Iowa Stroke Registry Report, 2013-2017

Victoria Crabb

Department of Epidemiology

University of Iowa, College of Public Health

ACKNOWLEDGEMENTS

University of Iowa

James Torner, PhD, MS
Professor, Department of Epidemiology
College of Public Health
University of Iowa

Victoria Crabb, MS, BSN
PhD Candidate, Department of Epidemiology
College of Public Health
University of Iowa

Erin Rindels, MSN, RN, CNRN, SCRN, NVRN-BC
Senior Coordinator, Comprehensive Stroke Center
University of Iowa Hospitals & Clinics

Angela Lewis, MSN, RN, CNRN, SCRN
Registry Quality Improvement Engineer-Stroke
Quality Improvement Program
University of Iowa Hospitals & Clinics

Mike Mueller, BS
Lead Database Administrator, Department of Epidemiology
College of Public Health
University of Iowa

Enrique Leira, MD, MS
Director, Cerebrovascular Diseases
University of Iowa Hospitals & Clinics

Consultant

Hillary Crabb, BA
GIS Specialist

Stroke survey team*

Diane Handler RN, MSN, ANVP
Stroke APN
UnityPoint St Luke's Hospital, Cedar Rapids

Jennifer Thoe, MSN, RN
Stroke Coordinator/Ortho/Neuro CCIS
MercyOne. Mason City

Paula Maddox, MSN, RN, CCRN-K
Stroke and Sepsis Coordinator
UnityPoint Health Quad Cities

Sharon Ellrich, MSN, RN, SCRN, CWS
Stroke Coordinator/Clinical Supervisor Emergency Department
Mary Greeley Medical Center

Theresa Hamm, RN, MA, BA
Stroke Team Coordinator
MercyOne, Des Moines

*This committee includes Erin Rindels

Iowa Stroke Task Force

As identified by the American Stroke Association's Task Force on the Development of Stroke Systems, stroke-wide stroke systems need to be tailored to specific needs and considerations at the local, regional, and state level.[2] The Iowa Stroke Task Force (ISTF) is comprised of professionals across multiple disciplines who provide care to stroke patients. These individuals often donate their time in an effort to ensure that stroke patients receive "standardized, timely, and appropriate stroke prevention, treatment and rehabilitation, regardless of location within the state, through provision of education and policy development."[3] Members of the task force demonstrate the highest level of commitment to improving outcomes after stroke. Through collaboration with other stroke professionals, healthcare professionals experiencing unique challenges within their institution receive mentoring from others in their efforts to develop strategies to improve their delivery of care to stroke patients. Without the efforts and guidance from the ISTF, the delivery of stroke care in Iowa would have a different picture.

EXECUTIVE SUMMARY

The Iowa Stroke Registry was established as part of the Centers for Disease Control and Preventions' Paul Coverdell National Acute Stroke Program to fund states for the purpose of collecting data to measure and track stroke care. The Iowa Stroke Registry was a component of the grant received by the Iowa Department of Public Health. The goal of the program was to assess the relationship and performance of the acute stroke system with the continuity of stroke care from stroke onset through discharge from hospital care. The Registry was developed, implemented, and coordinated by the Department of Epidemiology located at the University of Iowa College of Public Health. After an initial pilot developmental project, full registration of cases from 2013 through 2017 was provided by thirty institutions providing care to acute stroke patients.

This report is an overall view of stroke in Iowa during the 2013-2017 period utilizing national, state, and Iowa Stroke Registry data to provide a description of the magnitude of stroke, patient demographics, medical and stroke characteristics, and process measures of stroke care from stroke onset through hospital discharge. The goal of the report is to describe the burden of stroke in Iowa and to reflect on the Iowa stroke system of care from 2013 through 2017, highlighting successes and identifying areas for quality improvement. In addition, the report seeks to identify any disparities in the burden of stroke as well as the delivery of care by age, race, and gender.

BACKGROUND OF THE IOWA STROKE REGISTRY

Historically, clinical registries have played a key role in the evolution of patient care. The first prospective stroke registry in the US, the Harvard Cooperative Stroke Registry, originated in 1971 for the purpose of describing the clinical characteristics of stroke patients.[4] Analysis of data provided by these registries has enabled the identification of risk factors, monitoring of care delivered, and description of trends in stoke and stroke care. As more registries formed and matured, it was recognized that registries could serve to monitor the quality of care delivered to stroke patients on a system-wide basis. Examination of registry data allows for benchmarks to be established and quality improvement strategies to be drafted to address areas for improvement within institutions, among institutions, and across systems of care.

Time dependent acute stroke effective treatment became a reality in 1995 with the NINDS trial of rtPA for acute ischemic stroke. The results of the trial promulgated a movement for the development of a process of identification of the acute stroke patient and triage to hospitals and providers who could administer such time-dependent interventions. In 1997, NINDS sponsored a symposium on the Rapid Identification and Treatment of Stroke. As part of the symposium was development of hospital capabilities for acute stroke and a comprehensive health care system approach for the integration of care from identification to treatment, to outcome recovery.[5]

In partnership with the Iowa Department of Public Health and the American Heart Association, the Iowa State Stroke Task Force (currently Iowa Stroke Task Force-ISTF) was founded in 2005 with the vision of assuring "that all Iowans receive standardized, timely and appropriate stroke prevention, treatment, and rehabilitation, regardless of location within the state, through provision of education and policy development."[3] In 2006, the ISTF established a data working group to assess the status of stroke in Iowa. In 2008, the ISSTF reviewed a survey of acute care hospitals in Iowa to determine designations for stroke hospitals. A hospital verification and rehabilitation survey were initiated in 2009. Through pilot funding from the Iowa Department of Public Health, The University of Iowa assessed the status of stroke data in Iowa and initiated the development of a stroke registry.

In 2010, the Iowa Legislature passed Act HF2402, “an act relating to the development of a plan for a stroke triage system and registry” and was signed into law by Governor Chet Culver.[6] As part of the plan, a report was requested from the Iowa Department of Public Health in cooperation with the Iowa Healthcare Collaborative and the American Heart Association for the purpose of implementing a stroke triage and registry system. The main points of the legislation include,

1) A requirement that all hospitals be categorized according to their capability to provide stroke care.
2) Individual hospitals will agree to commit and provide resources to maintain levels of competencies in accordance with their designations.
3) the Iowa Department of Public Health to maintain a statewide registry to collect data for the purpose of monitoring, evaluating, and offering guidance to improve the care of acute stroke patients.

In 2010, a pilot registry was also developed. Funding was obtained from the Centers for Disease Control under Paul Coverdell National Acute Stroke Registry (PCNASR) with a subcontract to the University of Iowa to implement a registry, conduct training in data collection, perform system evaluation and produce reports for Iowa and the CDC. In 2012 the Iowa Stroke Registry was launched.

The Iowa Stroke Registry was established as part of the Centers for Disease Control and Preventions’ Paul Coverdell National Acute Stroke Program to fund states for the purpose of collecting data to measure and track stroke care. The Iowa Stroke Registry was a component of the grant received by the Iowa Department of Public Health. The goal of the program was to assess the relationship and performance of the acute stroke system with the continuity of stroke care from stroke onset through discharge from hospital care. The Registry was developed, implemented, and coordinated by the Department of Epidemiology located at the University of Iowa College of Public Health. After an initial pilot developmental project, full registration of cases from 2013 through 2017 was provided by one Comprehensive Stroke Center, sixteen out of seventeen Primary Stroke Centers, and volunteer Acute Stroke Ready Hospitals.

Although funding from the CDC for the PCNAS registry lapsed in 2016, there was continued data collection through 2017. In 2018, data collection through the Get With The Guidelines was mandated by legislation for Comprehensive and Primary Stroke Centers [7]. Acute stroke hospitals can participate via Get With The Guidelines or participate in the Iowa Stroke Registry at no cost.

Funding of the Iowa Stroke Registry

The data used for this report was made possible through funding from CDC (Contract Number: 5880HD03), Paul Coverdell National Acute Stroke Registry (PCNASR), and Iowa Department of Public Health.

KEY FINDINGS FROM THE IOWA STROKE REGISTRY, 2013-2017

ALL INSTITUTIONS MEETING TARGET GOALS IN 2017:

- Proportion of patients prescribed **VTE prophylaxis**
- Proportion of patients receiving **antithrombotics at the end of hospital day two**
- Proportion of patients receiving **antithrombotics at discharge**
- Proportion of patients **discharged on statin medication**
- Proportion of current smokers receiving **smoking cessation** counseling and/or therapy
- Proportion of patients with a **rehabilitation plan**

IMPROVEMENTS IN THE PROPORTION OF INSTITUTIONS MEETING TARGET GOALS FROM 2013-16 TO 2017:

- Proportion of patients receiving **rtPA within 60 minutes** (61.5% to 80%)
- **Door-to-imaging time less than 25 minutes** (47.1% to 62.5%)
- **Door-to-Image interpretation ≤ 45 minutes** (23.5% to 43.8%)
- Proportion of patients prescribed **VTE prophylaxis** (68.8% to 100%)

SIGNIFICANT OVERALL IMPROVEMENTS NOTED IN 2017 FROM 2013-16-TIME FRAME:

- Increase in the proportion of patients who arrive by **EMS with prenotification** (81.7% to 84.9%) with 55.6% of institutions reporting improvement
- Increase in the proportion of patients prescribed **VTE prophylaxis** (92.1% to 98.6%%) with all institutions meeting target goal
- Increase in the proportion of patients **discharged on statin medication** (96.5% to 98.6%) with all institutions meeting target goal

AREAS IDENTIFIED FOR QUALITY IMPROVEMENT (2013-16 TIME FRAME VERSUS 2017 TIME FRAME):

- Decrease in the proportion of patients who **arrive to the ED by EMS** (58.7% to 51.4%)
- Decrease in the proportion of patients who **arrive within 2 hours of LKW and are administered IV-rtPA within 3** hours (64.9% to 51.2%)
- Decrease in the proportion of patients who have a **NIHSS recorded** (67.1 to 53.1%) with substantial variability within institutions (0%-97.4%)
- Decrease in the proportion of patients who are **screened for dysphagia** (82.6% to 80.0%)
- Decrease in the proportion of patients diagnosed with **atrial fibrillation who receive anticoagulation** (88.3% to 82.0%)

CONCERNS IN THE PROPORTIONS OF INSTITUTIONS MEETING TARGET GOALS FROM 2013-16 TO 2017:

- Proportion of hospitals reporting **stroke education** (93.8% to 71.4%)
- **Median door-to-needle time** among patients receiving rtPA (50.0% to 46.2%)

CONCLUSIONS

The state of Iowa has witnessed significant reductions in stroke mortality. Between 1999 and 2017, age-adjusted mortality rates from cerebrovascular disease in Iowa have declined from 50.8 deaths per 100,000 to 25.9 deaths per 100,000 persons. Although these rates steadily declined until 2012, there has been a recent leveling off noted in the trend. Importantly, age-adjusted stroke mortality rates are not consistent across the state of Iowa. While 71% of the of counties experienced a decrease in mortality, the remaining 29% of counties witnessed a plateau or an increase in the age-adjusted rates. In 2017, there were 1253 deaths attributed to stroke and its sequelae in Iowa, representing 3.8% of the total deaths.[8] Strokes in Iowa dropped from the 3rd leading cause of death in 2007 to the 6th leading cause of death in 2017. An anticipated growth in the percent of individuals over the age of 65 years of age in Iowa by the year 2030 may have a substantial impact on the burden of stroke in the future.[9]

Primordial prevention for stroke by preventing the development of risk factors is the key strategy in addressing the burden of stroke. It has been suggested that the pathway to stroke begins at an early age.[10] Through identification and implementation of effective public health interventions targeting the prevention of the development of risk factors for stroke in children and adolescents, significant reductions in the burden of stroke could be realized. Although these strategies are ideally started during infancy (or possibly before), it is important to maintain a life course approach to the prevention of risk factors for stroke.

Differences in mortality rates were noted between urban and rural counties, by age group and race, and by stroke subtypes. Age-adjustment demonstrates differences in the age distribution of the counties account for much of the disparities; however, counties with a population between 10,000-49,000 have the highest rates. There are two factors which determine mortality rates, incidence rates and case-fatality rates. A recent study by Howard and Howard suggested differences in rural stroke mortality were likely the result of higher stroke incidence rather than higher case-fatality rates.[11] This emphasizes the need for a comprehensive stroke system aimed at both community and clinical settings.

Primarily stroke patients have their stroke not in a health care setting with differing arrival modes at stroke hospitals. Still one-third of patients choosing to arrive by private vehicle rather than EMS. While the private vehicle patients tend to have less severe strokes, many of these strokes present with clinically changeable symptoms that require prompt and highest quality care. There is substantial variability in the catchment areas among stroke hospitals in EMS and private vehicle arrival.

Little progress has been made in the proportion of patients who arrive by EMS for evaluation and treatment of stroke. Although stroke patients who arrive by private vehicle often have lower severity scores than patients who arrive by EMS, many of these patients have modifiable outcomes provided they receive prompt, high quality care. Substantial numbers of stroke patients who are initially identified within the healthcare system (outpatient and acute care settings), continue to arrive for care by private vehicle. Of note, there is substantial variability among hospitals' size and type of catchment areas. This variation may affect the proportion of patients who arrive by EMS as well as the proportion of ischemic strokes who arrive within certain treatment time window.

The reduction in stroke mortality and morbidity is thought to be the result of factors such as improvements in the control of risk factors, innovations in treatment of stroke, use of telemedicine, and adoption of stroke systems of care.[12] Organized stroke systems of care have led to reductions in mortality as well as improvements in functional outcomes.[13, 14] Reduction of disability is perhaps the most important goal in the care of stroke patients. This reduction in disability has important financial implications as well. Majersik and Woo estimated a reduction in Modified Rankin Score from 3 to 2, would reduce direct costs

by 85%.[15] Although there have been substantial gains in age-standardized stroke mortality and morbidity, a 2016 systematic review stated “the burden of stroke is likely to remain high.[16] The importance of continuing an effective stroke system while aiming for quality improvement cannot be overstated.

The state of Iowa has experienced substantial progress in the development of a stroke system of care in Iowa over the past decade. With support from Initiated by the Iowa Stroke Task Force and supported by the Iowa American Heart Association Affiliate in 2007, the Task Force has identified needs, but as a volunteer organization it has limited capacity. Its strength is the cohesiveness and drive by the stroke coordinators. The American Heart Association has provided the Iowa Stroke Task Force with current hospital performance via GWTG and willingness to support educational and lobbying efforts. IDPH has provided the current coordination of the Million Hearts plan and activities and the data analysis for the GWTG data. The system in Iowa is at a crossroads. The CDC funding through the Paul Coverdell Acute Stroke Program facilitated the recognition and the challenges on developing a stroke system in a rural state Several states have used their CDC funding and state support to launch comprehensive stroke systems. In Iowa, the Iowa Trauma System could serve as a model of education, protocols, and quality improvement for stroke.

KEY RECOMMENDATIONS FOR THE FUTURE

1. **Implement a comprehensive view** of the stroke system by stakeholders to include critical access and acute stroke-ready hospitals, EMS services, telemedicine, and rehabilitation facilities.
2. **Consider regionalization** in system integration for triage and treatment.
3. **Develop a comprehensive registry** to include Acute Stroke Ready Hospitals and stroke rehabilitation facilities to evaluate stroke patterns of care across entire state including data collection, integration of data across platforms, and analysis of said data for the purpose of identifying areas needing improvement or further research.
4. **Improve data quality** to allow for more accurate monitoring of the systems of care within the state while pinpointing potential causes.
5. **Develop an infrastructure** for review of the stroke system for the purpose of quality improvement.
6. **Focus on hospital variation** in performance for quality improvement.
7. **Develop strategies and tools** for stroke education and system integration for recognition, emergency response, triage protocols, and liaisons between local and stroke specialty hospitals state including collection, integration, and analysis focusing on identified areas needing improvement or further research.
8. **Improve stroke awareness** and knowledge of the care needs and capabilities by the public, EMS, public health departments, health care providers and facilities.

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LIST OF ACRONYMS

Abbreviation	Description
AHA	American Heart Association
BP	Blood pressure
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
CMO	Care measures only
CPSS	Cincinnati Prehospital Stroke Scale
CSC	Comprehensive Stroke Center
CT	Computed tomography
DTI	Door-to-Imaging
DTN	Door-to-Needle
DVT	Deep vein thrombosis
DX	Diagnosis
ED	Emergency Department
EDP	Emergency Department provider
EMS	Emergency Medical Systems
FAST	Face Arm Speech Test
GCS	Glasgow Coma Scale
GWTG	Get With The Guidelines®
HS	Hemorrhagic stroke
IA	Iowa
ICD	International Classification of Disease
ICH	Intracerebral hemorrhage
IDPH	Iowa Department of Public Health
IS	Ischemic stroke
ISR	Iowa Stroke Registry
ISTF	Iowa Stroke Task Force
ITE	Imaging-to-Evaluation
IV	Intravenous
LAPSS	Los Angeles Prehospital Stroke Screen
LDL	Low-density lipoprotein
LKW	Last known well

Abbreviation	Description
LQ	Lower quartile
LVO	Large vessel occlusion
MAX	Maximum
MEND	Miami Emergency Neurological Deficit
MIN	Minimum
MISA	Micropolitan Statistical Areas
mRS	Modified Rankin Scale
MSA	Metropolitan Statistical Areas
MW	Midwest
NIHSS	National Institute of Health Stroke Scale
NOS	Stroke, not otherwise specified
OTA	Onset-to-arrival
PSC	Primary Stroke Center
PV	Private vehicle
SAH	Subarachnoid hemorrhage
SCC	Stroke Capable Center
STK	Stroke
TIA	Transient ischemic attack
TTE	Transthoracic echocardiography
rtPA	Recombinant tissue plasminogen activator
UQ	Upper quartile
US	United States
VTE	Venous thromboembolism
WHO	World Health Organization

GLOSSARY

Age-adjusted rates are summary measures used to enable comparisons between populations that may differ in the distribution of age. For example, some counties may have higher proportions of older adults than other counties. To allow fair comparisons between these counties, a "standard" population distribution is used to adjust for these differences.

Age-adjusted mortality rates are "weighted averages of the age-specific mortality rates, where the weights represent a fixed population by age. These adjusted rates are used to compare relative mortality risk among groups and over time. An age-adjusted rate represents the rate that would have existed had the age-specific rates of the particular year prevailed in a population whose age distribution was the same as that of the fixed population. Age-adjusted rates should be viewed as relative indexes rather than as direct or actual measures of mortality risk." [8]

Body Mass Index (BMI) categories is based on the classification set forth by the National Institute of Health (NIH) and the World Health Organization.[17]

Classification	BMI (kg/m^2)
Underweight	< 18.5
Normal	18.5 to 24.9
Overweight	25.0 to 29.9
Class I obese	30.0 to 34.9
Class II obese	35.0 to 39.9
Class III obese	> 40.0

Confidence intervals are the range of values expected to contain the true value if sampled repeatedly. This interval is based on a specified probability (usually 95%).

Crude mortality rates are expressed as the number of deaths reported per 100,000 population, except where noted.

Death counts represent the number of deaths that occurred.

Incidence is the number of new cases of disease that develops within a specific unit of time. For this report, the period is a year.

Interquartile range is the measure of the dispersion around the median value, the middle 50 percent. It is calculated by subtracting the value at the 25^{th} percentile from the value at the 75^{th} percentile.

Metropolitan Statistical Areas (MSA), established by the U.S. Office of Management and Budget, serve to characterize regions including cities and their surrounding communities based on common social and economic factors.

The **Midwest Census Region** includes **Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota,** and **Wisconsin.**[18]

The 2013 **Urban-Rural (RUCA)** classification scheme for counties is utilized for the analyses of mortality data and health indicators at a population-level.[1] The six-level classification scheme includes:

Metropolitan Statistical Areas (MSA)

- Large central metro- counties in MSAs of one million or more population that did not qualify as large central metro counties.
- Large fringe metro-counties in MSAs of one million or more population that did not qualify as large central metro counties.
- Medium metro MSA population 250,000-999,999.
- Small metro MSA population less than 250,000.

Non-metropolitan (MISA)

- Micropolitan Urban cluster population-10,000—49,000.
- Noncore all other areas not classified as micropolitan

Prevalence is the estimated number of individuals with a disease or risk factor at a specific point of time.

p-trend represents the probability that a relationship changes with an increase in the order of a variable. This relationship may be positively or negatively correlated. It is based on a specified probability (usually 95%. P-trends less than 0.05 are considered significant.

Levels of prevention:

- **Primordial prevention** is aimed at preventing the development of risk factors for stroke. These efforts target at-risk communities (inadequate housing) or target whole populations (sedentary behavior).
- **Primary prevention** refers to those efforts to modify the known risk factors associated with specific diseases. These strategies may be implemented at the population-level (smoking cessation programs) or at the individual-level (prescription of anti-hypertensives for individuals with high blood pressure).
- **Secondary prevention** is aimed at preventing recurrence of stroke in those patients who have suffered a stroke. This type of prevention includes prescribing antithrombotic and statins at discharge.

Race and Ethnicity

In this report, the values for additional races and ethnicities are often small and as a result, may not be reliable for interpretation. Race and Ethnicity are a social construct and, in most instances, reflects differences in factors other than genetics. Although race and ethnicity are important for examining trends in health disparities, it is a complex taxonomy and may not accurately reflect differences within a given population[19].

Rural Referral Hospitals are higher volume hospitals located in rural settings[20]. Qualifying hospitals have met the following characteristics:

- ≥ 50% of Medicare patients are referred from other healthcare facilities
- ≥ 60% of Medicare patients live more than 25 miles from hospital
- ≥ 60% of all services are provided to Medicare patients who live more than 25 miles from the hospital

Suppressed data represents data with fewer than ten individuals.

Unreliable data represents data with fewer than 20 individuals.

Data Sources for Report

- Area Health Resource File/American Medical Association[21]
- Behavioral Risk Factor Surveillance System (BRFSS), 2017[22]
- CDC Wide-ranging Online Data for Epidemiologic Research (CDC WONDER)[23]
- Census Population Estimates[24]
- Centers for Medicare and Medicaid Services Medicare Provider Analysis and Review (MEDPAR) file, Part A[25]
- County Health Rankings & Roadmaps[26]
- Division for Heart Disease and Stroke Prevention (DHDSP) Statistics[27]
- EDFacts[28]
- Interactive Atlas of Heart Disease and Stroke[29]
- Iowa Department of Public Health. Iowa Behavioral Risk Factor Surveillance System[30]
- Iowa Public Health Tracking Portal[31]
- Iowa Stroke Registry (ISR)[32]
- National Center for Health Statistics (NCHS)[1]
- Places: Local Data for Better Health[33]
- Small Area Health Insurance Estimates[34]
- State Data Center of Iowa[35]
- United States Census Bureau[36]

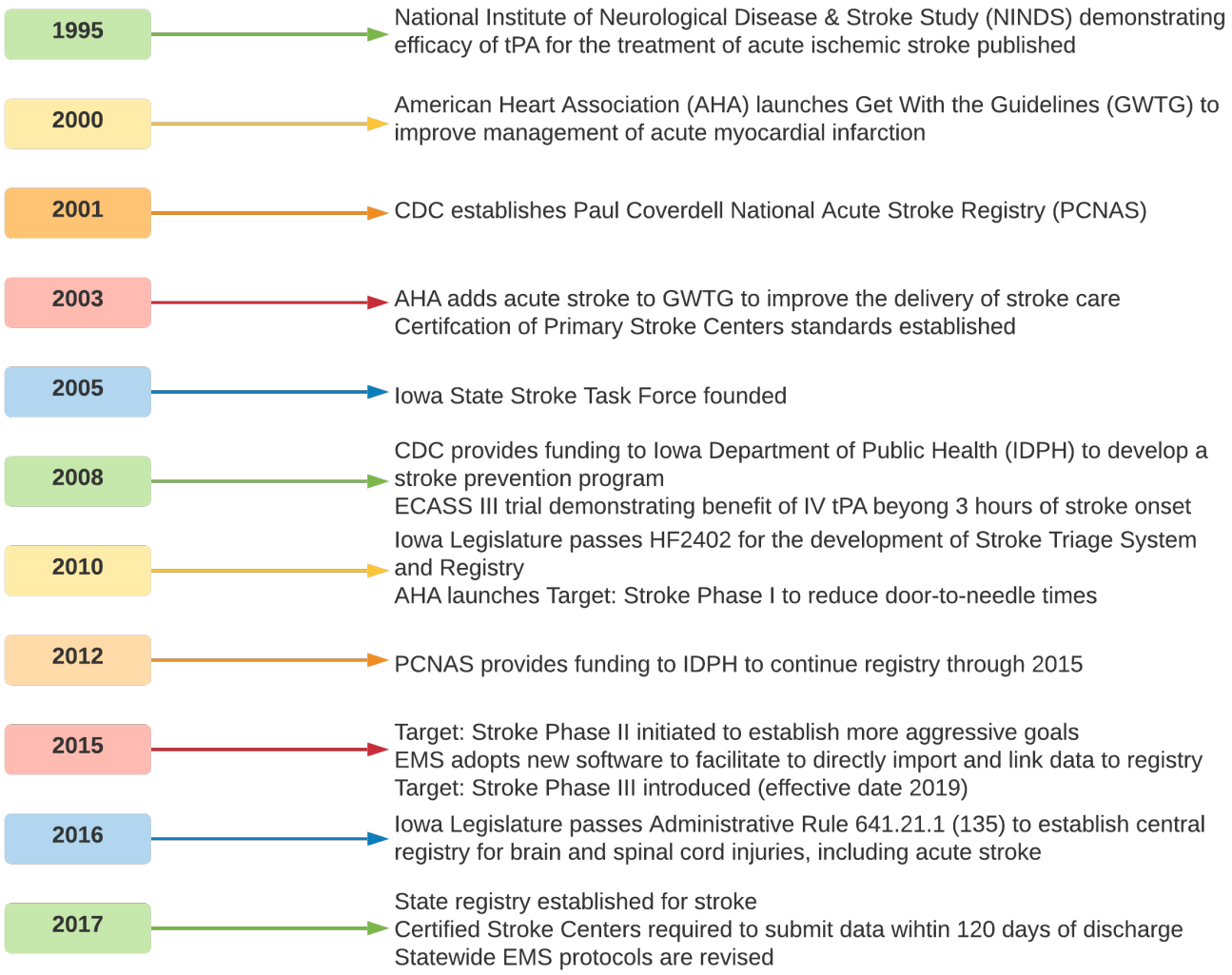


Figure 1. Timeline of the Iowa Stroke Registry

NINDS study[37]

ECASS III[38]

GOALS OF THE REGISTRY

The Iowa Stroke Registry was developed to:

- Implement standard definitions and protocols for inclusion in the stroke registry
- Supply data at the point of care from participating stroke hospitals
- Gather data in a systematic manner
- Maintain quality data for retrieval
- Analyze data to meet public health, stroke system quality improvement and research needs
- Disseminate information to the public, state officials, committees, and health care providers

OBJECTIVES OF THE REGISTRY

The Iowa Stroke Registry focused on patients with stroke who need acute care to:

- Monitor incidence and prevalence of stroke in Iowa
- Measure stroke risk factors in the population and in stroke patients to develop initiatives in stroke prevention
- Measure and assess stroke quality indicators of treatment in Iowa hospitals
- Measure outcomes of acute stroke care
- Assess and evaluate the hospitalization, triage, transfer, and continuity of stroke care
- Describe the incidence of recurrent stroke

DATA SOURCES FOR THE IOWA STROKE REGISTRY

Sources of data were inclusive of existing data and hospital-based data collection. They included:

- Death certificates from stroke
- EMS data
- Hospital Discharge data
- State Stroke Registry
- Stroke transfer data
- Stroke rehabilitation and follow-up

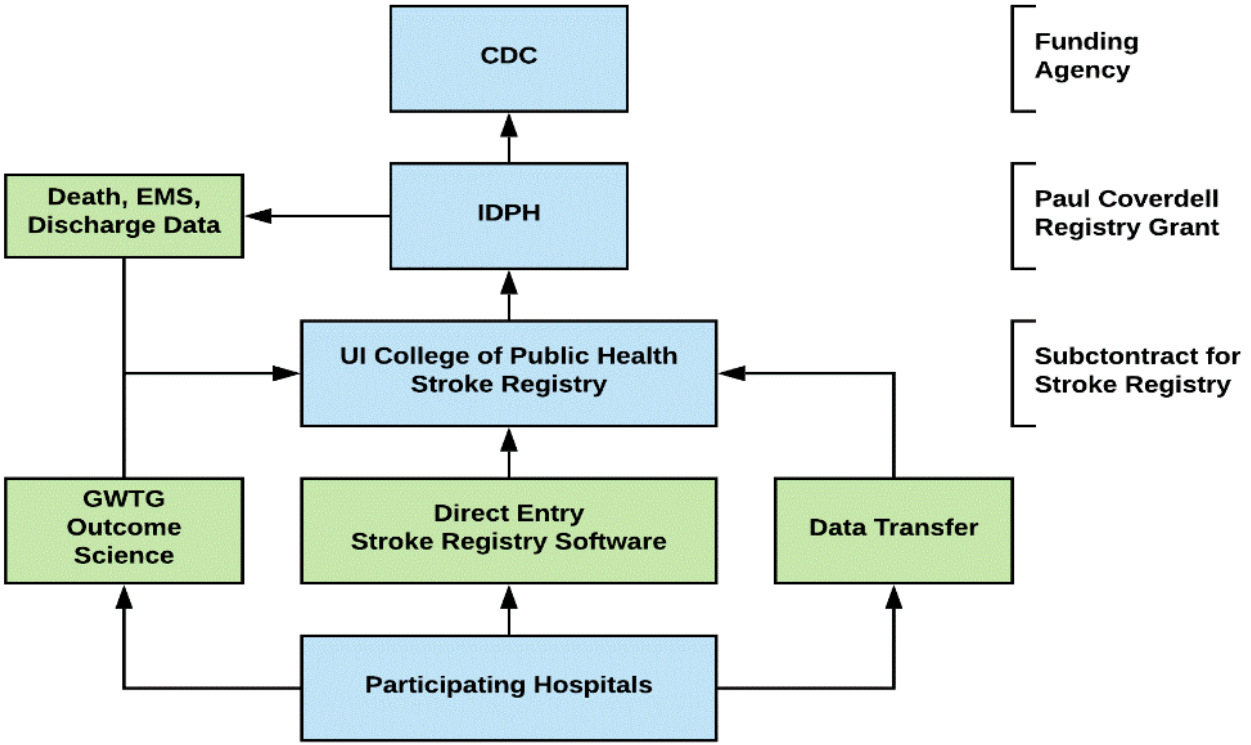


Figure 2. Organization and Data Collection Scheme for the Iowa Stroke Registry

SYSTEMS OF CARE

Twenty-five years ago, in 1996, NINDS sponsored the National Symposium on Rapid Identification and Treatment of Acute Stroke. The Acute Hospital Care Panel "identified three key issues (a) the proper design and use of stroke critical pathways, (b) the appropriate distribution of medical resources, and (c) the development of medical expertise needed in acute stroke management" for the development of acute stroke programs."[5]

The recommendations focused on hospital stroke plans including the care continuum of EMS and hospitals based on evidence-based guidelines, strategies for implementation, and outcomes assessment focused on quality improvement. Times were recommended as goals for acute treatment: time from door to CT scan: 25 minutes, time from door to CT reading: 45 minutes, time from door to drug: 60 minutes (80% success target), and time from door to monitored bed: 3 hours, and access to stroke expertise within 15 minutes of patient arrival at the hospital and neurosurgical expertise within 2 hours. The Symposium suggested that national stroke outcomes database should be determined if feasible. Criteria for distinguishing primary, intermediate, and comprehensive stroke centers need to be developed. At the system level a voluntary system for recognizing primary, intermediate, and comprehensive stroke centers be explored. The creation of local and regional stroke networks encompassing all levels of stroke care is endorsed. Educational changes recommended were residency and other health professional training programs developing acute stroke expertise with specialty-specific continuing medical education. Also, a national Stroke Toolbox be created and made available. All of this was a charge to the stakeholders for commitment to improve acute stroke.

Stroke certification began in 2003 with a joint initiative by the Joint Commission and the American Heart Association/American Stroke Association.[39] Primary Stroke Center Certification began in 2004. The Primary Stroke Center has a dedicated stroke program, qualified, stroke-trained medical professionals, coordinated care, quality performance in stroke treatment, outcomes and safety and comprehensive data collection. In 2012 The Joint Commission launched an advanced certification of Comprehensive Stroke Centers. These centers have enhanced specialization in stroke, diagnostic capabilities including advanced imaging, availability of surgical and interventional therapies, and organized infrastructure. In Iowa 2010 the Iowa Stroke Plan had stroke hospitals were categorized as Primary Stroke Centers and Acute Stroke-Capable Hospitals. In 2018, the Iowa Legislature adopted Iowa Administrative Code, chapter 146 which recognized the designation of a Primary Stroke Center and a Comprehensive Stroke Center for hospitals and the responsibility of joint data collection.

In 2001, The Paul Coverdell National Acute Stroke Registry was funded by Congress to establish high quality stroke registries with the goal of quality improvement. A pilot project from 2001—2004 developed the prototype and funded four states from 2004-2007, including 190 hospitals. National partnerships using six states led to a cooperative program of a common focus on improving stroke care. In 2007 the Joint Commission's Primary Stroke Center Certification Program began and the American Heart Association/American Stroke Association's Get with the Guidelines developed data elements for stroke center performance. In Iowa, the evolution of the stroke system of care has made steady progress in the past 15 years. The development of the Iowa Stroke Task Force was based on the recognition that early intervention in a rural state was through expansion of stroke protocols and organizational changes were necessary for the integration of EMS, emergency departments and hospitals to improve acute stroke care and increase the use of rtPA in acute ischemia. In 2010 the Iowa Comprehensive Heart Disease and Stroke Plan of 2010—2014 was launched and it created goals and objectives from prevention to care. It focused on blood pressure and cholesterol for prevention and improvement in heart attack and stroke recognition, EMS response, and universal quality of care. At the same time, the Iowa legislature established stroke hospital levels based on capabilities.

The Paul Coverdell Acute Stroke Program has emphasized the continuity of care across the continuum. It focuses on the system development of state level and health system level actions and partnerships. This recognizes the structural environment of prevention, care, and outcome to address local and regional

capabilities and disparities that increase risk or are associated with outcomes. Evaluation takes a comprehensive view on measures reflecting the passage of the stroke patient through the system and factor influencing availability and access of the system.

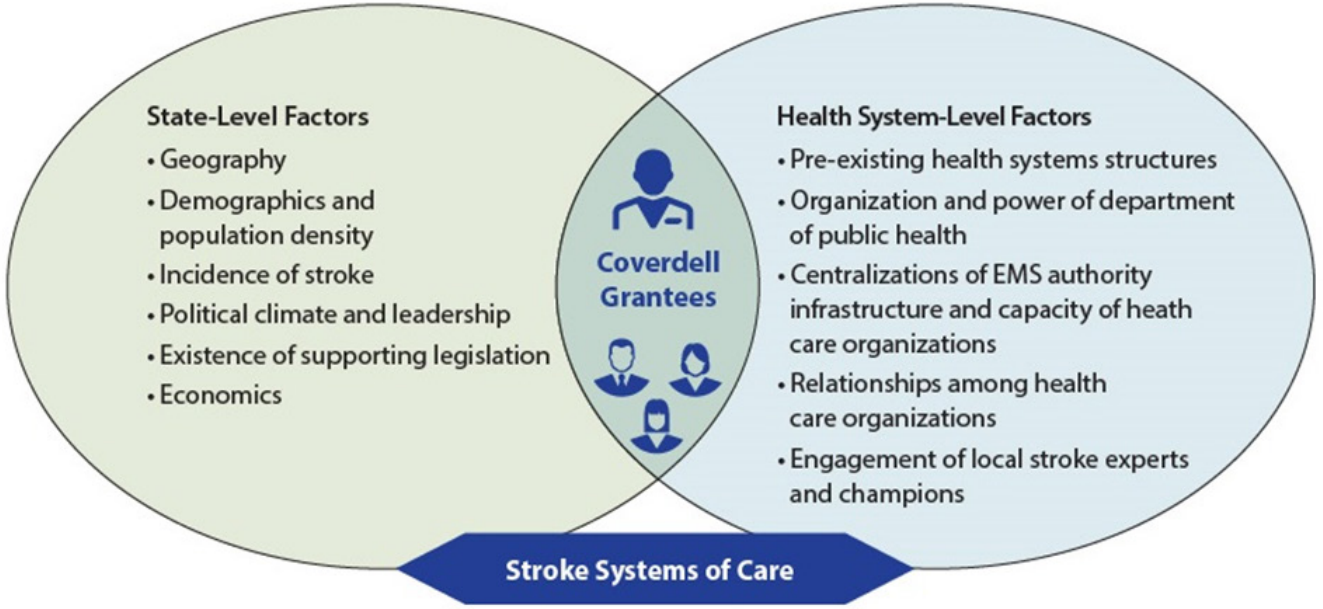


Figure 3. Venn Diagram of State- and Health System-level Contextual Factors
Reprinted from https://www.cdc.gov/dhdsp/evaluation_resources/pcnasp-evaluation-summary.htm[40]

Iowa Department of Public Health
Bureau of Emergency and Trauma Services
All-Hazard Emergency Preparedness and Response System Development
State and Local Points of Contact

IDPH Preparedness Program Service Areas as of July 1, 2020

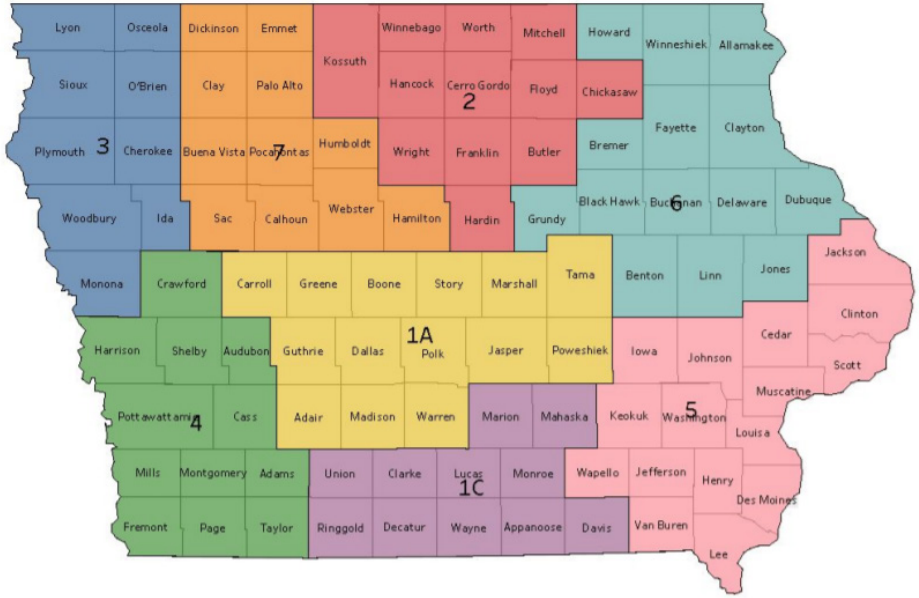


Figure 4. Time-critical Service Areas in Iowa

- In 2016, in response to an identified need to regionalize time-critical care in Iowa, the Iowa Department of Public Health evaluated patterns of care and existing partnerships for the purpose of designating time-critical conditions service areas.
- Seven districts, including twelve subregions, were established to "create more efficient systems of care, system development, and planning for response".[41]

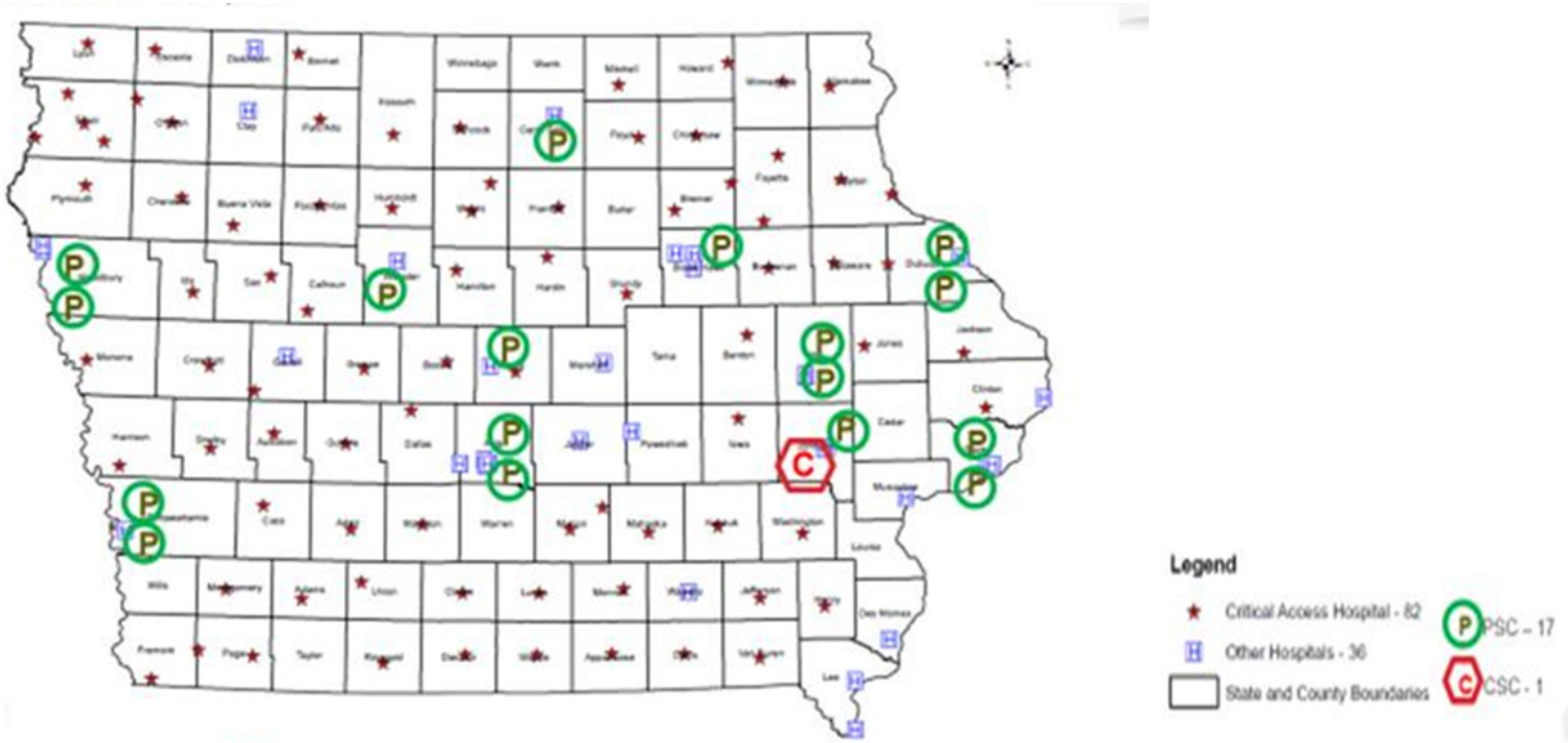


Figure 5. Map of Facilities Providing Care to Acute Stroke Patients in the State of Iowa, 2016

Source: Iowa Hospital Association, Iowa Department of Inspections & Appeals, and Iowa Department of Public Health-Bureau of Health Care Access
Prepared by the Iowa Department of Public Health, Bureau of Health Care Access[42]

- The distribution of primary and comprehensive stroke centers is primarily in large communities with disparities in facilities on northeast, northwest, and southern counties of Iowa.

Table 1. Iowa Comprehensive and Primary Stroke Center-designated Hospitals, 2017

Facility (current name)	Location	Designation	Accrediting Organization/Year First Certified as PSC
Mary Greeley Medical Center	Ames	PSC	DNV 2012
UnityPoint Health-Trinity-Bettendorf	Bettendorf	PSC	TJC 2012
Mercy Medical Center-Cedar Rapids	Cedar Rapids	PSC	TJC 2007
UnityPoint Health-St. Luke's Hospital	Cedar Rapids	PSC	TJC 2006
CHI Health Mercy Council Bluffs	Council Bluffs	PSC	TJC 2009
Methodist Jennie Edmundson	Council Bluffs	PSC	TJC 2014
Genesis Medical Center-Davenport	Davenport	PSC	TJC 2008
MercyOne-Des Moines Medical Center	Des Moines	PSC	TJC 2007
Unity Point Health-Iowa Methodist Medical Center	Des Moines	PSC	DNV 2010
MercyOne-Dubuque Medical Center	Dubuque	PSC	TJC 2012
UnityPoint Health-Finley Hospital	Dubuque	PSC	TJC 2014
UnityPoint Health-Trinity Regional Medical Center ₸	Fort Dodge	PSC	TJC 2012
Mercy Iowa City	Iowa City	PSC	TJC 2011
University of Iowa Hospitals and Clinics	Iowa City	CSC[3]	TJC 2007[4]
MercyOne North Iowa Medical Center ₸	Mason City	PSC	TJC 2009
MercyOne-Siouxland Medical Center	Sioux City	PSC	TJC 2010
St. Luke's Sioux City	Sioux City	PSC	DNV 2011
UnityPoint Health-Allen Hospital	Waterloo	PSC	TJC 2013
Great River Health System ₸	West Burlington	PSC	TJC 2006[4]

Abbreviations: PSC=Primary Stroke Center, CSC=Comprehensive Stroke Center, TJC=The Joint Commission, NR: not reported, DNV=DNV Healthcare Inc, TJC=The Joint Commission. ₸ Rural Referral Hospital, [1] Averages for institution reported to Iowa Stroke Registry 2013—2017, [2] Does not report data to ISR, [3] Certified as a CSC in 2013. [4] PSC designation for 2016 and 2017 only.

