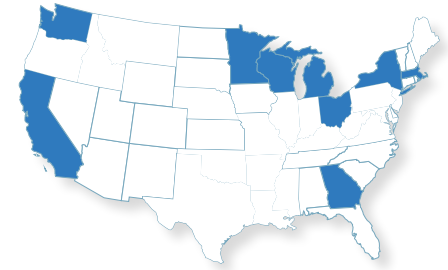


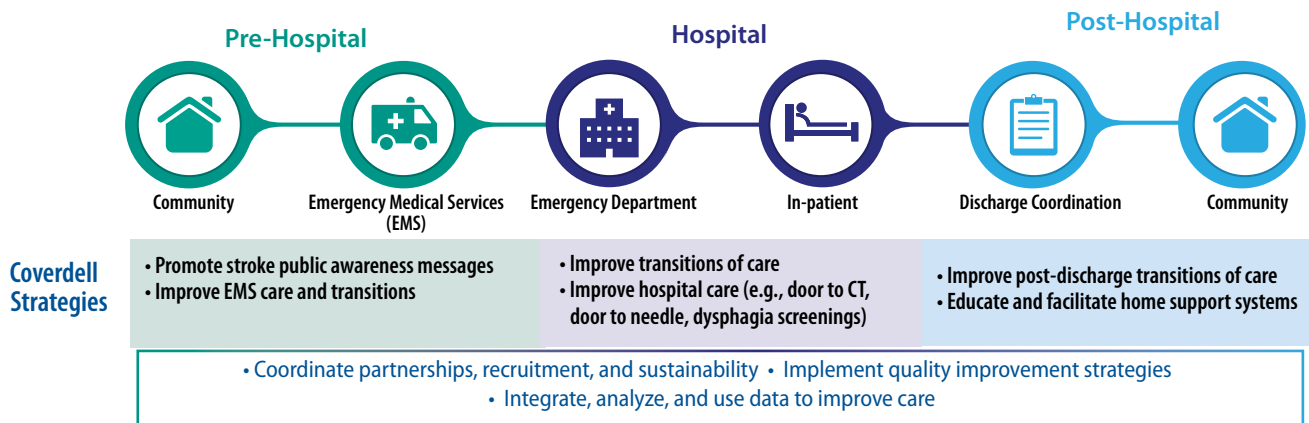
The Centers for Disease Control and Prevention’s (CDC’s) Paul Coverdell National Acute Stroke Program (Coverdell) funded nine state health department recipients from 2015-2021. Coverdell recipients partnered with organizations (stroke coalitions, Emergency Medical Service (EMS) agencies, and hospitals) to make improvements to stroke care quality. These partnerships focused on pre-hospital EMS response, hospital care, and post-hospital discharge and recovery.

This evaluation brief summarizes the Coverdell evaluation approach and presents findings from baseline (2014-2015) through Program Year 5 (2019-2020). Types of findings include: recipient implementation strategies for data collection and quality improvement; the extent to which Coverdell recipients and their partners had an effect on Stroke Systems of Care (SSOC) infrastructure; the extent to which Coverdell recipients and their partners had an effect on the efficiency and quality of stroke care and stroke patient health outcomes. This brief concludes with opportunities for Coverdell recipients, such as improving access to and quality of care for individuals at highest risk for stroke events.



Coverdell Recipients
California, Georgia, Massachusetts, Michigan, Minnesota, New York, Ohio, Washington, and Wisconsin.

Coverdell Strategies Across the Stroke System of Care



Evaluation Approach

Evaluation Questions

- 1 How have Coverdell recipients and their partners implemented strategies to improve stroke systems of care?
- 2 To what extent did Coverdell recipients and their partners have an effect on stroke systems of care in Coverdell-funded states?
- 3 To what extent did Coverdell recipients and their partners have an effect on the efficiency and quality of stroke care and stroke patient health outcomes in Coverdell-funded hospitals?
- 4 What is the estimated long-term impact and cost-effectiveness of Coverdell over a 10-year horizon?

