroke treatment.[1] Additionally, a stroke system of care including inter-facility transfer was linked with improved mortality rate.[2]

Groups studied

Studies reporting positive health-related outcomes examined the general population.[1-2]

Economic highlights

Inter-facility transfer, specifically drip and ship, has been linked to lower hospital charges.[1]

Settings

Studies of local or state stroke systems were set in California[2] and Minnesota.[1]

Evidence Base on Potential Public Health Impact

Research-based studies

No research-based studies January 1, 2007-May 31, 2017

Practice-based studies

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11. Southerland, A. M., Johnston, K. C., Molina, C. A., Selim, M. H., Kamal, N., & Goyal, M. (2016). Suspected large vessel occlusion: Should emergency medical services transport to the nearest primary stroke center or bypass to a comprehensive stroke center with endovascular capabilities? Stroke, 47(7), 1965-1967.

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f. Mixed health outcome – Transferred drip and ship patients were treated later but had similar mortality rates and functional outcomes as patients treated directly by the study hospital.

g. Mixed health outcome – Median transfer times were high despite relatively short distances to CSCs in the metropolitan hub-and-spoke system studied. Although emergent stroke treatment rates were high among transferred patients (77%), the odds of treatment decrease by 2.5% for every minute of transfer time.

h. Mixed health outcome – Although the drip and ship paradigm facilitates widespread tPA use in patients with acute stroke, mortality rates and symptomatic intracranial hemorrhage in patients treated via this method were slightly higher compared with "front-door" patients.

Pre-hospital Stroke Screening Tool Use by EMS Providers

Evidence Level: **PROMISING QUALITY**

The identification of stroke patients by EMS responders allows for initiation of appropriate treatment in the field along with rapid transport and triage of acute stroke patients. EMS responders can identify stroke patients with a high degree of accuracy when validated stroke screening algorithms for the pre-hospital setting are used. As such, policy encourages EMS responders to use a validated and standardized pre-hospital screening and neurological assessment tools to identify stroke patients.[7,15]

Example of state law addressing this policy intervention

The Nebraska Stroke System of Care Act requires the Nebraska Department of Health and Human Services (DHHS) to adopt and distribute to EMS a nationally recognized, standardized stroke triage assessment tool. All EMS providers must use the assessment (or substantially similar) tool and establish pre-hospital stroke-care & transport protocols. NEB. REV. STAT. §§ 71-4207 & 71-4208 (2017)

Evidence for Potential Public Health Impact:

Effectiveness: ●●○○
Equity & Reach: ●○○○
Efficiency: ○○○○
Transferability: ●●○○

Weaker=●○○○ ◄► ●●●●=Stronger

For more on how evidence for potential impact was Appendix

TOTAL: ●●●●○○○○○○○○○○

Weak | **Moderate** | Strong | Very Strong

SCORE: **MODERATE**

Evidence Quality:

Evidence Type: ●●○○
Source: ●●●○
Evidence from Research: ○○○○
Evidence from Translation & Practice: ●●●

Lower=●○○○ ◄► ●●●●=Higher

For more on how evidence quality was assessed, see the Appendix

TOTAL: ●●●●●●●●○○○○○○

Low | Moderate | **High** | Very High

SCORE: **HIGH**

Reported health-related outcomes	There were three studies finding that validated pre-hospital stroke screening tool use by EMS was linked to improved stroke recognition,[7,9,10] decreased time to rapid triage,[7] and increased access to appropriate stroke treatment.[7]
Groups studied	Studies reporting positive health-related outcomes examined the general population.[7,9,10]
Economic highlights	*No economic outcomes January 1, 2007 to May 31, 2017*
Settings	There were two national studies in the evidence base.[7,10] An additional study was set in a local stroke system in California.[9]