The following institutions voluntarily submitted data to the ISR:

- Dallas County Hospital (Perry)
- Dewitt Community Hospital (Dewitt)
- Grinnell Regional Medical Ctr (Grinnell)
- Hamilton Hospital (Webster City)
- Iowa Lutheran Hospital (Des Moines)
- Jackson County Public Hospital (Maquoketa)
- Jefferson County Hospital (Fairfield)
- Knoxville Area Community Hospital (Knoxville)
- Madison County Mem Hospital (Winterset)
- Manning Regional Healthcare (Manning)
- Mercy Medical Center (Clinton)
- Montgomery County Memorial Hospital (Red Oak)
- Stewart Memorial Comm Hospital (Lake City)
- Unity Hospital (Muscatine)
- Waverly Municipal Hospital (Waverly)
- Wayne County Hospital (Corydon)

Although the report includes data voluntarily submitted to the ISR from some Acute Stroke Ready hospitals, this data is not included in the statistics characterizing the delivery of care. The data is not comprehensive from all ASR hospitals and may not accurately represent the stroke system within this designation.

Table 2. Comparison of Capabilities and Requirements by Stroke Center Designation

Characteristic	ASRH	PSC	TSC	CSC
Location	Likely rural	Likely urban/suburban	Likely urban	Likely urban
Stroke team accessible/available 24/7	Yes	Yes	Yes	Yes
Non-contrast CT available 24/7	Yes	Yes	Yes	Yes
Advanced imaging available 24/7	No	Yes [1]	Yes [1]	Yes [1,2]
IV alteplase capable	Yes	Yes	Yes	Yes
Thrombectomy-capable	No	Possibly	Yes	Yes
Diagnoses of stroke pathogenesis and management of poststroke complications	Unlikely	Yes	Yes	Yes
Admits hemorrhagic strokes	No	Possibly	Possibly	Yes
Clips/coils ruptured aneurysms	No	Possibly	Possibly	Yes
Dedicated stroke unit	No	Yes	Yes	Yes
Dedicated neurocritical care unit/ICU	No	Possibly	Possibly	Yes
Participate in stroke research	Not required	Optional	Optional	Required
Participate in stroke registry	Optional in Iowa	Mandated in Iowa	Mandated in Iowa	Mandated in Iowa
Resources for basic stroke care	ED providers	Neurology call 24/7 [3]	Neuro-interventionalist	Neuro-interventionalist

Adapted from Adeoye et al, Recommendations for the Establishment of Stroke Systems of Care: A 2019 Update A Policy Statement from the American Stroke Association.[43]. Abbreviations ASRH: Acute Stroke Ready Hospital; PSC: Primary Stroke Center; TSC: Thrombectomy-capable Stroke Center; CSC: Comprehensive Stroke Center. Advanced imaging includes computed tomography angiography, computed tomography perfusion, magnetic resonance imaging, magnetic resonance angiography, magnetic resonance perfusion. [2] Includes transesophageal and transthoracic echocardiograms. [3]Joint Commission only.

MORTALITY

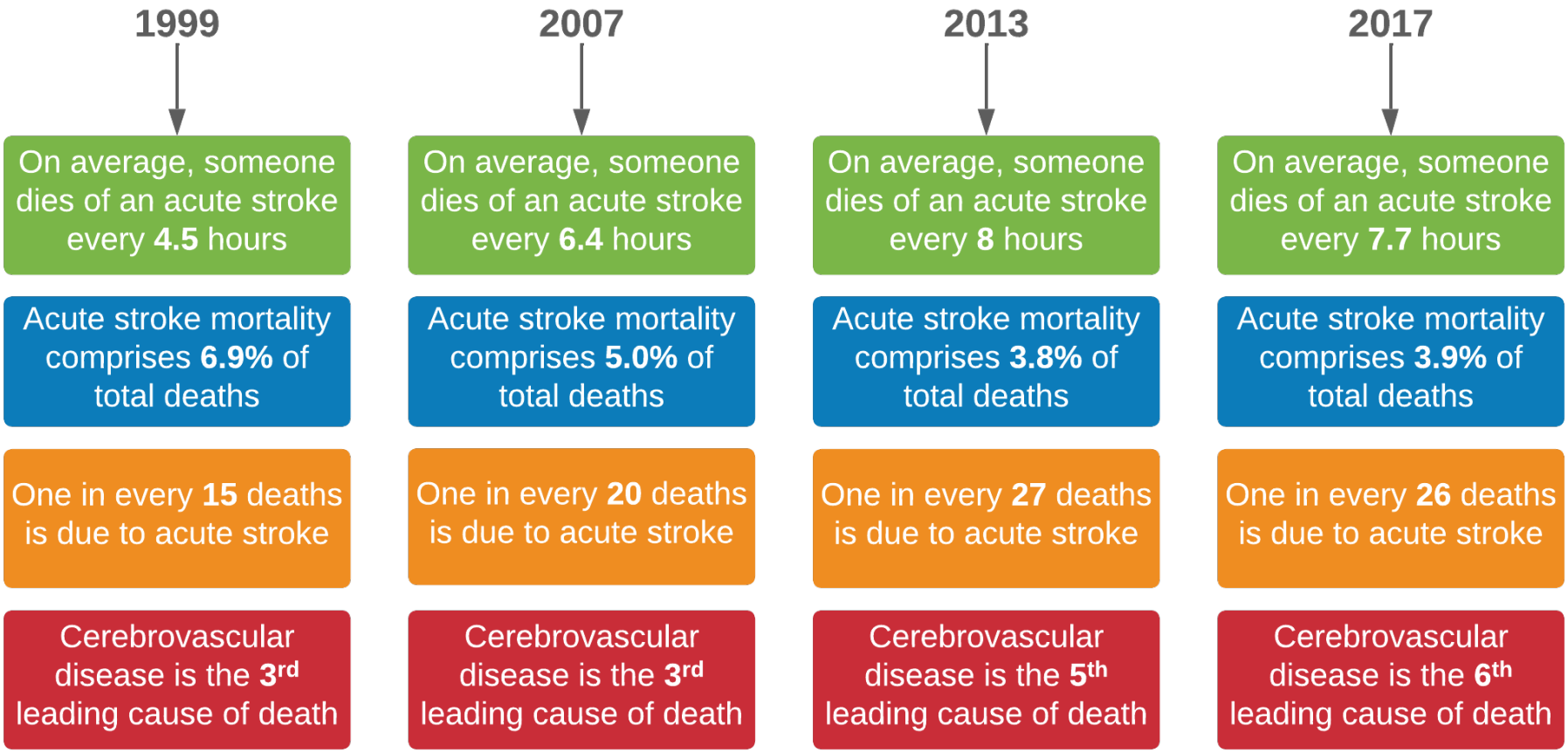


Figure 6. Summary of Trends in Stroke Mortality, Iowa, 1999 through 2017
Data Source: CDC Wonder[23]

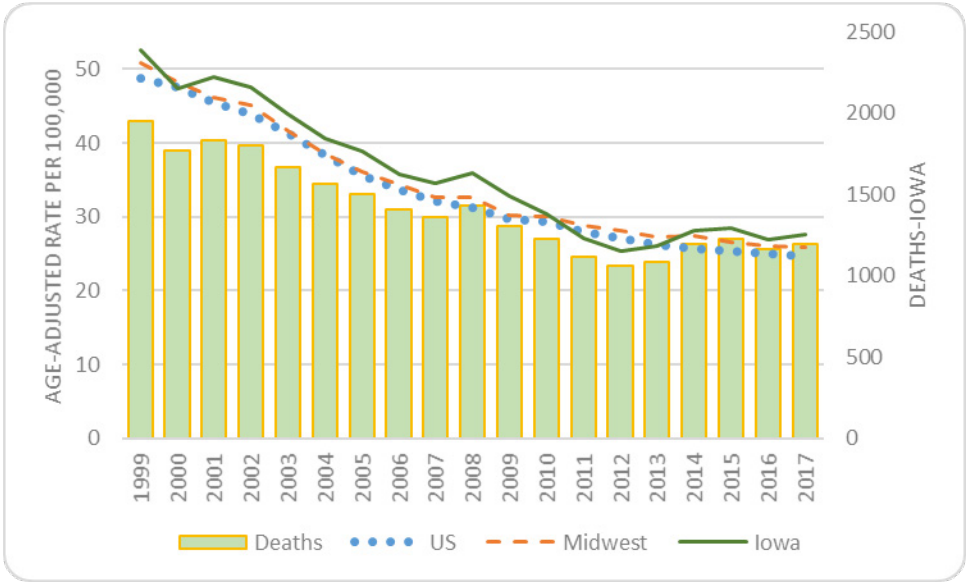
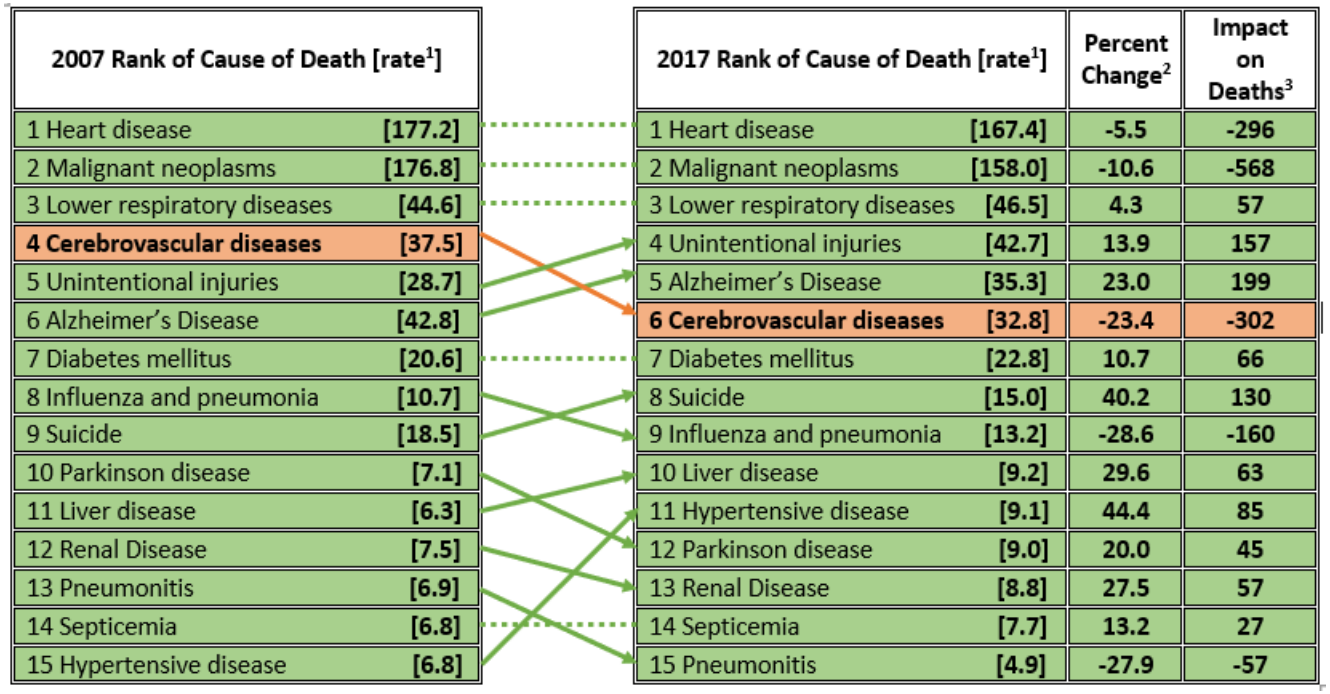


Figure 7. Trends in Age-adjusted Acute Stroke Mortality Rates in the US, Midwest, and Iowa, 1999—2017

Age-adjusted mortality rates; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018 [23]. ICD-10 codes include: I60 subarachnoid hemorrhage, I61 Intracerebral hemorrhage, I63 Cerebral infarction, I64 Stroke, not specified as hemorrhage or infarction. The ***Midwest Census Region*** *includes* ***Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota****, and* ***Wisconsin****.*

- **The US** and **Midwest** experienced declines in age-adjusted acute stroke mortality rates between 1999 and 2017. For **Iowa**, these rates declined until 2013 with some increased variability in rates from 2013 through 2017.
- In the **US**, the rate decreased 49.3% from 48.7 deaths per 100,000 to 24.7 deaths per 100,000.
- For the **Midwest**, the age-adjusted acute stroke mortality declined from 50.8 deaths per 100,000 to 25.9 deaths per 100,000, amounting to a 49% decrease.
- The age-adjusted acute stroke mortality declined overall in **Iowa** from 52.5 deaths per 100,000 in 1999 to 27.6 deaths per 100,000 in 2017, amounting to a 47.4% decrease.
- The number of actual deaths attributable to acute stroke in **Iowa** decreased by 38.9% (from 1,945 deaths to 1,193 deaths).
- The overall age-adjusted stroke mortality between 2013 and 2017 for the **US**, **Midwest**, and **Iowa**:
    - **US**: 25.4 deaths per 100,000
    - **Midwest**: 26.6 deaths per 100,000
    - **Iowa**: 27.5 deaths per 100,000



2007 Rank of Cause of Death [rate[1]]		2017 Rank of Cause of Death [rate[1]]		Percent Change[2]	Impact on Deaths[3]
1 Heart disease	[177.2]	1 Heart disease	[167.4]	-5.5	-296
2 Malignant neoplasms	[176.8]	2 Malignant neoplasms	[158.0]	-10.6	-568
3 Lower respiratory diseases	[44.6]	3 Lower respiratory diseases	[46.5]	4.3	57
4 Cerebrovascular diseases	[37.5]	4 Unintentional injuries	[42.7]	13.9	157
5 Unintentional injuries	[28.7]	5 Alzheimer's Disease	[35.3]	23.0	199
6 Alzheimer's Disease	[42.8]	**6 Cerebrovascular diseases**	[32.8]	-23.4	-302
7 Diabetes mellitus	[20.6]	7 Diabetes mellitus	[22.8]	10.7	66
8 Influenza and pneumonia	[10.7]	8 Suicide	[15.0]	40.2	130
9 Suicide	[18.5]	9 Influenza and pneumonia	[13.2]	-28.6	-160
10 Parkinson disease	[7.1]	10 Liver disease	[9.2]	29.6	63
11 Liver disease	[6.3]	11 Hypertensive disease	[9.1]	44.4	85
12 Renal Disease	[7.5]	12 Parkinson disease	[9.0]	20.0	45
13 Pneumonitis	[6.9]	13 Renal Disease	[8.8]	27.5	57
14 Septicemia	[6.8]	14 Septicemia	[7.7]	13.2	27
15 Hypertensive disease	[6.8]	15 Pneumonitis	[4.9]	-27.9	-57

Figure 8. Top 15 Leading Causes of Death and Percent Change, Iowa, 2007—2017

[1]Age-adjusted mortality rates per 100,000; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018.
[23] Percent change from 2007 through 2017 in age-adjusted mortality rates. [3]Expected impact on the number of deaths. Negative numbers indicate fewer deaths. Dotted lines indicate no change in rates. Solid lines indicate an increase or decrease in in rates.

- **Leading causes of deaths** 2007 and 2017 in Iowa:
  - **Cerebrovascular disease** (ICD10: I60—I69) moved from the **fourth leading cause of death** in 2007 to the **6th leading cause of death** in 2017, representing a 23.4% decrease in the age-adjusted mortality rate.
  - This change in rank reflects a decrease in the age-adjusted mortality rate for **cerebrovascular diseases** as well as an increase in the mortality associated with **unintentional injuries**.
  - **Cardiovascular disease**, **malignant neoplasms**, and **chronic lower respiratory diseases** remain unchanged in rank, occupying the **1st, 2nd, and 3rd places**, respectively. **Alzheimer's Disease** and **unintentional injuries** surpassed **cerebrovascular diseases** with ranks of **5th and 4th**, respectively.
  - The age-adjusted mortality rates from **cardiovascular** and **malignant neoplasms** decreased 5.5% and 10.6%, respectively, while **chronic lower respiratory infections** increased 4.3%.
  - Of note, deaths from **essential hypertension** and **hypertensive renal disease** moved up from the 15th to the 11th **leading cause of death**.
  - The age-adjusted mortality rate for **cerebrovascular disease** declined from 37.5 deaths per 100,000 to 32.8 deaths per 100,000.
  - This decline in the age-adjusted mortality rate **cerebrovascular disease** would have averted an estimated 302 deaths in 2017.

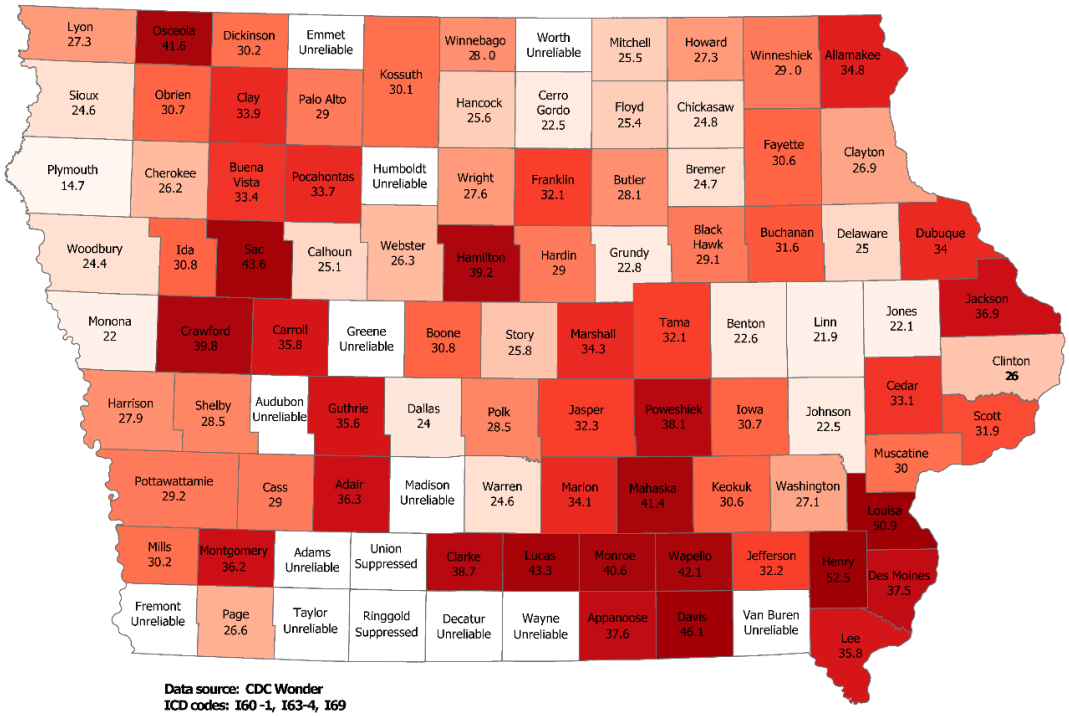


Figure 9. Age-adjusted Stroke Mortality by County, Iowa, 2013—2017

*Age-adjusted mortality rates; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018. ICD 160, I61, I63, I64 and I69 [23]. *Includes deaths from unspecified sequelae of cerebrovascular disease.*

- Substantial variability between counties for **age-adjusted stroke mortality** is noted, with the highest rate occurring in **Henry** County (52.5 deaths per 100,000) and the lowest rate in **Plymouth** County (14.7 deaths per 100,000).
- The median **age-adjusted stroke mortality** rate for all counties with reported rates was 30.2 deaths per 100,000, with 50% of age-adjusted mortality rates lying between 26.2 and 34.8 deaths per 100,000.
- Of the ninety-nine **counties** in **Iowa**, 42 **counties** had age-adjusted mortality rates below the median age-adjusted acute stroke mortality rate for Iowa.
- Sixty-one (61) **counties** exceeded the Midwest age-adjusted stroke mortality of 25.4 deaths per 100,000.
- Sixty-eight (68) **counties** exceeded the US rate of 26.6 deaths per 100,000 for the same time.
- Higher age-adjusted stroke mortality rates appear to occur in the southeastern, southcentral, and northwest portions of Iowa. Higher age-adjusted stroke mortality rates appear to be in the **southeastern**, **southcentral**, and **northwest** portion of **Iowa**.
- Nine **counties** have age-adjusted stroke mortality rates exceeding 40.3 deaths per 100,000 (90th percentile).

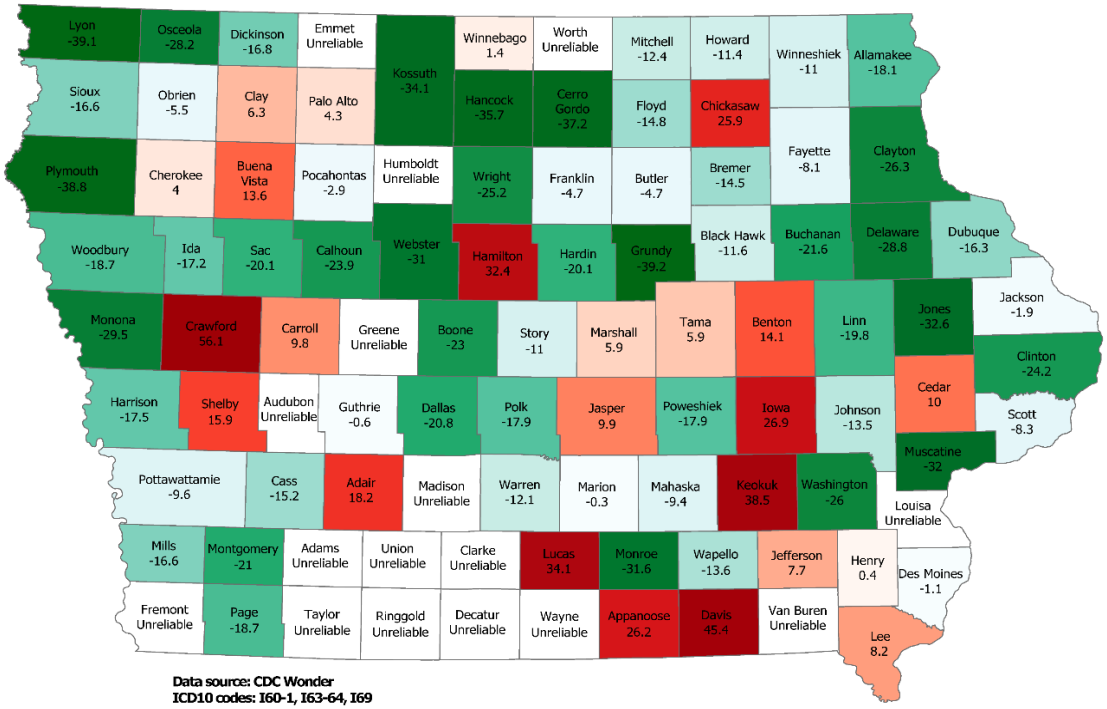


Figure 10. Change in Age-adjusted Stroke Mortality Rates by County in Iowa Between 2007—2012 and 2013—2017

Age-adjusted mortality rates; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018. ICD 160, I61, I63, I64 and I69 [23]. ***Values*** *represent the percent change between 2007 through 2012 and 2013 through 2017-time frames.* ***Negative*** *values indicate decreases (improvements) in the age-adjusted mortality rates in that county while* ***positive*** *values indicate increases in age-adjusted mortality rates.* ***Green*** *counties indicate decreases in the is considered unreliable. These counties include* ***Adams, Audubon, Clarke, Decatur, Emmet, Fremont, Greene, Humboldt, Louisa, Madison, Ringgold, Taylor, Union, Van Buren, Wayne, Worth****.*
**Note-includes deaths from unspecified sequelae of cerebrovascular disease.*

- Between the time periods 2008—2012 and 2013—2017, the age-adjusted stroke mortality rates were compared:
  - Sixteen (16) **counties** did not have reportable rates due to a small number of events for either or both time frames and are designated as unreliable.
  - Twenty-four (28.9%) **counties** experienced an increase in the age-adjusted stroke mortality rate while 59 (71.1%) **counties** experienced a decline in the rates.
  - The median change in the age-adjusted stroke mortality rates for all **counties** is a decline of 12.4 deaths per 100,000 with a range of 39.2 fewer deaths to 56.1 excess deaths per 100,000.

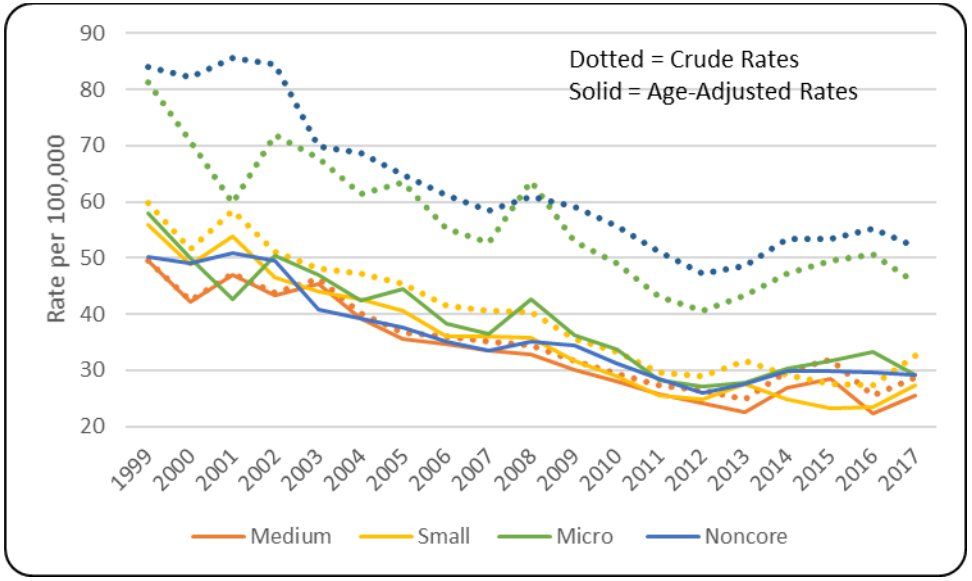


Figure 11. Trends in Age-adjusted Acute Stroke Mortality by Urbanization Classification, 1999—2017

Data: Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018 ICD 160, I61, I63, and I64 [23].
**2013 Rural-Urban Classification (RUCA) from the National Center for Health Statistics[1].*

- The state of Iowa is comprised of 61 **non-core, non-metropolitan** (mostly rural), 17 **micropolitan**, 12 **medium metro-counties**, and 9 **small metro-counties**.
- From 1999 to 2017, rural areas experienced higher mortality than urban areas.
- Areas classified as more **rural** had larger differences between age-adjusted and crude mortality rates indicating higher proportions of older adults in more **rural** counties.
- Since 1999, all **RUCA** classes experienced an overall decline in age-adjusted and crude acute stroke mortality rates with increases or plateaus in these rates noted since 2012.
- In 2017, counties designated as **micropolitan and non-core, non-metropolitan** had the highest average age-adjusted acute stroke mortality rate (29.2 deaths per 100,000), followed by **small metropolitan** (27.3 deaths per 100,000), and **medium metropolitan** (25.5 deaths per 100,000).
- The overall age-adjusted acute stroke mortality rates decreased for all rural-urban classes from 1999—2017 with the greatest decrease noted in **small metro-counties** (-151.1%) followed by **micropolitan** (-149.7%), **medium metro-counties** (-148.5%), and **non-core, non-metropolitan** counties experiencing the smallest percent decrease in rates (-142.0%).

The National Center for Health Statistics (NCHS) devised a classification scheme at the county level to enable researchers to examine associations between the level of urbanization and health outcomes. There are six designations ranging from most urbanized (metropolitan, large central) to most rural (non-core, non-metropolitan counties):

Metropolitan (Metropolitan Statistical Areas or MSAs)[1]

- ***Large central metropolitan counties*** *in MSAs of one million or more population that did not qualify as* ***large metropolitan counties****.*
- ***Large fringe metropolitan counties*** *in MSAs of one million or more population that did not qualify as* ***large central metro-counties****.*
- ***Medium metropolitan*** *MSA population 250,000—999,999.*

Small metropolitan *MSA population less than 250,000.*

Non-metropolitan (Micropolitan Statistical Areas or MISAs)

- ***Micropolitan*** *Urban cluster population-10,000—49,000.*
- ***Noncore*** *all other areas not classified as* ***micropolitan****.*

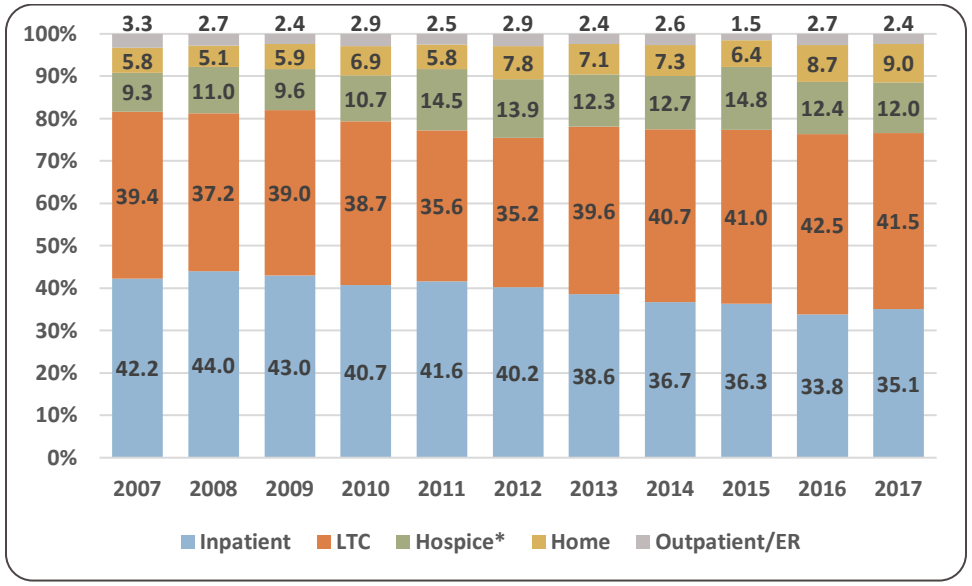


Figure 12. Yearly Trends in the Distribution of Place of Death after Stroke, Iowa, 2007—2017

Abbreviations: LTC=long-term care facility, ER=emergency room. Age-adjusted mortality rates; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018. ICD 160, I61, I63, and I64 [23].

- As of 2017, most deaths from acute strokes occurred in the **long-term care settings** (41.5%), followed by **inpatient** (35.1%), **hospice and other care** (10.9%), **home** (9.0%), and **outpatient or emergent care** (2.4%) settings.
- Since 2013, the largest percent change was noted in deaths occurring in the **home** setting (an increase of 25.9%). The percent of **inpatient** deaths have declined 3.5%.
- In 2017, there were 448 **inpatient** and **outpatient/ED** deaths per CDC Wonder. The Iowa Stroke Registry captured data on 285 deaths (63.6%) of the in-hospital mortality.

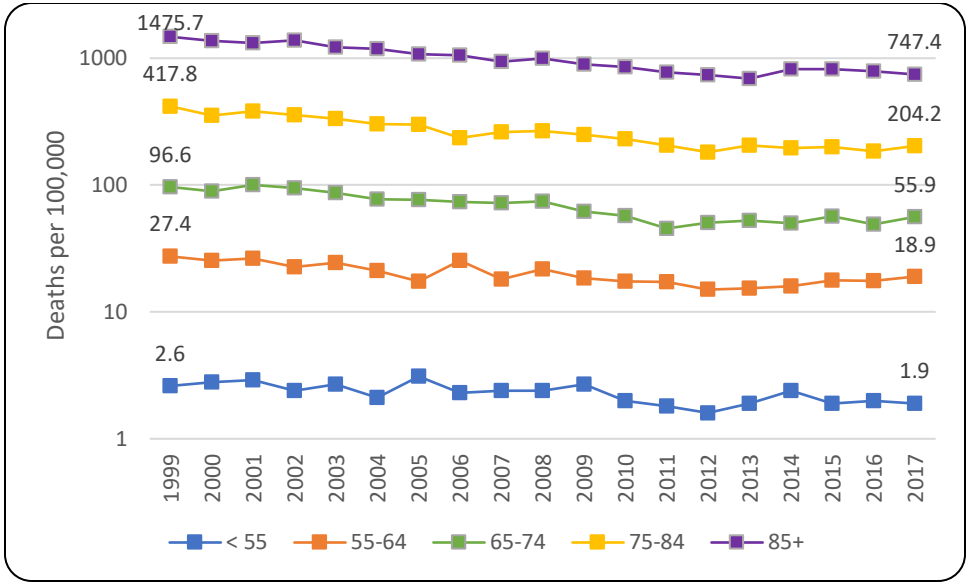


Figure 13. Yearly Trends in Crude Mortality Rates by Age Group, Iowa, 1999—2017

*Crude mortality rates; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999-2018. ICD 160, I61, I63, and I64 3. *Note the Deaths per 100,000 is on a log scale.*

- Overall, the crude mortality rates for all age groups declined between 1999 and 2017.
- The greatest decline in crude rates occurred among those **75 to 84 years** (-51.1% from 417.8 deaths per 100,000 to 204.2 deaths per 100,000), **85 years and older** (-49.4% from 1475.7 deaths per 100,000 to 747.4 deaths per 100,000), **65 to 74 years** (-42.1% from 96.6 deaths per 100,000 to 55.9 deaths per 100,000), **55 to 64 years** (-31.0% from 27.4 deaths per 100,000 to 18.9 deaths per 100,000), and **less than 55 years** (-26.9% from 2.6 deaths per 100,000 to 1.9 deaths per 100,000).
- For the **younger than 55** and **55 to 64 years** age groups, these changes were not statistically significant.
- These changes in rates exhibited the greatest impact on the estimated number of deaths prevented among those **85 years and older**, preventing an estimated 529 deaths in 2017. The number of estimated deaths prevented decreased with age, **75 to 84 years** (335 estimated deaths), **65 to 74 years** (94 estimated deaths), **55 to 64 years** (29 estimated deaths), and **younger than 55** (16 deaths).
- All age groups declined in most years until 2011-2013 followed by an increase in following years with a subsequent slowing of the rate of change or leveling of mortality rates. A similar trend has been described in national statistics.[44]

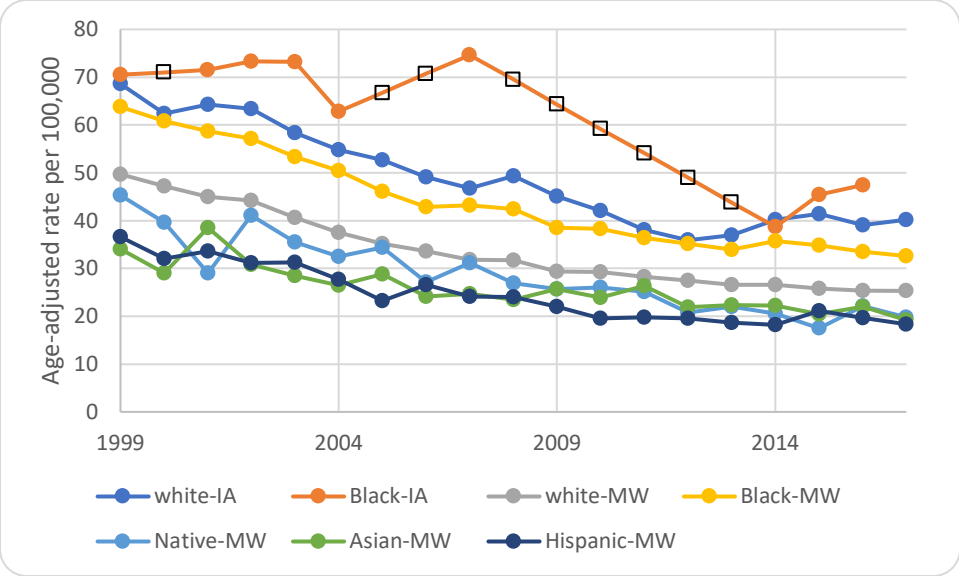


Figure 14. Yearly Trends in Age-adjusted Acute Stroke Mortality Rates by Race, Iowa, and the Midwest, 1999—2017

Abbreviations: IA=Iowa, MW=Midwest. Age-adjusted mortality rates; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018. ICD 160, I61, I63, and I64. [23]. Missing rates (unreliable) for Blacks or African Americans in Iowa (black squares). Values were imputed using weighted averages of adjacent rates. The Midwest Census Region: ***Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota,*** *and* ***Wisconsin****.*

- Overall, the age-adjusted acute stroke mortality rates have declined for all races from 1999—2017. The rate of decline varied by region and by race and ethnicity.
- **Midwestern American Indians/Alaska Natives** experienced the largest percent decline (-56.3%), followed by **Midwestern Whites** (-49.1%), **Midwestern Blacks** (-48.9%), **Midwestern Hispanics** (-50.0%), **Midwest Asians/Pacific Islanders** (-43.5%), **White Iowans** (41.4%), and **Black Iowans** (-32.8%).
- The average annual percent decline was similar for among the US, Midwest, and Iowa (3.5—3.6%).
- When stratified by race, substantial disparities are noted. **Midwest Whites** and **Blacks** experienced the same annual percent decline (-3.6%), followed by **Midwest Hispanics** (-3.4%), **Midwest Native Americans** (-3.2%), **White Iowans** (2.8%), **Midwest Asians** (-2.4%), and **Black Iowans** (-2.0%).
- As of 2017, **Midwest Hispanics** had the lowest median age-adjusted rate (23.2 deaths per 100,000) followed by **Asian/Pacific Islanders** (24.7 per 100,000), **American Indians/Alaska Natives** (26.9 per 100,000), **Whites** (31.7 per 100,000), and **Blacks** (42.4 per 100,000).
- In Iowa, the highest age-adjusted mortality occurred in **Black people** for both time points.
- In Iowa, the age-adjusted acute stroke mortality rates were unreliable for **American Indian/Alaska Native** and Asian**/Pacific Islander** for all years and therefore excluded. Rates were unreliable for some years in **Black people**.
- In Iowa, despite overall improvements in the age-adjusted acute stroke mortality, there has been a flattening or increase (**Black Iowans**) in recent year mortality rates among all populations.

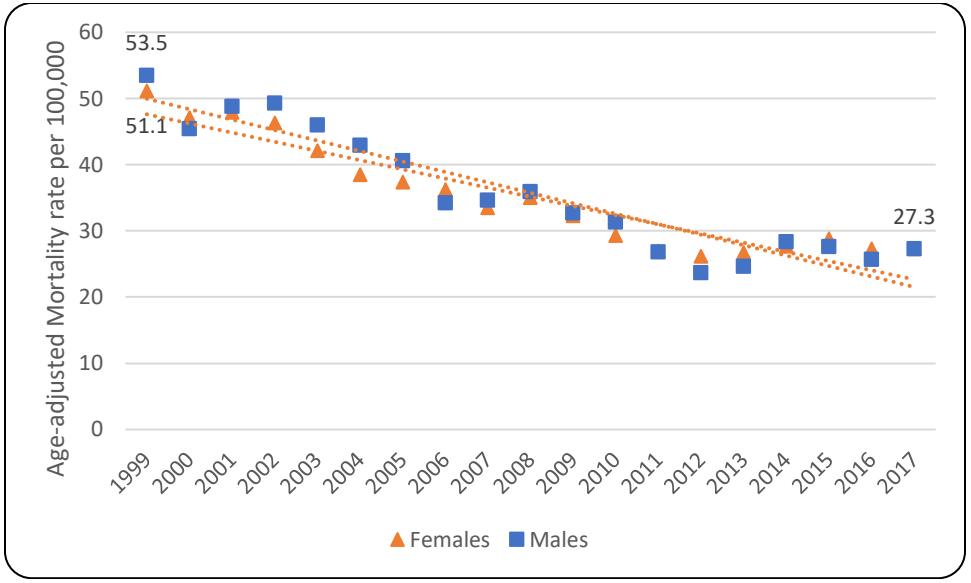


Figure 15. Comparison of Age-adjusted Acute Stroke Mortality Rates by Gender

Age-adjusted mortality rates; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018. ICD 160, I61, I63, and I64. [23]

- Overall, the age-adjusted stroke mortality rates have declined for both **males** and **females** from 1999 through 2017.
- In 1999, **males** had higher age-adjusted rates than **females** but experienced a significant percentage decrease (49.0% versus 46.6%) in these rates over time.
- In 2017, the age-adjusted rates were equivalent between **males** and **females** at 27.3 deaths per 100,000.
- In 2012, both **males** and **females** reached a minimum rate for the 1999–2017-time frame with rates in **females** (26.2 deaths per 100,000) higher than **males** (23.7 deaths per 100,000). The subsequent rates for both **males** and **females** rose and then leveled off.
- Between 1999 and 2017, 6,962 more **females** died of acute stroke than **males** with an overall ratio of **females** to **males** of 1.7 deaths.
- In 2017, 719 **females** died of acute stroke compared to 464 **males**, with a ratio of 1.5 **female** to **male** deaths.

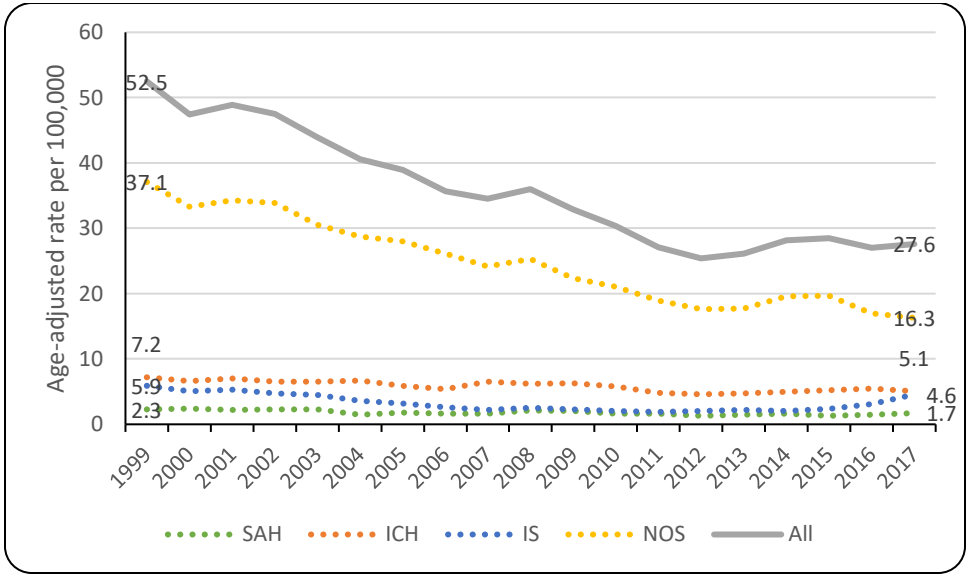


Figure 16. Trends in Age-adjusted Acute Stroke Mortality by Stroke Type, Iowa, 1999—2017

Data source: Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018. ICD 160, I61, I63, and I64.[23] Abbreviations: SAH= subarachnoid hemorrhage ICH= intracerebral hemorrhages IS= ischemic stroke (cerebral infarctions) NOS= stroke, not otherwise specified as hemorrhagic or ischemic.

- Overall, age-adjusted mortality rates have decreased from 1999 to 2017 for all types:
- **All acute stroke** age-adjusted mortality decreased from 52.5 deaths per 100,000 to 27.6 deaths per 100,000.
- **Strokes not otherwise specified as hemorrhagic or ischemic,** comprising most of the stroke mortality, decreased from 37.1 deaths per 100,000 to 16.3 deaths per 100,000.
- **Intracerebral hemorrhages** declined from 7.2 deaths per 100,000 to 5.1 deaths per 100,000. This decline is not statistically significant.
- **Cerebral infarctions** declined from 5.9 deaths per 100,000 to 4.6 deaths per 100,000. This decline is not statistically significant.
- **Subarachnoid hemorrhagic** strokes declined from 2.3 deaths per 100,000 to 1.7 deaths per 100,000. This decline is not statistically significant.
- Acute stroke mortality from all types decreased 47.4%. The largest percent decrease occurred in **strokes, not otherwise specified as hemorrhagic or ischemic** (56.1%), followed by **intracerebral hemorrhages** (29.2%), **subarachnoid hemorrhages** (26.1%), and **cerebral infarctions** (22.0%).
- In 2010, the **cerebral infarction** mortality age-adjusted rate remained unchanged until 2015 when the rate increased 130% from 2.0 deaths per 100,000 to 4.6 deaths per 100,000.
- The composition of acute stroke types changed over time, potentially reflecting improvements in diagnostic capability and coding specificity of strokes.
- **Strokes, not otherwise specified as hemorrhagic or ischemic**, initially accounting for 70.1% of strokes decreased to 52.9%. **Intracerebral hemorrhages** and **cerebral infarctions** increased 8.1% and 8.7%, respectively. The percentage of strokes classified as **subarachnoid hemorrhages** showed a 0.6% increase.