Methods/Data Sources

- Recipient Interviews:** Qualitative data collected via semi-structured phone interviews with program directors
- Case Studies¹:** Qualitative and quantitative data collected from 3 recipients' partners via document review and semi-structured phone interviews with key staff
- Cost Study:** Recipient-reported program implementation costs
- Coverdell Process and Outcome Performance Measures (POPM):** Recipient-reported measures collecting quantitative and qualitative data on short term (e.g. reach and data usage) and intermediate (e.g. efficiency of care and patient health) outcomes
- Coverdell Quality Performance Measure Data (QPM):** Recipient-reported data on EMS, hospital, and post-hospital quality performance
- Hospital Inventory Survey:** Recipient-reported data on characteristics of participating hospitals.
- Simulation Model:** Mathematical model developed using estimates from the literature on the impact of timely thrombolytic therapy on disability, mortality, and costs

¹ Data was collected in year 6, but reflects year 5 activities

Evaluation Question 1: How have Coverdell recipients and their partners implemented strategies to improve stroke systems of care?

Methods/Data Sources: Recipient and Partner Interviews Case Studies Cost Study

We conducted a cross-site thematic analysis using information collected from interviews with all nine Coverdell recipients and from document reviews and interviews with three Coverdell recipients and their partners to identify common and notable strategies implemented to improve stroke systems of care. We conducted mean cost analysis of recipient-reported implementation cost data.

Recipients and partners reported barriers, facilitators, and lessons learned for their implementation of strategies. Recipient findings revealed three emergent themes: **increasing data collection and linkages**, **implementing data-driven quality improvement (QI)**, and **improving the stroke systems of care infrastructure**. They also reported how they **utilized Coverdell funds and in-kind contributions** to implement Coverdell activities. Partner findings revealed strategies to facilitate improvements, such as **increasing diversity of staff**, **fostering an environment where QI can flourish**, **using data to inform change**, **identifying stroke champions**, and **building relationships among staff**.

Coverdell Recipient Implementation

Increasing Data Collection and Linkages

Recipients have successfully engaged EMS and hospital partners to collect stroke data, which is important for establishing data linkages and implementing data-driven QI.

Recipients have progressed toward establishing data linkages, such as

- gaining access to data (e.g., through data use agreements)
- implementing algorithms to connect patient data from various sources
- helping partners submit data using integrated data management systems

“We need champions at the hospitals to facilitate [data collection activities]. When I advocate to a hospital, if I don't have anyone bought in, no one will sign on.

—Coverdell Recipient”

Barriers to collecting, linking, and reporting high quality data, included

- inconsistent documentation (e.g., mismatched IDs)
- missing data such as time last known well (LKW)
- lack of staff who understand data abstraction and reporting requirements
- lack of an integrated data management system
- delays caused by upgrades in systems such as the state EMS information system
- difficulty prioritizing data collection among partners that have a lower volume of stroke patients, limited staff, or competing priorities

Key strategies to overcome these barriers included

- building capacity of EMS and hospital partners
- aligning data collection efforts with existing infrastructure and initiatives (e.g., Joint Commission)
- engaging partners to become more invested in stroke data collection

Implementing Data-Driven QI

Recipients have made significant progress recruiting and engaging partners to participate in data-driven QI activities. In addition to encouraging partners to participate in data-driven QI, recipients have emphasized the need for additional high quality data.

“We've helped the hospitals develop the capacity within the data system to report and look at performance data by the different EMS services that are delivering them patients and help create a regional infographics and data charts showing the performance of EMS regionally.