Evidence Base on Potential Public Health Impact

Research-based studies

No research-based studies January 1, 2007-May 31, 2017

Practice-based studies

1. Asimos AW, Ward S, Brice JH, Rosamond WD, Goldstein LB, Studnek J. Out-of-hospital stroke screen accuracy in a state with an emergency medical services protocol for routing patients to acute stroke centers. Annals of Emergency Medicine. 2014;64(5):509-515.[i]
2. Brice JH, Evenson KR, Lellis JC, et al. Emergency medical services education, community outreach, and protocols for stroke and chest pain in North Carolina. Prehospital Emergency Care. 2008;12(3):366-371.
3. Crocco TJ. Streamlining stroke care: from symptom onset to emergency department. Journal of Emergency Medicine. 2007;33(3):255-260.
4. Frendl DM, Strauss DG, Underhill BK, Goldstein LB. Lack of impact of paramedic training and use of the cincinnati prehospital stroke scale on stroke patient identification and on-scene time. Stroke. 2009;40(3):754-756.[j]
5. Gropen T, Magdon-Ismail Z, Day D, Melluzzo S, Schwamm LH, Group NA. Regional implementation of the stroke systems of care model: recommendations of the northeast cerebrovascular consortium. Stroke. 2009;40(5):1793-1802.
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8. Kesinger MR, Sequeira DJ, Buffalini S, Guyette FX. Comparing National Institutes of Health Stroke Scale among a stroke team and helicopter emergency medical service providers. Stroke. 2015;46(2):575-578.
9. Kim J-T, Chung P-W, Starkman S, et al. Field Validation of the Los Angeles Motor Scale as a Tool for Paramedic Assessment of Stroke Severity. Stroke; a journal of cerebral circulation. 2017;48(2):298-306. http://onlinelibrary.wiley.com/o/cochrane/clcentral/articles/759/CN-01331759/frame.html
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15. Park S, Schwamm LH. Organizing regional stroke systems of care. Current Opinion in Neurology. 2008;21:13.

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17. Brice JH, Griswell JK, Delbridge TR, Key CB. Stroke: From Recognition by the Public to Management by Emergency Medical Services. Prehosp Emerg Care. 2003;6(1):8.
18. Crocco TJ, Grotta JC, Jauch EC, et al. EMS management of acute stroke--prehospital triage (resource document to NAEMSP position statement). Prehospital Emergency Care. 2007;11(3):313-317.
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27. Schwamm LH, Pancioli A, Acker JE, et al. Recommendations for the Establishment of Stroke Systems of Care. Recommendations From the American Stroke Association's Task Force on the Development of Stroke Systems. 2005;36(3):690-703.
28. Siket MS. Treatment of Acute Ischemic Stroke. Emergency Medicine Clinics of North America. 2016;34(4):861-882.
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30. Sozener CB, Barsan WG. Impact of regional pre-hospital emergency medical services in treatment of patients with acute ischemic stroke. Annals of the New York Academy of Sciences. 2012;1268:51-56.

i. Negative outcome – Authors suggest that the specificity of the CPSS and LPSS may be too low for use within acute systems of care with bypass protocols in place, especially when ambulance resources are limited.

j. No outcome – Authors suggest that paramedic training in the CPSS, or its use, had no impact on the accuracy of their identification of patients with stroke/ transient ischemic attack or on-scene time.

k. Mixed outcome – Authors suggest that while the use of CPSS had a reasonable sensitivity level for stroke recognition, within the EMSS being studied, emergency medical dispatchers using the Medical Priority Dispatch System protocol with a high compliance rate had a higher sensitivity for recognizing stroke than that for paramedics using CPSS.

Continuing Education on Stroke for EMS Providers

Evidence Level: **EMERGING**

While most EMS providers will receive some education on stroke in their initial certification or licensure programs, states could encourage ongoing education for EMS providers about the signs and symptoms of stroke and training on stroke protocol.[7]

Example of state law addressing this type of intervention

The Illinois State Stroke Advisory Subcommittee is required to develop and disseminate to all EMS systems "an evidence-based statewide stroke assessment tool to clinically evaluate potential stroke patients". With the State EMS Advisory Council, the Subcommittee is also required to "select or develop the educational curriculum for instructing EMS System personnel on the use of the tool". In addition, each EMS Regional Stroke Advisory Subcommittee must make recommendations to the Region's EMS Medical Directors Committee for pre-hospital personnel continuing education requirements.[210 ILL. COMP. STAT. § 50/3.118.5 (2017) AND 77 ILL. ADM. CODE 515.5100 (2017)]

Evidence for Potential Public Health Impact:

Effectiveness: ●●○○
Equity & Reach: ○○○○
Efficiency: ○○○○
Transferability: ●●○○

Weaker=●●●● ◄► ●●●●=Stronger

For more on how evidence for potential impact was assessed, see the Appendix

TOTAL: ●●●●○○○○○○○○○○○○

Weak | Moderate | Strong | Very Strong

SCORE: WEAK

Evidence Quality:

Evidence Type: ●●○○
Source: ●●●○
Evidence from Research: ○○○○
Evidence from Translation & Practice: ●●●○

Lower=●●●● ◄► ●●●●=Higher

For more on how evidence quality was assessed, see the Appendix

TOTAL: ●●●●●●●●○○○○○○○○

Low | Moderate | High | Very High

SCORE: MODERATE

Reported health-related outcomes

The American Heart Association,[7] the Northeast Cerebrovascular Consortium,[3] and other stroke systems of care experts and practitioners recommend that EMS providers complete continuing education on stroke recognition, assessment, and care.[1,4,7-9] Stroke systems of care incorporating continuing education were linked to positive EMS provider outcomes.[1,5,6]

Groups studied

No health-related outcomes January 1, 2007 to May 31, 2017

Economic highlights

No economic outcomes January 1, 2007 to May 31, 2017

Settings

No health-related outcomes January 1, 2007 to May 31, 2017

Evidence Base on Potential Public Health Impact

Research-based studies

No research-based studies January 1, 2007-May 31, 2017

Practice-based studies

1. Evenson KR, Brice JH, Rosamond WD, Lellis JC, Christian JB, Morris DL. Statewide survey of 911 communication centers on acute stroke and myocardial infarction. Prehospital Emergency Care. 2007;11(2):186-191.
2. Frendl DM, Strauss DG, Underhill BK, Goldstein LB. Lack of impact of paramedic training and use of the cincinnati prehospital stroke scale on stroke patient identification and on-scene time. Stroke. 2009;40(3):754-756.[I]
3. Gropen T, Magdon-Ismail Z, Day D, Melluzzo S, Schwamm LH, Group NA. Regional implementation of the stroke systems of care model: recommendations of the northeast cerebrovascular consortium. Stroke. 2009;40(5):1793-1802.
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I. Mixed outcome - Paramedic training and continuing education on a screening tool or its use had no impact on the accuracy of their identification of patients with stroke/transient ischemic attack or on-scene time.

Continuous Quality Improvement of EMSS for Stroke

Evidence Level: **EMERGING**

Pilot and grant-funded quality improvement collaboratives have improved the quality of EMS and pre-hospital care in stroke systems.[1-3] Continuous quality improvement (CQI) interventions would involve ongoing assessments of the functions performed by all participants in the pre-hospital stroke system that affect the health outcomes of stroke patients.[6]

Example of state law addressing this type of intervention

The Rhode Island Department of Health must establish and implement a stroke care continuous quality improvement plan and require stroke centers and EMS agencies to report data for use in a statewide stroke database built on a nationally recognized platform such as Get With The Guidelines/Stroke. R.I. GEN. LAWS §§ 23-78.1-1 THROUGH 78.1-8 (2017)

Evidence for Potential Public Health Impact:

Effectiveness: ●●○○
Equity & Reach: ○○○○
Efficiency: ○○○○
Transferability: ●●○○

Weaker=●●●● ◄► ●●●●=Stronger

For more on how evidence for potential impact was assessed, see the Appendix

TOTAL: ●●●●○○○○○○○○○○○○

Weak | Moderate | Strong | Very Strong

SCORE: WEAK

Evidence Quality:

Evidence Type: ●●○○
Source: ●●●○
Evidence from Research: ○○○○
Evidence from Translation & Practice: ●●○○

Weaker=●●●● ◄► ●●●●=Stronger

For more on how evidence quality was assessed, see the Appendix

TOTAL: ●●●●●●●○○○○○○○○○

Low | Moderate | High | Very High

SCORE: MODERATE

Reported health-related outcomes	The American Heart Association, Northeast Care Collaborative, American Association of Neurological Surgeons, and other subject matter experts and practitioners recommend that CQI strategies be used to improve the quality of pre-hospital care.[4-7,9] The Rhode Island Department of Health has mandated that all EMS agencies participate in CQI activities.[8]
Groups studied	*No health-related outcomes January 1, 2007 to May 31, 2017*
Economic highlights	*No economic outcomes January 1, 2007 to May 31, 2017*
Settings	*No health-related outcomes January 1, 2007 to May 31, 2017*

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3. Paul Coverdell National Acute Stroke Registry Program: Summary Report 2007-2012.