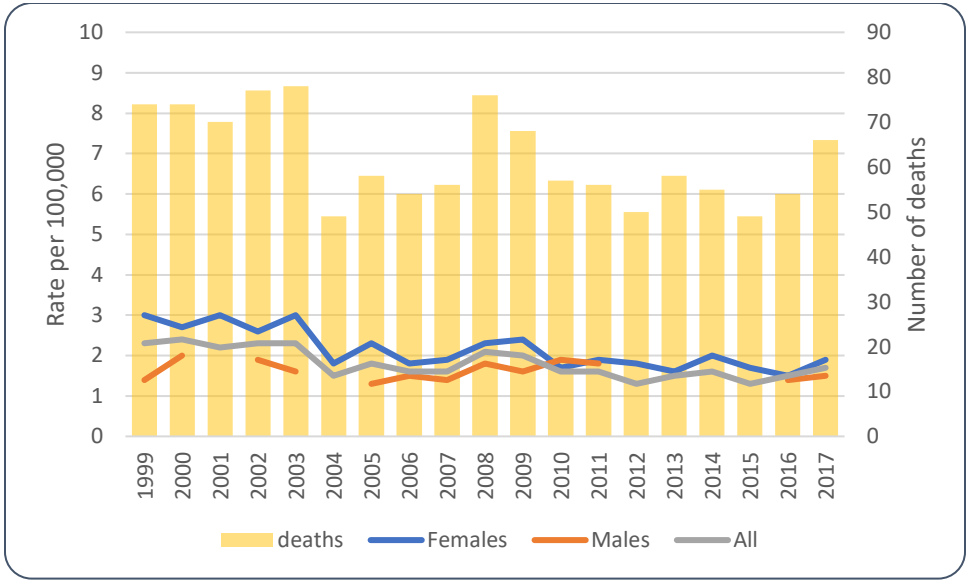


Figure 17. Temporal Trends in Age-adjusted Mortality Rates for Subarachnoid Hemorrhages by Sex, Iowa, 1999-2017

Age-adjusted mortality rates; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018. ICD 160. [23] The rates for males were not reported in 2001 and 2004 due to low counts.

- The age-adjusted mortality rate for **subarachnoid hemorrhages** declined from 2.3 (95% CI: 1.8—2.9) deaths per 100,000 in 1999 to 1.7 (95% CI: 1.3—2.2). deaths per 100,000 in 2017. This difference is not significant.
- The age-adjusted rates for **males** were not reliable for some years during the 1999—2017-time frame due to small numbers of events.
- In 1999, **females** had a higher age-adjusted mortality rate than **males** (3.0 deaths per 100,000 versus 1.4 deaths per 100,000).
- Overall, **females** experienced a 36.7% decrease in age-adjusted rates over time while the age-adjusted rates for **males** increased by 7.1%.
- In 2017, Iowa recorded sixty-six deaths from **subarachnoid hemorrhage** with a crude mortality rate of 2.1 deaths per 100,000.

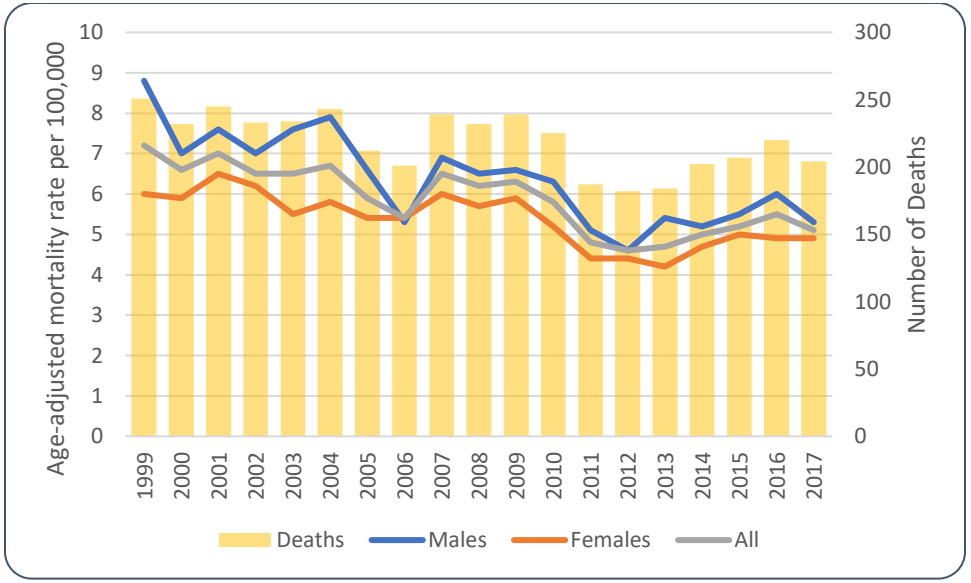


Figure 18. Temporal Trends in Age-adjusted Mortality Rates for Intracerebral Hemorrhages by Sex, Iowa, 1999—2017

Data: Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018. ICD 161.[23].

- The age-adjusted mortality rate in 1999 was 7.2 (95% CI: 6.3—8.1) deaths per 100,000 representing 251 deaths. This rate fell 29.2% to 5.1 (95% CI: 4.4—5.8) deaths per 100,000 in 2017.
- This rate was lowest in 2012 at 4.6 deaths per 100,000 and has risen to 5.1 deaths per 100,000 in 2017 (204 deaths).
- The decline in rates prevented an estimated sixty-three deaths in 2017.
- Overall, the rates of both **males** and **females** decreased from 1999 rates.
- **Males** have a higher rate than **females** but experienced a greater percent decline in the rates over time (39.8% decrease for **males** versus 18.3% decrease for **females**).
- **Males** reached a low rate in 2012 (4.6 deaths per 100,000) whereas **females** experienced the lowest rate in 2013 (4.2 deaths per 100,000).
- Subsequent rates increased about 16% in both sexes until 2017.
- In 2017, Iowa recorded 204 deaths with a crude mortality rate of 6.5 deaths per 100,000.

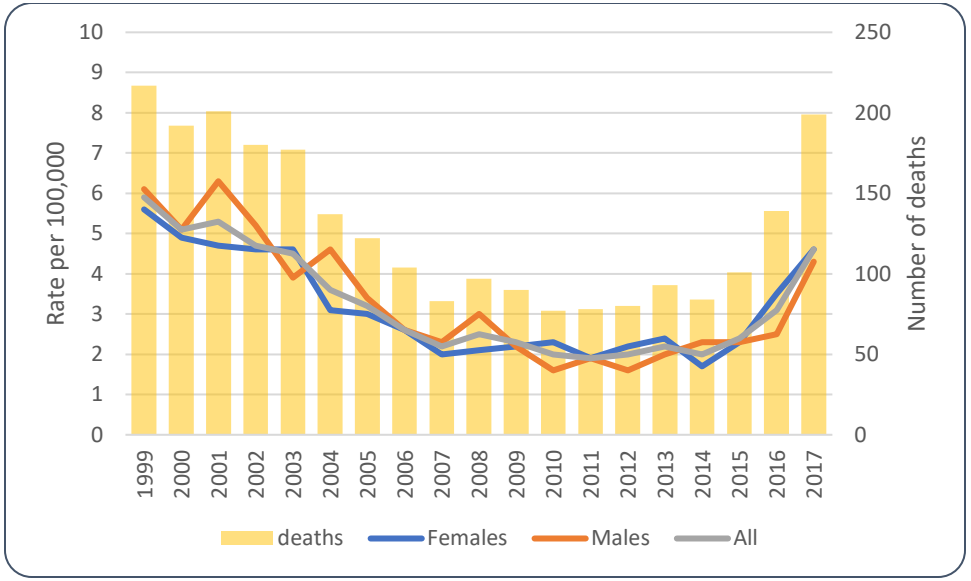


Figure 17. Temporal Trends in Age-adjusted Mortality Rates and Deaths for Ischemic strokes, Iowa, 1999—2017

Age-adjusted mortality rates; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018. ICD 163. [23]

- The age-adjusted mortality rates for **ischemic strokes** have demonstrated some variability from year to year with an overall decrease of 22.0% from 5.9 deaths per 100,000 to 4.6 deaths per 100,000.
- These rates exhibited a downward trend until 2010 with a leveling of rates until 2014 followed by an increase in rates.
- The decline in age-adjusted mortality rates prevented an estimated thirty-nine deaths in 2017.
- The age-adjusted mortality rates for **ischemic strokes** in **females** decreased from 1999 to 2017 (5.6 to 4.6 per 100,000) representing a 17.9% decrease. For **males**, the decrease in rates started in 2001 but experienced a greater decrease in rates (29.5%).
- The rates in **females** reached the lowest point in 2014 (1.7 per 100,000) and have increased to 4.6 per 100,000 in 2017. For **males**, the lowest rate occurred in 2012 (1.6 per 100,000) and has increased to 4.3 per 100,000 in 2017. The percent increase was similar in **males** and **females** (170.6% and 168.8%, respectively).
- In 2017, Iowa recorded 199 deaths from **cerebral infarction** with a crude rate of 6.3 deaths per 100,000. Of these deaths, 61% (122 deaths) occurred in **females**.

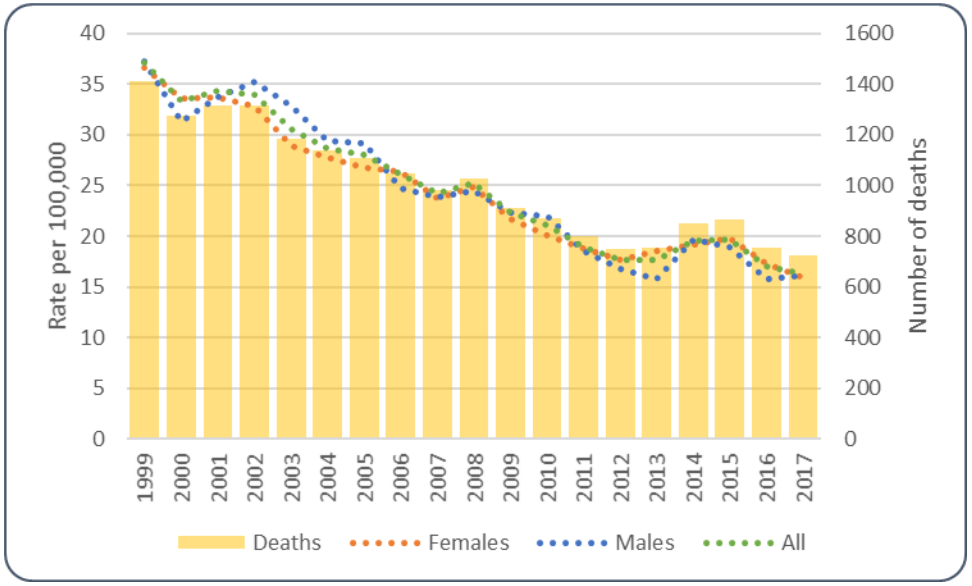


Figure 18. Trends in Age-adjusted Mortality Rates and Deaths for Strokes, Not Otherwise Specified as Hemorrhagic or Ischemic, Iowa, 1999—2017

Age-adjusted mortality rates; data from Centers for Disease Control and Prevention, National Center for Health Statistics, Underlying Cause of Death 1999—2018. ICD 164. [23]

- Overall, the age-adjusted acute stroke mortality rate for **strokes, not otherwise specified as ischemic or hemorrhagic** decreased from 37.1 (95% CI: 35.1—39.0) deaths per 100,000 in 1999 to 16.3 (95% CI: 15.0—17.5) deaths per 100,000 in 2017.
- This decline would have prevented an estimated 628 deaths in 2017.
- A similar trend was noted in both **males** and **females**.
- Among **females**, the age-adjusted mortality rate declined 56.6% from 36.6 per 100,000 in 1999 to 15.9 per 100,000 in 2017.
- Among **males**, the age-adjusted mortality rate declined 56.1% from 37.1 per 100,000 in 1999 to 16.3 per 100,000 in 2017.
- Improvements have been noted in the rates since 1999 with an increase noted in 2014 and 2015.
- The actual number of deaths have declined 48.7%, from 1,412 deaths to 724 deaths.
- More **females** die of **strokes**, **not specified as ischemic or hemorrhagic**, than **males**.
- The percent decrease in deaths was greater in **females** than **males** (-52.5% versus -41.3%).

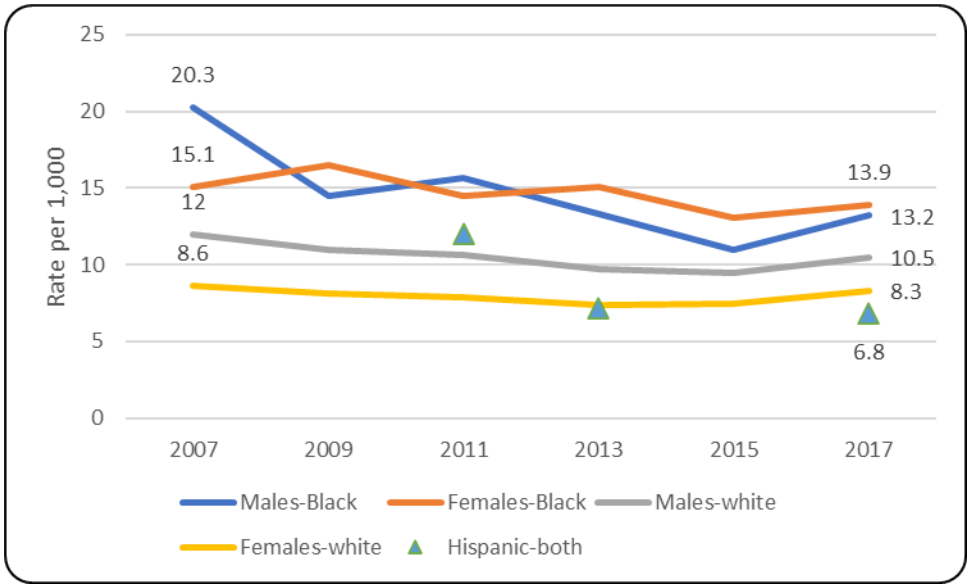


Figure 19. Trends in the Hospitalization Rates of Medicare Beneficiaries by Race and Ethnicity, Iowa, 2007—2017

Data source: Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, Interactive Atlas of Heart Disease and Stroke Figures. [45] Rates are per 1,000 Medicare Beneficiaries, all genders, aged 65+ years.

- **Black people** had consistently higher hospitalization rates than **Whites** and **Hispanics** at all time points. **White females** had the lowest overall rates.
- **White females** had lower hospitalization rates than **White males**, although this trend was not seen in **Black people.**
- **Black males** experienced the greatest percent decline in hospitalization rates (-35.0%) compared to **Black females** (-7.9%), **White males** (-12.5%), and **White females** (-3.5%).
- Hospitalization rates increased for **Black people** and **Whites** between 2015 and 2017.
- Hospitalization rates were not available for all time points among the **Hispanic** population.
- The rate of hospitalization decreased 43.3% from 2011 through 2017.

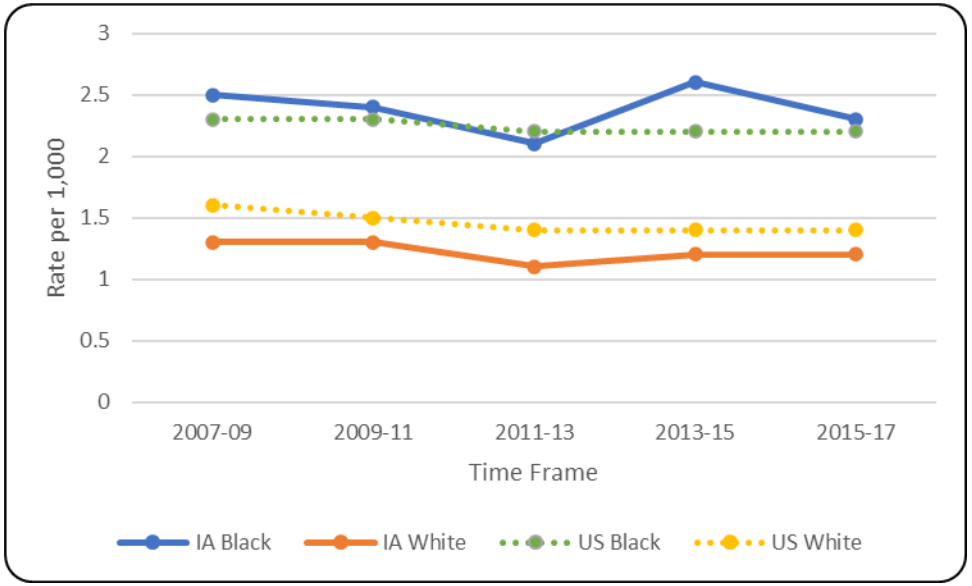


Figure 20. Comparison of Iowa and US Biennial Trends in Hospitalization Rates for Hemorrhagic Strokes, by Race. 2007—2017

Data source: Medicare Provider Analysis and Review (MEDPAR)[25]. Abbreviations: IA=Iowa, US=United States. Rates are per 1,000 Medicare Beneficiaries, all genders, aged 65+ years. Rates for Hispanics and other racial groups have insufficient data and are not displayed in figure.

- The hospitalization rates have remained relatively stable over time for **Blacks** and **Whites**.
- Hospitalization rates for **Black Iowans** exceed the US hospitalization rates, whereas **White Iowans** experience lower than average national rates.

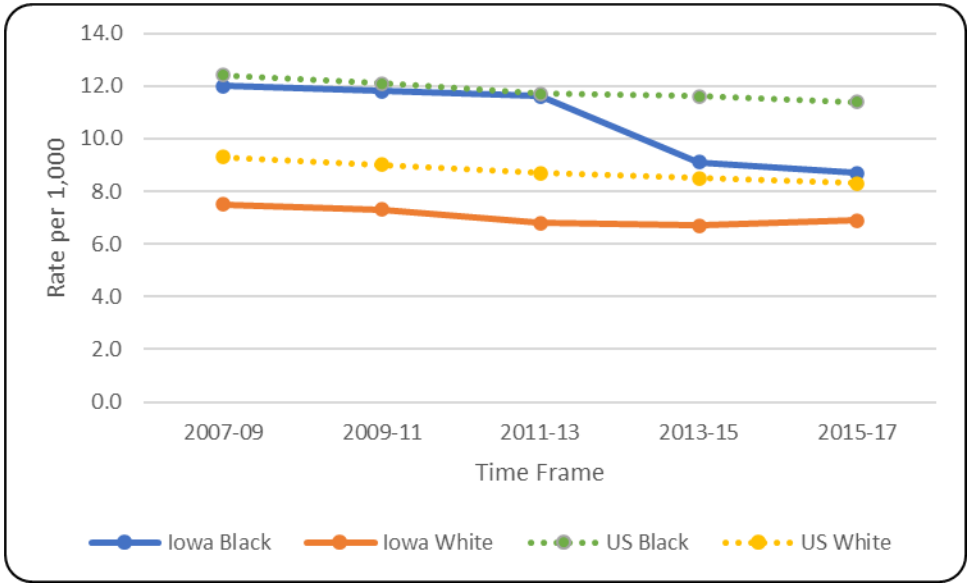


Figure 21. Comparison of Iowa and US Biennial Trends in Hospitalization Rates for Ischemic Strokes, by Race. 2007—2017

Data source: Medicare Provider Analysis and Review (MEDPAR)[25]. Abbreviations: IA=Iowa, US=United States. Rates are per 1,000 Medicare Beneficiaries, all genders, aged 65+ years. Rates for Hispanics and other racial groups have insufficient data and are not displayed in figure.

- Hospitalizations for **Black Iowans** declined from 2011—13-time frame, all other rates remained stable.
- The hospitalization rates for **Black Iowans** were higher than US hospitalization rates.

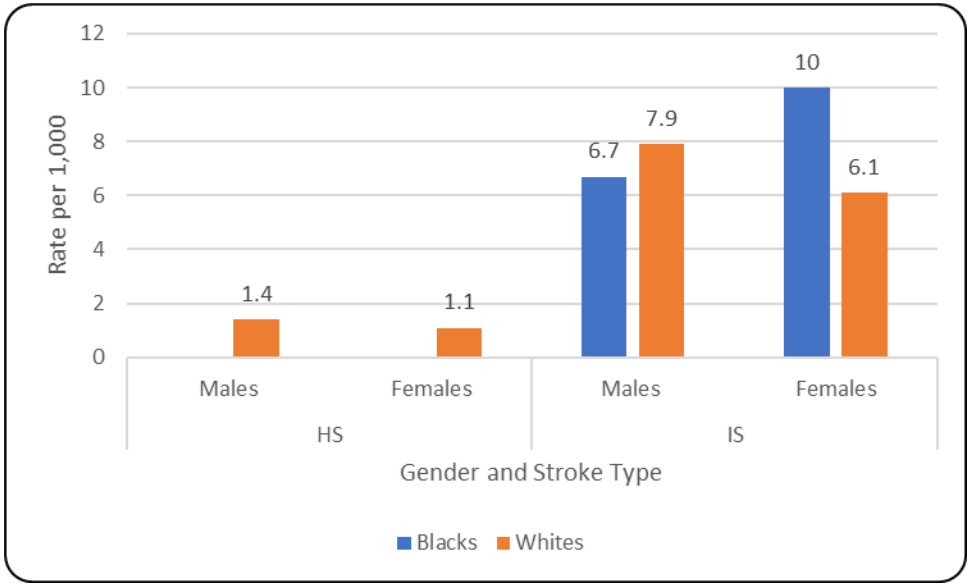


Figure 22. Comparisons of Hospitalization Rates Between Stroke Types by Gender and Race, 2015—17, Iowa

Data source: Medicare Provider Analysis and Review (MEDPAR)[25]. Abbreviations: IA=Iowa, US=United States. Rates are per 1,000 Medicare Beneficiaries, all genders, aged 65+ years. Rates for Hispanics and other racial groups have insufficient data and are not displayed in figure.

- Hospitalization rates for ischemic strokes were highest in **Black females** and lowest in **White females**.

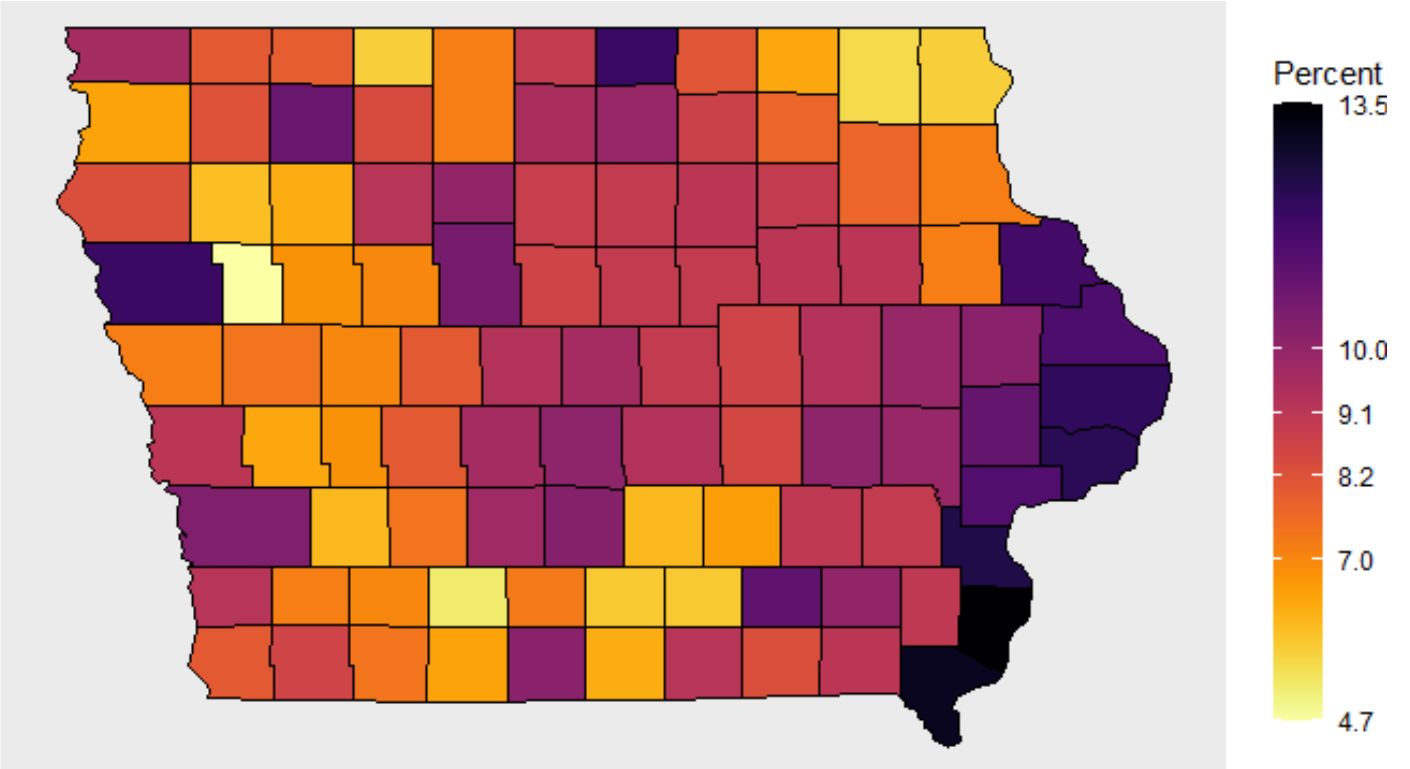


Figure 23. Stroke Hospitalization Rates per 1,000 Medicare Beneficiaries, 65+ Years of Age by County, Iowa 2015—2017

Data source: Medicare Provider Analysis and Review (MEDPAR) [25]. The county data includes all stroke hospitalization rates per 1,000 Medicare Beneficiaries aged 65+ and includes all races and ethnicities and both sexes from 2015 to 2017.

- The **national** all-stroke hospitalization rate is 11.6 hospitalizations per 1,000 Medicare Beneficiaries. Overall, **Iowa** ranks the 11th lowest for stroke **hospitalization** rates with an overall rate of 9.3 **hospitalizations** per 1,000 Medicare Beneficiaries.
- The rates in individual counties ranged from a low of 4.3 hospitalizations per 1,000 Medicare beneficiaries in **Union** County to 14.6 **hospitalizations** per 1,000 Medicare beneficiaries in **Worth** county. Ten counties (**Clay, Iowa, Dubuque, Woodbury, Scott, Clinton, Lee, Louisa, Des Moines, and Worth**) exceeded the national rate.
- **Forty-seven** (47) counties had rates in the lowest 20 percent of the national average (<8.7 **hospitalizations** per 1,000 Medicare Beneficiaries). **Twelve** counties had hospitalization rates above the median national rate of 10.9 **hospitalizations** while **four** counties (**Des Moines, Lee, Louisa,** and **Scott**) had hospitalization rates above the upper 80% of the national average (>12.1 **hospitalizations** per 1,000 Medicare Beneficiaries).
- According to a report by the Iowa Department of Public Health, the average inpatient costs of stroke was $39,287 in 2016 reflecting a 12% increase from $35,031 in 2015.[46]

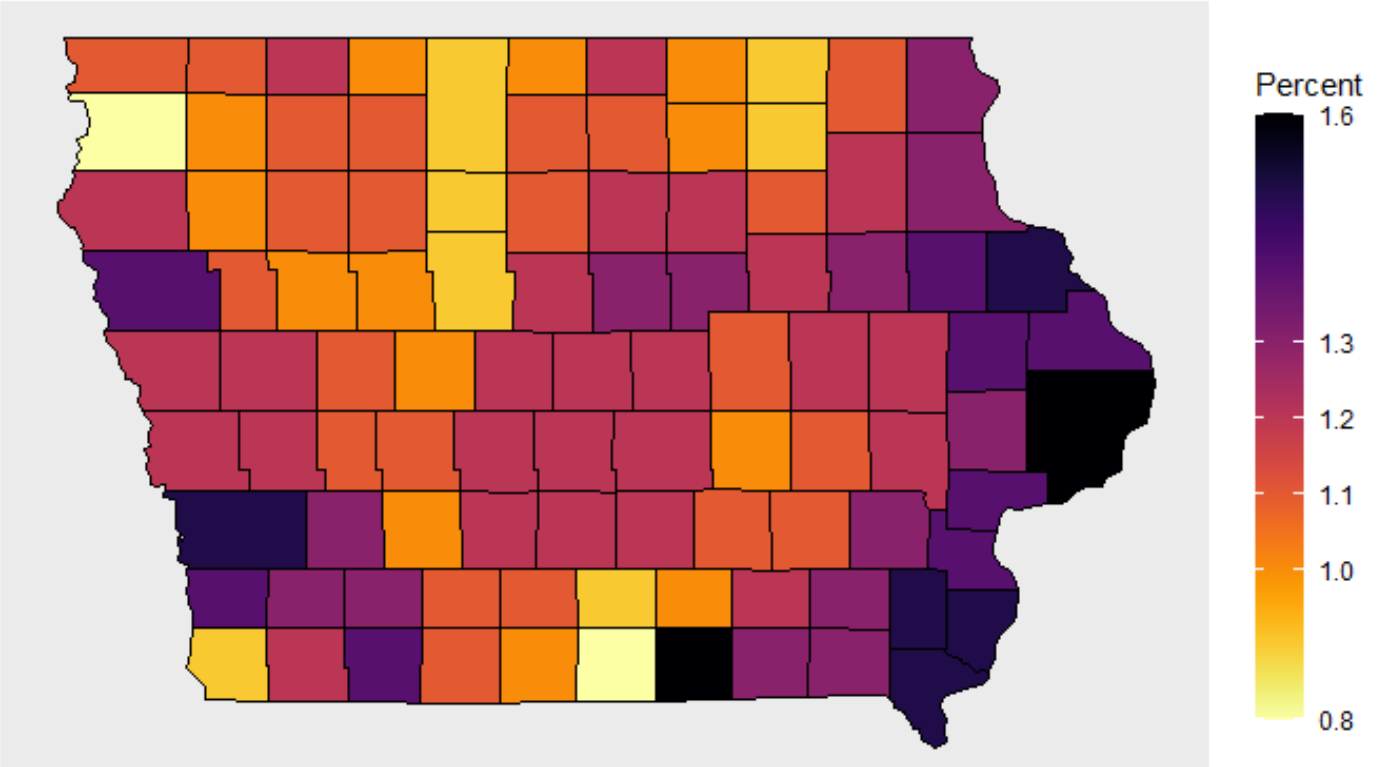


Figure 24. Hospitalization Rates by County for Hemorrhagic Strokes, 2015—2017
Data provided by the Medicare Provider Analysis and Review (MEDPAR) [25].

- The **national** hospitalization rates for hemorrhagic strokes per 1,000 Medicare beneficiaries was 1.5.
- The rate of hospitalizations for **Iowa** is **1.2** hospitalizations per 1,000 Medicare beneficiaries.
- The county rates for these hospitalizations ranged from **0.8** hospitalizations per 1,000 Medicare beneficiaries (**Sioux**) to 1.6 hospitalizations per 1,000 Medicare beneficiaries (**Clinton, Appanoose,** and **Scott**).

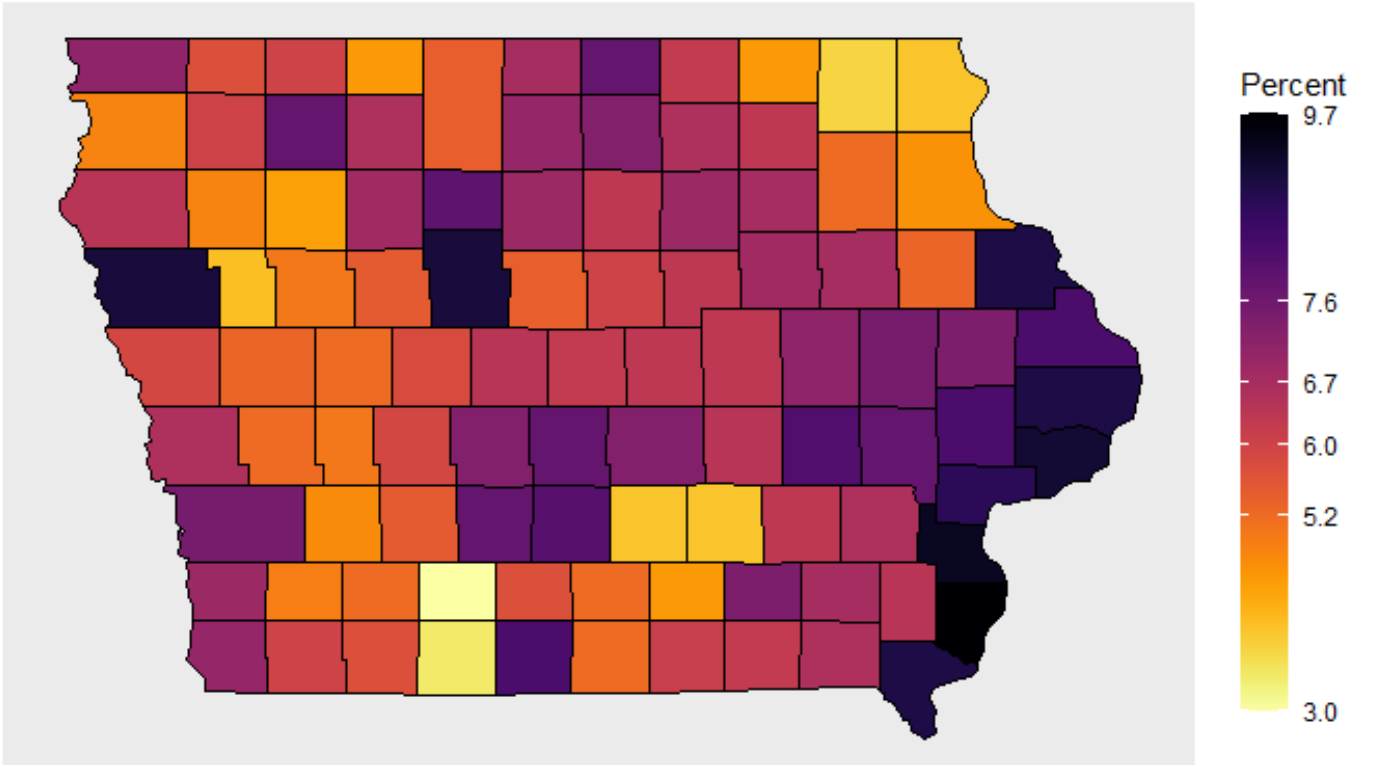


Figure 25. Hospitalization Rates by County for Ischemic Strokes, 2015—2017
Data provided by the Medicare Provider Analysis and Review (MEDPAR)[25].

- For ischemic strokes, the hospitalization rate per 1,000 Medicare beneficiaries, 2015—2017 was **8.5 hospitalizations** per 1,000 Medicare beneficiaries for the **U.S.** and **6.9 hospitalizations** per 1,000 Medicare beneficiaries for **Iowa**.
- By county, **hospitalization** rates per 1,000 Medicare beneficiaries, ranged from 3.0 (**Union**) to 9.7 (**Des Moines**).
- Nine counties, including **Muscatine, Lee, Dubuque, Clinton, Woodbury, Webster, Scott, Louisa,** and **Des Moines**, exceeded the national rate.

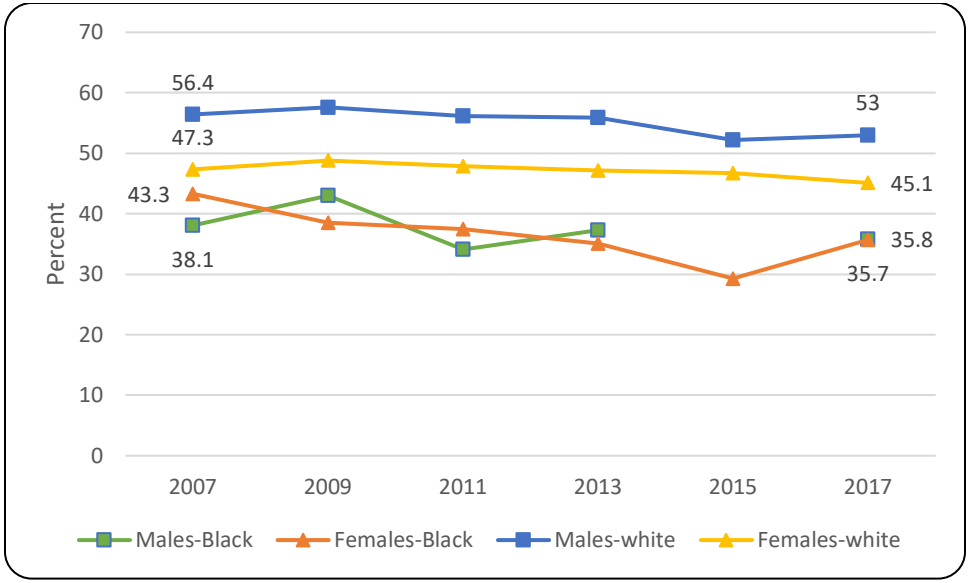


Figure 26. Trends in the Percent of Medicare Beneficiaries Discharged to Home by Sex and Race, Iowa, 2007—2017

*Data source: Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, Interactive Atlas of Heart Disease and Stroke Figures. This is Medicare beneficiaries, age 65 years and older. [45] The rates for **Black males** were unavailable for 2015.*

- Overall, the percent discharged to **home** settings declined for **all groups**. This percent change was most prominent in **Black females** (-17.6%). Both **White** and **Black** racial groups decreased by 6%. **White females** experienced the least change (-4.7%)
- **Whites** had a higher percent of patients discharged to **home** settings than **Black people.**
- **White males** had the highest percentage of discharged to **home** settings than **Black people** and **White females**.

PREVALENCE OF STROKE

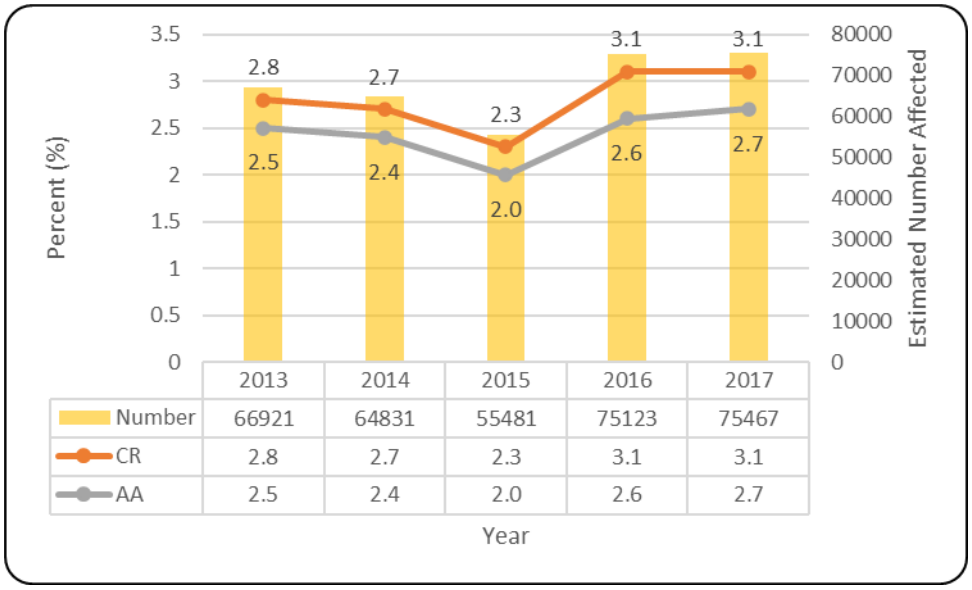


Figure 27. Trends in Stroke Prevalence, Iowa, 2013—2017

Abbreviations: AA: age-adjusted, CR: crude. Data Source: Iowa BRFSS Annual Reports, 2013 through 2017. [22, 47-51]. Estimates of numbers affected are based on census data [24]. *Prevalence is the number of individuals reporting a specific disease, condition, or characteristic at a specific point in time point or interval.

- The **prevalence** of adults Iowans who have been told they had a stroke declined from 2013 through 2015 and has increased since 2015, although this change is not statistically significant. These numbers represent an estimated 55,000 to 75,000 Iowans each year.
- As of 2018, **Iowa** ranks **sixth** in the country for lowest stroke prevalence (range 2.0 – 5.4%) among adults aged eighteen years and older. [45]
- The estimated number affected by stroke may be explained by the increase in the proportion of individuals over the age of sixty-five as well as population growth.
    - **Iowa** experienced a 4.7% growth in population since 2010. [52]
    - The proportion of **Iowans** over the age of 65 years increased from 14.9% in 2010 to 17.1% in 2018. [53, 54]
    - **Colorado** has the lowest stroke prevalence at 2.0% (95% CI: 2.0 – 2.6%) and **Tennessee** has the highest stroke prevalence at 5.4% (95% CI: 4.2 – 5.4).[29]

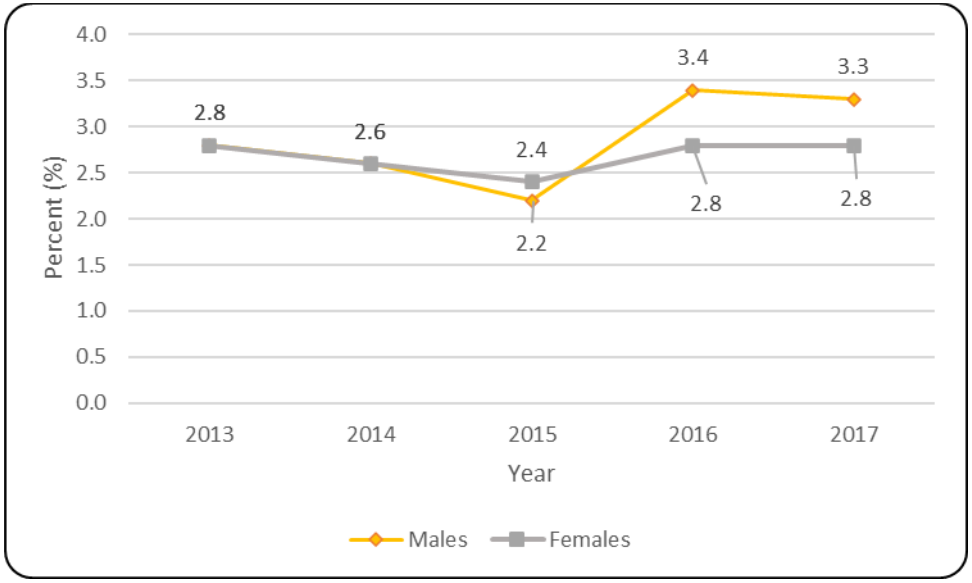


Figure 28. Yearly Trends in the Crude Stroke Prevalence by Gender

Data Source: Iowa BRFSS. [51]

- The crude stroke prevalence was similar between **males** and **females** in 2013 and 2014. The gap between **males** and **females** has increased since 2015 although the differences are not statistically significant.

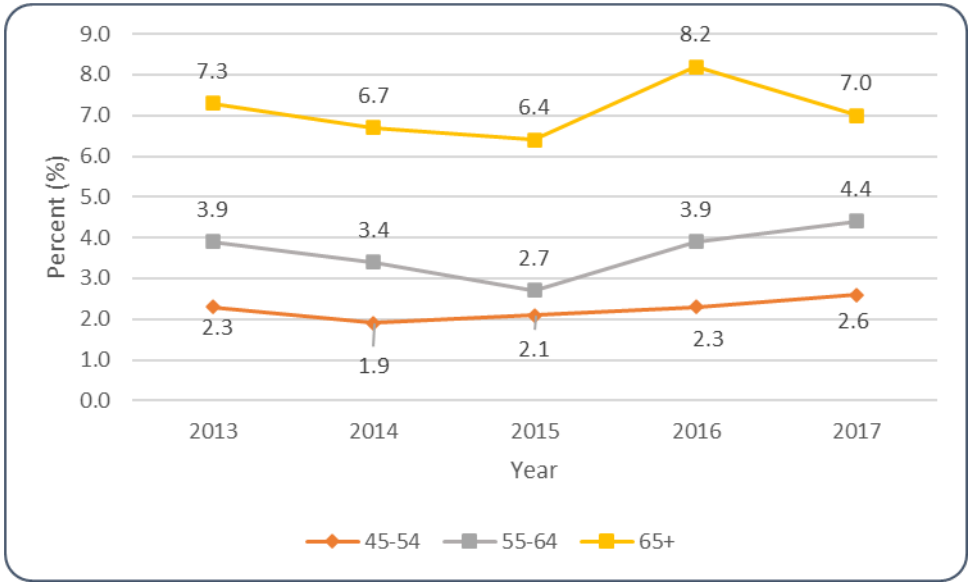


Figure 29. Yearly Trends in Stroke Prevalence by Age Group, 2013—2017, Iowa

Data Source: Iowa BRFSS. [51]

- The prevalence of stroke is lowest in those **45—54** years of age, followed by the **55–64**-year-old age group with the highest prevalence in those over **65** years of age. Similar patterns occurred in all age groups.