—Coverdell Recipient”

Barriers to implementing data-driven QI with partners included

- high turnover of stroke coordinators
- limited capacity (e.g. lack of time and lack of knowledge or training among new stroke coordinators)
- low prioritization of improving stroke care
- lack of awareness of the importance of stroke systems of care

Key strategies to overcome these barriers included

- providing training and technical assistance to build capacity
- starting with smaller-scale efforts before ramping up
- engaging leadership and champions to facilitate Coverdell efforts

Improving the Stroke Systems of Care Infrastructure

Recipients have engaged partners and fostered collaboration among local and regional partners from across the care continuum to improve stroke systems of care infrastructure. Recipients brought together partners from the same community or region or partners within the same discipline (e.g., stroke coordinators) across regions. Taking time to engage partners has helped to facilitate more effective communication among partners, gain partner trust and allow for more productive collaboration.

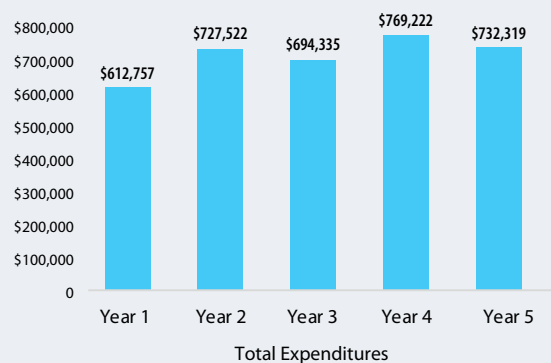
“ The most effective strategies are identifying [hospital and EMS] needs and goals and how they align with Coverdell, to find those areas that match up. Because it’s got to be a win-win in order to have the best impact on patient care. It’s identifying the common denominators and goals and the details of how to move forward to make improvements for provider care and patient care.

—Coverdell Recipient

Utilizing Coverdell Funds and In-Kind Contributions

We assessed expenditures on implementation activities among Coverdell recipients. The average total recipient expenditures in year 5 was \$732,319 (out of the five-year total average of \$3,536,155), similar to expenditures in year 4 (\$769,222). Quality improvement incurred the greatest costs in the last two years (\$190,759 in year 4 and \$174,437 in year 5), exceeding data collection, linkages, and management which had been the most costly activities in years prior. Costs on many activities decreased slightly from year 4 to year 5, but public awareness and partner recruitment activities increased in year 5.

Average Recipient Expenditures, by Program Year



Coverdell Partner Implementation

Coverdell partners in 3 case study partnerships also reported key strategies, barriers, facilitators, and lessons learned to stroke system of care improvement. In addition to enhancing our understanding of the diversity and unique context of each stroke system partnership, our findings revealed several common lessons regarding effective health system partner collaboration to improve stroke care. The recipients' partnerships implemented QI activities that ultimately improved the quality of stroke care across the continuum within each of their regions. Although activities and goals varied across the partnerships, all found that obtaining leadership buy-in facilitated implementation of QI activities.

Partners also reported other ways to facilitate their stroke system improvement efforts including

- involving a **diversity of staff** in QI activities, developing informal and formal channels of communication and feedback
- fostering an **environment where QI can flourish** and staff have a desire to learn
- focusing on educational efforts, **using data to inform changes** and drive QI activities
- **identifying champions** to advocate for stroke care
- **building relationships among staff** within and across stroke care settings

“ It’s a collaborative effort. And really that relationship building that goes on between the hospital and the fire department is really an essential part of that to make it work successfully.

—EMS Partner

When we have our cases of strokes that are missed or LVO positive that are missed and we meet with the crew and discuss, I never think of that as a communication with just one or two or three members, it’s those three members [who] learn and they share with 10 other members, who then share with 10 other members the importance of that. That’s one of the values that we really see in these brief 15-minute meetings that we have with the crew is that communication spreads.

—EMS Partner

Evaluation Question 2: To what extent did Coverdell recipients and their partners have an effect on stroke systems of care in Coverdell-funded states?

Methods/Data Sources: POPM

We conducted descriptive analysis of recipient-report POPM data to assess the extent to which Coverdell recipients and their partners had an effect on stroke systems of care infrastructure.