Evidence Base on Potential Public Health Impact

Research-based studies

No research-based studies January 1, 2007-May 31, 2017

Practice-based studies

4. Gropen T, Magdon-Ismail Z, Day D, Melluzzo S, Schwamm LH, Group NA. Regional implementation of the stroke systems of care model: recommendations of the northeast cerebrovascular consortium. Stroke. 2009;40(5):1793-1802.
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Appendix

Method

Public decision makers need to know which policies are feasible and most likely to achieve the desired impact. **Early evidence assessment** involves compiling and appraising all relevant, available evidence. This report uses a novel approach to complete an early evidence assessment called the Quality and Impact of Component Evidence Assessment, or QuIC. For more on the QuIC method, contact CDC DHDSP.

In a QuIC assessment, "best available evidence" refers to the written evidence base relevant to assessing a policy's potential public health impact. This evidence base includes empirical and non-empirical analyses of public health policies, programs, and activities. Using data or expert opinion, it directly and/or indirectly links interventions of interest with actual or expected outcomes. In a QuIC assessment, best available evidence can include: journal articles, editorials, commentaries, and perspectives; policy briefs, statements, recommendations, and guidelines; evaluation and technical reports; conference papers; and white papers.

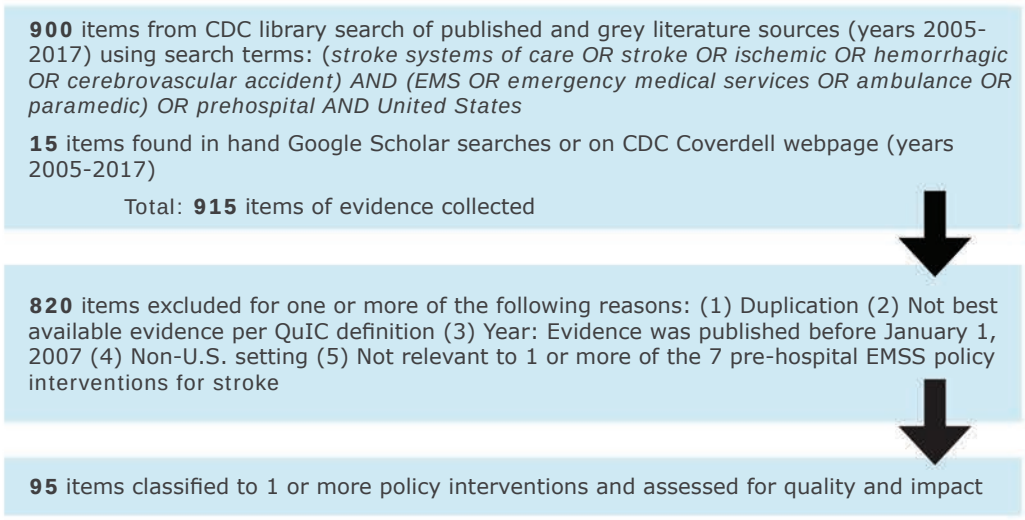
Public decision makers need to know which policies are feasible and most likely to achieve the desired impact. **Early evidence assessment** involves compiling and appraising all relevant, available evidence. This report uses a novel approach to complete an early evidence assessment called the Quality and Impact of Component Evidence Assessment, or QuIC. For more on the QuIC method, contact CDC DHDSP.

In this assessment, **best available evidence** included evaluation studies of stroke systems of care and subject matter expert and practitioner recommendations drawn from the published and grey literature.

To select pre-hospital EMSS policy interventions for stroke addressed in existing state law to assess, CDC DHDSP reviewed published policy recommendations by the Joint Commission, Brain Attack Coalition, and the American Heart Association (AHA) to the content of existing state laws. Only types of pre-hospital EMS policy interventions for stroke that 1) were recommended by one or more of these groups and 2) had been enacted into law by at least one state by May 31, 2017 were chosen for the evidence assessment.