***Data to describe the trends in crude stroke prevalence stratified by race and ethnicity was not available due to small sample sizes.**

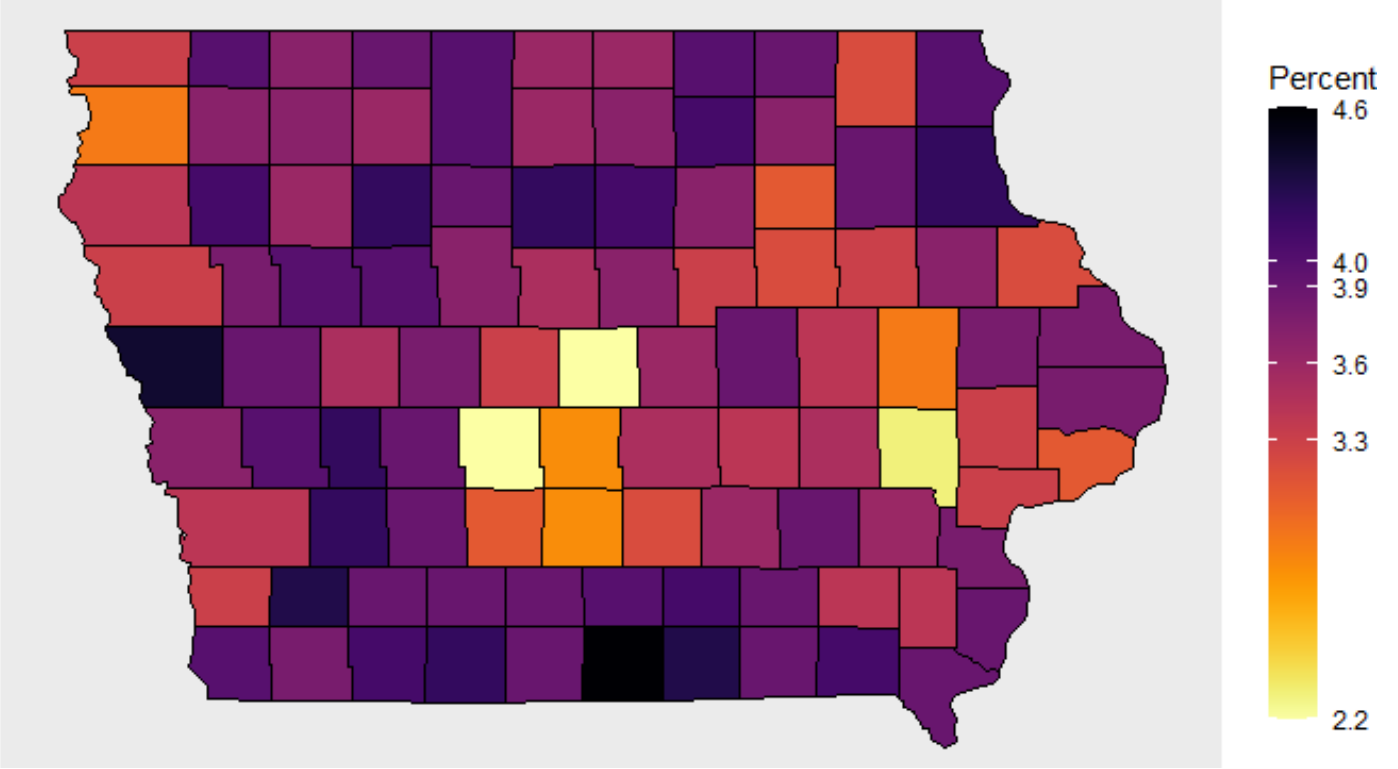


Figure 30. Map of Crude Stroke Prevalence by County for Resident Adults, Aged 18 years and older, Iowa 2017

Data source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health[33].
Numerator: Respondents aged ≥18 years who report ever having been told by a doctor, nurse, or other health professional that they have had a stroke.
Denominator: Respondents aged ≥18 years who report or do not report ever having been told by a doctor, nurse, or other health professional that they have had a stroke (excluding those who refused to answer, had a missing answer, or answered "don't know/not sure").

- The crude **prevalence** for stroke in **Iowa** is 3.1% (95% CI: 2.7—3.5).
- The crude **prevalence** rate for stroke in the **United States** is 3.4% (95% CI: 3.3—3.5) per 100,000 adults ages eighteen and older.
- The crude **prevalence** in Iowa counties ranges from 2.2% (**Dallas**) to 4.6% (**Wayne**).

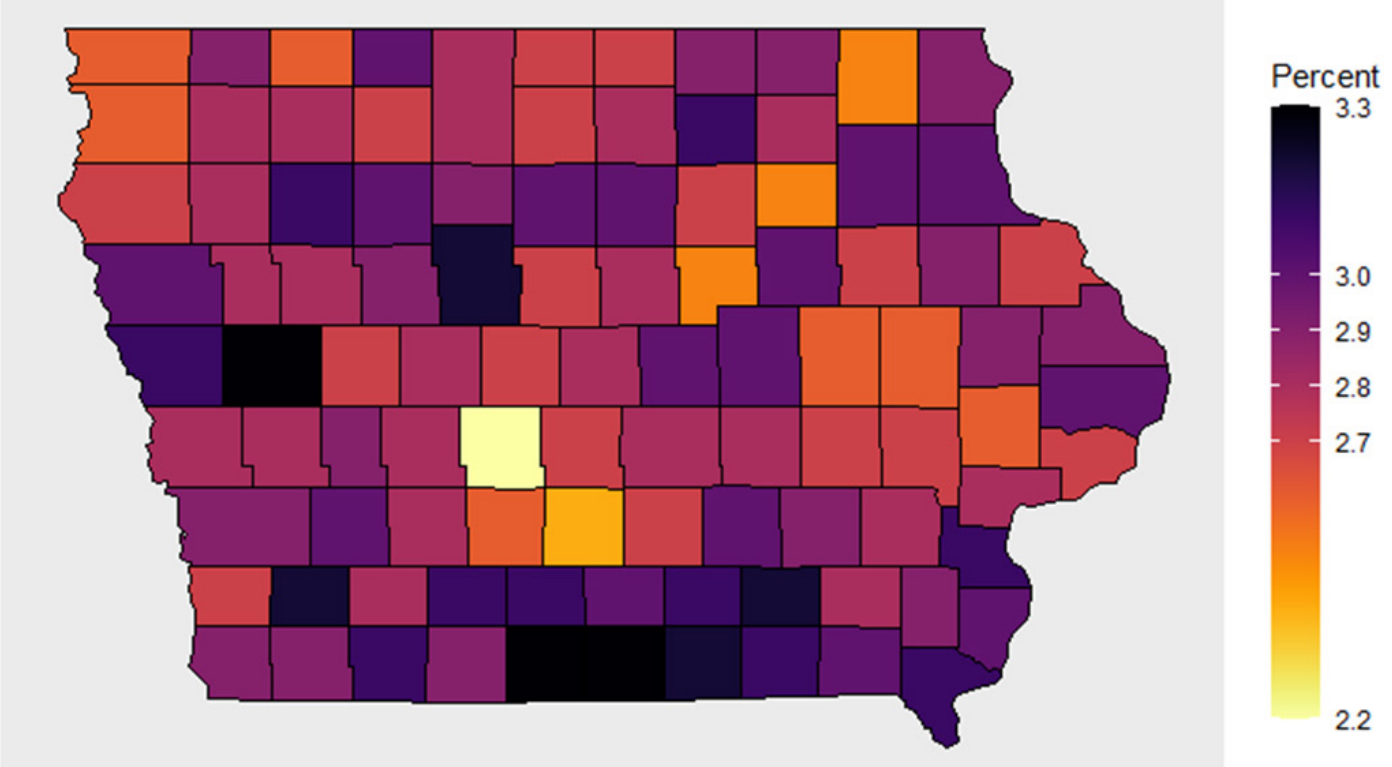


Figure 31. Map of Age-adjusted Stroke Prevalence by County, Iowa 2017

Data source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health[33]. Numerator: Respondents aged ≥18 years who report ever having been told by a doctor, nurse, or other health professional that they have had a stroke. Denominator: Respondents aged ≥18 years who report or do not report ever having been told by a doctor, nurse, or other health professional that they have had a stroke (excluding those who refused to answer, had a missing answer, or answered "don't know/not sure").

- The age-adjusted stroke **prevalence** for the **US** is 3.0% (95% CI: 2.9—3.1).
- The age-adjusted **prevalence** for stroke in **Iowa** is 2.7% (95% CI: 2.3—3.1).
- The age-adjusted **prevalence** in Iowa counties ranges from 2.2% (**Dallas**) to 3.3% (**Crawford**, **Decatur**, and **Wayne**).

Table 3. Summary of Measures and Sources of Data

Measure	Abbreviation	Description	Source	Year(s)
Stroke Mortality	Mortality	Crude and age-adjusted mortality rates (ICD10 Codes: I60—I61, I63—I64	CDC Wonder	2013—17
Hospitalization Rates	Hosp	Stroke hospitalization rates per 1,000 Medicare Beneficiaries, 65+ with principal diagnosis (ICD10: I60—I69	Centers for Medicare and Medicaid Services Medicare Provider Analysis and Review (MEDPAR) file, Part A	2015—17
Hospitalization Rates Ischemic Strokes	Hosp IS	Stroke hospitalization rates per 1,000 Medicare Beneficiaries, 65+ with principal diagnosis of ICD: I63, I65—I66	Centers for Medicare and Medicaid Services Medicare Provider Analysis and Review (MEDPAR) file, Part A	2015—17
Hospitalization Rates Hemorrhagic Strokes	Hosp HS	Stroke hospitalization rates per 1,000 Medicare Beneficiaries, 65+ with principal diagnosis of ICD: I60—I62	Centers for Medicare and Medicaid Services Medicare Provider Analysis and Review (MEDPAR) file, Part A	2015—17
Cardiovascular Mortality	–	Crude and age-adjusted mortality (ICD10: I20—I25)	CDC Wonder	2013—17
Stroke Prevalence	Prevalence	Percent of adults who report ever been told by a healthcare professional that they have had a stroke	Behavioral Risk Factor Surveillance System (BRFSS)	2017
Median Age	–	Median age of population	Census Population Estimates	2010
Percent over sixty-five	Over sixty-five	Percent of population aged 65 years and older	Census Population Estimates	2015
Percent Black	Black	Percent of population who identify as Black or African American	Census Population Estimates	2015
Percent Hispanic	Hispanic	Percent of population who identify as Hispanic	Census Population Estimates	2015
Percent Uninsured	Uninsured	Percent of population under age 65 without health insurance	Small Area Health Insurance Estimates	2010
Primary Care Physicians	PCP	Ratio of population to primary care physicians per 100,000 population	Area Health Resource File/American Medical Association	2018
Percent Rural	Rural	Percent of county characterized as rural	Census Population Estimates	2010
High school graduation	HS	Percent of ninth-grade cohort that graduates in four years	EDFacts	2014—15
Adult smoking	Smoke	Percentage of adults who are current smokers or report having smoked ≥ 100 cigarettes in their lifetime	Behavioral Risk Factor Surveillance System (BRFSS)	2017
Adult obesity	Obese	Percentage of adults that report a BMI of 30 or more	Behavioral Risk Factor Surveillance System (BRFSS)	2017
Binge Drinking	Binge	Percentage of adults reporting binge drinking (women > 4 drinks, men > 5 drinks) on an occasion in the past 30 days	Behavioral Risk Factor Surveillance System (BRFSS)	2017
Physical inactivity	Inactive	Percentage of adults aged twenty and over reporting no leisure-time physical activity in the past month	Behavioral Risk Factor Surveillance System (BRFSS)	2017
Hypertension	HTN	Percent of respondents who report being told by a healthcare professional that they have high blood pressure in the past year	Behavioral Risk Factor Surveillance System (BRFSS)	2017
High Cholesterol	CHOL	Percent of adults, age ≥ 18 who report being told by a healthcare professional that they have high cholesterol in the past five years	Behavioral Risk Factor Surveillance System (BRFSS)	2017

Measure	Abbreviation	Description	Source	Year(s)
Diabetes prevalence	**DIAB**	**Respondents aged ≥18 years who report ever been told by a doctor, nurse, or other health professional that they have diabetes other than diabetes during pregnancy**	**Behavioral Risk Factor Surveillance System (BRFSS)**	**2017**
Atrial fibrillation	**AFIB**	**Atrial Fibrillation Hospitalization Rate per 1,000 Medicare Beneficiaries, 65+**	**Interactive Atlas of Heart Disease and Stroke**	**2015—17**
Chronic Kidney Disease	**CKD**	**Percent of adults aged ≥18 years who report ever having been told by a doctor, nurse, or other health professional that they have kidney disease in the past year**	**Behavioral Risk Factor Surveillance System (BRFSS)**	**2017**
Loss of Teeth	**Dental**	**Percent of adults aged ≥ 65 years who report having lost all their natural teeth because of tooth decay or gum disease.**	**Behavioral Risk Factor Surveillance System (BRFSS)**	**2017**

Data Source: Places: Local Data for Better Health[33]. Measure definitions[55].

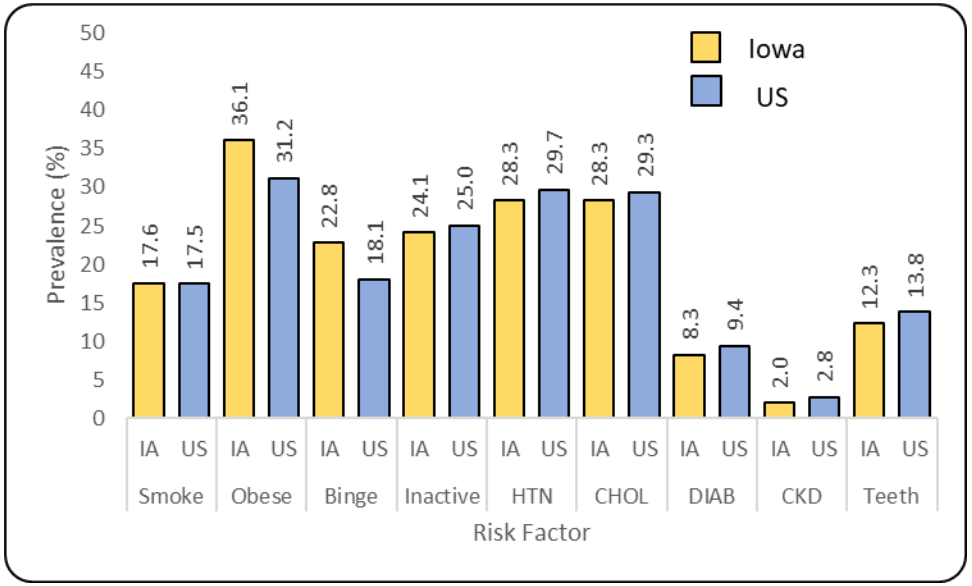


Figure 32. Prevalence of Self-reported Age-adjusted Stroke Risk Factors, US, and Iowa, 2017

Abbreviations: HTN=hypertension, CHOL=high cholesterol, DIAB=diabetes, CKD=Chronic Kidney Disease, IA=Iowa, US=United States. Data Source: PLACES: Local Data for Better Health[33].

- The age-adjusted prevalence of **obesity** and **binge drinking** is statistically higher in Iowa compared to the US.
- The prevalence of **hypertension, diabetes,** and **chronic kidney disease** is lower in Iowa compared to the US.

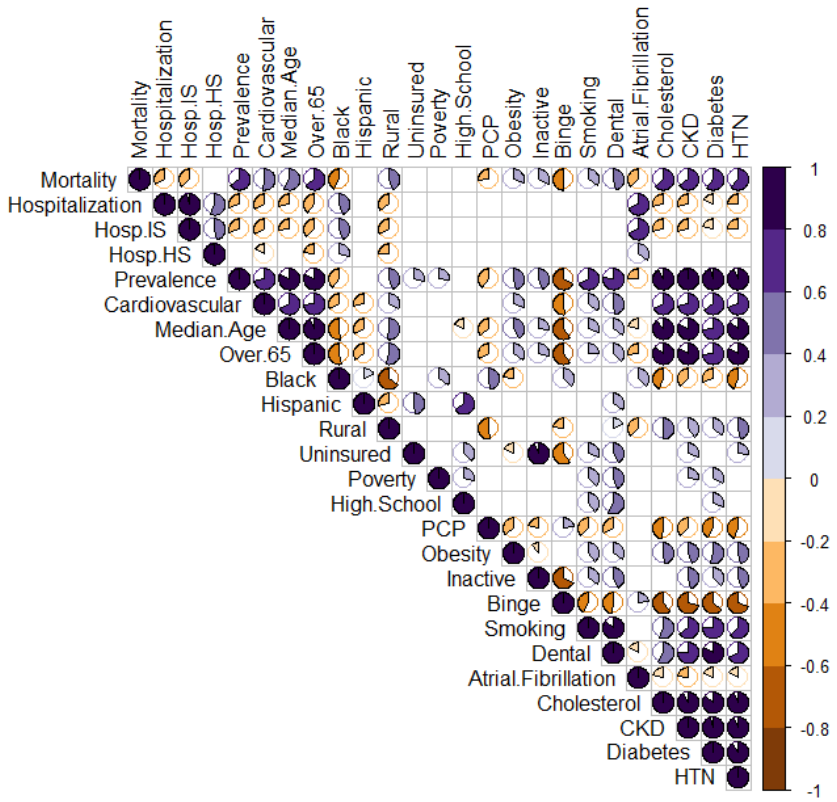


Figure 33. Correlation Matrix of Crude County-level Risk Factors for Stroke in Iowa

Abbreviations: Hosp IS=hospitalization rates for ischemic strokes, Hosp HS=hospitalization rates for hemorrhagic strokes, PCP=primary care provider, CKD=chronic kidney disease, HTN=hypertension. ***Positive correlations*** *are displayed in purple and* ***negative correlations*** *are displayed in orange. The* ***intensity*** *of the colors and the* ***sizes*** *of the circles are* ***proportional to the correlation coefficients****.* ***Non-significant at 95% confidence interval correlations*** *are indicated by blank cells****.*** *Cells with* ***no circles*** *indicate* ***zero correlations.*** *Correlations must be interpreted with caution as they provide evidence of association, not causation. In addition, correlations may be affected by outliers.*

- **Crude stroke mortality** was moderately correlated (r between 0.5 and 0.7) at the county-level with crude **prevalence** of stroke, **crude cardiovascular mortality**, **median age**, percent of population 1) over **65 years of age**, 2) reporting **high cholesterol**, 3) reporting **chronic kidney disease** 4) reporting **diabetes diagnosis**, 5) diagnosed with **hypertension**.
- **Hospitalizations per 1,000 Medicare Beneficiaries** was moderately correlated (r between 0.5 and 0.7) with **hospitalization rates for atrial fibrillation**.
- **Crude prevalence** was strongly correlated (r > 0.7) with **crude cardiovascular mortality**, percent of population **over 65 years of age**, percent of population reporting 1) **current smoking,** 2) **loss of all teeth due to decay,** 3) **high cholesterol,** 4) **chronic kidney disease**, 5) **diabetes,** and 6) **hypertension**.

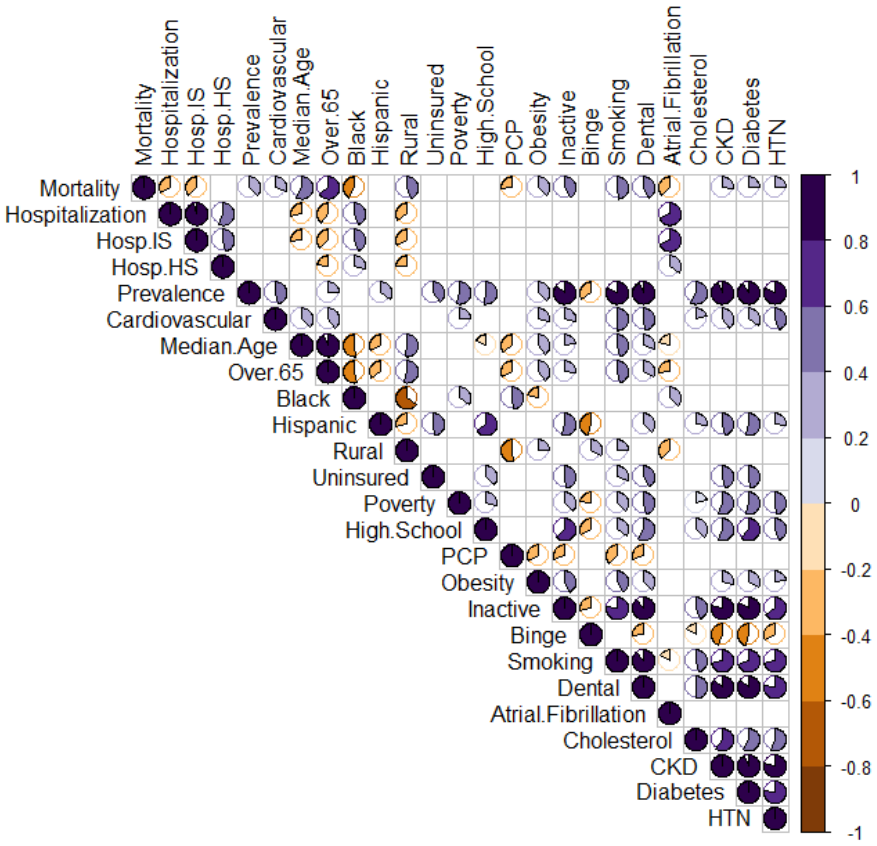


Figure 34. Correlation Matrix of Age-adjusted County-level Risk Factors in Iowa

Abbreviations: Hosp=Hospitalization, PCP=Primary Care Physicians. ***Positive correlations*** *are displayed in purple and* ***negative correlations*** *are displayed in orange. The* ***intensity*** *of the colors and the proportion filled in the circles are* ***proportional to the correlation coefficients****.* ***Non-significant at 95% confidence interval correlations*** *are indicated by blank cells****.*** *Cells with* ***no circles*** *indicate* ***zero correlations.*** *Correlations must be interpreted with caution as they provide evidence of association, not causation. In addition, outliers may affect correlations.*

After adjusting for age:

- **Age-adjusted stroke mortality** was moderately correlated (r between 0.5 and 0.7) with **median age** of population, and the percent of the **population over 65** years of age.
- **Hospitalizations per 1,000 Medicare Beneficiaries** was moderately correlated (r between 0.5 and 0.7) with hospitalization rates for **atrial fibrillation**.
- **Age-adjusted prevalence** was strongly correlated (r > 0.7) with percent of population reporting 1) **inactive lifestyle**, 2) **current smoking** 3) **loss of all teeth due to decay** 4) **chronic kidney disease** 5) **diabetes** 6) **hypertension**. Factors moderately correlated (r between 0.5 and 0.7) with age-adjusted prevalence include percent reporting **living in poverty**, percent reporting finishing **high school**, and percent reporting **high cholesterol**.

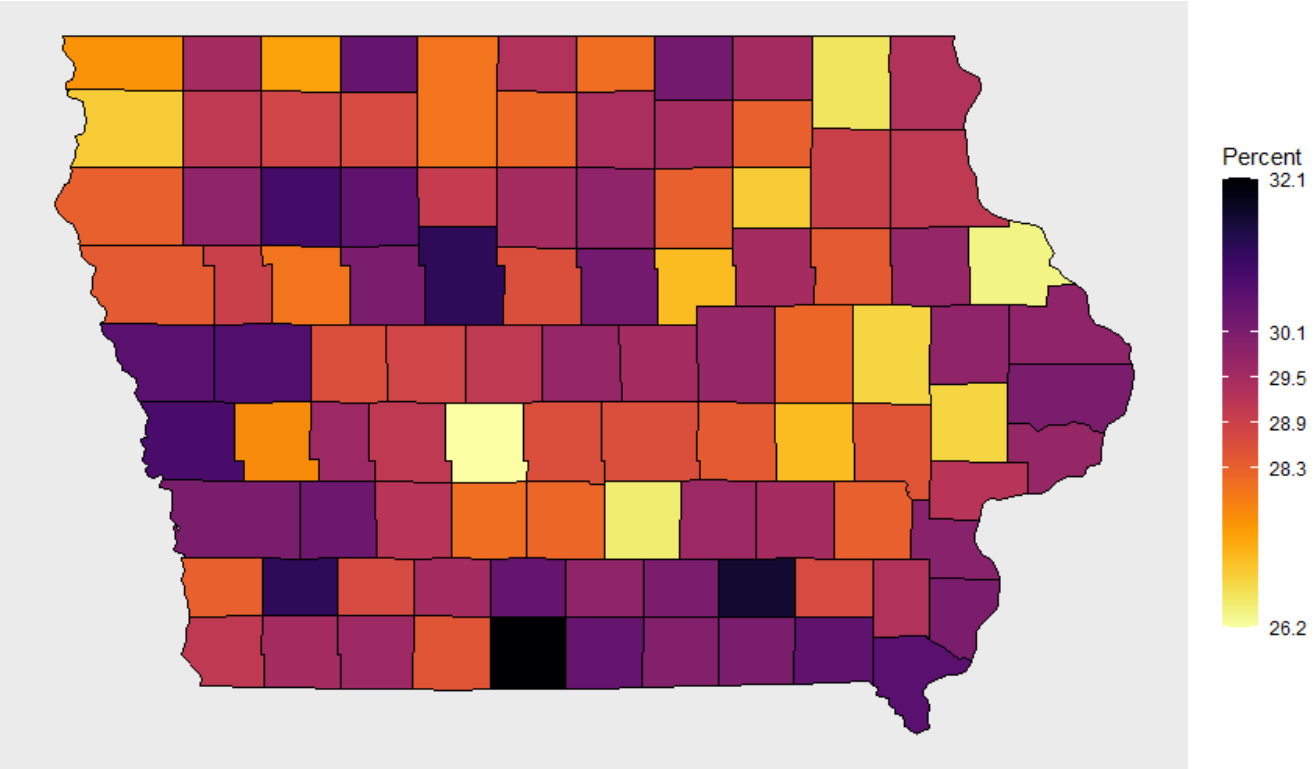


Figure 35. Age-adjusted County Prevalence of Hypertension in Adults, Iowa, 2017

Data Source: PLACES: Local Data for Better Health, BRFSS[33]. Percent of respondents who report being told by a healthcare professional that they have high blood pressure in the past year.

- **Thirty counties** exceed the US age-adjusted prevalence of 29.7% for hypertension.
- The top ten counties having the highest age-adjusted prevalence for hypertension include: **Buena Vista, Crawford, Decatur, Harrison, Lee, Monona, Montgomery, Pocahontas, Van Buren, Wapello,** and **Webster**.

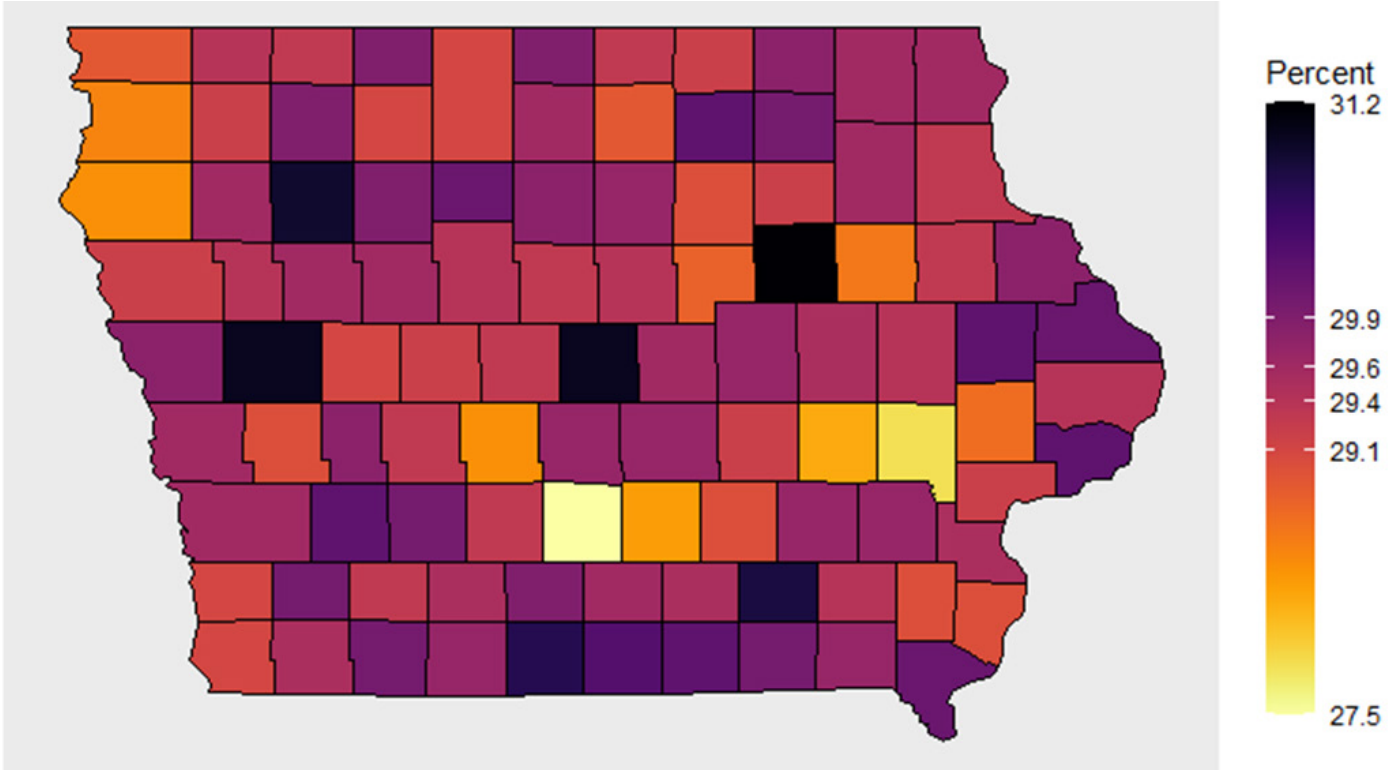


Figure 36. Age-adjusted County Prevalence of High Cholesterol in Adults, Iowa, 2017

*Data Source: PLACES: Local Data for Better Health, BRFSS[33]. Percent of adults, age ≥ 18 who report being told by a healthcare professional that they have **high cholesterol** in the past five years.*

- **Ninety-five** (95) counties report prevalence rates higher than the US prevalence of 28.3%.

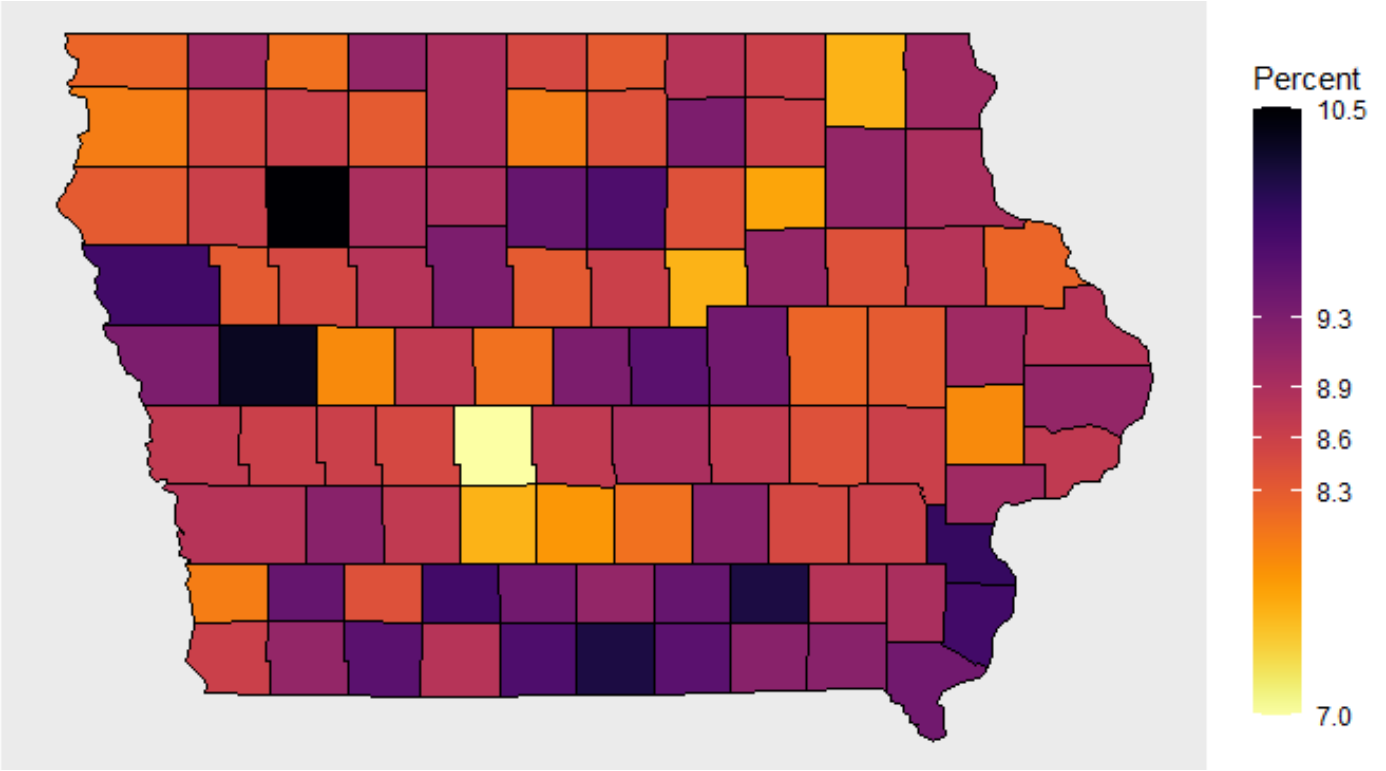


Figure 37. Age-adjusted County Prevalence of Diabetes in Adults, Iowa, 2017

*Data Source: PLACES: Local Data for Better Health, BRFSS[33]. Respondents aged ≥18 years who report ever been told by a doctor, nurse, or other health professional that they have **diabetes** other than diabetes during pregnancy.*

- The overall US prevalence of reported diabetes per BRFSS is 8.3. **Eighty-two (82) Iowa counties** report prevalence higher than US prevalence of **diabetes**.

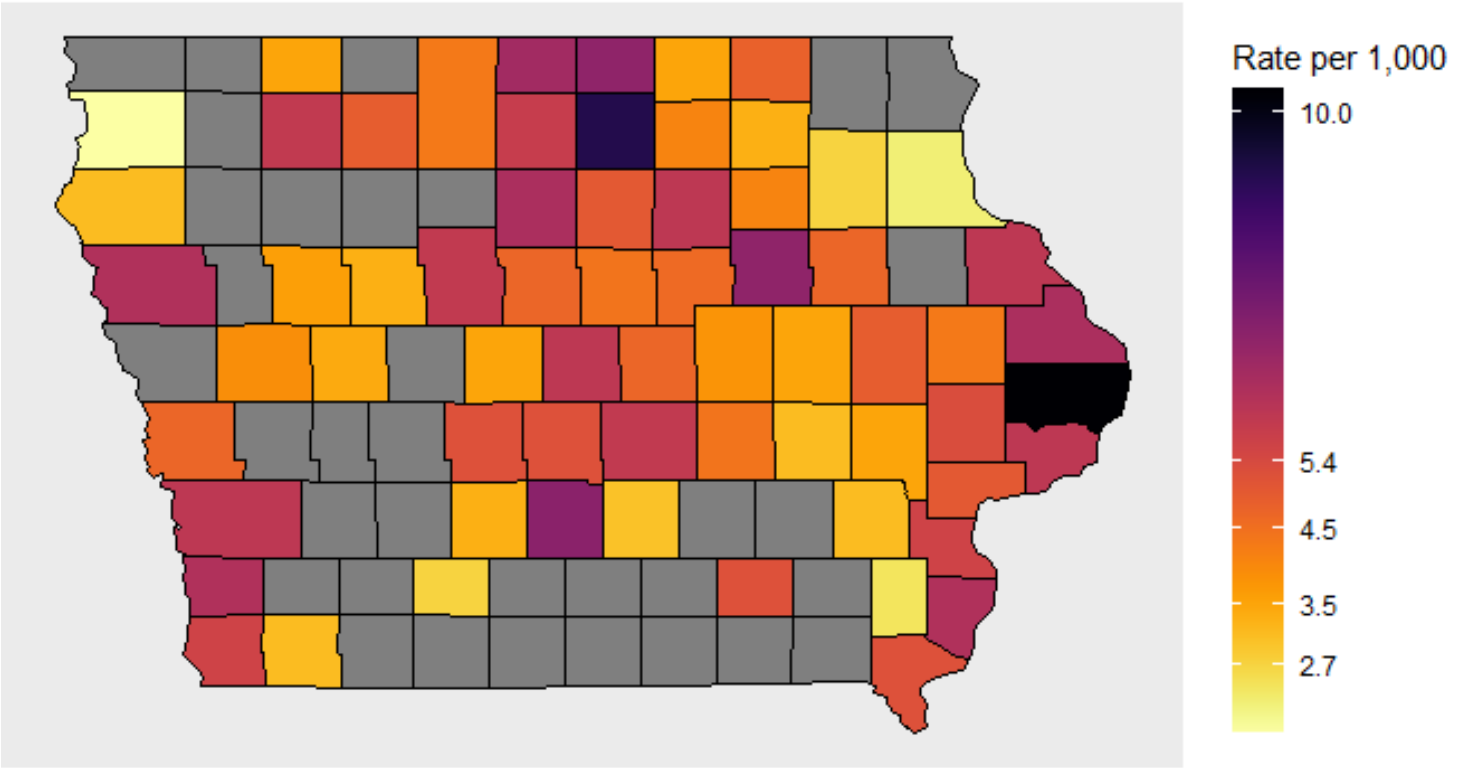


Figure 38. Atrial Fibrillation Hospitalization Rate per 1,000 Medicare Beneficiaries 65+, Iowa, 2015—2017

Data Source: Centers for Medicare and Medicaid Services Medicare Provider Analysis and Review (MEDPAR) file, Part A. Atrial Fibrillation Hospitalization Rate per 1,000 Medicare Beneficiaries, 65+. Gray indicates counties with unreliable data due to low counts.

- **Iowa** ranks 15th lowest among US states and territories for hospitalization rates for **atrial fibrillation** (4.7 hospitalizations per 1,000 Medicare beneficiaries over the age of 64 years.
- The reported rate of hospitalizations for atrial fibrillation per 1,000 Medicare beneficiaries, 65+ years of age in the **US** is 6.3 per 1,000.[45] **Eigh**t Iowa counties including **Black Hawk, Cerro Gordo, Clinton, Jackson, Warren, Winnebago**, and **Wright**, exceed the national rate.

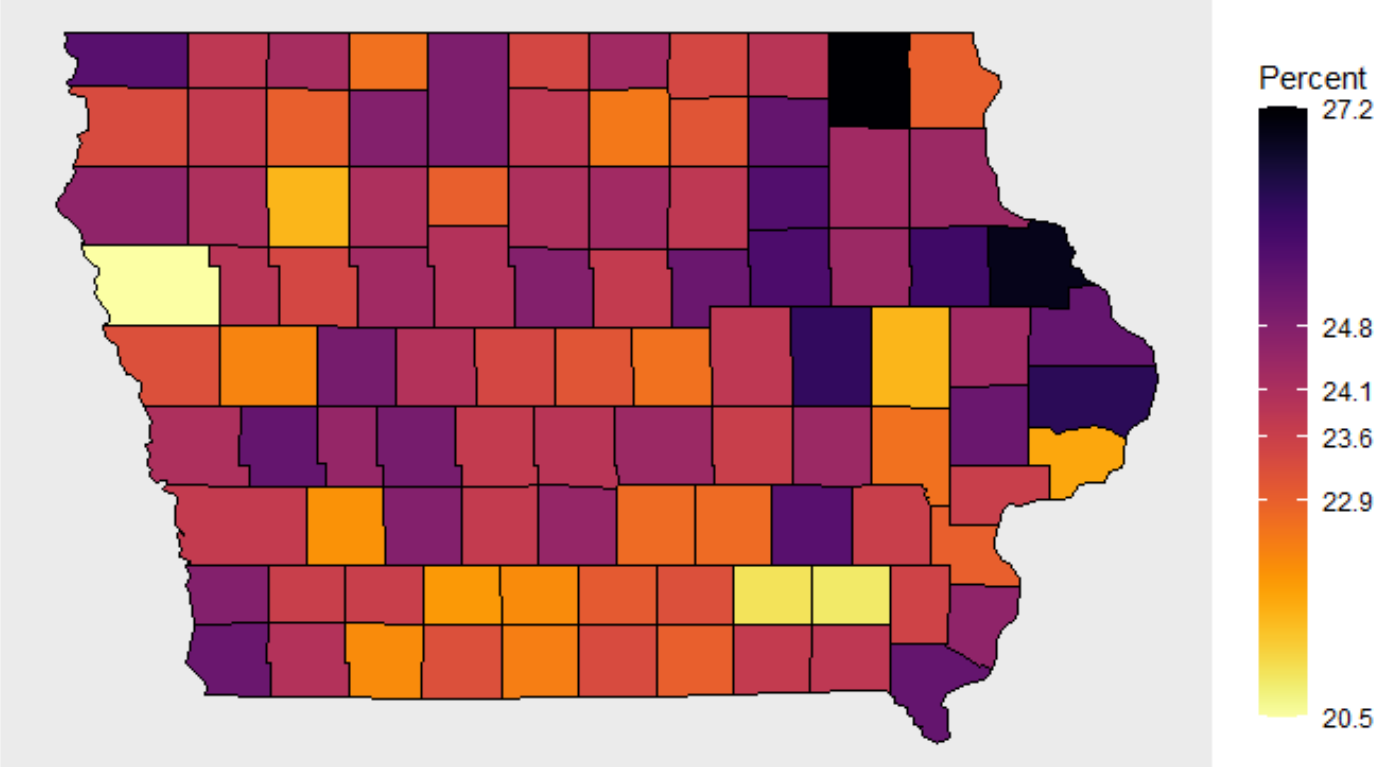


Figure 39. Age-adjusted County Prevalence of Binge Drinking in Adults, Iowa, 2017

Data Source: PLACES: Local Data for Better Health, BRFSS[33]. Percentage of adults reporting binge drinking (women > 4 drinks, men > 5 drinks) on an occasion in the past 30 days.

- All **ninety-nine** (99) **counties** in Iowa reported prevalence of **binge-drinking** exceeding the **US** prevalence of 17.5%.