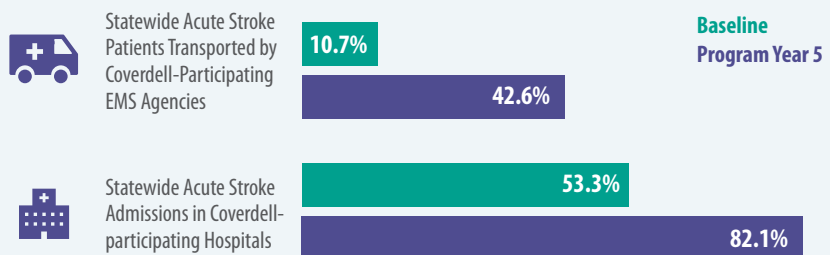
The following includes recipient and partner findings such as **recruiting EMS and hospital partners** to reach **more stroke patients**, **supporting greater public awareness messaging**, **increasing linkage of stroke patient data across care settings**, and **increasing QI to inform changes in stroke care practices**.

Recruitment of EMS and Hospital Partners

Coverdell recipients developed collaborations with stroke partners across the continuum of care to expand the reach of program activities and improve coordination between organizations involved in the care of acute stroke patients. From baseline through program Year 5, Coverdell recipients recruited **353 EMS agencies** for pre-hospital care activities, **350 hospitals** for in-hospital care activities, and **158 hospitals** for post-hospital care activities.

Greater Stroke Patient Reach

Recruitment efforts across program years led to an increase in the number of acute stroke patients transported by Coverdell-participating EMS agencies from 6,207 patients annually at baseline to **37,512** annually in Program Year 5. The number of acute stroke patients treated by Coverdell-participating hospitals also increased from 108,494 patients annually at baseline to **134,780 patients** annually in Program Year 5.



Greater Public Awareness Messaging

Greater public awareness messaging of signs and symptoms of stroke may improve the public's knowledge of the appropriate action for suspected stroke (i.e., call 911) leading to a reduction in time to treatment by encouraging patients with suspected stroke to be transported to the hospital by EMS. Further, it may increase knowledge among health practitioners leading to improved diagnosis by EMS and use of stroke pre-alert notifications.

In Program Year 5, Coverdell recipients and their partners continued to implement messaging campaigns aimed at increasing awareness of signs and symptoms of stroke such as hosting community events, sponsoring advertisements, and distributing info cards. Overall, stroke public awareness efforts grew from 24 activities at baseline to **108 activities** in Program Year 5.

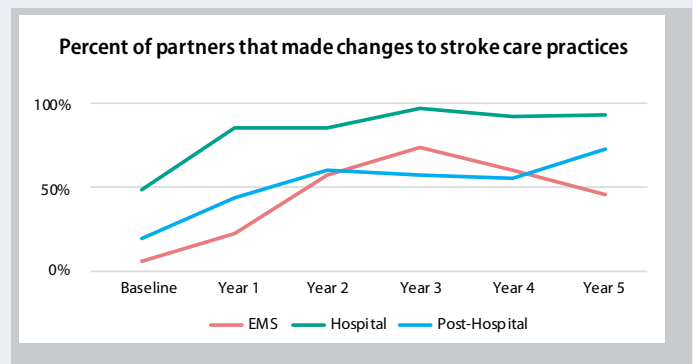
Increased Linkage of Stroke Patient Data Across Care Settings

Coverdell recipients collect, analyze, and share data with their partners to drive the identification and implementation of QI activities in all three settings of the stroke system of care. Linking stroke patient data across settings helps to facilitate the timely delivery and high quality stroke care. At baseline, no Coverdell-participating EMS agencies had data linked to in-hospital data. This increased to **541 EMS agencies** in Program Year 5.

Increased QI Informing Changes in Stroke Care Practices

In Program Year 5, Coverdell recipients and their partners implemented **67 QI activities** in the EMS setting (up from 19 at baseline) and **560 QI activities** in the hospital setting (up from 63 at baseline). These QI activities included trainings and technical assistance around topics such as stroke symptom identification and stroke pre-alert notification protocols and were intended to support changes in stroke care practices across the continuum of stroke care.