In total, seven policy interventions common to both published expert recommendations and existing state law were identified. This list was refined based on input from a group of nine individuals with expertise in stroke systems of care from CDC DHDSP, state stroke programs, and AHA, as well as through discussion with CDC's state Coverdell grantees.[m] This group also provided sources of evidence and keywords to classify evidence to policy interventions.

The following search was completed in May 2017 for best available evidence published between January 1, 2007 and May 31, 2017.



m. Paul Coverdell National Acute Stroke Program: https://www.cdc.gov/dhdsp/programs/stroke_registry.htm

In total, 95 items of evidence were relevant to assessing one or more of the seven policy interventions. This included 29 published recommendations from subject matter experts and practitioners as well as 65 practice-based studies that either included the policy interventions of interest or recommended these policy interventions based on study findings. There was only 1 research-based study in the evidence base, in which the authors recommended pre-notification, but did not test pre-notification outcomes. The lack of research studies was not surprising due to the expected difficulty of assigning patients to intervention and control groups in stroke systems of care.

To determine the evidence level for a type of intervention addressed in a state policy, a QuIC Evidence Assessment appraises 1) evidence for potential public health impact and 2) evidence quality.[n] Five CDC policy staff assigned the pre-hospital EMSS stroke evidence base to the seven policy interventions. Next, the team abstracted and coded a sample of evidence for each policy intervention for potential impact and discussed coding issues as a group. The codebook was updated with the decisions made, and then each item of evidence for each policy intervention was independently coded by two of the five coders. Coding discrepancies were reconciled through 11 hours of discussion among coding pairs and three meetings of the whole coding team. Consensus was reached on all coding rules by the team, and coding agreement was reached by every pair.[o]

Reconciled evidence coding data for each policy intervention were input into the QuIC Evidence Assessment Tool (page 29). Seven QuIC Tools were completed, one for each policy intervention. To calculate the **evidence for potential impact level** and the **evidence quality level** for a policy intervention, the eight criteria scores from the QuIC Tool were each assigned a numeric score for the highest level reached (0-4 points). The four criteria scores for evidence for potential impact were summed, as were the four criteria scores for evidence quality.

The numeric evidence for potential impact and quality scores were converted back into ordinal evidence levels.[p] This procedure gave each of the seven policy intervention a final **evidence for potential impact level** and a final **evidence quality level**, which together, were used to categorize each policy intervention as **"best," "promising (quality)," "promising (impact)," or "emerging"** (Table).

Table. Method for categorizing overall evidence level using evidence for potential impact and quality levels

Evidence for Potential Public Health Impact Level	Evidence Quality Level	Evidence Level
Strong or Very Strong	High or Very High	**Best**
Weak or Moderate	High or Very High	**Promising Evidence Quality**
Strong or Very Strong	Low or Moderate	**Promising Evidence for Potential Public Health Impact**
Weak or Moderate	Low or Moderate	**Emerging**

n. Contact CDC DHDSP for the QuIC Evidence Assessment Handbook.

o. This method has been shown to achieve Very Good to Excellent inter-rater agreement within 3 previous QuIC assessments: Centers for Disease Control and Prevention. Division for Heart Disease and Stroke Prevention. What Could Be Addressed in an Evidence-Informed State Workplace Health Promotion Law? Atlanta, GA: Centers for Disease Control and Prevention; 2017; Centers for Disease Control and Prevention. Division for Heart Disease and Stroke Prevention. What Evidence Supports State Laws to Establish Community Health Worker Scope of Practice and Certification? Atlanta, GA: Centers for Disease Control and Prevention; 2017; & Centers for Disease Control and Prevention. Division for Heart Disease and Stroke Prevention. What Evidence Supports State Laws to Enhance Public Access Defibrillation? Atlanta, GA: Centers for Disease Control and Prevention; 2017

p. The evidence for potential impact level was determined using the following conversion: 1-4 points= weak; 5-8 points= moderate; 9-12 points = strong; and 13-16 points= very strong. The evidence quality level was determined using the following conversion: 1-4 points= low; 5-8 points= moderate; 9-12 points = high; and 13-16 points= very high. For example, if the Effectiveness criterion scored "very strong" and the Equity and Reach criterion scored "very strong" and the Efficiency criterion scored "strong" and the Transferability criterion scored "strong," then 4+4 +3+3=14="very strong" evidence for potential impact.