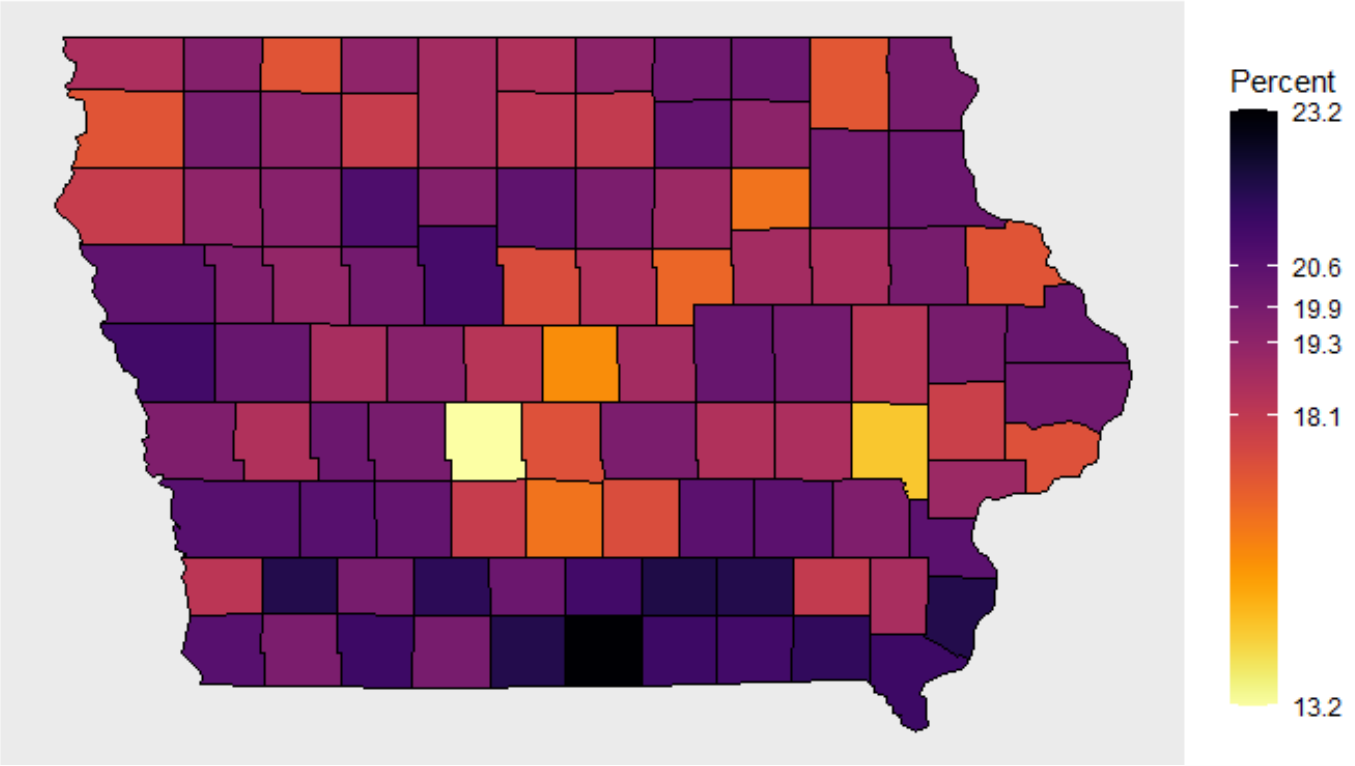


Figure 40. Age-adjusted County Prevalence of Current Adult Smokers, Iowa, 2017

Data Source: PLACES: Local Data for Better Health, BRFSS[33]. Percentage of adults who are current smokers or report having smoked ≥ 100 cigarettes in their lifetime.

- When compared to the US prevalence (17.5%), **85 Iowa counties** reported higher prevalence of **current smokers**.

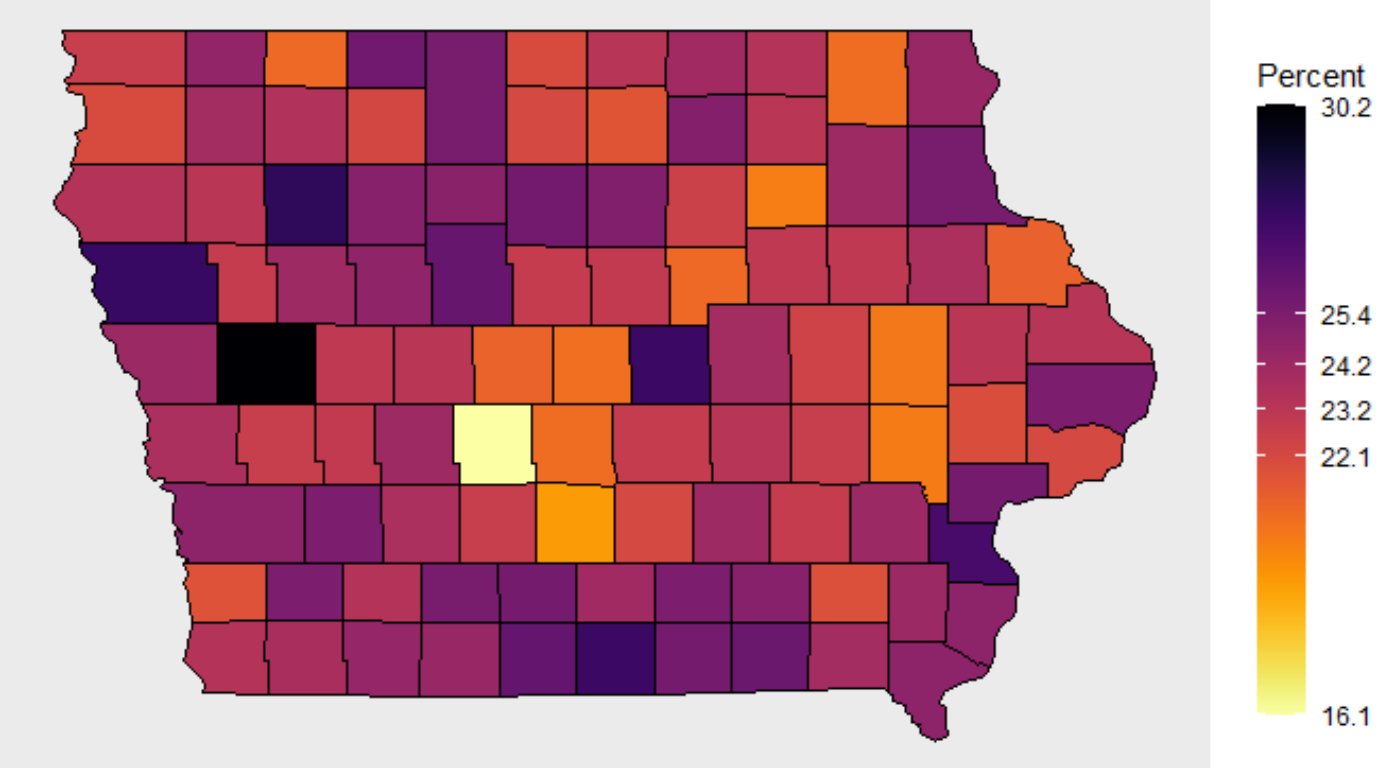


Figure 41. Age-adjusted County Prevalence of Inactive Lifestyles in Adults, Iowa, 2017

Data Source: PLACES: Local Data for Better Health, BRFSS[33]. Percentage of adults aged twenty and over reporting no leisure-time physical activity in the past month.

Twenty-three (23) counties report prevalence of **inactivity** exceeding the US overall prevalence (25.0%).

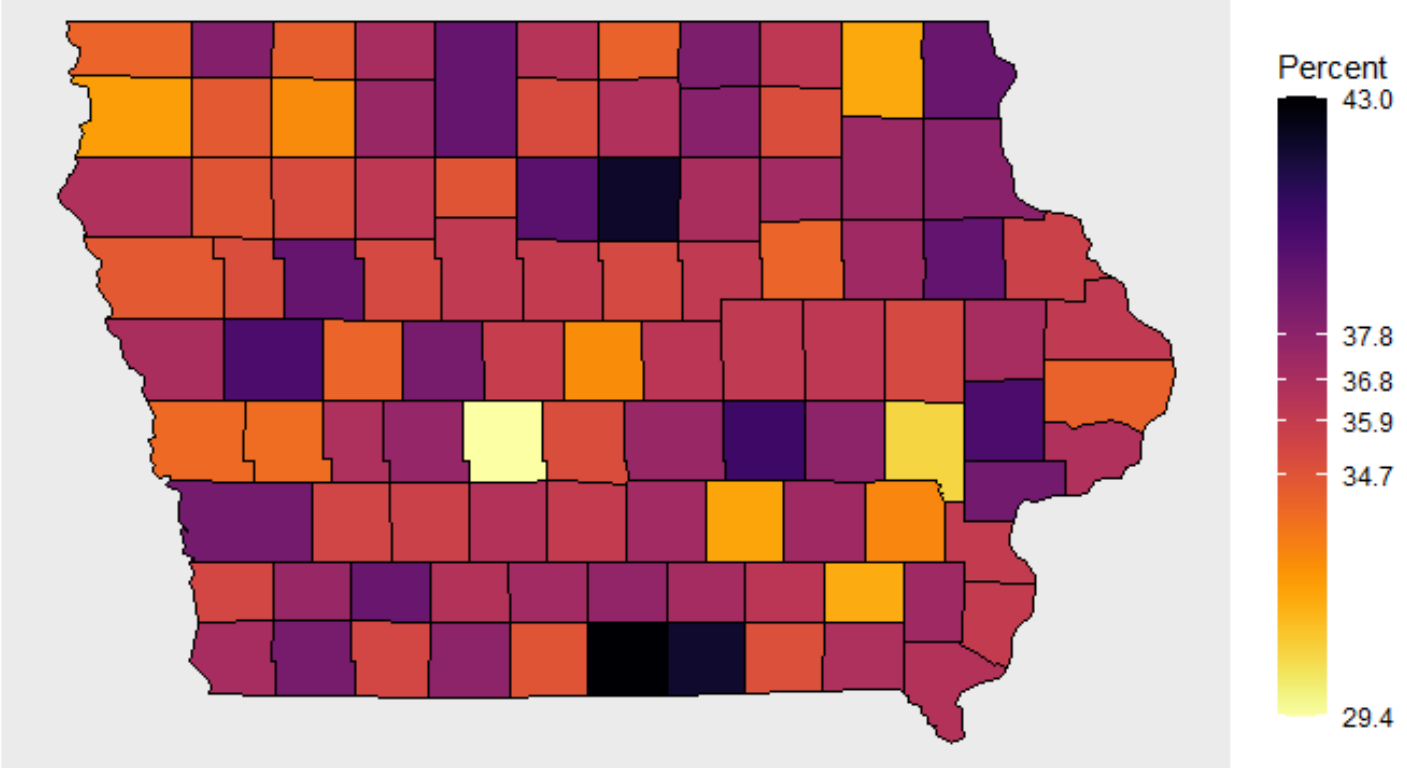


Figure 42. Age-adjusted County Prevalence of Obesity in Adults, Iowa, 2017

Data Source: PLACES: Local Data for Better Health, BRFSS[33]. Percentage of adults reporting a BMI of 30 or more.

- **Ninety-seven (97) counties** report prevalence of **obesity** higher than the US prevalence (31.2%).

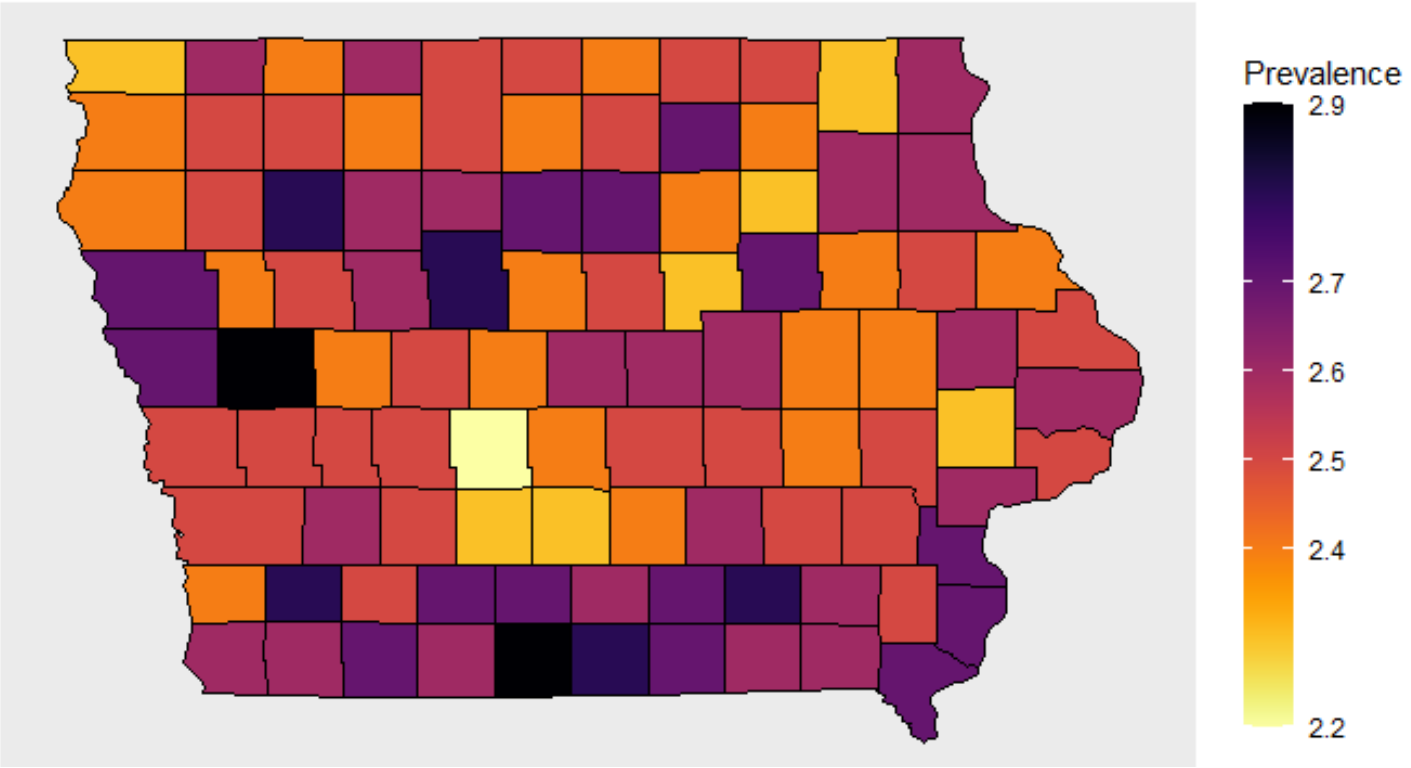


Figure 43. Prevalence of Reported Chronic Kidney Disease by Count, Iowa, 2017

Data Source: PLACES: Local Data for Better Health, BRFSS[33]

Percent of adults aged ≥18 years who report ever having been told by a doctor, nurse, or other health professional that they have kidney disease in the past year.

- Two counties (**Crawford** and **Decatur**) report prevalence rates above the US prevalence of 2.8% for **chronic kidney disease** (CKD).

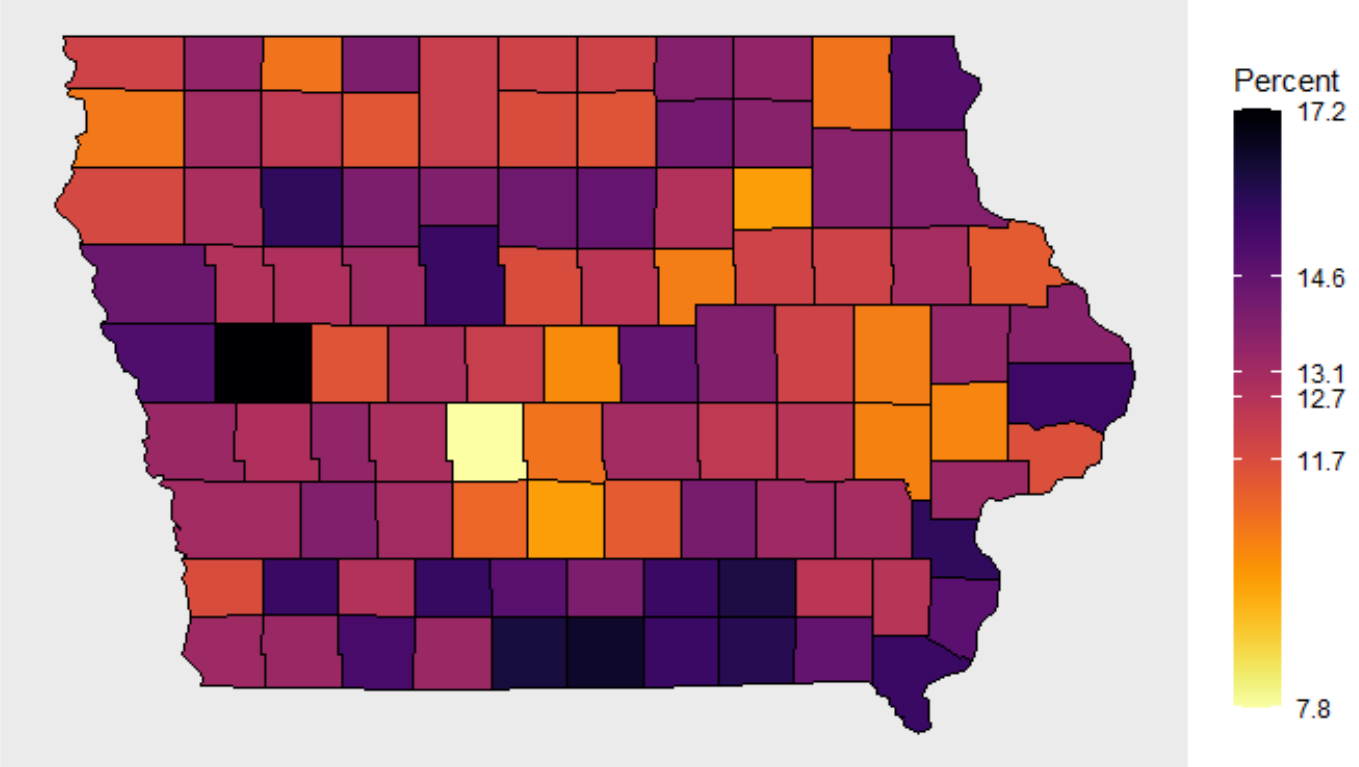


Figure 44. Prevalence of Older Adults Reporting Tooth Loss, 2017

Data Source: PLACES: Local Data for Better Health, BRFSS[33]

Percent of adults aged ≥ 65 years who report having lost all their natural teeth because of tooth decay or gum disease.

- **Thirty-two counties** exceed the US prevalence (13.8%) of adults over 64 years of age who have lost all their **natural teeth** because of tooth decay or gum disease.
- A recent meta-analysis of 30 longitudinal cohort studies, found a modest, but consistent elevated risk of incident stroke in patients with periodontal disease (RR 1.24, 95% CI: 1.12—1.38).[56]

The following tables examine

Table 3. Crude and Age-adjusted Stroke Prevalence, Hospitalizations, Mortality, and Cardiovascular Mortality by County, Iowa

Legend	* Not available	0—20th Percentile	20—40th percentile	40—60th percentile	60—80th percentile	80—100th percentile

	Stroke Prevalence[1]		Stroke Hospitalizations[2]			Stroke Mortality[3,4,5]			Cardiovascular Mortality[6]	
County	Crude	AA	All [7]	IS [8]	HS [9]	Deaths [10]	Crude	AA	Crude	AA
Adair	3.9	2.8	7.4	5.5	1.0	28	77.1	36.3	264.5	124.9
Adams	3.9	2.8	7.0	5.2	1.3	13	UNR	UNR	211.1	116.5
Allamakee	4.0	2.9	5.7	3.9	1.3	42	60.1	33.1	230.5	137.4
Appanoose	4.3	3.2	9.2	6.1	1.6	40	63.8	36.5	298.3	169.5
Audubon	4.2	2.9	6.8	5.0	1.1	12	UNR	UNR	139.4	77.4
Benton	3.4	2.6	9.3	7.1	1.2	43	33.5	22.1	164.4	113.5
Black Hawk	3.2	3.0	9.1	6.8	1.2	229	34.5	26.9	122.5	98.8
Boone	3.3	2.7	9.3	6.4	1.2	60	45.3	29.0	169.9	115.2
Bremer	3.1	2.5	8.9	6.7	1.1	44	35.5	24.3	160.0	102.9
Buchanan	3.3	2.7	9.1	6.7	1.3	43	40.8	30.4	192.8	141.4
Buena Vista	3.6	3.1	6.3	4.4	1.1	50	49.0	32.9	183.2	124.2
Butler	3.7	2.7	9.1	6.9	1.2	40	53.8	27.6	265.0	137.6
Calhoun	4.0	2.9	7.0	5.5	1.0	26	52.8	23.6	227.6	117.3
Carroll	3.5	2.7	7.0	5.2	1.1	72	70.3	35.8	155.3	90.9
Cass	4.2	3.0	6.1	4.7	1.3	36	53.9	29.0	293.5	154.9
Cedar	3.3	2.6	11.0	8.2	1.3	51	55.3	30.3	128.1	78.8
Cerro Gordo	3.7	2.8	9.9	7.3	1.1	82	38.0	21.5	204.7	122.4
Cherokee	4.1	2.8	6.0	4.8	1.0	27	46.4	22.6	185.6	90.1
Chickasaw	3.7	2.8	7.7	6.3	0.9	25	41.2	24.0	247.1	149.3
Clarke	3.9	3.1	7.3	5.7	1.1	28	60.2	38.7	170.0	119.3
Clay	3.7	2.8	10.9	7.8	1.1	48	58.5	32.4	136.6	78.8
Clayton	4.2	3.0	7.2	4.6	1.3	43	48.7	25.5	151.7	85.4
Clinton	3.8	3.0	12.1	8.9	1.6	93	39.0	25.1	254.9	166.3
Crawford	3.9	3.3	7.4	5.3	1.2	45	52.5	35.6	146.9	101.6
Dallas	2.2	2.2	9.6	7.3	1.2	85	21.0	22.7	73.0	76.8
Davis	3.9	3.1	8.3	6.2	1.3	29	65.7	44.7	131.3	91.6
Decatur	3.9	3.3	10.2	8.2	1.0	12	UNR	UNR	196.5	126.2
Delaware	3.7	2.9	7.2	5.3	1.4	31	35.7	22.9	178.5	111.1
Des Moines	3.9	3.0	13.5	9.7	1.5	116	58.0	34.4	201.1	130.6
Dickinson	3.7	2.6	7.9	6.0	1.2	49	57.3	29.7	220.0	108.3
Dubuque	3.2	2.7	11.7	8.9	1.5	220	45.5	31.5	130.0	94.1
Emmet	3.9	3.0	5.7	4.5	1.0	17	UNR	UNR	190.4	106.2

County	Stroke Prevalence[1]		Stroke Hospitalizations[2]			Stroke Mortality[3,4,5]			Cardiovascular Mortality[6]	
	Crude	AA	All [7]	IS [8]	HS [9]	Deaths [10]	Crude	AA	Crude	AA
Fayette	3.9	3.0	7.7	5.2	1.2	50	49.5	27.6	208.0	123.0
Floyd	4.1	3.1	8.7	6.6	1.0	36	45.1	25.4	228.2	130.4
Franklin	4.1	3.0	8.9	6.3	1.2	30	58.1	31.2	215.1	122.6
Fremont	4.0	2.9	8.0	7.0	0.9	14	UNR	UNR	197.7	109.5
Greene	3.8	2.8	8.0	5.8	1.0	16	UNR	UNR	227.1	126.2
Grundy	3.3	2.5	8.9	6.3	1.3	27	43.7	22.8	160.3	89.1
Guthrie	3.9	2.8	8.0	5.9	1.1	33	61.8	34.8	196.7	109.2
Hamilton	3.5	2.7	8.6	5.4	1.2	49	64.6	37.1	162.2	88.8
Hancock	3.6	2.7	9.5	7.0	1.1	23	42.0	24.8	173.7	99.8
Hardin	3.7	2.8	8.9	6.0	1.3	45	52.1	27.9	253.5	128.5
Harrison	3.7	2.8	9.1	6.6	1.2	31	43.5	26.8	162.7	98.6
Henry	3.4	2.9	9.0	6.4	1.5	77	77.0	50.8	199.0	136.1
Howard	3.9	2.9	6.4	4.5	0.9	22	46.9	27.3	332.3	183.4
Humboldt	3.9	2.9	10.0	7.9	0.9	16	UNR	UNR	419.3	216.3
Ida	3.8	2.8	4.7	4.0	1.1	19	UNR	UNR	165.4	78.5
Iowa	3.5	2.7	10.1	8.1	1.1	46	56.4	30.7	166.8	102.6
Jackson	3.8	2.9	11.5	8.2	1.4	59	60.6	35.9	209.6	126.7
Jasper	3.5	2.8	9.3	7.3	1.2	93	50.5	31.8	131.5	87.7
Jefferson	3.4	2.8	10.0	6.7	1.3	37	41.9	28.8	210.9	151.2
Johnson	2.3	2.7	9.9	7.8	1.2	126	17.5	21.3	76.5	91.1
Jones	3.8	2.9	10.2	7.4	1.4	32	31.2	20.3	163.9	104.6
Keokuk	3.9	2.9	9.0	6.3	1.1	24	47.1	26.7	196.1	112.2
Kossuth	4.0	2.8	7.2	5.4	0.9	48	63.3	30.1	249.3	116.4
Lee	3.9	3.1	13.0	8.9	1.5	88	50.3	34.0	242.9	165.0
Linn	2.9	2.6	9.9	7.5	1.2	274	24.9	21.1	122.2	101.9
Louisa	3.8	3.1	12.4	9.3	1.4	34	60.8	45.5	132.3	95.5
Lucas	4.0	3.0	5.8	5.2	0.9	31	71.6	42.2	247.1	141.1
Lyon	3.3	2.6	9.6	7.1	1.1	27	46.0	26.0	136.3	86.5
Madison	3.1	2.6	9.7	7.8	1.2	18	UNR	UNR	119.5	86.2
Mahaska	3.6	3.0	6.6	3.9	1.1	70	62.8	39.6	196.4	131.8
Marion	3.2	2.7	6.1	3.9	1.2	77	46.3	32.9	222.0	159.3
Marshall	3.6	3.0	8.9	6.3	1.2	93	45.8	30.7	120.6	81.1
Mills	3.3	2.7	9.2	6.9	1.4	27	36.2	30.2	96.5	73.7
Mitchell	4.0	2.9	8.1	6.2	1.0	28	52.1	24.3	310.9	145.1
Monona	4.4	3.1	7.2	5.9	1.2	21	46.9	22.0	429.2	195.7
Monroe	4.1	3.1	5.8	4.5	1.0	25	63.0	40.6	204.0	133.6
Montgomery	4.3	3.2	7.2	4.9	1.3	35	68.0	34.6	272.2	149.5
Muscatine	3.3	2.8	11.4	8.7	1.4	74	34.5	28.7	128.2	104.6
O'Brien	3.7	2.8	8.2	6.0	1.0	44	62.9	27.9	173.1	83.6
Osceola	4.0	2.9	8.0	5.7	1.1	23	74.9	41.6	221.6	119.4
Page	3.8	2.9	8.6	6.0	1.2	39	50.4	24.9	219.8	126.3

County	Stroke Prevalence[1]		Stroke Hospitalizations[2]			Stroke Mortality[3,4,5]			Cardiovascular Mortality[6]	
	Crude	AA	All [7]	IS [8]	HS [9]	Deaths [10]	Crude	AA	Crude	AA
Palo Alto	3.6	2.7	8.4	6.6	1.1	26	57.1	25.5	191.0	98.6
Plymouth	3.4	2.7	8.3	6.4	1.2	27	21.6	14.3	102.4	66.7
Pocahontas	4.2	3.0	9.2	6.8	1.1	24	68.5	33.7	296.9	159.8
Polk	2.8	2.7	10.1	7.8	1.2	607	26.0	26.8	97.5	98.5
Pottawattamie	3.4	2.9	10.4	7.5	1.5	164	35.2	28.1	128.0	99.1
Poweshiek	3.4	2.8	8.5	6.4	1.0	58	62.6	35.7	187.8	109.2
Ringgold	4.2	2.9	6.5	3.4	1.1	SUP	SUP	SUP	351.9	147.2
Sac	4.0	2.8	6.8	5.0	1.0	46	92.3	43.6	281.0	131.8
Scott	3.1	2.7	12.2	9.1	1.6	284	33.1	27.2	94.3	78.6
Shelby	4.0	2.8	6.4	5.2	1.2	36	60.7	28.5	151.9	78.7
Sioux	2.9	2.6	6.5	4.8	0.8	56	32.2	23.0	88.0	65.3
Story	2.2	2.8	9.6	6.2	1.2	115	24.1	25.6	70.8	75.7
Tama	3.9	3.0	8.6	6.3	1.1	47	54.2	30.7	143.0	86.9
Taylor	4.1	3.1	7.4	5.7	1.4	12	UNR	UNR	236.2	126.7
Union	3.9	3.1	5.2	3.0	1.1	SUP	SUP	SUP	200.2	130.5
Van Buren	4.1	3.0	9.1	6.6	1.3	18	UNR	UNR	180.0	110.7
Wapello	3.9	3.2	11.1	7.4	1.2	101	57.5	40.5	205.9	151.8
Warren	2.8	2.4	10.3	8.0	1.2	66	27.1	22.6	125.5	105.5
Washington	3.6	2.8	8.9	6.6	1.3	47	42.4	25.7	150.6	93.3
Wayne	4.6	3.3	6.3	5.2	0.8	18	UNR	UNR	292.7	157.6
Webster	3.7	3.2	10.6	9.0	0.9	68	36.9	24.8	195.2	138.9
Winnebago	3.6	2.7	8.9	6.7	1.0	27	51.0	26.0	151.1	86.0
Winneshiek	3.2	2.5	5.5	3.7	1.1	51	49.4	27.8	169.5	98.2
Woodbury	3.3	3.0	11.9	9.0	1.4	137	26.7	23.9	92.9	80.7
Worth	3.6	2.7	11.9	7.8	1.2	18	UNR	UNR	174.7	109.5
Wright	4.2	3.0	8.8	6.9	1.1	43	67.0	27.6	240.1	123.4

Abbreviations: AA=age-adjusted, IS=ischemic stroke, HS=hemorrhagic stroke, UNR=unreliable, SUP=suppressed. [1] Respondents aged ≥18 years who report ever having been told by a doctor, nurse, or other health professional that they have had a stroke. Data source: BRFSS[57]. [2] Stroke Hospitalization Rate per 1,000 Medicare Beneficiaries, 65+, 2015—2017; Data source: Centers for Medicare and Medicaid Services Medicare Provider Analysis and Review (MEDPAR) file, Part A.[25]. [3] Stroke mortality (ICD10 Codes including I60—61, I63 and I64). Data Source: CDC Wonder [23]. [4] Counts fewer than twenty are considered unreliable (UNR). [5] Counts fewer than ten are suppressed (SUP) for confidentiality. [6] Cardiovascular mortality (ICD10 Codes include I20—25). Data Source: CDC Wonder[23] [7] All hospitalizations with principal diagnosis (ICD10: I60—69)[29]. [8] Hospitalizations with ischemic stroke principal diagnosis of ICD: I63, I65—66[29]. [9] Hospitalizations with hemorrhagic stroke principal diagnosis of ICD: I60—62[29]. [10] Number of actual deaths[23]

Table 4. Ranked County-level Crude Stroke Mortality Rates and Risk Factors for Stroke in Iowa

Legend	* Not available	0—20th Percentile	20—40th percentile	40—60th percentile	60—80th percentile	80—100th percentile

	Stroke		Risk Factors									
County	Mortality[1,2]	Rank[3]	Smoke (%)[4]	Obese (%)[5]	Binge (%)[6]	Inactive (%)[7]	HTN (%)[8]	CKD (%)[9]	CHOL (%)[10]	DIAB (%)[11]	AFIB (rate)[12]	Dental (%)[13]
Johnson	17.5	1	13.6	28.4	24.3	22.6	24.8	27.9	7.4	3.7	3.5	10.1
Dallas	21.0	2	13.6	29.8	23.6	23.7	26.5	31.4	7.1	5.1	5.2	7.6
Plymouth	21.6	3	16.9	36.6	21.7	24.6	33.6	35.8	10.2	3.2	3.1	11.7
Story	24.1	4	13.8	28.4	25.6	23.1	24.1	29.4	7.3	5.5	6.0	10.1
Linn	24.9	5	17.8	35.1	20.5	21.6	29.0	34.6	9.2	4.9	4.9	10.4
Polk	26.0	6	17.3	35.1	23.6	23.9	29.3	33.3	9.1	5.2	5.2	10.4
Woodbury	26.7	7	19.9	34.1	19.5	20.5	30.5	34.5	10.7	6.2	6.3	14.1
Warren	27.1	8	15.7	35.9	22.9	24.5	31.1	32.9	8.9	6.6	7.1	9.6
Jones	31.2	9	18.6	37.0	21.0	24.3	35.6	38.4	11.4	4.5	4.3	13.3
Sioux	32.2	10	15.8	30.9	22.1	23.3	28.6	33.1	8.7	2.0	1.8	10.6
Scott	33.1	11	16.8	36.7	20.4	21.8	32.7	36.0	9.9	6.0	6.0	11.4
Benton	33.5	12	18.9	36.5	22.8	26.1	33.6	37.3	10.4	3.9	3.5	11.9
Black Hawk	34.5	13	17.5	32.6	24.9	25.7	30.4	35.8	9.6	6.9	7.0	11.8
Muscatine	34.5	13	18.4	38.7	21.8	23.6	32.8	35.6	10.5	5.2	5.0	13.0
Pottawattamie	35.2	15	19.8	38.6	21.5	23.7	34.2	36.4	10.5	5.9	6.0	12.8
Bremer	35.5	16	14.8	36.1	23.1	25.6	30.8	35.6	9.2	4.3	4.1	9.8
Delaware	35.7	17	18.4	39.2	22.3	25.9	35.9	37.7	11.2	2.5		13.0
Mills	36.2	18	17.4	35.9	21.8	24.8	33.9	37.0	10.2	6.2	6.3	11.3
Webster	36.9	19	19.6	35.1	22.1	24.0	34.8	36.1	10.9	5.6	5.9	15.3
Cerro Gordo	38.0	20	16.5	36.3	19.2	22.5	35.6	37.1	10.8	9.0	9.2	11.4
Clinton	39.0	21	18.8	34.2	22.9	26.2	35.9	37.4	11.5	10.0	10.3	15.2
Buchanan	40.8	22	17.8	37.4	21.8	24.4	33.3	35.9	10.3	4.7	4.7	11.8
Chickasaw	41.2	23	17.8	35.0	21.4	25.3	35.0	39.0	11.2	3.5	3.3	13.7
Jefferson	41.9	24	16.6	31.0	19.1	20.9	32.3	36.1	10.4	2.2		11.9
Hancock	42.0	25	16.6	34.8	19.9	23.8	35.5	38.7	10.6	6.0	5.8	11.7
Washington	42.4	26	18.5	32.9	20.8	23.6	33.7	37.3	10.6	3.2	3.1	13.0
Harrison	43.5	27	18.5	34.2	20.7	24.1	37.2	38.0	11.2	4.7	4.7	13.2
Grundy	43.7	28	15.2	35.8	21.6	25.2	33.1	36.8	9.8	5.2	4.6	10.6
Floyd	45.1	29	18.7	37.8	19.6	23.1	36.2	39.1	12.0	4.4	4.1	14.1
Boone	45.3	30	17.5	36.1	20.9	23.4	33.9	36.5	9.9	4.7	3.5	11.9
Dubuque	45.5	31	16.0	34.9	24.8	26.9	29.8	36.1	9.6	5.9	6.0	11.1
Marshall	45.8	32	17.8	35.9	20.4	22.6	34.0	36.5	11.4	4.9	4.7	14.5
Lyon	46.0	33	17.4	33.9	22.6	25.5	32.6	36.0	10.0	3.1		12.1
Marion	46.3	34	16.1	36.5	20.7	22.7	30.3	34.7	9.5	3.5	3.0	11.1
Cherokee	46.4	35	17.4	34.4	19.6	24.1	38.2	39.5	11.6	2.6		13.1

County	Stroke		Risk Factors									
	Mortality[1,2]	Rank[3]	Smoke (%)[4]	Obese (%)[5]	Binge (%)[6]	Inactive (%)[7]	HTN (%)[8]	CKD (%)[9]	CHOL (%)[10]	DIAB (%)[11]	AFIB (rate)[12]	Dental (%)[13]
Monona	46.9	36	18.8	36.2	18.7	23.2	39.0	39.8	12.6	4.1	4.8	13.6
Howard	46.9	36	18.6	36.0	20.2	23.9	36.3	38.6	11.3	4.1		15.2
Keokuk	47.1	38	19.0	37.1	21.5	25.5	36.6	38.7	11.2	3.1		13.2
Clayton	48.7	39	18.2	37.8	19.9	24.4	37.2	39.1	12.2	2.4	2.2	13.7
Buena Vista	49.0	40	18.7	34.3	20.4	21.6	33.4	36.4	11.5	1.5		15.6
Winneshiek	49.4	41	14.9	30.4	24.2	27.2	30.5	36.4	9.2	2.0		10.7
Fayette	49.5	42	18.2	36.7	21.0	24.3	34.8	37.8	11.6	2.9	2.7	13.7
Lee	50.3	43	20.0	36.6	22.1	25.3	36.3	38.3	11.8	5.2	5.2	15.2
Page	50.4	44	18.3	38.4	20.5	24.0	35.7	37.8	11.5	3.3	3.1	13.2
Jasper	50.5	45	18.7	37.4	21.6	24.4	33.7	37.3	10.9	5.6	5.9	13.0
Winnebago	51.0	46	16.7	35.6	20.1	23.4	35.1	37.9	10.8	6.6	6.6	12.0
Mitchell	52.1	47	18.2	37.8	19.8	23.4	37.4	38.0	11.3	5.2	4.4	12.6
Hardin	52.1	47	16.9	34.7	20.1	23.7	36.7	37.8	11.1	3.9	3.5	13.9
Crawford	52.5	49	19.4	39.4	20.4	22.3	34.8	38.0	11.9	4.1	3.9	17.1
Calhoun	52.8	50	18.1	34.7	20.3	24.3	37.1	38.5	11.5	3.5	3.3	13.3
Butler	53.8	51	17.4	36.7	19.9	23.8	35.4	37.9	11.1	6.0	6.0	12.6
Cass	53.9	52	18.7	35.2	18.1	22.1	37.9	39.7	12.3	2.0		13.9
Tama	54.2	53	18.8	35.7	20.6	23.8	35.9	38.1	11.8	4.3	3.8	13.8
Cedar	55.3	54	16.7	40.3	21.8	25.2	32.4	36.5	10.0	5.4	5.3	10.2
Iowa	56.4	55	17.4	37.8	21.3	24.4	32.8	35.9	10.6	3.7	3.1	12.7
Palo Alto	57.1	56	16.1	36.5	21.2	24.8	34.9	37.1	10.5	4.5	4.9	11.5
Dickinson	57.3	57	15.3	34.3	19.4	24.2	35.9	39.3	11.3	3.5	3.5	10.5
Wapello	57.5	58	20.9	35.9	19.2	21.0	35.6	37.8	11.9	4.9	5.2	15.9
Des Moines	58.0	59	20.4	35.8	21.4	24.6	35.9	37.0	12.3	6.2	6.3	14.7
Franklin	58.1	60	18.3	41.9	20.6	24.3	36.8	38.6	12.6	5.4	5.0	14.4
Clay	58.5	61	18.0	32.7	19.8	22.9	34.9	38.1	10.9	5.5	5.9	12.5
Allamakee	60.1	62	18.1	38.8	19.0	22.9	37.0	39.2	12.0	1.9		14.8
Clarke	60.2	63	19.2	37.1	19.7	22.2	35.7	37.5	11.5	2.7		14.6
Jackson	60.6	64	18.7	36.1	21.5	25.3	36.7	39.2	11.4	6.5	6.4	13.6
Shelby	60.7	65	16.6	33.5	20.8	25.3	35.5	38.4	11.6	3.2		12.9
Louisa	60.8	66	19.7	36.1	20.5	22.9	34.6	36.8	12.0	5.5	5.6	15.5
Guthrie	61.8	67	18.2	37.6	20.8	25.0	36.8	38.7	11.3	2.8		12.8
Poweshiek	62.6	68	16.3	38.5	21.1	23.6	32.6	36.1	10.3	4.3	4.4	12.3
Mahaska	62.8	69	19.3	31.7	20.6	22.7	33.8	35.8	10.9	2.6		13.9
O'Brien	62.9	70	18.2	34.0	20.2	23.7	35.6	37.4	10.8	2.3		13.3
Monroe	63.0	71	20.6	37.2	20.0	23.2	36.3	37.9	12.1	3.2		15.3
Kossuth	63.3	72	16.7	38.6	20.3	24.9	36.0	38.6	12.0	4.5	4.3	12.3
Appanoose	63.8	73	19.4	41.9	19.0	22.9	37.7	39.9	12.9	2.7		15.4
Hamilton	64.6	74	16.1	35.9	21.4	24.8	34.7	37.3	10.5	5.1	4.7	11.7
Davis	65.7	75	19.8	34.7	21.0	23.7	35.1	37.7	11.3	3.5		15.9
Wright	67.0	76	18.5	38.9	20.0	24.1	37.3	39.1	12.5	4.2	6.4	14.4

County	Stroke		Risk Factors									
	Mortality[1,2]	Rank[3]	Smoke (%)[4]	Obese (%)[5]	Binge (%)[6]	Inactive (%)[7]	HTN (%)[8]	CKD (%)[9]	CHOL (%)[10]	DIAB (%)[11]	AFIB (rate)[12]	Dental (%)[13]
Montgomery	68.0	77	20.1	37.3	19.8	23.6	38.4	39.1	12.4	3.8		15.4
Pocahontas	68.5	78	18.9	35.9	19.7	24.1	39.0	39.9	12.1	3.6		14.0
Carroll	70.3	79	17.2	33.8	21.5	25.0	34.7	37.2	10.0	3.2	3.4	11.5
Lucas	71.6	80	19.4	37.4	19.3	23.0	37.1	38.8	11.9	2.4		13.9
Osceola	74.9	81	17.8	37.8	19.7	23.8	37.0	38.6	11.9	2.4		13.7
Henry	77.0	82	17.5	36.7	21.3	23.5	33.5	35.7	10.6	2.6	2.4	12.5
Adair	77.1	83	18.6	35.4	20.6	24.8	36.7	39.3	11.5	1.8		13.2
Sac	92.3	84	17.2	38.7	19.0	23.4	35.9	39.1	11.5	3.2	3.6	12.9
Adams	UNR		18.2	39.1	19.4	23.6	36.7	38.9	11.4	2.4		10.8
Audubon	UNR		17.9	36.3	19.7	24.5	38.4	40.1	11.8	2.4		13.5
Decatur	UNR		19.0	32.4	20.6	22.4	35.2	37.4	11.2	3.5		12.9
Emmet	UNR		17.8	36.4	19.6	22.6	36.4	38.1	11.5	3.6		13.9
Fremont	UNR		18.9	37.0	20.8	25.2	36.8	38.5	11.6	5.3	5.6	12.7
Greene	UNR		17.7	38.3	20.1	24.0	36.0	38.2	11.4	3.7		13.7
Humboldt	UNR		17.9	34.5	19.2	22.9	35.8	38.9	11.6	4.6		14.0
Ida	UNR		17.8	34.6	19.9	23.9	36.4	38.6	11.0	3.5		11.8
Madison	SUP		17.2	37.2	21.2	23.7	32.7	36.4	9.3	4.1	3.3	12.6
Ringgold	UNR		17.6	37.3	18.5	23.2	36.6	39.3	12.0	3.2		13.1
Taylor	UNR		19.6	35.0	18.8	22.2	36.8	39.0	12.4	3.2		16.2
Union	UNR		20.0	36.0	19.3	22.0	34.6	37.1	12.1	2.6	2.7	15.2
Van Buren	SUP		19.7	36.8	19.8	23.8	38.0	39.2	12.4	1.7		14.4
Wayne	UNR		20.9	42.5	19.3	23.3	37.8	39.6	13.4	2.5		15.5
Worth	UNR		18.0	34.2	21.0	24.3	34.0	37.6	10.6	3.6	7.0	16.7

Abbreviations: HTN=hypertension, CHOL=high cholesterol, DIAB=diabetes, AFIB=atrial fibrillation, CKD=chronic kidney disease, UNR=Unreliable, SUP=suppressed
[1] Counts fewer than twenty are considered unreliable (UNR). [2] Counts fewer than ten are suppressed for confidentiality. [3] Counties are ranked based on the value of the age-adjusted stroke mortality rates. [4] Percentage of adults who are current smokers or report having smoked ≥ 100 cigarettes in their lifetime
[5] Percentage of adults that report a BMI of 30 or more. [6] Percentage of adults reporting binge drinking (women > 4 drinks, men > 5 drinks) on an occasion in the past 30 days. [7] Percentage of adults aged twenty and over reporting no leisure-time physical activity in the past month. [8] Percent of respondents who report being told by a healthcare professional that they have high blood pressure in the past year. [9] Percent of adults, age ≥ 18 who report being told by a healthcare professional that they have high cholesterol in the past five years. [10] Respondents aged ≥18 years who report ever been told by a doctor, nurse, or other health professional that they have diabetes other than diabetes during pregnancy. [11] Atrial Fibrillation Hospitalization Rate per 1,000 Medicare Beneficiaries, 65+
[12] Percent of adults aged ≥18 years who report ever having been told by a doctor, nurse, or other health professional that they have kidney disease in the past year. [13] Percent of adults aged ≥ 65 years who report having lost all their natural teeth because of tooth decay or gum disease.