The percent of partners reporting changes in stroke care practices (e.g. implementing stroke care protocols) increased from 11% of EMS agencies (9) at baseline to **45%** (142) in Program Year 5, 48% of hospitals (141) at baseline to **87%** (424) in Program Year 5, and 27% of post-hospital partners (46) at baseline to **69%** (230) in Program Year 5.



Evaluation Question 3: To what extent did Coverdell recipients and their partners have an effect on the efficiency and quality of stroke care and stroke patient health outcomes in Coverdell-funded hospitals?

Methods/Data Sources: POPM, QPM

We conducted descriptive analysis, event study analysis, and structural equation modeling to assess the extent to which Coverdell recipients and their partners had an effect on efficiency and quality of stroke care from pre-baseline² and baseline through Program Year 5.

The following describes recipient and partner findings, such as improving **EMS response, proportion of patients with door-to-CT within 45 minutes, use of stroke pre-alert notification, proportion of patients receiving clot-busting drug alteplase, and proportion of patients receiving defect free care.**

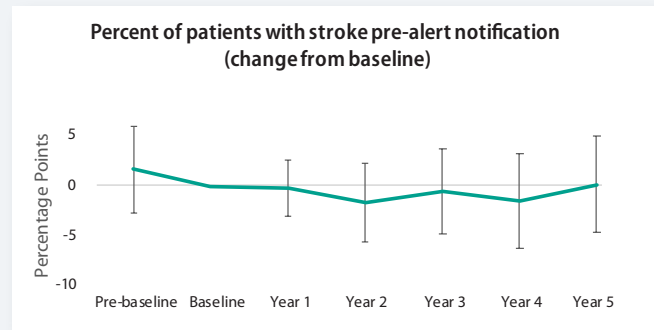
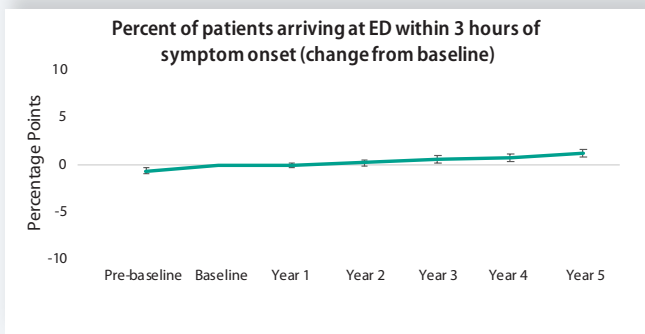
EMS Response

Earlier entry into care for suspected stroke patients continues to be an opportunity for improvement, as the percent of suspected stroke patients who arrived at Coverdell-participating hospitals by EMS has remained constant at 45% from baseline to Program Year 5. In addition, only 24% of patients arrived at the emergency department within 2 hours since onset of stroke symptoms (among those who had time of symptom onset documented) leaving 76% of patients arriving outside this critical time window. The amount of time a hospital participated in Coverdell was not correlated with arrival by EMS.

Clinical guidelines recommend that patients receive thrombolytic therapy within 4.5 hours after stroke symptom onset. Therefore, delays in hospital arrival are a major barrier to improving the proportion of ischemic stroke patients treated with thrombolytic therapy. Strategies used by Coverdell recipients to improve arrival by EMS and reduce delays in arrival include public awareness and trainings on the signs and symptoms of stroke, and trainings and QI with EMS and hospital partners around topics such as stroke symptom identification and stroke pre-alert notification protocols.