Three of the seven policy interventions' evidence bases scored less than the highest level of "best." Stroke Screening Tool Use by EMS Providers had an evidence base that scored "promising" because it only had "moderate" evidence for potential public health impact as several studies of validated stroke screening tools indicated no-, mixed-, or negative-outcomes related to the specificity and sensitivity of the tools. In some of these studies, stroke was not identified by the tool or underreported. It will be important to show that EMS providers can use stroke screening tools to recognize stroke, since the effectiveness and cost-effectiveness of the interventions that come after stroke recognition (e.g., pre-notification and triage and transport) may depend on this. Overall, more studies are needed showing positive health-related outcomes and economic outcomes of pre-hospital stroke screening tool use by EMS providers.

Both Continuing Education on Stroke for EMS Providers and Continuous Quality Improvement of EMSS for Stroke had evidence bases that scored "emerging." These policy interventions were recommended by experts and practitioners; however, studies are needed to ensure that these ongoing efforts lead to improved stroke outcomes and are ultimately worth the resource investments made by stroke systems. It should also be noted that even the evidence bases in this assessment that scored "best" could use improvement. Overall, the evidence for EMSS pre-hospital policy interventions for stroke lacked information on economic outcomes (e.g., cost-effectiveness and return on investment) and impacts on disparate populations including children and populations experiencing health disparities.

After each policy intervention's evidence base was scored, coding pairs developed an evidence summary together. They summarized the abstracted positive health-related outcomes observed and the populations and setting in which they were found, as well as the economic outcomes. See page 29 for more on how an evidence summary was written.

In the evidence summaries, select state law examples were chosen based on their alignment with the policy interventions addressed in expert recommendations and the evidence base on outcomes. A full description of existing state stroke laws will be provided in a DHDSP State Law Fact Sheet. Additionally, the evidence summaries provide the specific outcomes and populations studied under higher-level outcomes; for example, if a study found increased tissue plasminogen activator (tPA) administration, this was reported as "increased access to appropriate stroke treatment." The list of specific outcomes and populations from this assessment could be useful to those evaluating stroke systems of care—please contact DHDSP for this list.

QuIC Evidence Assessment Tool

Section 1. Evidence for Potential Public Health Impact

Criterion and what it measures	**Weak Evidence** ●○○○	**Moderate Evidence** ●●○○	**Strong Evidence** ●●●○	**Very Strong Evidence** ●●●●
Effectiveness *Does it work, i.e., improve outcomes relevant to health?*	Indirect evidence for a positive expected outcome relevant to health	Direct evidence for a positive expected outcome relevant to health	Indirect evidence of mostly positive actual outcomes relevant to health	Direct evidence of mostly positive actual outcomes relevant to health
Equity and Reach *Does it work for target population(s)?*	Indirect evidence for a positive expected outcome relevant to equity and reach	Direct evidence for a positive expected outcome relevant to equity and reach	Indirect evidence of mostly positive actual outcomes relevant to equity and reach	Direct evidence of mostly positive actual outcomes relevant to equity and reach
Efficiency *Is it a good use of resources?*	Indirect evidence for a positive expected outcome relevant to efficiency	Direct evidence for a positive expected outcome relevant to efficiency	Indirect evidence of mostly positive actual outcomes relevant to efficiency	Direct evidence of mostly positive actual outcomes relevant to efficiency
Transferability *Does it work across diverse settings?*	Indirect evidence for a positive expected outcome relevant to health in two or more regions of the United States	Direct evidence for a positive expected outcome relevant to health in two or more regions of the United States	Indirect evidence of mostly positive actual outcomes relevant to health in two or more regions of the United States	Direct evidence of mostly positive actual outcomes relevant to health in two or more regions of the United States

Note: if none of its requirements are met, a criterion is assigned a score of 0 points, ●●●●