Table 5. Ranked County-level Age-adjusted Stroke Mortality Rates and Risk Factors for Stroke in Iowa

Legend	*Not available	0—20th Percentile	20—40th percentile	40—60th percentile	60—80th percentile	80—100th percentile

County	Stroke		Risk Factors										
	Mortality[1,2]	Rank[3]	Smoke (%)[4]	Obese (%)[5]	Binge (%)[6]	Inactive (%)[7]	HTN (%)[8]	BP Med (%)[9]	CKD (%)[10]	CHOL (%)[11]	DIAB (%)[12]	AFIB (rate)[13]	Dental (%)[14]
Plymouth	14.3	1	17.9	36.6	24.6	23.4	28.3	55.6	2.4	28.4	8.3	3.1	11.8
Jones	20.3	2	19.9	36.9	24.3	23.2	29.8	56.7	2.6	30.2	9.0	4.3	13.4
Linn	21.1	3	18.3	35.2	21.6	20.3	26.8	56.9	2.4	29.4	8.3	4.9	10.5
Johnson	21.3	4	14.5	30.8	22.6	20.2	28.5	58.1	2.5	27.8	8.6	3.5	10.4
Cerro Gordo	21.5	5	18.0	36.6	22.5	21.6	29.4	55.9	2.5	28.9	8.4	9.2	11.5
Monona	22.0	6	21.2	36.8	23.2	24.3	30.6	57.1	2.7	29.8	9.3		15.0
Benton	22.1	7	20.0	36.1	26.1	22.4	28.2	55.9	2.4	29.5	8.2	3.5	12.0
Warren	22.6	8	16.3	35.9	24.5	19.2	28.2	56.9	2.5	27.5	7.8	5.2	12.9
Cherokee	22.6	8	19.3	34.7	24.1	23.2	29.8	57.2	2.8	29.6	8.6		16.1
Dallas	22.7	10	13.2	29.4	23.7	16.1	26.2	55.8	2.2	28.4	7.0	5.2	7.8
Grundy	22.8	11	16.6	36.0	25.2	20.8	27.1	55.5	2.3	28.8	7.6	4.6	10.5
Delaware	22.9	12	19.9	39.2	25.9	23.7	29.7	55.6	2.5	29.3	8.8		13.0
Sioux	23.0	13	17.1	32.3	23.3	22.0	26.9	54.8	2.4	28.5	8.0	1.8	10.6
Calhoun	23.6	14	20.0	35.2	24.3	24.7	30.1	57.1	2.6	29.6	8.8	3.3	13.2
Woodbury	23.9	15	20.5	34.5	20.5	27.7	28.4	55.4	2.3	29.2	9.8		10.7
Chickasaw	24.0	16	19.4	35.0	25.3	23.2	28.3	56.4	2.4	30.0	8.6	3.3	13.7
Bremer	24.3	17	16.3	37.1	25.6	20.1	26.9	55.2	2.3	29.2	7.7	3.5	9.8
Mitchell	24.3	17	20.1	38.3	23.4	24.1	30.2	56.6	2.5	29.2	8.8	4.1	13.8
Hancock	24.8	19	21.1	36.0	24.0	26.1	31.2	56.0	2.4	29.4	9.3	5.8	11.7
Webster	24.8	19	18.2	35.1	23.8	22.1	28.2	57.5	2.8	29.6	8.0		16.5
Page	24.9	21	19.8	38.5	24.0	23.8	29.5	56.5	2.6	29.5	9.1	3.1	13.3
Clinton	25.1	22	20.1	34.2	26.2	25.4	30.1	56.9	2.6	29.4	9.1	10.3	15.4
Floyd	25.4	23	20.4	38.0	23.1	25.1	29.5	57.0	2.7	30.2	9.3	4.1	14.2
Palo Alto	25.5	24	20.2	37.9	24.4	25.5	29.1	56.2	2.4	29.3	8.9	2.2	11.4
Clayton	25.5	24	17.9	37.4	24.8	22.2	28.7	56.7	2.6	29.1	8.3	4.9	13.8
Story	25.6	26	15.7	32.8	23.1	20.6	29.7	56.7	2.6	31.0	9.3	6.0	10.2
Washington	25.7	27	19.7	33.0	23.6	24.3	28.3	54.4	2.3	29.7	8.6	7.1	9.8
Lyon	26.0	28	18.6	34.1	25.5	22.7	27.6	55.2	2.3	28.9	8.2	5.9	12.0
Winnebago	26.0	28	18.5	36.4	23.4	22.0	29.3	57.9	2.8	29.9	8.5		15.5
Keokuk	26.7	30	20.6	37.2	25.5	22.8	29.5	56.3	2.5	29.7	8.5		13.2
Polk	26.8	31	17.2	35.0	23.9	20.7	28.6	56.8	2.4	29.7	8.7	4.7	10.7
Harrison	26.8	31	19.7	33.9	24.1	23.7	30.8	57.6	2.5	29.6	8.7	5.2	13.3
Black Hawk	26.9	33	18.8	34.1	25.7	23.0	29.5	57.2	2.7	31.2	9.1	7.0	12.0
Scott	27.2	34	17.2	36.6	21.8	22.1	29.7	58.6	2.5	30.2	8.7	6.0	11.6
Howard	27.3	35	20.2	36.1	23.9	23.4	29.5	56.3	2.5	29.8	8.6	4.8	13.5
Butler	27.6	36	20.0	37.3	24.3	24.2	28.9	57.1	2.7	29.6	9.1	6.4	14.3

County	Stroke		Risk Factors										
	Mortality[1,2]	Rank[3]	Smoke (%)[4]	Obese (%)[5]	Binge (%)[6]	Inactive (%)[7]	HTN (%)[8]	BP Med (%)[9]	CKD (%)[10]	CHOL (%)[11]	DIAB (%)[12]	AFIB (rate)[13]	Dental (%)[14]
Fayette	27.6	36	19.0	36.8	23.8	22.5	28.3	55.8	2.4	29.0	8.4	2.7	12.0
Wright	27.6	36	20.5	39.5	24.1	25.7	29.5	56.0	2.4	29.8	9.5	6.0	12.7
Winneshiek	27.8	39	17.0	32.0	27.2	20.7	26.6	57.1	2.6	29.6	7.6	7.0	13.7
Hardin	27.9	40	18.5	35.2	23.7	22.9	30.2	56.9	2.5	29.4	8.6	6.6	12.0
O'Brien	27.9	40	19.9	34.5	23.7	24.0	29.1	55.3	2.5	29.2	8.5	4.4	12.5
Pottawattamie	28.1	42	20.7	38.6	23.7	24.8	30.1	56.7	2.5	29.6	8.8		13.1
Shelby	28.5	43	18.5	33.8	25.3	22.7	27.7	56.5	2.5	29.0	8.6	6.0	13.1
Muscatine	28.7	44	19.0	38.7	23.6	25.6	29.2	56.3	2.5	29.2	9.0		12.8
Jefferson	28.8	45	18.0	31.9	20.9	21.8	28.7	55.6	2.6	29.4	8.8	5.0	13.3
Boone	29.0	46	18.3	35.8	23.4	21.0	29.1	57.5	2.6	29.3	8.1		12.5
Cass	29.0	46	20.7	35.4	22.1	25.4	30.3	56.8	2.4	30.2	9.2	3.5	12.2
Dickinson	29.7	48	17.1	34.3	24.2	20.8	27.4	57.7	2.6	29.3	8.1		13.9
Kossuth	30.1	49	18.8	39.1	24.9	25.5	28.0	56.0	2.4	29.1	8.9	3.5	10.7
Mills	30.2	50	18.2	35.3	24.8	21.7	28.3	55.8	2.5	29.1	8.0	4.3	12.2
Cedar	30.3	51	17.8	40.0	25.2	21.9	26.8	55.7	2.4	28.7	7.9	6.3	11.7
Buchanan	30.4	52	18.6	37.2	24.4	23.0	28.4	55.1	2.3	28.6	8.4	5.3	10.3
Iowa	30.7	53	18.8	36.2	22.6	27.6	29.5	56.0	2.4	29.6	9.6	4.7	12.0
Marshall	30.7	53	20.3	36.0	23.8	24.0	29.7	56.0	2.4	29.7	9.4	3.1	12.6
Tama	30.7	53	18.6	37.8	24.4	22.7	27.1	56.2	2.6	28.2	8.4	3.8	13.9
Franklin	31.2	56	19.8	42.0	24.3	25.2	29.8	56.4	2.6	29.7	9.7	4.7	14.6
Dubuque	31.5	57	17.1	35.6	26.9	21.1	26.4	56.4	2.7	29.8	8.2	5.0	14.5
Jasper	31.8	58	19.8	37.4	24.4	22.8	28.6	56.5	2.4	29.7	8.9	6.0	11.3
Clay	32.4	59	19.4	32.9	22.9	23.5	28.8	56.6	2.5	29.9	8.6	5.9	13.1
Marion	32.9	60	17.3	37.1	22.7	22.1	26.5	55.2	2.5	28.3	8.1	5.9	12.4
Buena Vista	32.9	60	19.5	35.1	21.6	28.0	30.9	55.7	2.4	30.9	10.5	3.0	11.3
Allamakee	33.1	62	19.9	39.0	22.9	24.4	29.3	57.5	2.8	29.6	9.0		15.7
Pocahontas	33.7	63	20.9	36.1	24.1	25.0	30.5	55.9	2.6	29.9	8.9		14.9
Lee	34.0	64	21.3	36.5	25.3	24.8	30.6	56.9	2.6	30.1	9.4		14.0
Des Moines	34.4	65	21.9	35.9	24.6	24.8	30.1	56.7	2.7	29.0	9.8	5.2	15.5
Montgomery	34.6	66	21.9	37.4	23.6	25.4	31.2	58.0	2.7	30.0	9.5	6.3	14.8
Guthrie	34.8	67	19.9	37.5	25.0	24.2	29.1	57.2	2.8	29.3	8.5		15.5
Crawford	35.6	68	20.3	40.0	22.3	30.2	30.7	56.1	2.5	31.0	10.3		12.9
Poweshiek	35.7	69	18.5	40.4	23.6	23.3	28.4	57.4	2.9	29.2	8.7	3.9	17.2
Carroll	35.8	70	18.7	34.1	25.0	23.0	28.6	56.5	2.5	29.1	7.9	4.4	12.4
Jackson	35.9	71	20.3	36.0	25.3	23.3	29.8	56.2	2.4	30.1	8.8	3.4	11.5
Adair	36.3	72	20.4	35.6	24.8	23.7	29.2	56.8	2.5	30.0	8.7	6.4	13.7
Appanoose	36.5	73	21.3	41.9	22.9	25.6	30.0	56.0	2.5	30.2	9.6		13.1
Hamilton	37.1	74	17.3	35.9	24.8	22.8	28.6	57.4	2.7	29.3	8.3		15.5
Clarke	38.7	75	20.2	37.1	22.2	25.6	30.4	55.7	2.4	29.9	9.4	4.7	11.7
Mahaska	39.6	76	20.6	32.1	22.7	24.2	29.6	56.6	2.7	29.0	9.2		14.8
Wapello	40.5	77	21.9	36.2	21.0	25.0	31.6	56.7	2.6	30.8	10.1		14.1

County	Stroke		Risk Factors										
	Mortality[1,2]	Rank[3]	Smoke (%)[4]	Obese (%)[5]	Binge (%)[6]	Inactive (%)[7]	HTN (%)[8]	BP Med (%)[9]	CKD (%)[10]	CHOL (%)[11]	DIAB (%)[12]	AFIB (rate)[13]	Dental (%)[14]
Monroe	40.6	78	22.0	37.0	23.2	25.4	30.1	56.8	2.6	29.5	9.5		14.6
Osceola	41.6	79	19.6	38.1	23.8	24.6	29.5	56.1	2.7	29.4	9.0		15.5
Lucas	42.2	80	21.2	37.6	23.0	24.1	29.8	56.3	2.6	29.6	9.1		13.5
Sac	43.6	81	19.2	39.1	23.4	24.2	28.0	56.3	2.6	29.6	8.5		14.0
Davis	44.7	82	21.2	34.9	23.7	26.0	30.1	55.9	2.5	30.0	9.2	3.6	12.8
Louisa	45.5	83	20.6	35.9	22.9	27.2	29.9	57.0	2.6	29.5	9.9		15.9
Henry	50.8	84	18.7	37.2	23.5	24.3	29.3	56.2	2.7	29.0	8.9	5.6	15.7
Madison	UNR		19.9	39.0	23.6	23.4	28.7	56.6	2.5	29.3	8.4	2.4	12.6
Worth	UNR		20.2	36.7	24.5	22.9	29.6	56.0	2.3	29.8	8.6	2.7	11.0
Adams	UNR		21.9	34.7	22.4	26.2	32.1	56.1	2.4	30.7	9.7	3.1	12.7
Greene	UNR		19.3	36.9	22.6	25.8	30.4	56.1	2.5	29.9	9.1	3.3	12.7
Ida	UNR		20.7	36.9	25.2	23.4	29.1	56.3	2.5	29.1	8.6	5.6	12.9
Audubon	UNR		19.5	38.5	24.0	23.2	28.8	56.3	2.5	29.2	8.7	6.3	13.0
Fremont	UNR		19.6	34.7	22.9	24.9	29.0	56.3	2.5	30.1	8.9		13.2
Humboldt	UNR		19.7	35.0	23.9	22.8	28.9	56.5	2.6	29.4	8.3		13.3
Ringgold	SUP		17.9	36.5	23.7	22.7	28.1	56.5	2.6	29.3	7.6		13.5
Emmet	UNR		19.9	37.8	23.2	24.4	28.5	56.7	2.6	29.7	8.8		13.9
Van Buren	UNR		21.3	35.3	22.2	24.5	29.6	56.8	2.6	30.0	9.6		14.0
Taylor	UNR		21.7	36.5	22.0	25.5	29.5	56.9	2.7	29.5	9.8		14.4
Union	SUP		21.6	36.7	23.8	24.0	30.5	57.3	2.7	29.7	9.2		15.2
Decatur	UNR		23.2	43.0	23.3	27.6	30.4	57.6	2.7	30.3	10.1		15.6
Wayne	UNR		19.4	34.2	24.3	23.3	28.1	58.1	2.9	29.3	8.3		16.2

Abbreviations: HTN=hypertension, CHOL=high cholesterol, DIAB=diabetes, AFIB=atrial fibrillation, CKD=chronic kidney disease, UNR=Unreliable, SUP=suppressed
[1] Counts fewer than twenty are considered unreliable (UNR). [2] Counts fewer than ten are suppressed for confidentiality. [3] Counties are ranked based on the value of the age-adjusted stroke mortality rates. [4] Percentage of adults who are current smokers or report having smoked ≥ 100 cigarettes in their lifetime
[5] Percentage of adults that report a BMI of 30 or more. [6] Percentage of adults reporting binge drinking (women > 4 drinks, men > 5 drinks) on an occasion in the past 30 days. [7] Percentage of adults aged twenty and over reporting no leisure-time physical activity in the past month. [8] Percent of respondents who report being told by a healthcare professional that they have high blood pressure in the past year. [9] Percent of adults, age ≥ 18 who report being told by a healthcare professional that they have high cholesterol in the past five years. [10] Respondents aged ≥18 years who report ever been told by a doctor, nurse, or other health professional that they have diabetes other than diabetes during pregnancy. [11] Atrial Fibrillation Hospitalization Rate per 1,000 Medicare Beneficiaries, 65+
[12] Percent of adults aged ≥18 years who report ever having been told by a doctor, nurse, or other health professional that they have kidney disease in the past year. [13] Percent of adults aged ≥ 65 years who report having lost all their natural teeth because of tooth decay or gum disease.

Table 6. Stroke Mortality, Hospitalization, Prevalence, and Demographics by County, Iowa

Legend	*Not available	0—20th Percentile	20—40th percentile	40—60th percentile	60—80th percentile	80—100th percentile

County	Mortality (AA)[1]	Hospitalization [2]	Prevalence[3]	Median Age (yrs.)	% Over 65 Yrs.	Black (%)	Hispanic (%)	Rural (%)	Not Ins (%)	Poverty (%)	High School (%)	PCP per 1,000[4]
Johnson	17.5	9.9	2.7	29.5	10.4	5.9	5.5	18.5	9.0	17.0	4.9	276.4
Dallas	21.0	9.6	2.2	34.4	11.5	1.7	6.2	30.6	7.9	4.9	4.6	49.9
Plymouth	21.6	8.3	2.7	42.4	17.9	0.5	4.3	62.9	9.8	10.3	5.6	43.8
Story	24.1	9.6	2.8	26.5	10.8	2.7	3.1	16.9	8.9	7.3	10.0	74.4
Linn	24.9	9.9	2.6	36.9	14.7	4.6	3.0	12.7	9.0	10.0	5.3	71.3
Polk	26.0	10.1	2.7	34.8	12.0	6.5	8.2	4.9	10.4	11.8	7.9	123.0
Woodbury	26.7	11.9	3.0	35.3	13.9	2.8	15.7	17.5	12.8	13.3	14.2	83.9
Warren	27.1	10.3	2.4	38.8	15.2	0.7	2.6	42.0	8.4	16.6	12.6	56.8
Jones	31.2	10.2	2.9	43.1	19.0	2.4	1.9	58.0	10.3	10.5	7.7	43.4
Sioux	32.2	6.5	2.6	33.2	14.7	0.5	10.2	50.8	10.2	9.0	8.9	83.1
Scott	33.1	12.2	2.7	37.4	14.8	7.2	6.4	13.5	9.8	11.6	7.9	107.9
Benton	33.5	9.3	2.6	40.4	17.2	0.5	1.5	80.7	9.1	7.8	7.2	15.6
Muscatine	34.5	11.4	2.8	38.2	15.5	2.0	17.5	25.6	12.6	12.9	8.9	46.6
Black Hawk	34.5	9.1	3.0	34.6	15.2	8.8	4.2	13.5	10.3	16.1	8.9	115.6
Pottawattamie	35.2	10.4	2.9	38.6	15.9	1.6	7.5	26.4	10.9	10.9	8.6	51.3
Bremer	35.5	8.9	2.5	38.5	18.9	0.9	1.5	64.5	8.4	6.7	4.1	52.1
Delaware	35.7	7.2	2.9	41.9	18.2	0.4	1.3	71.5	9.8	9.5	8.6	70.3
Mills	36.2	9.2	2.7	41.8	16.5	0.6	2.7	59.6	9.4	11.4	8.3	73.0
Webster	36.9	10.6	3.2	40.0	17.4	4.3	4.5	33.9	11.1	17.9	10.7	57.9
Cerro Gordo	38.0	9.9	2.8	43.9	20.1	1.4	4.5	20.6	9.7	11.7	6.5	185.2
Clinton	39.0	12.1	3.0	41.8	18.6	3.2	3.1	32.2	10.2	13.5	8.3	53.7
Buchanan	40.8	9.1	2.7	39.1	16.7	0.4	1.5	68.5	9.6	10.1	7.0	33.0
Chickasaw	41.2	7.7	2.8	43.2	19.4	0.5	2.1	73.5	9.7	10.9	9.2	66.9
Jefferson	41.9	10.0	2.8	44.3	19.7	1.8	3.4	38.7	10.4	14.0	5.2	76.2
Hancock	42.0	9.5	2.7	44.8	20.3	0.7	3.9	70.0	9.5	8.8	6.6	28.0
Washington	42.4	8.9	2.8	42.0	18.7	0.8	5.8	69.5	10.6	6.8	4.3	67.8
Harrison	43.5	9.1	2.8	43.1	19.6	0.3	1.3	81.1	9.7	10.9	8.0	49.5
Grundy	43.7	8.9	2.5	42.3	19.9	0.4	1.3	100.0	8.5	6.3	4.8	24.4
Floyd	45.1	8.7	3.1	43.7	21.3	2.3	2.4	52.7	10.7	12.9	10.1	44.4
Boone	45.3	9.3	2.7	40.7	17.3	1.1	2.5	50.6	9.0	9.2	6.2	64.5
Dubuque	45.5	11.7	2.7	38.8	16.5	3.1	2.3	27.0	9.3	10.5	7.7	88.8
Marshall	45.8	8.9	3.0	38.9	17.7	1.7	20.7	33.9	14.2	12.2	14.9	55.0
Lyon	46.0	9.6	2.6	38.0	17.2	0.2	2.7	100.0	9.7	7.3	9.4	33.9
Marion	46.3	6.1	2.7	38.6	16.7	0.9	1.9	48.7	9.3	8.5	6.8	104.8
Cherokee	46.4	6.0	2.8	47.2	23.4	0.8	3.5	61.4	9.7	10.9	9.3	61.8
Howard	46.9	6.4	2.9	42.2	20.0	0.8	1.6	63.0	10.2	9.8	10.4	54.4

County	Mortality (AA)[1]	Hospitalization [2]	Prevalence[3]	Median Age (yrs.)	% Over 65 Yrs.	Black (%)	Hispanic (%)	Rural (%)	Not Ins (%)	Poverty (%)	High School (%)	PCP per 1,000[4]
Monona	46.9	7.2	3.1	46.8	24.9	0.4	1.8	71.2	10.3	10.1	9.5	80.7
Keokuk	47.1	9.0	2.9	44.0	20.4	0.6	1.5	100.0	10.1	12.0	7.7	19.6
Clayton	48.7	7.2	3.0	45.0	21.4	0.6	1.8	96.6	10.2	9.9	8.8	34.2
Buena Vista	49.0	6.3	3.1	36.5	15.0	2.7	24.6	43.9	15.8	12.1	20.6	45.3
Winneshiek	49.4	5.5	2.5	40.6	18.7	0.7	2.2	59.0	8.4	10.5	8.4	124.8
Fayette	49.5	7.7	3.0	42.6	20.6	1.2	2.3	70.6	10.3	12.8	9.0	35.6
Lee	50.3	13.0	3.1	42.8	19.1	2.9	3.4	40.6	11.0	14.0	7.7	61.7
Page	50.4	8.6	2.9	43.8	20.8	2.5	2.9	33.4	10.5	10.5	12.6	78.7
Jasper	50.5	9.3	2.8	42.1	18.3	1.8	2.1	57.5	10.2	10.1	6.9	40.4
Winnebago	51.0	8.9	2.7	43.8	20.4	1.5	4.2	66.1	9.9	14.3	8.6	47.5
Mitchell	52.1	8.1	2.9	44.6	21.5	0.8	1.4	67.2	10.4	8.8	7.4	28.4
Hardin	52.1	8.9	2.8	44.0	21.2	1.5	4.3	71.1	9.9	11.0	8.2	47.4
Crawford	52.5	7.4	3.3	39.1	17.1	2.2	27.4	51.8	17.0	14.1	21.3	23.3
Calhoun	52.8	7.0	2.9	47.4	22.4	2.0	1.9	100.0	10.0	12.4	7.0	82.5
Butler	53.8	9.1	2.7	43.5	21.4	0.3	1.2	100.0	9.4	9.8	7.6	20.6
Cass	53.9	6.1	3.0	44.8	21.9	0.3	2.4	53.6	10.6	12.8	10.6	54.1
Tama	54.2	8.6	3.0	42.2	19.6	0.5	8.5	72.4	11.2	19.2	3.2	29.6
Cedar	55.3	11.0	2.6	42.8	18.7	0.5	1.7	83.4	8.7	6.6	5.8	26.8
Iowa	56.4	10.1	2.7	42.1	18.3	0.6	2.5	82.2	9.4	7.2	7.5	68.2
Palo Alto	57.1	8.4	2.7	42.9	21.6	0.7	2.4	61.5	9.1	14.7	10.2	33.6
Dickinson	57.3	7.9	2.6	48.4	24.6	0.4	1.8	35.0	8.3	7.8	4.4	75.8
Wapello	57.5	11.1	3.2	39.8	16.9	2.2	10.5	30.5	12.6	14.5	12.4	59.7
Des Moines	58.0	13.5	3.0	41.8	19.4	5.8	3.2	26.7	10.6	16.1	8.0	71.5
Franklin	58.1	8.9	3.0	43.4	20.3	0.5	12.0	60.2	11.7	11.6	10.8	29.6
Clay	58.5	10.9	2.8	42.6	19.5	0.7	3.3	34.3	9.8	9.1	6.6	86.8
Allamakee	60.1	5.7	2.9	44.4	21.9	1.3	5.5	74.0	11.0	13.2	13.1	57.8
Clarke	60.2	7.3	3.1	41.0	18.2	0.8	12.0	48.1	12.5	11.6	9.4	31.8
Jackson	60.6	11.5	2.9	44.1	20.1	0.6	1.4	53.3	9.8	13.0	8.5	41.2
Shelby	60.7	6.4	2.8	46.2	22.4	0.5	3.0	59.4	9.7	13.4	7.6	51.8
Louisa	60.8	12.4	3.1	39.7	17.0	0.9	16.2	100.0	13.9	11.4	18.5	9.0
Guthrie	61.8	8.0	2.8	45.1	21.6	0.4	2.3	100.0	9.7	9.9	7.6	37.3
Poweshiek	62.6	8.5	2.8	40.9	19.5	1.5	3.3	52.0	10.0	10.3	10.3	96.3
Mahaska	62.8	6.6	3.0	39.3	17.2	1.4	2.1	43.9	10.5	12.3	8.1	68.2
O'Brien	62.9	8.2	2.8	44.0	20.8	0.7	4.6	66.3	10.2	10.8	13.0	65.0
Monroe	63.0	5.8	3.1	42.3	19.1	0.7	2.4	55.2	11.0	12.8	8.9	51.4
Kossuth	63.3	7.2	2.8	46.8	22.6	0.7	2.1	65.6	9.6	11.4	5.1	60.4
Appanoose	63.8	9.2	3.2	44.6	21.6	0.7	1.7	58.3	10.6	18.7	10.4	96.5
Hamilton	64.6	8.6	2.7	42.0	19.7	0.7	5.8	50.5	9.9	9.3	7.4	40.1
Davis	65.7	8.3	3.1	38.0	17.7	0.2	1.2	100.0	11.5	12.9	14.7	44.4
Wright	67.0	8.8	3.0	44.6	21.7	0.6	10.5	56.8	37.3	12.6	9.5	39.4
Montgomery	68.0	7.2	3.2	45.2	21.2	0.4	3.5	47.9	11.2	12.5	9.8	60.0
Pocahontas	68.5	9.2	3.0	47.4	22.5	0.9	3.8	100.0	10.5	8.4	7.4	29.7

County	Mortality (AA)[1]	Hospitalization [2]	Prevalence[3]	Median Age (yrs.)	% Over 65 Yrs.	Black (%)	Hispanic (%)	Rural (%)	Not Ins (%)	Poverty (%)	High School (%)	PCP per 1,000[4]
Carroll	70.3	7.0	2.7	42.2	19.5	0.9	2.3	52.0	9.3	8.8	7.4	99.2
Lucas	71.6	5.8	3.0	44.3	21.3	0.3	1.6	56.2	10.2	14.9	7.3	69.4
Osceola	74.9	8.0	2.9	43.7	20.5	0.3	7.2	58.4	11.0	10.1	7.6	33.1
Henry	77.0	9.0	2.9	40.3	18.3	2.3	4.7	57.1	10.6	12.4	7.9	74.8
Adair	77.1	7.4	2.8	45.6	22.6	0.2	1.6	100.0	9.9	10.7	6.0	42.5
Sac	92.3	6.8	2.8	46.5	22.5	0.3	2.8	100.0	9.5	14.3	8.0	82.3
Fremont	UNR	8.0	2.9	46.0	21.7	0.5	2.6	100.0	9.7	11.6	7.2	14.3
Taylor	UNR	7.4	3.1	44.4	20.8	0.4	8.1	100.0	11.8	12.1	8.9	16.2
Decatur	UNR	10.2	3.3	38.3	18.5	1.8	2.7	100.0	11.2	20.0	14.0	25.4
Worth	UNR	11.9	2.7	44.0	20.1	0.8	2.9	100.0	34.0	8.9	7.7	26.8
Adams	UNR	7.0	2.8	46.9	22.5	0.3	1.1	100.0	9.5	12.3	6.2	27.4
Ida	UNR	4.7	2.8	46.5	22.1	0.4	2.2	100.0	9.7	10.2	6.4	29.2
Humboldt	UNR	10.0	2.9	44.1	20.6	0.5	3.9	46.6	10.4	10.0	8.2	31.4
Madison	UNR	9.7	2.6	40.1	16.5	0.4	1.6	67.8	8.9	7.8	5.6	55.4
Greene	UNR	8.0	2.8	45.1	21.9	0.4	2.7	58.2	9.9	11.2	7.7	55.7
Wayne	UNR	6.3	3.3	45.3	22.1	0.4	1.7	100.0	11.4	9.9	8.6	62.5
Emmet	UNR	5.7	3.0	40.5	20.0	0.8	9.4	39.9	11.2	10.9	10.3	64.8
Audubon	UNR	6.8	2.9	47.1	24.5	0.3	1.0	100.0	9.8	11.1	9.5	72.7
Union	UNR	5.2	3.1	41.3	19.4	1.0	2.9	39.2	10.8	12.3	9.0	80.9
Van Buren	UNR	9.1	3.0	44.1	20.9	0.3	1.3	100.0	10.3	13.2	8.7	99.7
Ringgold	UNR	6.5	2.9	46.0	24.6	0.4	2.1	100.0	10.1	11.0	7.3	120.8

Abbreviations: Ins=insured, PCP=primary care providers, UNR=unreliable. [1]Age-adjusted stroke mortality (ICD 10: I60—I61, I63—I64) per 100,000 population [2] Rate of Medicare Beneficiaries hospitalized for stroke per 10,000. [3] Prevalence of individuals reporting ever had a stroke. [4] Number of primary care providers per 100,000 population.

DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF STROKE PATIENTS BY STROKE TYPE

Table 7. Demographics of Stroke Patients by Type of Stroke Reported to the Iowa Stroke Registry Between 2013 and 2017

Demographic Characteristic	Patients With Acute Stroke by Type, %			
	SAH (n =720)	ICH (n=2542)	IS (n=14 473)	NOS (n=1018)
Male sex	40.8%	51.2%	51.2%	46.4%
Age, median (IQR), year	61 (51—72)	73 (62—82)	72 (61—82)	74 (63—84)
Age Group				
Less than 55 years	35.9%	14.0%	13.8%	12.1%
55—64 years	22.1%	16.6%	18.2%	17.6%
65—74 years	21.6%	21.4%	23.1%	21.8%
75+ years	20.5%	48.0%	45.0%	48.5%
Race/Ethnicity				
Hispanic	3.2%	2.4%	1.7%	2.3%
White, non-Hispanic	89.0%	88.5%	91.6%	88.2%
Black, non-Hispanic	3.2%	4.2%	3.3%	4.8%
Other	4.7%	4.9%	3.4%	4.8%
Type of Insurance Coverage				
Medicare	25.1%	39.9%	44.1%	55.3%
Medicaid	11.5%	6.2%	5.6%	2.3%
Private/Other	40.5%	22.5%	22.2%	18.3%
No insurance	1.9%	1.8%	1.7%	3.1%
Not documented	2.3%	1.8%	0.9%	0%
More than one type	18.8%	27.9%	26.4%	21.0%

Abbreviations: SAH=subarachnoid hemorrhage, ICH=intracerebral hemorrhage, IS=ischemic stroke, NOS=stroke, not otherwise specified, IQR=interquartile range.

- Individuals who experience a **SAH** have higher proportions of female, Hispanic, and younger individuals. In addition, this population reports higher percentages of patients covered by private insurance and Medicaid, reflecting a younger population.
- **Intracerebral hemorrhage** and **ischemic stroke** tend to affect those who are older.

Table 8. Admission Clinical Characteristics of Stroke Patients by Stroke Type

Characteristic	Stroke Type, %			
	SAH (n =720)	ICH (n=2542)	IS (n=14473)	NOS (n=1018)
BMI, kg/m^2, median (IQR)	27.2 (23.4—31.6)	27.1 (23.4—27.1)	28.1 (24.4—32.7)	27.1 (23.3—32.4)
BMI categories				
Underweight	3.3%	4.5%	2.8%	4.9%
Normal	32.1%	30.0%	25.8%	31.3%
Overweight	30.8%	31.1%	32.6%	27.1%
Class 1 obese	20.2%	19.4%	22.3%	21.9%
Class 2 obese	8.0%	9.0%	9.7%	9.4%
Class 3 obese	5.6%	6.0%	6.9%	5.6%
Systolic blood pressure, median (IQR)	143 (126—161)	153 (136—171)	152 (134—170)	152 (137—174)
Diastolic blood pressure, median (IQR)	81 (71—92.5)	83 (72—96)	83 (72—94)	81 (70—92)
Blood Pressure Categories				
Normal	13.4%	8.0%	8.3%	8.8%
Elevated	7.8%	5.3%	5.9%	2.8%
Stage 1 HTN	14.6%	11.7%	13.7%	14.9%
Stage 2 HTN	52.8%	53.6%	54.2%	51.9%
Hypertensive urgency	11.4%	21.5%	17.9%	21.6%
Blood glucose, mg/dL, median (IQR)	138 (113—174)	125 (105—158)	117 (101—150)	112.5 (98—141)
Glycemia Class				
Hypoglycemic	1.2%	1.2%	2.0%	2.9%
Normal	55.2%	64.7%	65.5%	68.6%
Hyperglycemic, diabetes history	12.1%	17.0%	24.3%	21.5%
Hyperglycemic, no diabetes history	0.8%	0.4%	0.3%	1.7%
Hyperglycemic, diabetes history unknown	30.6%	16.8%	7.9%	5.2%
NIHSS, median (IQR)	2 (0—13)	6 (2—16)	3 (1—8)	3 (1—7)
NIHSS categories				
0-No symptoms reported	33.3%	18.6%	23.9%	16.4%
1—4 Mild stroke	44.4%	27.1%	42.9%	45.8%
5—15 Moderate stroke	11.1%	34.8%	25.5%	26.6%
16—20 Moderate to severe stroke	11.1%	10.2%	4.0%	5.6%
21—42 Severe stroke	0%	9.3%	3.8%	5.6%

Abbreviations: SAH=subarachnoid hemorrhage, ICH=intracerebral hemorrhage, IS=ischemic stroke, NOS=stroke, not otherwise specified, IQR=interquartile range, HTN=hypertension, NIHSS=National Institute Health Stroke Scale.

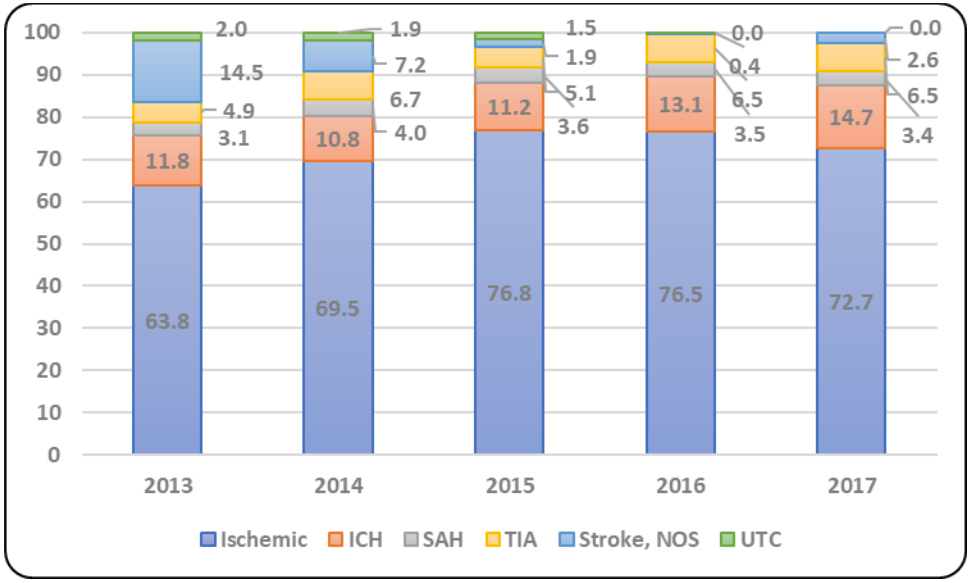


Figure 45. Yearly Trends in the Distribution of Stroke Types Reported to the Iowa Stroke Registry, 2013 – 2017

Abbreviations: ICH=intracerebral, SAH=subarachnoid, TIA=transient ischemic attack, NOS=not otherwise specified, UTC=unable to classify.

- The proportion of **ischemic** and **intracerebral** hemorrhagic strokes have increased. These increases are likely due to improvements in the specificity of diagnoses (fewer **strokes, not otherwise specified**, and **strokes, unable to be classified**).
- These proportions reflect what is reported by PSCs and the CSC and may not accurately represent the distribution of strokes in Iowa.

Table 9. Reported Past Medical History, Medication History, and Symptoms by Stroke Type

Characteristic	SAH n=168	ICH n=1042	IS n=9144	NOS n=837
Past Medical History	%	%	%	%
Not reported[1]	19.6	13.3	5.6	27.1
Atrial fibrillation	10.7	13.5	14.0	5.0
Carotid stenosis	0.0	1.0	2.7	0.8
Depression	1.2	1.7	1.4	0.2
Diabetes	14.3	16.1	19.9	9.0
Drug or alcohol abuse	6.0	4.5	3.8	0.7
Dyslipidemia	21.4	28.6	31.3	12.4
Family stroke	1.8	3.1	5.1	1.0
Heart failure	4.2	4.8	5.2	1.8
Hypertension	41.1	53.1	46.8	22.0
MI or CAD	13.7	16.0	15.7	8.1
Migraine	1.2	1.5	1.9	0.5
Obesity	2.4	4.2	5.4	2.3
PAD	1.2	2.5	2.6	0.5
Prior stroke	6.0	13.1	14.5	9.2
Renal disease	4.8	3.6	4.2	1.4
Sickle cell anemia[2]	0.0	0.0	0.9	0.0
Sleep apnea	0.0	0.5	0.4	0.1
Smoking	19.0	13.4	20.6	14.8
TIA	3.6	3.8	5.4	3.5
Valve prosthesis	0.0	0.7	0.8	0.0
Medication history[3]				
Anticoagulant	7.7	12.7	7.2	3.2
Antidepressant	5.4	9.6	8.1	2.6
Antihypertensive	39.9	52.4	49.7	21.0
Antiplatelet	19.0	30.4	33.8	9.3
Antithrombotic	0.6	0.6	0.6	4.7
HRT[4]	1.3	0.9	0.4	0.2

Characteristic	SAH n=168	ICH n=1042	IS n=9144	NOS n=837
Symptoms	**%**	**%**	**%**	**%**
Not reported[1]	**51.8**	**37.9**	**51.6**	**71.0**
Altered LOC	**32.7**	**30.7**	**11.8**	**5.5**
Aphasia	**8.3**	**23.0**	**18.1**	**8.0**
Dizziness	**0.0**	**1.8**	**2.1**	**1.1**
Headache	**7.7**	**3.6**	**1.6**	**1.7**
Imbalance	**2.4**	**1.6**	**2.6**	**2.9**
Incoordination	**1.2**	**0.5**	**0.5**	**0.7**
Nausea	**2.4**	**2.4**	**0.7**	**0.2**
Posterior circulation	**0.0**	**0.1**	**0.8**	**0.8**
Sensory	**1.2**	**1.0**	**2.4**	**0.7**
Speech	**1.8**	**4.6**	**6.4**	**6.1**
Visual changes	**1.2**	**0.7**	**1.6**	**1.4**
Weakness/paresis	**17.9**	**44.4**	**36.5**	**22.6**

Abbreviations: SAH=subarachnoid hemorrhage, ICH=intracerebral hemorrhage, IS=ischemic stroke, NOS=stroke, not otherwise specified, MI=myocardial infarction, CAD=coronary artery disease, PAD=peripheral artery disease, TIA=transient ischemic attack, HRT=Hormone replacement therapy, LOC=level of consciousness. [1]The percentage of observations where no past medical history or symptoms are reported. Symptoms, past medical history, and medication history are not mandatory variables and should be interpreted with caution. Potential explanations include missing data or a true absence of a past medical history or symptoms. Both are likely under-reported and may not represent a valid description of medical histories or symptoms. In addition, patients with more severe alterations in consciousness may be unable to be assessed for other symptoms. [2]Denominator includes those who identify as Black or African American only. [3] Patients adherence to medication is not assessed. Interpretation should proceed with caution.
[4]Denominator includes females only.

Past medical history:

- **Hypertension** was the most frequently reported past medical history for all types of strokes, followed by **dyslipidemia**.
- **Diabetes** was the third most reported past medical history for ischemic strokes and intracerebral hemorrhages. In contrast, smoking was the third most documented past medical history in patients with subarachnoid hemorrhages.

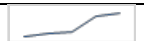
Medication history:

- A medication history of **anti-hypertensive medications** was the most often reported medication history for all types of strokes.

Reported symptoms on admission:

- The most reported symptoms for all stroke types were **altered LOC**, **aphasia**, and **weakness/paresis**.
- **Altered LOC** was the most reported symptom in subarachnoid hemorrhages.
- **Weakness** was the most reported symptoms for intracerebral hemorrhages and ischemic strokes.

Table 10. Trends in the Reported Medical History, ISR, 2013—2017.

Characteristic	2013 (n=3103)	2014 (n=3073)	2015 (n=3591)	2016 (n=3703)	2017 (n=4192)	Avg % change	P-value (Trend)	Trend
Medication history								
Anticoagulant	7.2%	7.4%	7.5%	8.2%	8.4%	13.7	0.0105	
Antidepressant	0.1%	5.6%	8.7%	12.5%	11.9%	3970.5	<.0001	
Antihypertensive	40.7%	38.6%	40.4%	51.9%	53.9%	28.7	<.0001	
Antiplatelet	29.3%	30.7%	31.9%	34.3%	36.8%	17.6	<.0001	
Cholesterol-lowering	36.7%	35.4%	35.1	37.0	38.6	1.9	0.013	
Hormone-replacement	0.2%	0.5%	0.5%	0.5%	0.4%	171.5	0.4766	
Medical history								
Atrial Fibrillation	12.6%	13.6%	11.4%	12.3%	11.8%	-1.3	0.0672	
Carotid Stenosis	3.7%	3.7%	3.8%	3.3%	2.4%	-15.8	0.0002	
Depression	0.2%	1.2%	2.7%	0.5%	0.2%	426.4	0.0166	
Diabetes	18.5%	17.1%	16.8%	19.2%	20.5%	6.1	0.0004	
Drug or alcohol use	2.9%	3.5%	3.7%	4.6%	5.0%	51.7	<.0001	
Dyslipidemia	29.5%	28.1%	26.2%	28.9%	28.3%	-1.7	0.5162	
Family History of Stroke	4.1%	5.1%	4.2%	3.3%	3.3%	-13.5	0.0002	
Heart Failure	4.3%	4.5%	4.2%	4.8%	5.1%	12.4	0.0684	
Hypertension	18.3%	17.3%	20.0%	20.3%	24.1%	15.4	<.0001	
MI or CAD	15.6%	15.6%	14.0%	15.1%	16.6%	-0.5	0.2936	
Migraines	1.7%	2.1%	2.1%	2.4%	2.1%	33.4	0.1127	
Obesity	4.8%	4.8%	4.7%	4.8%	5.7%	4.8	0.0592	
Peripheral artery disease	2.8%	2.6%	2.6%	2.6%	3.0%	-5.2	0.6397	
Prior stroke	12.7%	12.4%	11.9%	12.3%	13.6%	-1.2	0.2380	
Renal disease	3.8%	3.4%	3.3%	4.0%	4.0%	7.6	0.2687	
Smoking	14.6%	16.5%	17.9%	20.3%	16.3%	31.0	0.0002	
TIA	4.8%	4.8%	5.0%	4.3%	5.1%	-6.1	0.9329	
Valve prostheses	0.6%	1.0%	0.8%	0.9%	0.9%	56.1	0.2102	

Legend: ▲ Significant increase ▲ Non-significant Increase ▼ Non-significant decrease ▼ Significant decrease

Abbreviations: Avg=average, MI=myocardial infarction, CAD=coronary artery disease, UNR= unreliable, TIA=transient ischemic attack. Arrows indicate the overall trend. Note: Under trend, the line graph reflects visual trends in reported percentages over time. The vertical axes differ by variable.

AGE AND GENDER DISTRIBUTION BY STROKE TYPE

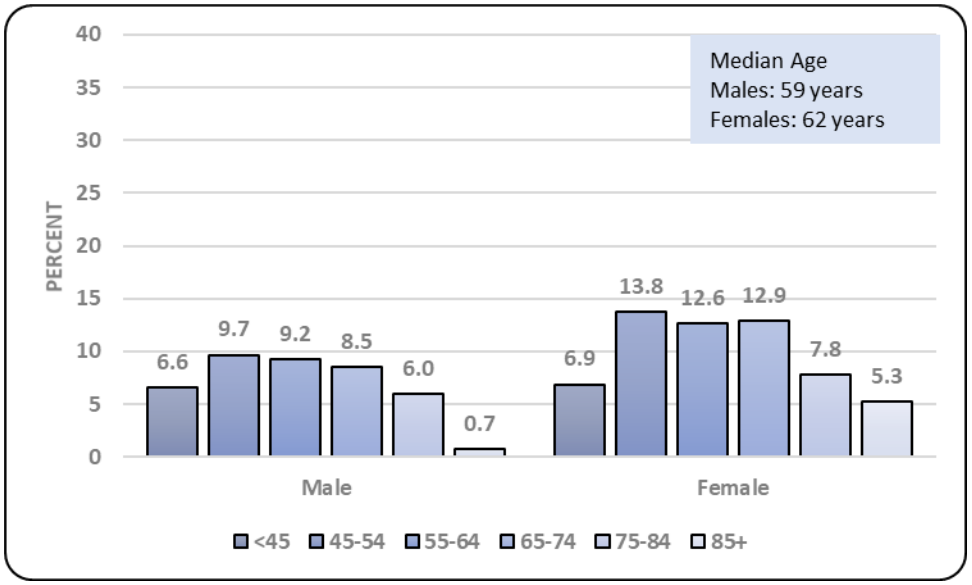


Figure 46. Age Distribution by Gender for Subarachnoid Hemorrhages

- More **females** (59.2%) than **males** (40.8%) suffer subarachnoid hemorrhages.
- The age distributions appear similar between **males** and **females**.