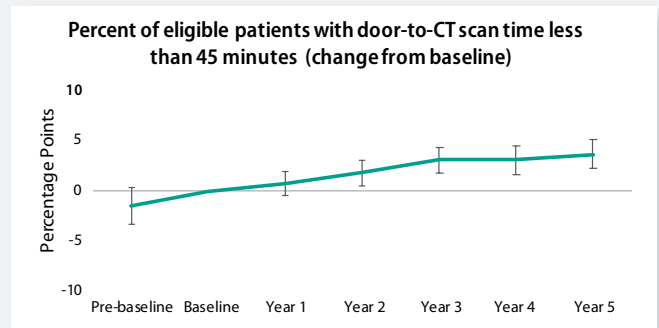
Use of Stroke Pre-Alert Notification

Stroke pre-alert notification can help prepare the hospital to receive a suspected stroke patient and reduce delays in care. By Program Year 5, EMS agencies provided a stroke pre-alert notification for 59% of suspected stroke transports to Coverdell-participating hospitals, identical to the percent at baseline. The amount of time a hospital participated in Coverdell was not correlated with stroke pre-alert notification.



Proportion of Patients with Door-to-CT within 45 minutes

Brain imaging scans can help determine if the patient is eligible for the clot busting drug, IV-tPA or alteplase. The percentage of eligible patients that received a brain imaging scan within 45 minutes of arrival at the emergency department (Door-to-CT) significantly increased from 82% at baseline to **87%** in Program Year 5. This percentage increased as hospitals participated longer in Coverdell quality improvement activities.

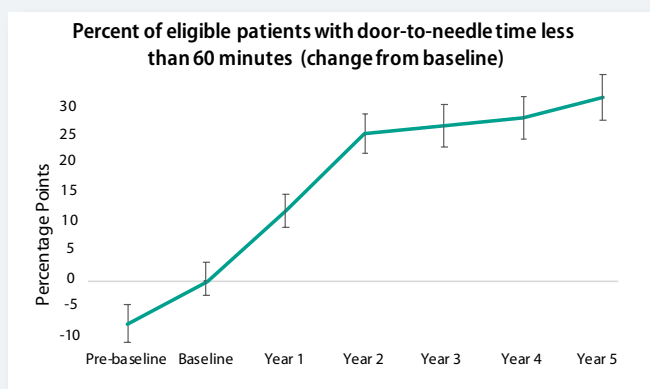


²2013-2014

Proportion of Patients Receiving the Clot Busting Drug Alteplase

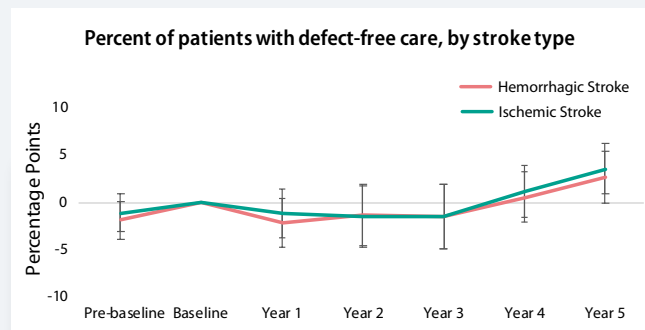
The percentage of eligible ischemic stroke patients for whom treatment with the clot-busting drug alteplase was initiated at the hospital within 3 hours of time last known well significantly increased from 90% at baseline to **94%** by Program Year 5. Median time from hospital arrival to receipt of IV alteplase (door-to-needle time) among eligible patients decreased from 69 minutes at baseline to **42 minutes** in Program Year 5.

The percent of patients with door-to-needle time less than 60 minutes increased from 59% at baseline to **88%** in Program Year 5. The amount of time a hospital participated in Coverdell was strongly correlated with the proportion of patients with door-to-needle time of less than 60 minutes. One additional year engaging in quality improvement activities increased the percentage of patients who received alteplase within 60 minutes by **3 percentage points**.



Proportion of Patients Receiving Defect-Free Care

Defect-free care is the proportion of stroke patients who received all of the interventions for which they were eligible, such as antithrombotic treatments, anticoagulation therapy, statin medications, and counseling and educational materials.³ The percentage of patients with ischemic and hemorrhagic stroke receiving defect free care was flat from baseline to Program Year 4 and increased in Program Year 5.