Section 2. Evidence Quality

Criterion and what it measures	*Low Quality* ●○○○	*Moderate Quality* ●●○○	*High Quality* ●●●○	*Very High Quality* ●●●●
Evidence Types *What is the most rigorous design?*	*A narrative review or commentary suggests a positive outcome*	*A non-experimental study suggests a positive outcome*	*An experimental or quasi-experiment suggests a positive outcome*	*A systematic review suggests a positive outcome*
Sources *What is the most credible source?*	*A peer-reviewed journal or conference publication without conflict of interest disclosure suggests a positive outcome*	*A publication by a nonprofit or government organization suggests a positive outcome*	*A peer-reviewed journal or conference publication with conflict of interest disclosure suggests a positive outcome*	*A publication by a public health authority suggests a positive outcome*
Evidence from Research *Relevance to controlled settings?*	*A small amount of evidence from research suggests positive outcomes*	*A moderate amount of evidence from research suggests positive outcomes*	*A large amount of evidence from research suggests positive outcomes*	*A very large amount of evidence from research suggests positive outcomes*
Evidence from Translation and Practice *Relevance to real world?*	*A small amount of evidence from translation and practice suggests positive outcomes*	*A moderate amount of evidence from translation and practice suggests positive outcomes*	*A large amount of evidence from translation and practice suggests positive outcomes*	*A very large amount of evidence from translation and practice suggests positive outcomes*

Note: if none of its requirements are met, a criterion is assigned a score of 0 points, ●●●●

Evidence Summary Template

Policy Intervention

Evidence Level: *This field provides this pre-hospital EMSS policy intervention's evidence level which is meant to help inform its priority during decision making. This evidence level can be BEST, PROMISING (QUALITY), PROMISING (IMPACT), or EMERGING.*

This section describes this policy intervention in detail, often providing supportive references.

Example of state law addressing this type of intervention

This box briefly describes an example of a provision of state law addressing the policy intervention.

Evidence for Potential Public Health Impact:

Effectiveness: ●●●●
Equity & Reach: ●●●●
Efficiency: ●●●●
Transferability: ●●●●

Weaker=●●●● ◄► ●●●●=Stronger

For more on how evidence for potential impact was assessed, see the Appendix

TOTAL: ●●●●●●●●●●●●●●●●

Weak | Moderate | Strong | Very Strong

SCORE: **Weak, Moderate, Strong, or Very Strong**

Evidence Quality:

Evidence Type: ●●●●
Source: ●●●●
Evidence from Research: ●●●●
Evidence from Translation & Practice: ●●●●

Weaker=●●●● ◄► ●●●●=Stronger

For more on how evidence quality was assessed, see the Appendix

TOTAL: ●●●●●●●●●●●●●●●●

Low | Moderate | High | Very High

SCORE: **Low, Moderate, High, or Very High**

Reported health-related outcomes	If there are studies analyzing health-related outcomes in the evidence base, this field provides the positive outcomes found and whether they were for this policy intervention and/or for a stroke system including this policy intervention (among others). Non-positive outcomes are footnoted in the "Evidence base" list below. If there were no studies observing positive outcomes, this field provides expert recommendations for the policy intervention, i.e., the rationale for health impact. While studies projecting positive outcomes contribute to scoring evidence for impact, they are not listed in this table.
Groups studied	If positive health-related outcomes were found, this field provides the groups who were studied and/or cites the studies looking at general populations.
Economic highlights	If there are studies analyzing economic outcomes—such as cost-effectiveness, return on investment, or quality of life—positive findings are provided in this field. Otherwise, absence of economic outcomes is noted.
Settings	This field provides the states in which the studies finding positive health-related outcomes were set and/or lists the national studies. Most studies in the evidence base for stroke systems of care were of local (e.g., city, county, or regional) stroke systems, although there were a few state-level initiatives examined.

References

Here you will find the references supporting the description of the policy intervention.

Evidence Base on Potential Public Health Impact

Research-based studies

Here you will find the studies including this policy intervention that took place in a research context, in which researchers were able to allocate subjects into the intervention and the control groups.

Practice-based studies

Here you will find the studies of this policy intervention that took place under real-world circumstances. In these studies, evaluators were not able to allocate subjects into the intervention and the control groups.

Narratives and commentaries

Here you will find the evidence that provides recommendations for this policy intervention from subject matter experts and practitioners.

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