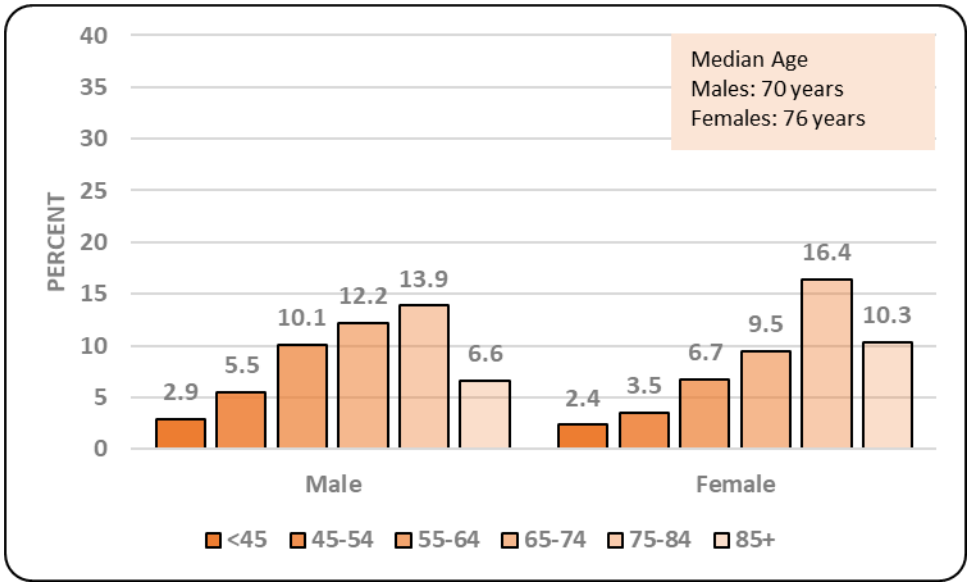


Figure 47. Age Distribution by Gender for Intracerebral Hemorrhages

- More **males** (51.3%) experience intracerebral hemorrhages than **females** (48.8%).
- **Males** tend to experience intracerebral hemorrhages at younger ages than **females**.

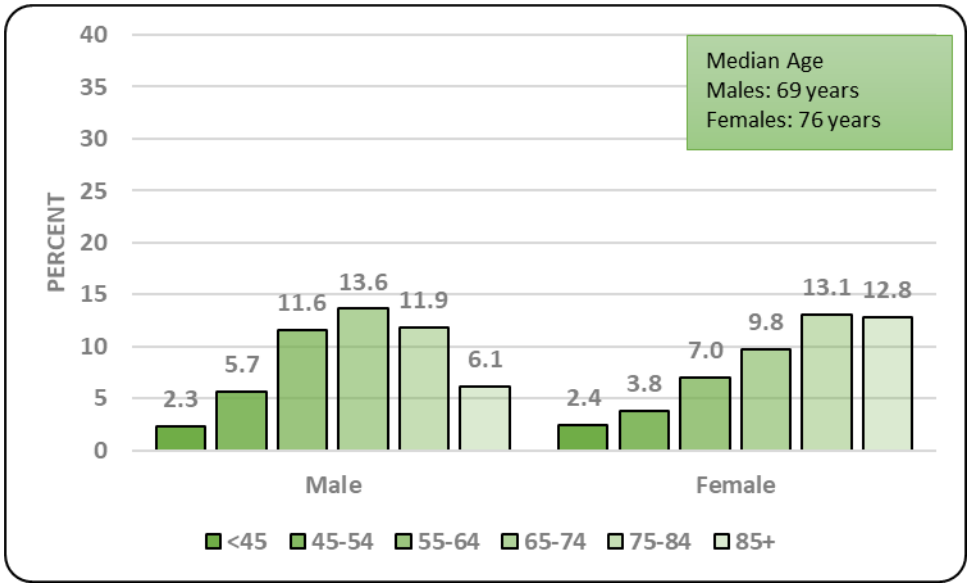


Figure 48. Age Distribution by Gender for Ischemic Strokes

- More **males** than **females** experience ischemic strokes (51.2% versus 48.8%).
- **Males** tend to sustain ischemic strokes at younger ages than **females**.

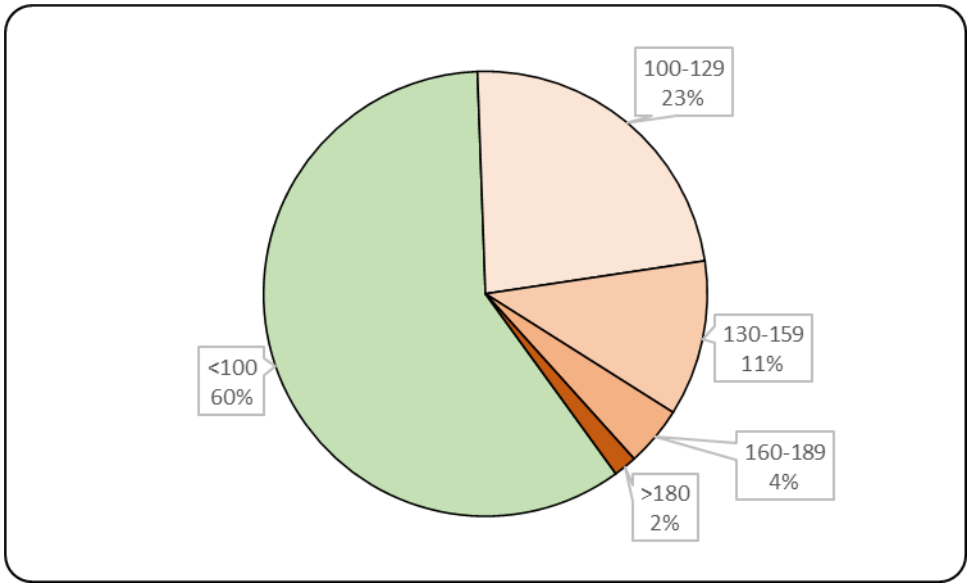


Figure 49. LDL Classification of Patients with Acute Ischemic Stroke

Abbreviations: LDL=low-density lipoproteins.

- Most ischemic stroke patients (60%) have **LDL** <100 mg/dL.

PLACE OF OCCURRENCE

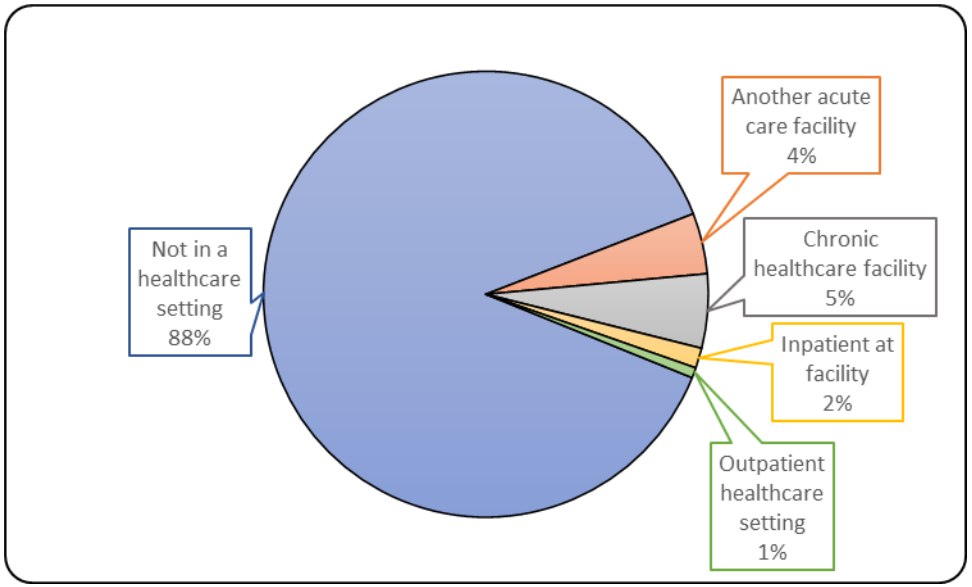


Figure 50. Distribution of Place Where Stroke Occurred

- Most strokes occur at **home** or outside a **healthcare facility**.

MODE OF ARRIVAL

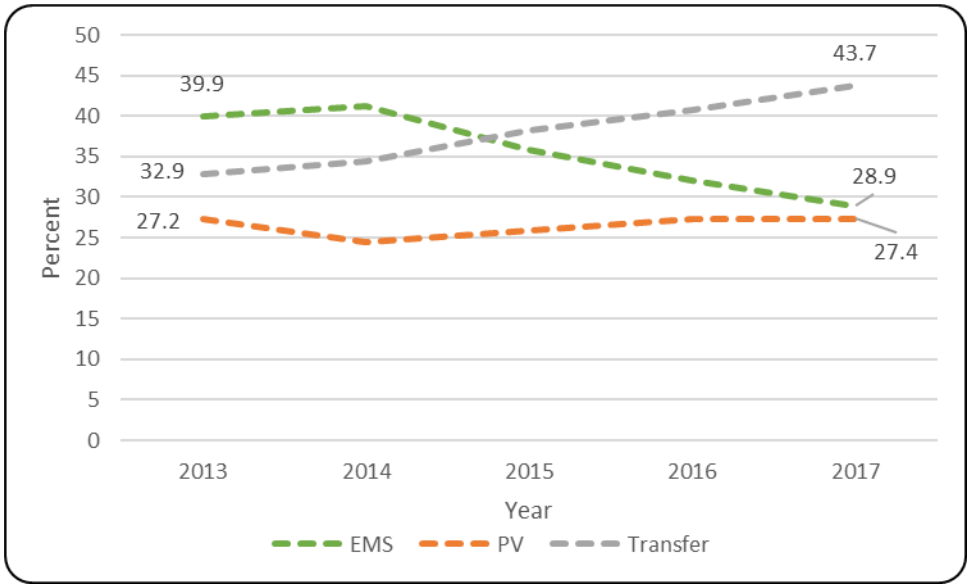


Figure 51. Yearly Trends in the Mode of Arrival

Abbreviations: EMS=Emergency Medical Services, PV=private vehicle

- The proportion of patients arriving by **EMS** has declined approximately 28% over time while the proportion of **transfers** has increased by a similar percent, possibly reflecting stroke severity. These are not mutually exclusive categories so interpretation of trends should be made with caution.

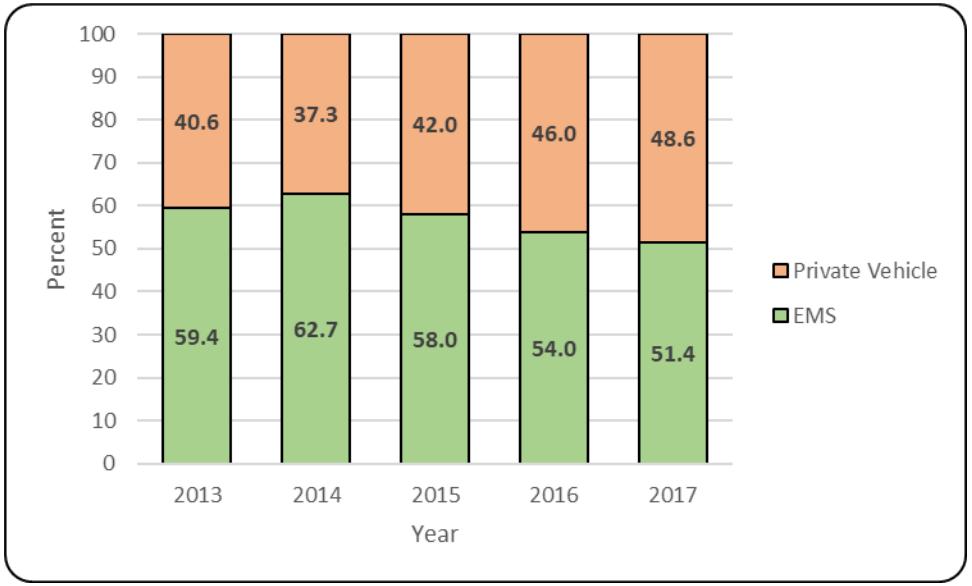


Figure 52. Yearly Trends in the Mode of Arrival Among Nontransferred Patients

Abbreviations: EMS=emergency medical systems.

- The proportion of patients who arrive by **EMS** has decreased 13.6% since 2013 from 59.4% to 51.4% (p-trend <.0001).

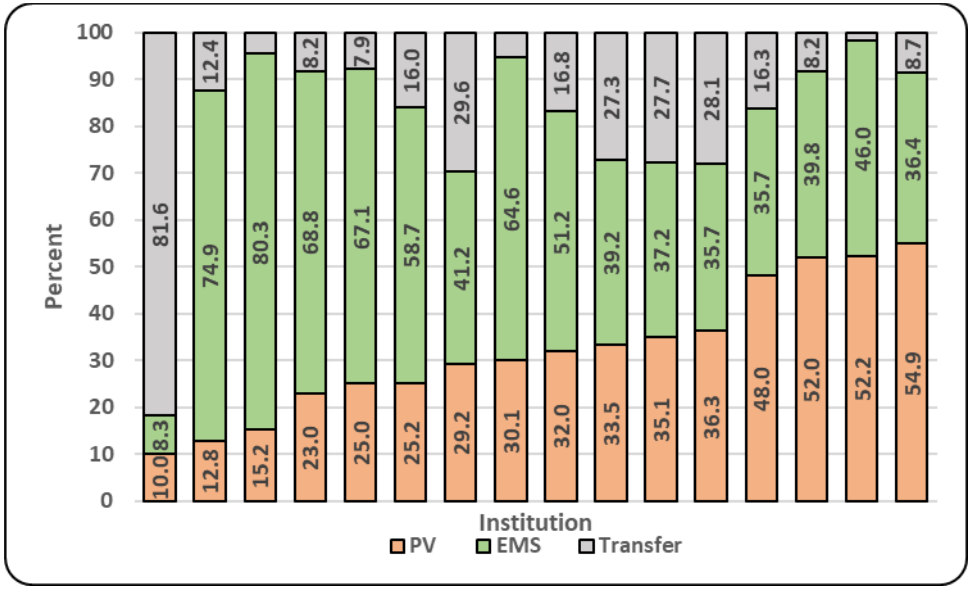


Figure 53. Arrival Mode by Institution, 2013 – 2017

*Abbreviations: EMS=Emergency Medical Services, PV=private vehicle. *This figure does not name individual institutions.*

- There is substantial variability in the **arrival mode** among institutions.
- Institutional variability may be explained factors such as rurality, access to professional EMS services, and the type of specialized care provided.

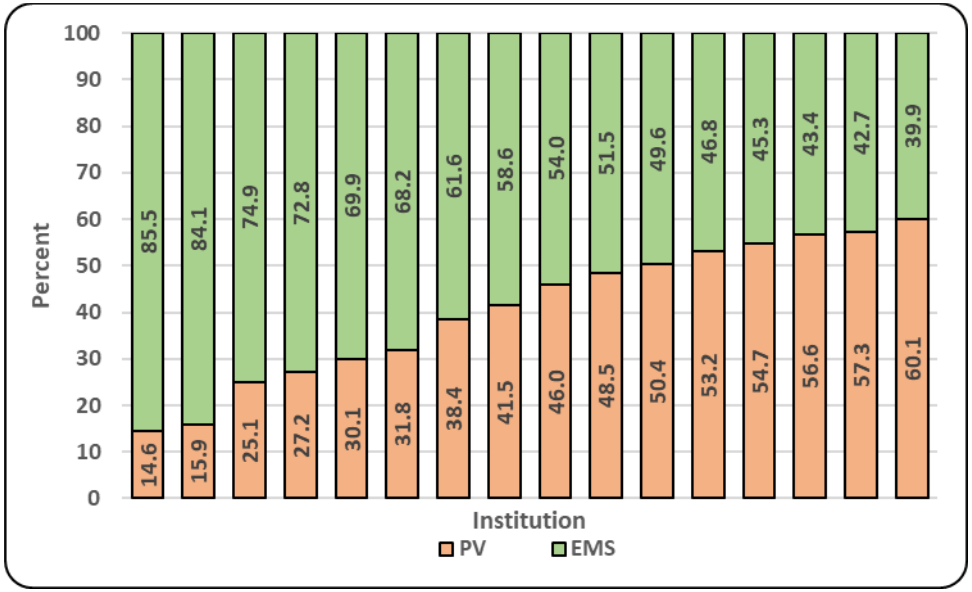


Figure 54. Comparison of Arrival Modes Among Institutions in Nontransferred Patients, 2013—2017

*Abbreviations: PV=private vehicle, EMS=Emergency Medical Services. *This figure does not identify individual institutions. *Two hospitals do not report data for modes of arrival.*

- There is substantial variability in the **arrival mode** among institutions.

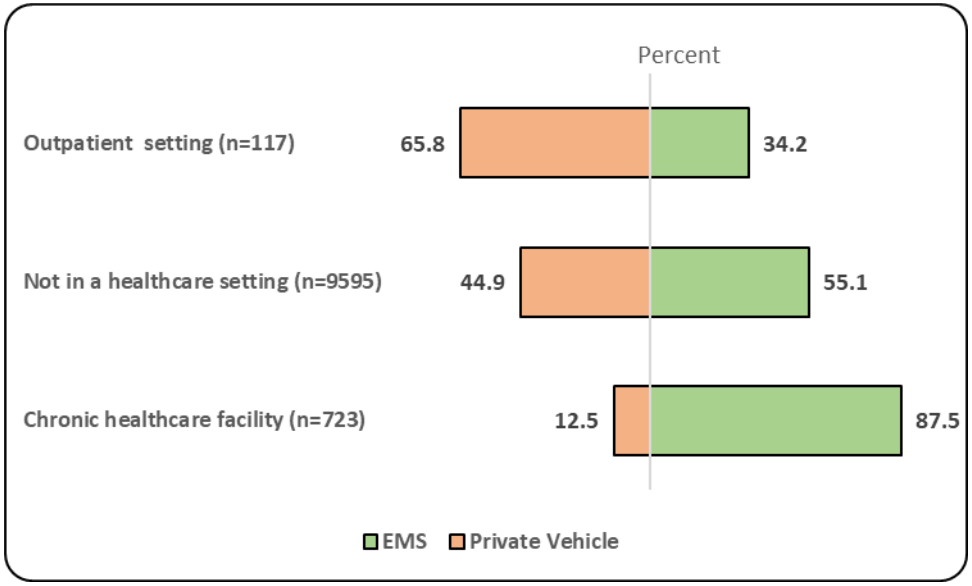


Figure 55. Comparison of Mode of Arrival According to the Place Where Stroke Occurred, ISR 2013 - 2017

Abbreviations: EMS=Emergency Medical Services

**Excludes patients who were transferred from another acute care hospital and inpatient strokes*

Of the 10,435 patients first evaluated for stroke at primary and comprehensive centers, with data on arrival mode and location where stroke occurred:

- For those outside the **healthcare setting**, more patients arrive by EMS (55.1%) than by private vehicle (44.9%).
- For those strokes occurring in **chronic healthcare facilities**, more arrive using EMS (87.5%) than private vehicle (12.5%).
- Of particular concern is the proportion of patients in an **outpatient setting** who arrive by private vehicle (65.8%).

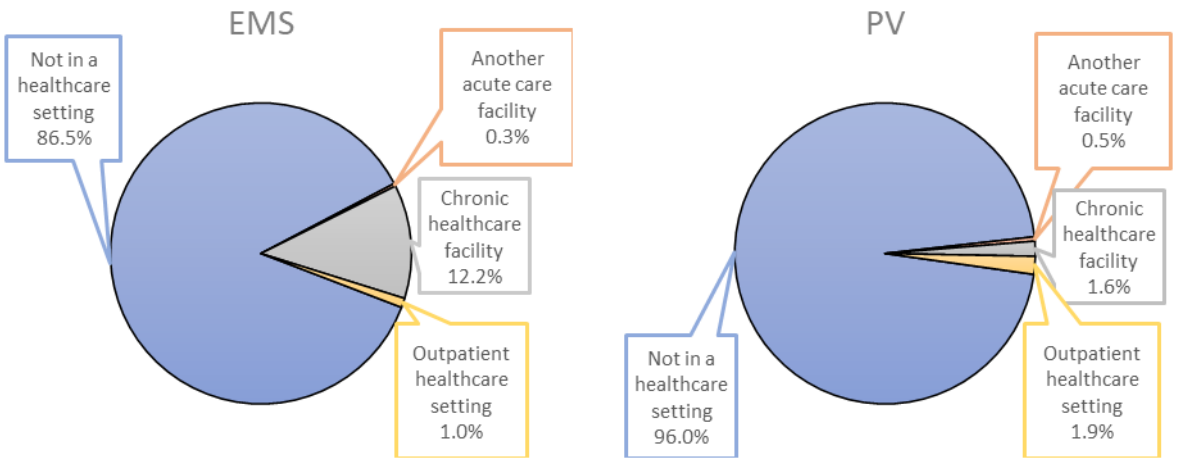


Figure 56. Comparison of the Distribution of Place Where Stroke Occurred by Mode of Arrival

Abbreviations: EMS=emergency medical services, PV=private vehicle

- Admissions from strokes occurring at **chronic healthcare** facilities make up a larger portion of transports by **EMS** than by **private vehicle** (12.5% versus 1.6%).

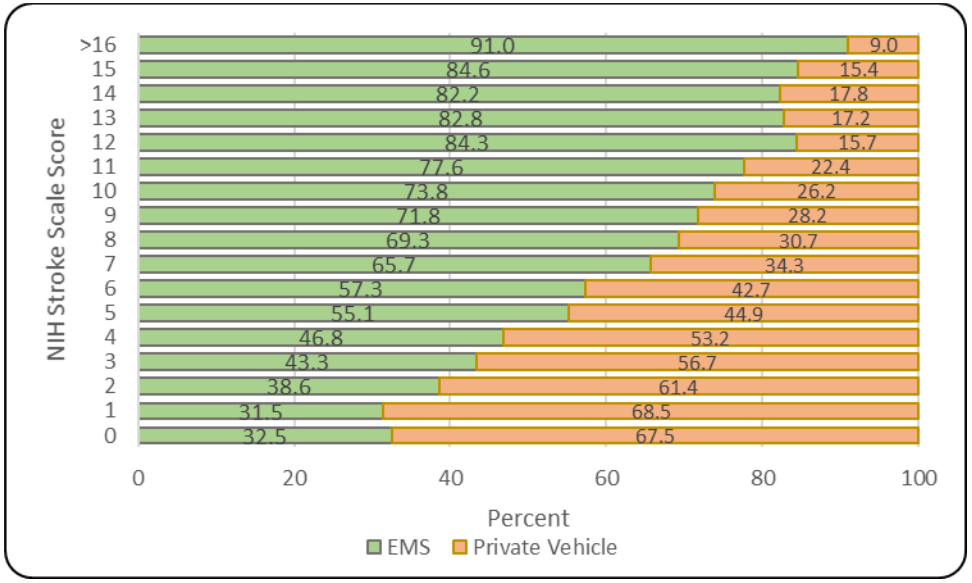


Figure 57. Arrival Mode by NIH Stroke Scale Score

Abbreviations: EMS=emergency medical services, PV=private vehicle

- There is an increasing trend in proportion of patients arriving by **EMS** as **NIH Stroke Scale** increases.

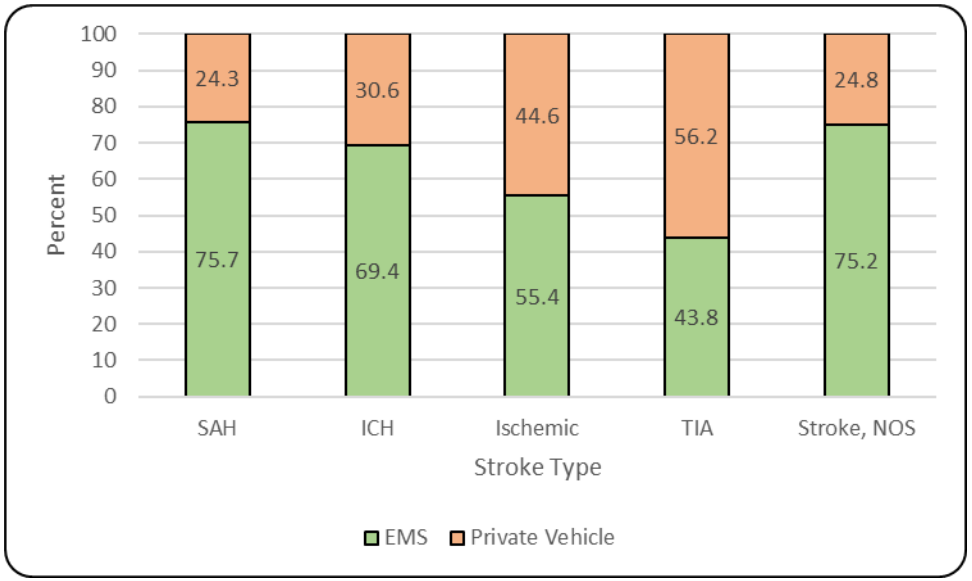


Figure 58. Arrival Mode by Stroke Type

Abbreviations: SAH=subarachnoid hemorrhage, ICH=intracerebral hemorrhage, TIA=transient ischemic attack, NOS=not otherwise specified, EMS=emergency medical services.

- The proportion of patients who arrive by **EMS** varies according to the type of stroke.
- Hemorrhagic strokes have higher proportions of patients who arrive by **EMS**.
- Smaller percentages of patients diagnosed with TIA, arrive by **EMS**. This may reflect severity of stroke.

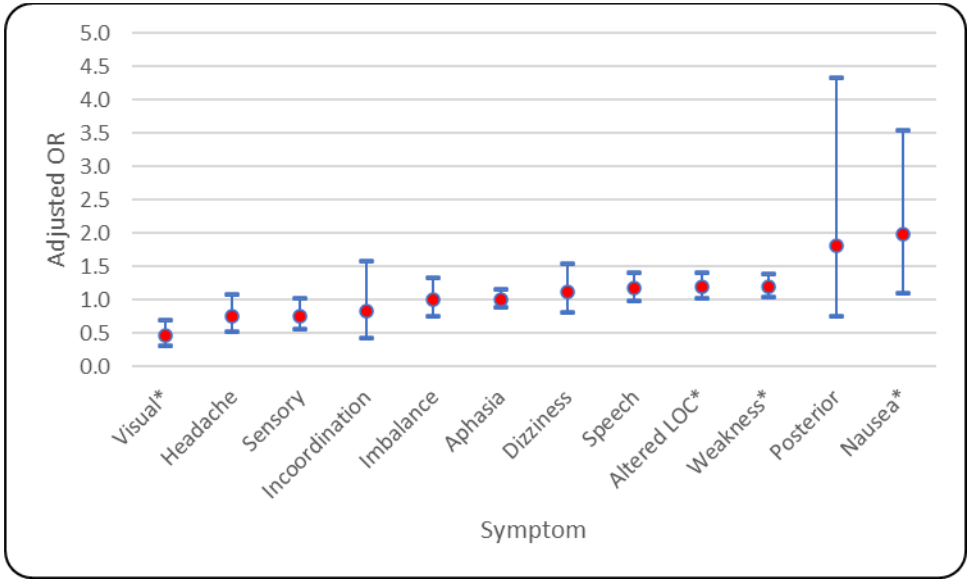


Figure 59. Adjusted Odds of Arrival by EMS by Symptom Reported

Abbreviations: LOC=level of consciousness

** Statistically significant*

The upper and lower bars represent the 95% confidence intervals. The intervals that contain one are considered non-significant.

Excludes patients who arrive by transfer, are inpatient strokes, or those without documented symptoms.

- After adjusting for severity, patients experiencing **visual changes** are significantly less likely to arrive to the hospital by EMS.
- Patients who were more likely to arrive by EMS include those with **altered level of consciousness, weakness**, and **nausea**.
- A prior study found that only a small percent of stroke patients (3%) contact EMS services themselves. [58] Patients with more severe symptoms of stroke may not be discovered soon after onset of symptoms and may affect the accuracy of reporting of symptoms.

Table 11. Descriptive Characteristics of Patients by Onset to Hospital Arrival Times

Characteristic	Onset to Arrival Time		p-value
	≤120 minutes N=2759 (33.7%)	>120 minutes N=5423 (66.3%)	
Male (%)	51.3	51.2	0.9900
Age			
Median (IQR)	73 (62—83)	72 (61—81)	<.0001
<45 years	4.6	4.7	0.0180
45—65 years	25.3	28.3	
65+ years	70.1	67.1	
Race and Ethnicity			
Hispanic	1.6	2.0	0.3530
White, non-Hispanic	93.2	91.8	
Black, non-Hispanic	2.3	2.9	
Other	3.0	3.4	
Insured, yes (%)	98.2	98.3	0.7776
Arrival Mode			
EMS	67.6	24.0	<.0001
Private vehicle	25.9	19.1	
Transfer	6.5	56.9	
Stroke type			
SAH	1.2	2.2	<.0001
ICH	9.8	10.6	
IS	84.3	84.3	
Stroke NOS	4.8	2.9	
NIH Stroke Scale Score			
Median (IQR)	5 (2—13)	4 (2—11)	0.0016
0	22.8	22.0	0.0359
1—4	37.0	45.0	
5—15	29.8	23.6	
16—20	4.7	5.5	
21+	5.7	3.9	
Time of Presentation			<.0001
7a—5p	57.4	53.6	
5p—12a	33.6	32.6	
12a—7a	9.0	13.8	
Weekend presentation	33.2	32.8	0.6697
Past medical history			
Atrial fibrillation	17.0%	15.0%	0.0192
Carotid stenosis	2.4%	2.4%	0.9700
Depression	1.4%	0.5%	<.0001
Diabetes	17.0%	20.3%	0.0003
Drug abuse	3.3%	4.6%	0.0056
Dyslipidemia	30.3%	29.5%	0.4773

Characteristic	Onset to Arrival Time		p-value
	≤120 minutes N=2759 (33.7%)	>120 minutes N=5423 (66.3%)	
Stroke in family	5.8%	3.7%	<.0001
Heart failure	5.6%	4.9%	0.2161
Hypertension	46.4%	50.8%	0.0001
Migraines	2.0%	1.6%	0.1804
Myocardial infarction or CAD	16.6%	16.6%	0.9460
Obesity	5.6%	5.5%	0.9523
Peripheral artery disease	2.8%	3.1%	0.5266
Prior stroke	14.5%	13.7%	0.3255
Renal disease	3.9%	3.8%	0.8286
Sleep apnea	0.5%	0.2%	0.0786
TIA	5.5%	4.5%	0.0485
Valve prothesis	1.1%	1.1%	0.7070
Symptoms			
Weakness	43.9%	51.8%	<.0001
Altered LOC	27.1%	72.9%	<.0001
Visual changes	0.5%	0.7%	0.2123
Aphasia	26.4%	29.4%	0.0043
Speech	7.1%	3.6%	<.0001
Nausea	0.4%	0.4%	0.6504
Dizziness	1.0%	0.8%	0.3062
Imbalance	1.2%	1.0%	0.4508
Headache	1.0%	0.6%	0.0558
Posterior circulation	0.2%	0.1%	0.5532
Sensory	1.7%	1.1%	0.0225
Incoordination	0.1%	0.1%	0.6017

Abbreviations: IQR=interquartile range, EMS=emergency medical services, SAH=subarachnoid hemorrhage, ICH=intracerebral hemorrhage, IS=ischemic stroke, NOS=not otherwise specified, LOC=level of consciousness

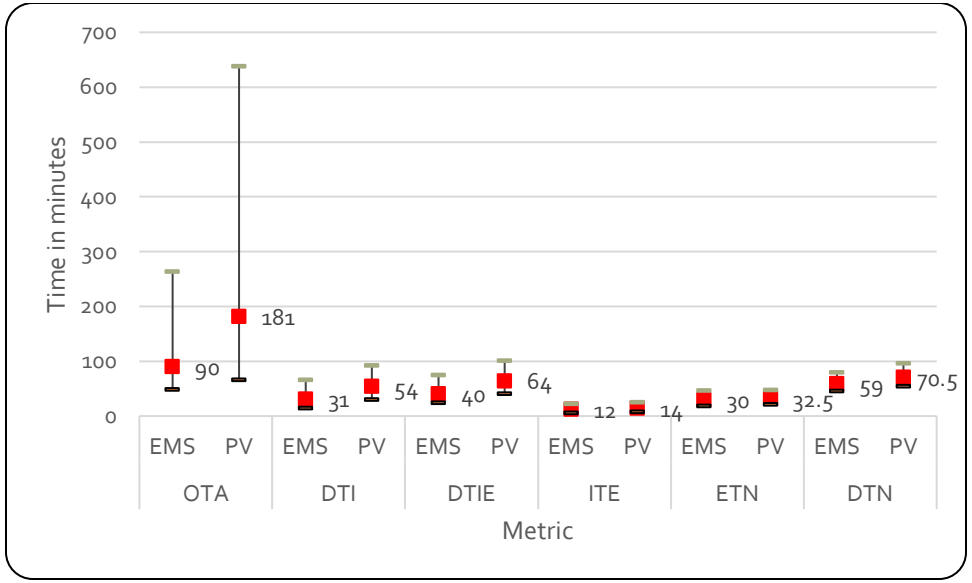


Figure 60. Timed Metrics by Arrival Mode

Abbreviations: EMS=emergency medical services, PV=private vehicle, OTA=onset to arrival, DTI=door-to-imaging, DTIE=door-to-imaging evaluation, ITE=imaging to evaluation, ETN=evaluation to needle, DTN=door to needle

- The median NIH Stroke Scale Score for **EMS** is five compared to a median score of 2 for **private vehicle**.
- All time metrics are longer in those arriving by **private vehicle** compared to those arriving by **EMS**. A further analysis is warranted to determine the impact of severity on these metrics.

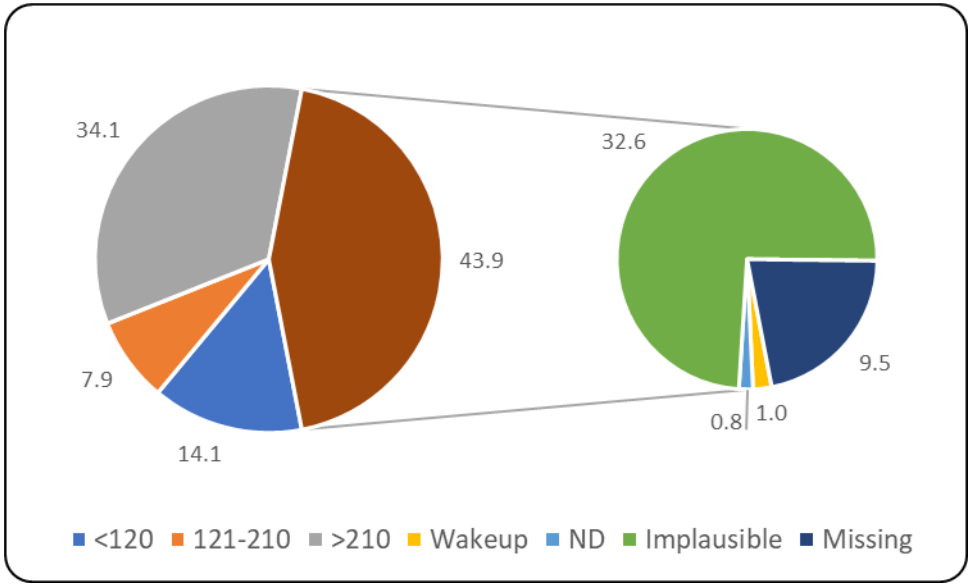


Figure 61. Percent Distribution of Arrival Times for Ischemic Strokes, 2013—2017

ND=not documented

Note. Wakeup strokes are those strokes whose symptoms are discovered upon wakening.

Of non-missing data for arrival and last known well times for ischemic stroke patients:

- 25.1% of patients arrive within **120 minutes**.
- 39.2% % arrive within **210 minutes**.
- 60.8% arrive outside the **3.5-hour** time window for treatment.
- For **missing data** (43.9%), most of the data was determined to be missing for **implausible values** (74.3%).

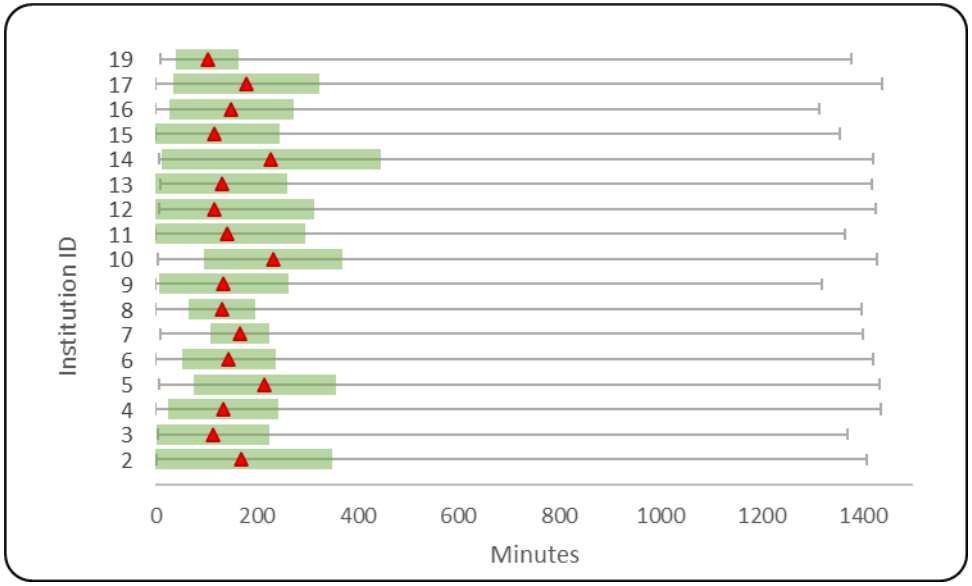


Figure 62. Median and Range of Arrival Times from Last Known Well by Institution

Note. Excludes patients with unknown LKW times and those with LKW to arrival times greater than 24 hours.
Red triangles represent median LKW to arrival times. Green shaded bars represent interquartile ranges (25th to 75th percentile).
Gray lines represent the minimum and maximum LKW to arrival times.

- Overall, the median **LKW to arrival** times was 147 minutes with 50% of patients arriving between 63 and 436 minutes.
- The range of median **LKW to arrival** times was 102 to 233 minutes among institutions.

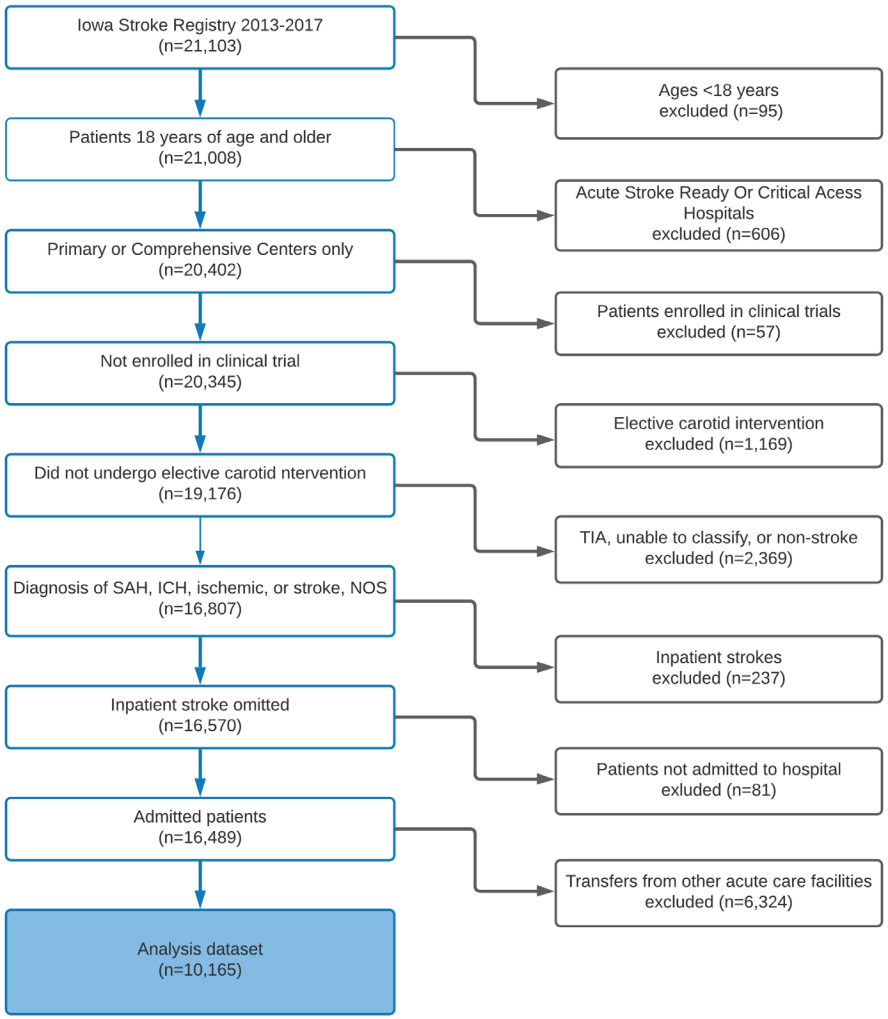


Figure 63. Flow Diagram of Inclusions and Exclusions for Study Population for the Evaluation of Hospital Metrics

SUMMARY OF METRIC CHANGES FROM THE 2013—16 TO 2017-TIME FRAMES

Table 12. Description of Stroke Performance Metrics and Applicable Populations

Metric	Population	Description
Venous thromboembolism (VTE) prophylaxis	HS, IS, NOS	Received VTE prophylaxis or have documentation on why no VTE prophylaxis was given the day of or the day after hospital admission
Discharged on antithrombotic Therapy	IS	Patients prescribed antithrombotic therapy at hospital discharge
Anticoagulation therapy for atrial fibrillation/flutter	IS	Patients with atrial fibrillation/flutter who are prescribed anticoagulation therapy at hospital discharge
Thrombolytic therapy	IS	Patients who arrive at this hospital within 2 hours of time last known well and for whom IV rtPA was initiated at this hospital within 3 hours of time last known well
Antithrombotic therapy by end of hospital day 2	IS	Patients administered antithrombotic therapy by the end of hospital day two
Discharged on statin medication	IS	Patients with LDL greater than or equal to 100 mg/dL, or LDL not measured, or who were on a lipid-lowering medication prior to hospital arrival are prescribed statin medication at hospital discharge
Stroke education	HS, IS, NOS	Patients or their caregivers who were given educational materials during the hospital stay addressing all the following: activation of emergency medical system, need for follow-up after discharge, medications prescribed at discharge, risk factors for stroke, and warning signs and symptoms of stroke
Assessed for rehabilitation	HS, IS, NOS	Patients assessed for rehabilitation services after experiencing an ischemic or hemorrhagic stroke or stroke not otherwise specified
Smoking cessation counseling	HS, IS, NOS	Patients who are current smokers who receive or refuse smoking cessation counseling
Dysphagia screening	HS, IS, NOS	Patients aged 18 years and older who receive any food, fluids, or medication by mouth (PO) for whom a dysphagia screening was performed prior to PO intake in accordance with a dysphagia screening tool approved by the institution in which the patient is receiving care
Recording of NIH Stroke Scale Score	IS, NOS	Patients aged eighteen and older with an initial NIH Stroke Scale recorded. Patients with acute ischemic stroke who receive IV rtPA who have an NIH stroke scale score recorded.
Time to intravenous thrombolytic therapy	IS	Patients aged 18 years and older receiving intravenous rtPA therapy during the hospital stay and having a time from hospital arrival to initiation of thrombolytic therapy administration (door-to-needle time) of 60 minutes or less. Median time from hospital arrival to administration of IV rtPA therapy in acute ischemic stroke patients aged 18 years and older
Door to brain imaging time	HS, IS	Head CT scan completed within 25 minutes of arrival for acute ischemic stroke or hemorrhagic stroke patients who arrive within 2 hours of time last known well
Door to evaluation of brain imaging time	HS, IS	Head CT Scan Interpretation within 45 minutes of arrival for acute ischemic stroke or hemorrhagic stroke patients who arrive within 2 hours of time last known well who received head CT
Arrival within 120 minutes of last-known-well	HS, IS, NOS, TIA	Patients who arrive at the hospital within 120 minutes of time last known well
Arrival by EMS	HS, IS, NOS, TIA	Patients who arrive by EMS for evaluation of stroke
EMS hospital prenotification	HS, IS, NOS, TIA	Patients transported by EMS with prenotification of hospitals

Abbreviations: HS=hemorrhagic stroke; IS=acute ischemic stroke; NOS=stroke, not otherwise specified, LDL=low-density lipoproteins, EMS=emergency medical services.