³Saver, J. L., Fonarow, G. C., Smith, E. E., Reeves, M. J., Grau-Sepulveda, M. V., Pan, W., et al. (2013). Time to treatment with intravenous tissue plasminogen activator and outcome from acute ischemic stroke. *Journal of the American Medical Association*, 309, 2480-2488.

⁴Overwyk, K. J., Yin, X., Tong, X., King, S. M. C., Wiltz, J. L., (2021). Defect-free care trends in the Paul Coverdell National Acute Stroke Program, Program, 2008-2018. *American Heart Journal*, 232, 177-184.

Evaluation Question 4: What is the estimated long-term impact and cost-effectiveness of Coverdell over a 10-year horizon?

Methods/Data Sources: Simulation Model, QPM

We developed a mathematical model of stroke care using estimates from the literature on the impact of timely thrombolytic therapy on disability, mortality, and costs. We used this model to simulate the potential long-term impact of improvements in door-to-needle time within Coverdell-participating hospitals on quality of life through reductions in death and disability from stroke. These estimates can demonstrate the long-term cost-effectiveness of Coverdell.

Modeling results suggest that **stroke patients treated in Coverdell-participating hospitals have lower costs and higher quality of life than if they had received standard stroke treatment**. Over the 10-year simulation period, Coverdell treatment gained 0.12 quality adjusted life years (QALYs) and saved \$2,574 per person.

	Simulation for Coverdell Treatment	Simulation for Standard Treatment	Gain from Coverdell Treatment
Average Costs (USD 2020)	\$82,209	\$84,783	-\$2,574
Average Health Utility (QALYs)	2.43	2.31	0.12



Opportunities for Improvement

While Coverdell recipients made improvements to transitions in care and statewide stroke systems of care, this evaluation also revealed several future opportunities for Coverdell recipients.

- **Improve EMS Response.**
Recipients could place greater emphasis on activities that facilitate timely and appropriate EMS response. For example, recipients could further improve awareness so members of the public and healthcare professionals more quickly and accurately recognize the signs and symptoms of stroke; provide training to EMS partners to respond to a suspected stroke; and continue to enhance communication between EMS and hospitals regarding patient care provided and clinical outcomes.
- **Increase Technical Assistance and Training on Data Reporting.**
Recipients could identify and replicate successful strategies that their partners have used to improve documentation of time last known well and other metrics. For example, some recipients built data systems that allowed partners to access data in near real-time across the stroke systems of care and this has improved documentation. Others provided technical assistance to improve measurement of door to imaging and timely thrombolytics outcomes. These activities could help recipients link data and calculate performance measures with date and time elements, such as last known well time.
- **Share Data to Promote Data-Driven QI.**
Recipients were already sharing reports with examples of linked data, which has helped partners understand the importance of data reporting for monitoring and implementing data-driven QI. Continuing to share examples of data reports and use of data to improve patient care may also help EMS partners better understand the importance of reporting and linking data at the state-level.
- **Continue to Focus on In-Hospital Quality of Care.**
The percentage of ischemic stroke patients with defect-free inpatient care is an area needing greater focus. It began to improve in Year 5, but there is still need for improvement. Recipients could continue to monitor in-hospital quality of care performance measures and promote QI activities, especially as new hospitals with less capacity are recruited into Coverdell.
- **Expand Outreach of Post-Hospital Partners.**
Recipients focused on building their capacity to gather post-hospital data to facilitate coordination of care for discharged stroke patients, but most programs still experienced challenges working with partners to collect data.
- **Improve Access to and Quality of Care for Populations Disproportionately Impacted by Stroke.**
While not specifically explored in this evaluation, recipients could build upon accomplishments, outcomes achieved, and lessons learned through Year 5 to address disparities in stroke events. Improving access to and quality of care for those individuals at highest risk for stroke events and for stroke patients across the care continuum is imperative for closing the gap in stroke disparities.