Table 13. Summary of Performance Measures

Care category	Indicator (applicable population)	Years 2013—2016			Year 2017			Improved no./total (%) [b]	Percent change [c]	
		Overall (%)	Variability institutions (min—max)	Meeting target No./total (%) [a]	Overall (%)	Variability institutions (min—max)	Meeting target No./total (%) [a]			
Public awareness	Proportion of patients who arrive within 120 minutes of LKW (IS)	48.2%	27.9%—61.8%	–	46.9%	27.5%—74.1%	–	6/17 (35.3%)	-2.6%	▽
	Proportion of patients who arrive to ED by EMS (HS, IS, NOS, TIA)	58.7%	42.0%—86.1%	–	51.4%	33.3%—69.5%	–	3/15 (20.0%)	-12.4%	▼
EMS	Pre-notification of arrival by EMS (HS, IS, NOS, TIA)	81.7%	61.0%—100%	–	84.9%	69.2%—100%	–	5/9 (55.6%)	3.9%	▲
Acute ED care	Proportion of patients who arrive within 2 hrs. receiving IV-rtPA within 3 hrs. of LKW (IS)	64.9%	0%—83.1%	13/18 72.2%)[d]	51.2%	26.9%—63.6%	6/9 (66.7%)[d]	3/9 (33.3%)	-21.1%	▼
	rtPA Within 60 Minutes of ED Arrival (IS)	52.9%	16.7%—73.7%	8/13 (61.5%)[d]	50.6%	50.0%—73.3%	4/5 (80%)[d]	4/11 (36.4%)	-4.5%	▽
	Median door-to-needle time among patients receiving rtPA, in minutes (IS)	60.0	47.5—88.5	8/16 (50%)	60.5	50—105	6/13 (46.2%)	9/19 (47.3%)	0.8%	△
	NIHSS recorded (IS)	67.1%	0%—99.1%	5/16 (31.3%)	53.1%	0%—97.4%	4/15 (26.7%)	4/16 (25%)	-20.9%	▼
	Door-to-Imaging ≤ 25 minutes (HS, IS)	48.7%	0%—73.4%	8/17 (47.1%)[d]	49.8%	27.3%—75.0%	10/16 (62.5%)[d]	8/15 (53.3%)	2.2%	△
	Door-to-Image interpretation ≤ 45 minutes (HS, IS)	37.9%	0%—70.4%	4/17 (23.5%)[d]	39.3%	0%—82.6%	7/16 (43.8%)[d]	7/16 (43.8%)	3.7%	△
Acute in-hospital	VTE prophylaxis (HS, IS, NOS)	92.1%	31.4%—99.3%	11/16 (68.8%)	98.6%	90.3%—100%	16/16 (100%)	15/16 (93.8%)	7.0%	△
	Antithrombotic therapy at end of hospital day 2 (IS)	96.6%	90.1%—99.3%	17/17 (100%)	96.6%	91.1%—100%	16/16 (100%)	10/17 (58.8%)	0%	
	Dysphagia screening (HS, IS, NOS)	82.6%	69.8%—95.2%	6/16 (37.5%)	80.0%	71.2%—100%	4/15 (26.7%)	5/14 (35.7%)	-3.2%	▼
Secondary prevention	Antithrombotic therapy at discharge (IS)	98.5%	89.6%—100%	17/17 (100%)	98.9%	86.7%—100%	15/15 (100%)	10/16 (62.5%)	0.4%	▽
	Anticoagulation for atrial fibrillation (IS)	88.3%	59.1%—98.8%	10/16 (62.5%)	82.0%	61.1%—100%	9/15 (60.0%)	8/15 (53.3%)	-7.2%	▼
	Discharge on statin medication (IS)	96.5%	85.4%—100%	17/17 (100%)	98.6%	90.0%—100%	16/16 (100%)	13/15 (86.7%)	2.2%	▲
	Stroke education (HS, IS, NOS)	94.0%	68.1%—99.2%	15/16 (93.8%)	92.5%	69.6%—100%	10/14 (71.4%)	8/15 (53.3%)	-1.6%	▽
	Smoking cessation (HS, IS, NOS)	96.9%	84.6%—100%	14/14 (100%)	95.6%	82.9%—100%	8/8 (100%)	11/14 (78.6%)	-1.4%	▽
Rehabilitation	Rehabilitation plan (HS, IS, NOS)	99.0%	95.5%—100%	17/17 (100%)	99.3%	92.6%—100%	16/16 (100%)	13/16 (81.3%)	0.3%	△

▲ *Increase, significant* △ *Increase, non-significant* ▽ *Decrease, non-significant* ▼ *Decrease, significant*

Abbreviations: min=minimum; max=maximum, no.=number; LKW=last-known-well; IS=ischemic stroke; ED=emergency department; EMS=emergency medical services; HS=hemorrhagic stroke; NOS=stroke, not otherwise specified; TIA=transient ischemic attack; IV-rtPA=intravenous recombinant tissue plasminogen activator; NIHSS=National Institutes of Health Stroke Scale; VTE=venous thromboembolism. [a] *Target goals are 85% except where noted.* [b] *Represents the number of institutions reporting improvements from 2013—2016 to 2017.* [c] *Represents the average percent change from 2013—2016 to 2017. The direction and statistical significance of the change reflected by the color and directions of the arrows.* [d] *Target goal of 50%*

Table 14. Summary of Gender Differences in Performance Measures Among All Primary and Comprehensive Stroke Centers Reported to ISR

Care category	Indicator (applicable population)	Gender	Year [a]					Average percent change [b]		Overall (%)	p-value [c]
			2013	2014	2015	2016	2017				
Public awareness	Proportion of patients who arrive within 120 minutes of LKW (IS) [d]	Males	50.9%	54.4%	47.4%	47.2%	43.8%	▼	- 3.4%	49.6%	0.5086
		Females	50.6%	53.5%	51.2%	46.1%	49.0%	▽	-1.1%	48.5%	
	Proportion of patients who arrive to ED by EMS (HS, IS, NOS, TIA) [d]	Males	52.0%	45.9%	46.4%	49.7%	48.6%	▽	-1.5%	48.7%	<.0001*
		Females	52.8%	52.7%	48.2%	56.4%	52.7%	△	0.4%	52.9%	
EMS	Pre-notification of arrival by EMS (HS, IS, NOS, TIA) [d]	Males	62.0%	70.8%	65.8%	74.2%	85.4%	▲	8.7%	71.9%	0.4212
		Females	58.2%	66.7%	68.2%	74.7%	85.4%	▲	10.1%	70.8%	
Acute ED care	Proportion of patients who arrive within 2 hrs. receiving IV-rtPA within 3 hrs. of LKW (IS) [e]	Males	73.5%	76.7%	81.0%	56.3%	46.9%	▼	-9.3%	60.6%	0.4199
		Females	66.2%	83.6%	81.8%	44.1%	49.7%	▼	-2.3%	58.0%	
	rtPA Within 60 Minutes of ED Arrival (IS) [e]	Males	48.4%	56.6%	52.5%	61.0%	46.2%	△	0.4%	53.3%	0.6964
		Females	41.8%	42.1%	63.2%	53.8%	55.1%	△	9.6%	51.8%	
	Median door-to-needle time among patients receiving rtPA, in minutes (IS) [e]	Males	62.0	59.0	58.0	57.0	63.0	△	0.6%	59.0	0.6157
		Females	67.0	65.5	56.0	59.0	58.0	▼	-3.3%	60.0	
	NIHSS recorded (IS)	Males	80.0%	84.5%	85.7%	52.3%	54.6%	▼	-6.9%	67.4%	0.9213
		Females	83.8%	81.4%	85.1%	52.9%	51.6%	▼	-9.6%	67.5%	
	Door-to-imaging ≤ 25 minutes (HS, IS) [e]	Males	49.7%	52.7%	56.0%	49.2%	47.8%	▽	-0.6%	50.4%	0.8736
		Females	40.9%	53.7%	54.4%	48.7%	52.0%	△	7.2%	50.0%	
	Door-to-image interpretation ≤ 45 minutes (HS, IS) [e]	Males	41.8%	42.5%	59.2%	43.9%	37.7%	△	0.2%	43.7%	0.7829
		Females	32.6%	50.0%	57.6%	43.5%	41.3%	△	9.8%	44.3%	
Acute in-hospital	VTE prophylaxis (HS, IS, NOS)	Males	95.7%	99.0%	98.0%	98.4%	98.4%	▲	0.7%	98.0%	0.3354
		Females	96.6%	98.0%	99.0%	98.7%	98.7%	▲	0.5%	98.3%	
	Antithrombotic therapy at end of hospital day 2 (IS)	Males	97.7%	98.3%	96.2%	97.3%	96.3%	▽	-0.4%	97.1%	0.9994
		Females	96.8%	97.3%	97.1%	97.4%	96.9%		0%	97.1%	
	Dysphagia screening (HS, IS, NOS)	Males	85.0%	85.8%	82.4%	80.9%	79.4%	▼	-1.7%	82.0%	0.3366
		Females	85.8%	85.8%	84.1%	80.9%	80.8%	▼	-1.5%	82.9%	

Care category	Indicator (applicable population)	Gender	Year [a]					Average percent change [b]		Overall (%)	p-value [c]
			2013	2014	2015	2016	2017				
Secondary stroke prevention	Antithrombotic therapy at discharge (IS)	Males	98.8%	99.0%	99.6%	99.4%	98.8%		0%	99.1%	0.3985
		Females	99.3%	98.9%	99.6%	99.6%	99.0%	▽	-0.1%	99.3%	
	Anticoagulation for atrial fibrillation (IS)	Males	92.1%	94.9%	97.2%	91.7%	82.5%	▼	-11.6%	90.4%	0.3034
		Females	92.1%	100%	98.9%	81.6%	81.5%	▼	-10.5%	88.4%	
	Discharge on statin medication (IS)	Males	94.9%	97.5%	98.9%	98.2%	99.0%	▲	1.1%	97.8%	0.0382*
		Females	92.6%	96.3%	96.5%	98.3%	98.7%	△	1.6%	97.0%	
	Stroke education (HS, IS, NOS)	Males	95.1%	95.9%	96.5%	95.5%	93.1%	▼	-2.7%	94.9%	0.4568
		Females	95.2%	94.8%	96.1%	95.4%	91.8%	▼	-3.8%	94.4%	
	Smoking cessation (HS, IS, NOS)	Males	94.3%	93.6%	96.4%	98.1%	95.6%	▽	-0.6%	96.1%	0.4544
		Females	100%	97.7%	98.3%	95.9%	95.5%	▽	-2.3%	97.0%	
Rehabilitation	Rehabilitation plan (HS, IS, NOS)	Males	99.0%	98.4%	98.7%	99.5%	99.1%	△	0.1%	99.0%	0.0588
		Females	99.7%	98.8%	99.8%	99.2%	99.6%	△	0.2%	99.4%	

▲ *Increase, significant* △ *Increase, non-significant* ▽ *Decrease, non-significant* ▼ *Decrease, significant*

*Abbreviations: min=minimum; max=maximum, no.=number; LKW=last-known-well; IS=ischemic stroke; ED=emergency department; EMS=emergency medical services; HS=hemorrhagic stroke; NOS=stroke, not otherwise specified; TIA=transient ischemic attack; IV-rtPA=intravenous recombinant tissue plasminogen activator; NIHSS=National Institutes of Health Stroke Scale; VTE=venous thromboembolism. [a] Target goals are 85% except where noted. [b] Represents the average percent change from 2013 to 2017. The direction and statistical significance of the change reflected by the color and directions of the arrows. [c] The p-value represents overall differences between males and females. [d] No target goal. Higher proportions are desirable. [e] Target goal of 50%. * Statistically significant.*

Table 15. Summary of Racial Differences in Performance Measures

Care category	Indicator (applicable population)	Race	Year [a]					Average percent change [b]		Overall (%)	p-value [c]
			2013	2014	2015	2016	2017				
Public awareness	Proportion of patients who arrive within 120 minutes of LKW (IS) [d]	Non-White	52.0%	46.6%	52.5%	43.4%	37.5%	▽	-7.2%	45.3%	0.0299*
		White	53.1%	54.5%	50.5%	50.3%	49.1%	▼	1.9%	51.6%	
	Proportion of patients who arrive to ED by EMS (HS, IS, NOS, TIA) [d]	Non-White	59.4%	53.0%	40.7%	51.0%	40.4%	▼	-7.4%	48.1%	0.3849
		White	52.7%	49.1%	47.6%	50.9%	49.2%	△	-1.6%	49.9%	
EMS	Pre-notification of arrival by EMS (HS, IS, NOS, TIA) [d]	Non-White	62.8%	67.4%	58.0%	68.4%	83.6%	▲	8.4%	67.7%	0.2718
		White	59.8%	68.8%	67.7%	75.2%	85.5%	▲	9.5%	70.7%	
Acute ED care	Proportion of patients who arrive within 2 hrs. receiving IV-rtPA within 3 hrs. of LKW (IS) [e]	Non-White	–	–	–	–	–	–	–	58.8%	0.9539
		White	66.9%	79.8%	81.1%	48.2%	43.8%	▼	-7.2%	59.3%	
	rtPA Within 60 Minutes of ED Arrival (IS) [e]	Non-White	–	–	–	–	–	–	–	94.6%	0.6096
		White	44.0%	48.6%	60.7%	52.4%	51.9%	△	5.2%	95.6%	
	Median door-to-needle time among patients receiving rtPA, in minutes (IS) [f]	Non-White	–	–	–	–	–	–	–	61.5	0.9869
		White	65.0	61.0	57.0	60.0	58.0	▽	-2.7%	60.0	
	NIHSS recorded (IS)	Non-White	84.0%	88.2%	85.7%	75.8%	81.1%	▽	-0.6%	82.0%	0.7557
		White	82.2%	82.7%	86.0%	80.4%	81.9%		0%	82.6%	
	Door-to-imaging ≤ 25 minutes (HS, IS) [d]	Non-White	–	–	–	63.6%	50.0%	–	–	56.3%	0.3172
		White	44.0%	52.4%	55.6%	48.6%	52.1%	△	4.9%	50.5%	
	Door-to-image interpretation ≤ 45 minutes (HS, IS) [e]	Non-White	–	–	–	45.5%	30.0%	–	–	46.3%	0.9154
		White	41.2%	45.7%	58.2%	45.7%	39.3%	△	0.7%	45.6%	
Acute in-hospital	VTE prophylaxis (HS, IS, NOS)	Non-White	95.9%	95.7%	100%	99.2%	98.2%	△	0.6%	98.0%	0.9648
		White	96.0%	98.6%	98.5%	98.2%	98.3%	▲	0.6%	97.9%	
	Antithrombotic therapy at end of hospital day 2 (IS)	Non-White	97.0%	100%	98.3%	98.1%	97.1%	△	0.1%	98.0%	0.3319
		White	97.0%	97.6%	96.5%	97.2%	97.2%		0%	97.1%	
	Dysphagia Screening (HS, IS, NOS)	Non-White	79.5%	91.0%	84.1%	82.3%	78.0%	▽	-0.1%	91.3%	0.5697
		White	85.5%	85.4%	83.6%	82.3%	80.9%	▼	-1.4%	91.9%	
	Antithrombotic therapy at discharge (IS)	Non-White	100%	100%	100%	100%	98.8%	▽	-0.3%	99.8%	0.4044
		White	99.4%	98.9%	99.6%	99.8%	99.6%	△	0.1%	99.5%	

Care category	Indicator (applicable population)	Race	Year [a]					Average percent change [b]		Overall (%)	p-value [c]
			2013	2014	2015	2016	2017				
Secondary Stroke Prevention	Anticoagulation for atrial fibrillation (IS)	Non-White	–	–	–	–	–	–	–	93.3%	0.5528
		White	91.4%	97.6%	98.0%	97.7%	94.4%	△	0.9%	95.6%	
	Discharge on statin medication (IS)	Non-White	98.3%	96.7%	100%	100%	100%	▲	0.5%	99.2%	0.0504*
		White	93.5%	96.9%	98.2%	99.5%	99.8%	▲	1.7%	97.7%	
	Stroke education (HS, IS, NOS)	Non-White	95.9%	100%	90.4%	100%	93.7%	▽	-0.3%	95.9%	0.8172
		White	94.7%	95.1%	97.0%	96.7%	94.6%		0%	96.0%	
	Smoking cessation (HS, IS, NOS)	Non-White	–	–	–	93.8%	91.4%	–	–	94.2%	0.4511
		White	96.5%	94.9%	98.4%	95.7%	93.8%	▽	-0.7%	95.8%	
Rehabilitation	Rehabilitation plan (HS, IS, NOS)	Non-White	98.7%	100%	98.8%	100%	100%	△	1.3%	99.6%	0.4784
		White	99.3%	98.6%	99.3%	99.7%	99.5%	△	0.2%	99.3%	

▲ *Increase, significant* △ *Increase, non-significant* ▽ *Decrease, non-significant* ▼ *Decrease, significant*

*Abbreviations: min=minimum; max=maximum, no.=number; LKW=last-known-well; IS=ischemic stroke; ED=emergency department; EMS=emergency medical services; HS=hemorrhagic stroke; NOS=stroke, not otherwise specified; TIA=transient ischemic attack; IV-rtPA=intravenous recombinant tissue plasminogen activator; NIHSS=National Institutes of Health Stroke Scale; VTE=venous thromboembolism. [a] Target goals are 85% except where noted. [b] Represents the average percent change from 2013 to 2017. The direction and statistical significance of the change reflected by the color and directions of the arrows. [c] The p-value represents overall differences between Whites and non-Whites. Due to small cell counts, individuals who identify as other than white, were grouped together. [d] No target goal. Higher proportions are desirable. [e] Target goal of 50%. * Statistically significant. -Fewer than twenty observations.*

Table 16. Summary of Age Differences in Performance Measures

Care category	Indicator (applicable population)	Age group	Year [a]					Average percent change [b]		Overall	p-value [b]
			2013	2014	2015	2016	2017				
Public awareness	Proportion of patients who arrive within 120 minutes of LKW (IS) [d]	<45	53.9%	50.9%	47.1%	61.7%	50.0%	▽	-0.2%	52.2%	0.1003
		45—64	49.7%	46.1%	45.0%	45.7%	45.0%	▽	-2.4%	45.4%	
		65+	50.3%	50.9%	48.9%	48.2%	49.7%	▽	-0.3%	49.5%	
	Proportion of patients who arrive to ED by EMS (HS, IS, NOS, TIA) [d]	<45	41.9%	48.7%	48.0%	36.5%	38.2%	▽	-1.1%	42.3%	<.0001*
		45—64	50.9%	57.8%	53.3%	44.0%	41.3%	▼	-4.4%	49.3%	
		65+	63.1%	64.0%	59.9%	57.1%	55.4%	▼	-3.1%	60.3%	
EMS	Pre-notification of arrival by EMS (HS, IS, NOS, TIA) [d]	<45	34.6%	76.0%	56.1%	57.1%	86.7%	▲	36.7%	61.8%	0.0003*
		45—64	55.3%	67.6%	64.2%	68.7%	82.3%	▲	11.0%	67.1%	
		65+	62.8%	68.7%	68.5%	76.8%	86.3%	▲	8.4%	71.8%	
Acute ED Care	Proportion of patients who arrive within 2 hours of LKW And IV-rtPA administered within 3 hours of LKW (IS) [e]	<45	33.3%	69.2%	72.7%	47.4%	42.9%	△	17.1%	54.0%	0.1616
		45—64	63.2%	75.0%	64.9%	61.7%	48.8%	▼	-5.2%	61.6%	
		65+	67.6%	77.9%	54.5%	46.3%	48.5%	▼	-6.3%	55.6%	
	rtPA Within 60 Minutes of ED Arrival (IS) [e]	<45	60.0%	25.0%	37.5%	75.0%	57.1%	△	17.0%	50.0%	0.2938
		45—64	45.5%	55.6%	56.0%	48.4%	42.3%	▽	-0.8%	49.6%	
		65+	43.2%	46.0%	61.6%	61.7%	53.7%	▲	6.9%	53.9%	
	Median door-to-needle time among patients receiving rtPA (IS)	<45	54.0%	64.0%	77.5%	53.0%	67.0%	△	8.6%	60.0%	0.6071
		45—64	64.5%	59.0%	59.5%	61.0%	67.5%	△	1.4%	61.0%	
		65+	65.0%	62.0%	56.0%	58.0%	59.0%	▼	-2.2%	59.0%	
	NIHSS recorded (IS)	<45	78.4%	80.3%	64.0%	47.1%	58.3%	▼	-5.1%	64.2%	0.4353
		45—64	78.8%	75.0%	62.9%	53.9%	52.3%	▼	-9.6%	63.1%	
		65+	82.4%	75.7%	65.5%	52.5%	53.1%	▼	-10.1%	64.6%	
	Door-to-imaging ≤ 25 minutes (HS, IS)	<45	27.3%	56.3%	47.4%	23.1%	39.1%	△	27.2%	37.9%	0.0079*
		45—64	40.5%	52.9%	41.0%	47.5%	45.3%	△	4.8%	45.4%	
		65+	47.9%	53.3%	49.5%	51.5%	52.3%	△	2.4%	51.0%	
	Door-to-image interpretation ≤ 45 minutes (HS, IS)	<45	27.3%	37.5%	31.6%	26.9%	21.7%	▽	-3.1%	28.4%	0.0883
		45—64	32.4%	39.1%	35.9%	48.3%	32.0%	△	3.3%	37.8%	
		65+	37.6%	37.2%	32.3%	43.4%	43.4%	▲	5.1%	39.1%	
	VTE prophylaxis (HS, IS, NOS)	<45	97.1%	100%	80.3%	96.6%	100%	△	1.8%	93.9%	0.5225
		45—64	92.9%	95.6%	80.1%	99.2%	98.6%	▲	2.5%	93.0%	
		65+	95.5%	95.4%	82.3%	98.5%	98.4%	▲	1.4%	93.7%	

Care category	Indicator (applicable population)	Age group	Year [a]					Average percent change [b]		Overall	p-value [b]
			2013	2014	2015	2016	2017				
Acute In-hospital	Antithrombotic therapy at end of hospital day 2 (IS)	<45	–	–	98.0%	100%	93.6%	▽	-1.6%	98.0%	0.4785
		45—64	97.1%	95.9%	96.1%	96.9%	96.7%	▽	-0.1%	96.5%	
		65+	96.4%	97.3%	95.0%	97.4%	96.7%	△	0.1%	96.5%	
	Dysphagia screening (HS, IS, NOS)	<45	84.2%	88.9%	80.0%	72.3%	72.9%	▼	-3.3%	78.4%	0.0982
		45—64	83.5%	84.7%	80.1%	80.9%	80.8%	▽	-0.8%	81.7%	
		65+	84.4%	82.9%	83.8%	81.3%	80.2%	▼	-1.3%	82.4%	
	Antithrombotic therapy at discharge (IS)	<45	93.0%	93.9%	97.3%	97.0%	100%	▲	1.8%	96.8%	0.0138*
		45—64	98.8%	96.5%	98.3%	99.8%	98.5%	▲	0%	98.4%	
		65+	98.8%	98.5%	97.8%	99.6%	99.0%	▲	-0.1%	98.7%	
Secondary Stroke Prevention	Anticoagulation for atrial fibrillation (IS)	<45	–	–	–	–	–	–	–	100%	0.1793
		45—64	91.7%	–	86.4%	94.3%	85.7%	▽	-1.4%	89.4%	
		65+	91.2%	94.7%	85.2%%	85.4%	81.3%	▼	-2.7%	86.4%	
	Discharge on statin medication (IS)	<45	85.3%	92.3%	94.0%	93.3%	97.0%	▲	3.3%	93.2%	0.0015*
		45—64	93.9%	96.9%	97.1%	98.6%	98.7%	▲	1.3%	97.3%	
		65+	93.9%	96.5%	96.5%	98.3%	98.7%	▲	1.3%	97.0%	
	Stroke education (HS, IS, NOS)	<45	93.9%	94.9%	92.7%	98.2%	91.9%	▽	-0.4%	94.1%	0.1545
		45—64	92.0%	91.7%	93.7%	94.1%	91.7%	▽	-0.1%	92.7%	
		65+	94.6%	92.7%	94.2%%	96.1%	93.1%	▽	-0.4%	94.2%	
	Smoking cessation (HS, IS, NOS)	<45	–	–	–	91.7%	95.8%	–	–	95.8%	0.9148
		45—64	96.1%	93.2%	99.4%	98.5%	94.3%	▽	-0.4%	96.7%	
		65+	94.1%	98.1%	95.6%	96.8%	97.7%	△	1.0%	96.5%	
Rehabilitation	Rehabilitation plan (HS, IS, NOS)	<45	97.9%	98.0%	97.5%	100%	100%	△	0.5%	98.9%	0.0027*
		45—64	97.8%	97.0%	98.8%	99.2%	99.2%	▲	0.4%	98.5%	
		65+	99.2%	99.4%	99.3%	99.4%	99.4%		0%	99.3%	

▲ *Increase, significant* △ *Increase, non-significant* ▽ *Decrease, non-significant* ▼ *Decrease, significant*

Abbreviations: min=minimum; max=maximum, no.=number; LKW=last-known-well; IS=ischemic stroke; ED=emergency department; EMS=emergency medical services; HS=hemorrhagic stroke; NOS=stroke, not otherwise specified; TIA=transient ischemic attack; IV-rtPA=intravenous recombinant tissue plasminogen activator; NIHSS=National Institutes of Health Stroke Scale; VTE=venous thromboembolism. [a] Target goals are 85% except where noted.

*[b] Represents the average percent change from 2013 to 2017. The direction and statistical significance of the change reflected by the color and directions of the arrows. [c] The p-value represents overall differences between age groups. [d] No target goal. Higher proportions are desirable. [e] Target goal of 50%. * Statistically significant. -Fewer than twenty observations.*

PUBLIC AWARENESS INDICATORS

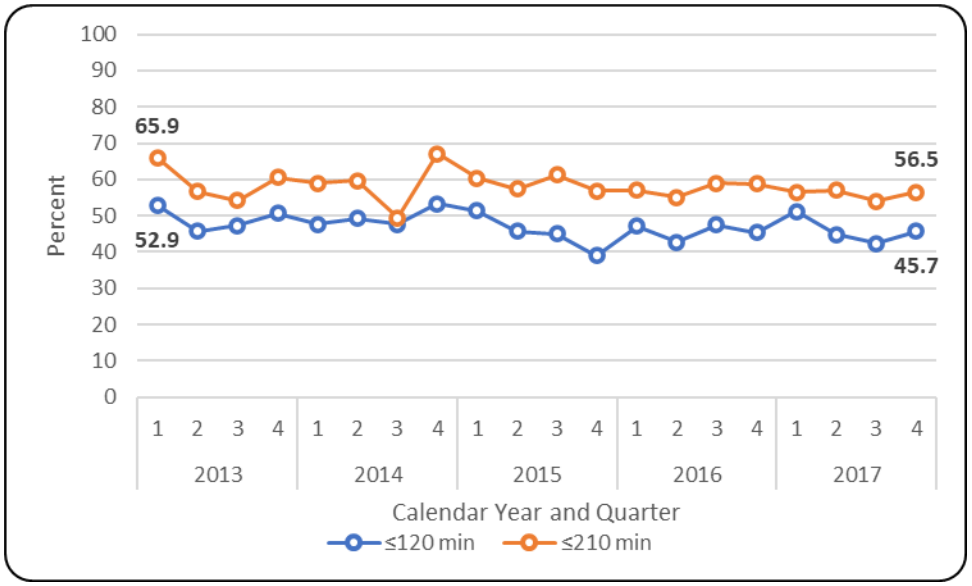


Figure 64. Quarterly Trends in the Proportion of Ischemic Stroke Patients Who Arrive Within 120 and 210 Minutes of LKW
Abbreviations: min=minute

- The overall trend in the proportion of patients with ischemic strokes **arriving within 120 minutes** of last known well has decreased 5.7% since 2017 (p-trend=0.0460). This trend in patients arriving within 210 minutes has declined 4.3% but is non-significant (p-trend=0.1311).
- There is a non-significant decrease in the proportions of patients **arriving within 120 minutes** of last known well between the 2013—2016 (48.2%) and 2017 (46.9%) time frames (p=0.4422).
- This parallels the pattern for ischemic stroke patients who **arrive within 210 minutes** of last known well (58.6%, 56.1%, p=0.1470 respectively).

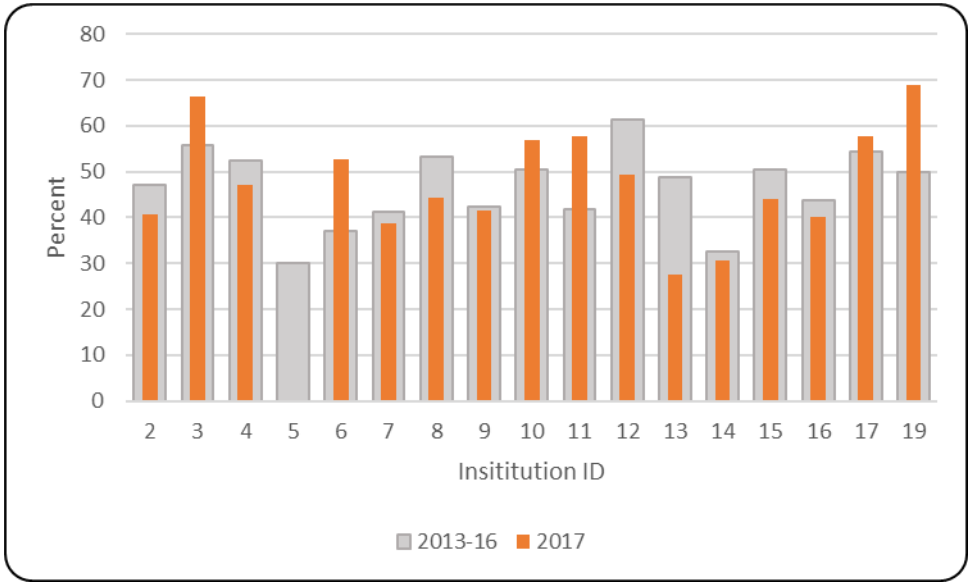


Figure 65. Hospital Variability in the Proportions of Ischemic Stroke Patients Arriving Within 120 Minutes of LKW

Abbreviations: LKW=last known well

- Six out of 17 reporting institutions (35.3%) improvements in the proportion of ischemic stroke patients **arriving within 120 minutes of last-known-well** in 2017 compared to the 2013—16-time frame.
- There is substantial variability among institutions (27.5%—68.9%) for both time frames.

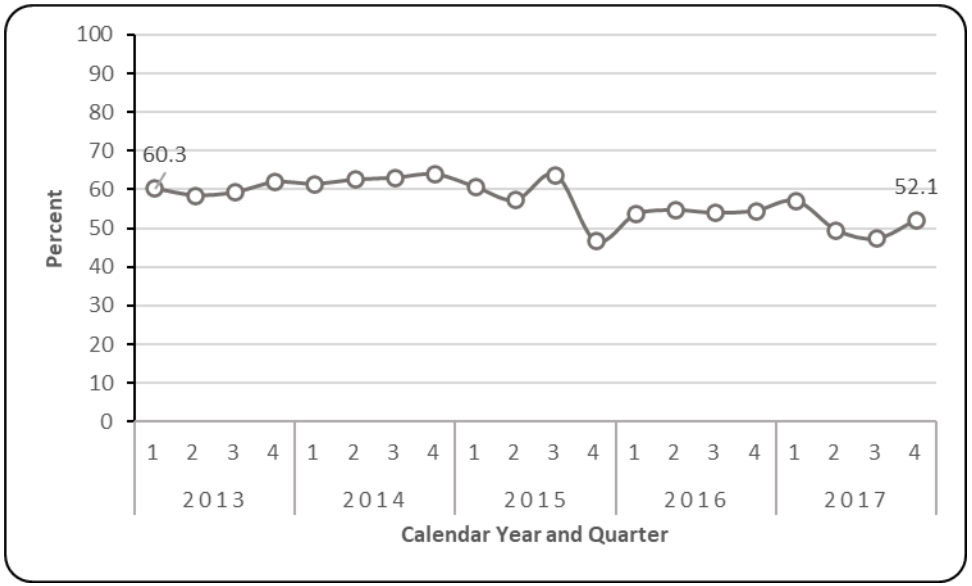


Figure 66. Quarterly Trends in the Proportion of Acute Stroke Patients Who Arrive to the ED by EMS

**Excludes transfers, stroke-capable facilities, and strokes that occurred after admission to the facility (inpatient strokes)*

** Includes TIA patients.*

- There is a significant decrease in the proportion of patients who **arrive to the ED by EMS** over time (average percent quarterly change=-0.3%, p<.0001).

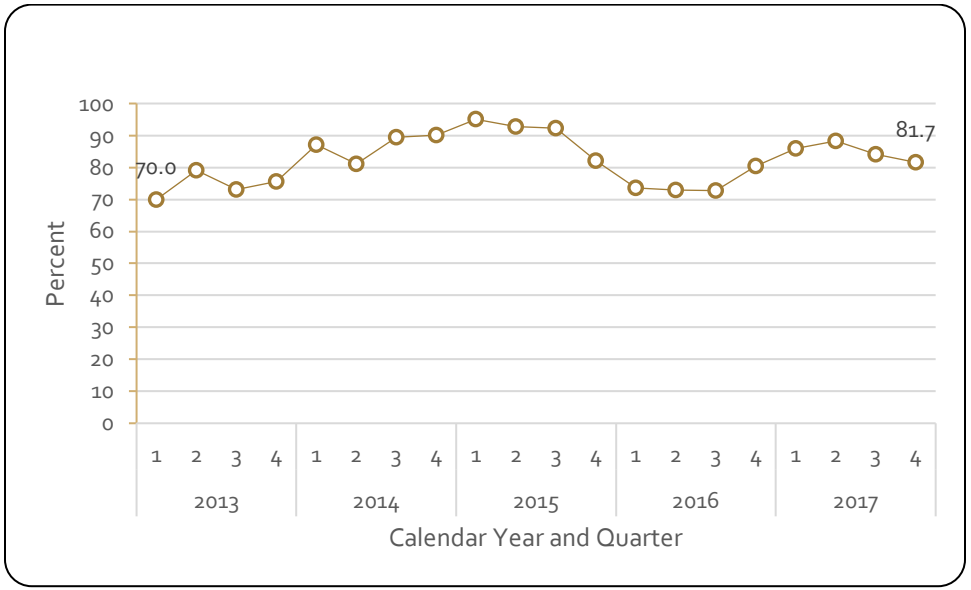


Figure 67. Quarterly Trends in the Proportion of Patients Arriving by EMS with Prenotification

- There is a non-significant quarterly increase (average percent change=1.1%) in the proportion of patients **arriving by EMS with prenotification** (p trend=0.1749). The overall trend may be masked by variability.
- This proportion of patients increased in 2017 compared to the 2013—16-time frame (81.7% versus 84.9%, p=0.0393).
- In a study examining over 370,000 stroke patients transported by EMS from 2003 through 2011, 67.0% arrived with **prenotification**. **Prenotification by EMS** increases the proportion of stroke patients with 1) door-to-imaging times less than 25 minutes, 2) door-to-needle times less than 60 minutes times, 3) onset-to-needle times less than 121 minutes, and 4) the administration of rtPA within 3 hours of onset. [59]

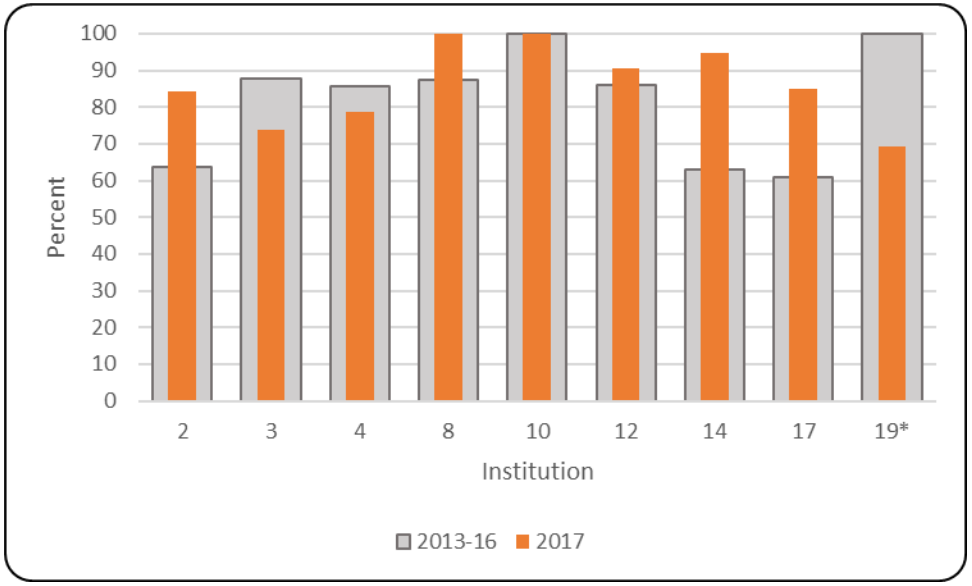


Figure 68. Variability Among Institutions in the Proportion of Patients Arriving by EMS with Prenotification between 2013—16 and 2017

**<20 observations reported*

Not a mandatory variable for collection. Multiple institutions did not report data.

- There is a moderate amount of variability among institutions (range is 39.0% for 1st time frame and 25.6% for the 2nd time frame).
- Of the institutions reporting data, five out of nine institutions (55.6%) reported an increase in the proportion of patients **arriving by EMS with prenotification**.

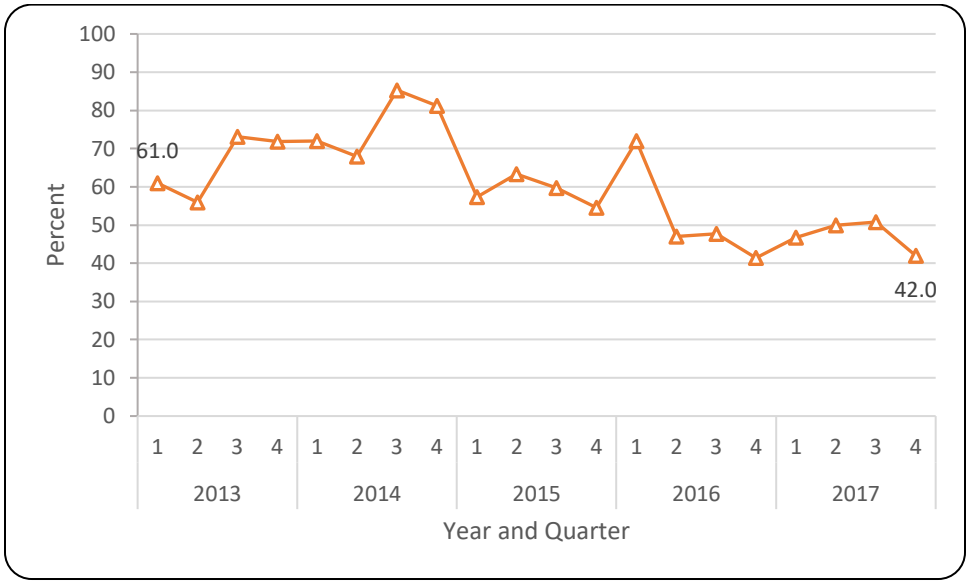


Figure 69.Quarterly Tends in the Proportion of Patients Who Arrive Within 2 Hours of LKW and IV-rtPA Administered Within 3 Hours of LKW (IS)

This is limited to ischemic strokes only

- The proportion of patients who **arrive within two hours of last known well and are treated within three hours of last known well** has decreased an average 4.5% percent change per quarter (p-trend <.0001).
- Fifteen out of 20 quarters (75%) achieved a target of 50%.
- For the 1st time frame (2013—2016), 60.1% of ischemic stroke patients who **arrived within two hours of LKW were treated within three hours** compared to the 2nd time from (2017) when 48.3% received treatment.

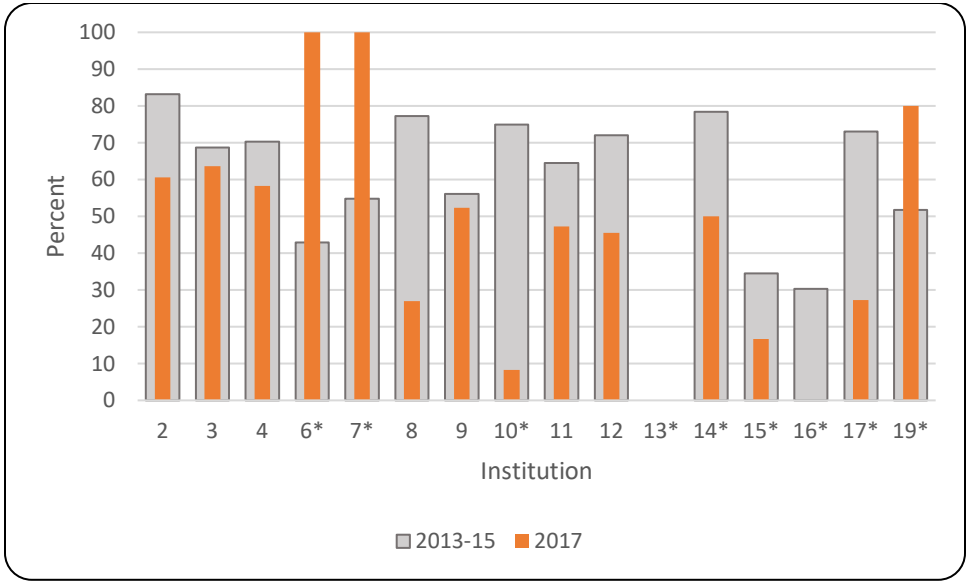


Figure 70. Comparison of the Proportion of Patients Who Arrive Within 2 Hours of LKW and IV-rtPA Administered Within 3 Hours of LKW between 2013—16 and 2017 Among Institutions

This is limited to ischemic strokes only

** Less than 20 observations for 2017. These values should be interpreted with caution.*

- Of the seven (7) institutions with more than 20 observations, three institutions reported improvement in the proportion of patients who **arrived within two hours of LKW and received treatment within three hours of LKW**.

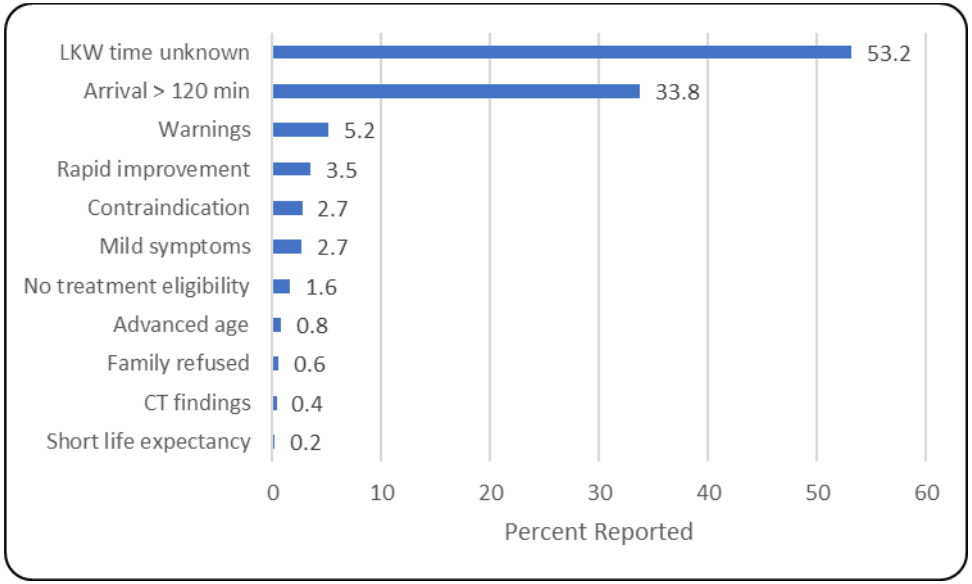


Figure 71. Overview of Reported Factors for Non-treatment with rtPA in Ischemic Strokes, ISR, 2013—2017

Abbreviations: LKW: last known well time, CT: computed tomography

- The largest proportion of patients **were not treated** because the date and time of the patient's last known well was unknown (53.2%).
- **Delays resulting in arrival over 120 minutes** of last known well was the 2nd most common factor for non-treatment with rtPA.
- Of patients **arriving over 210 minutes** of last known well, 25 (0.3%) received rtPA.

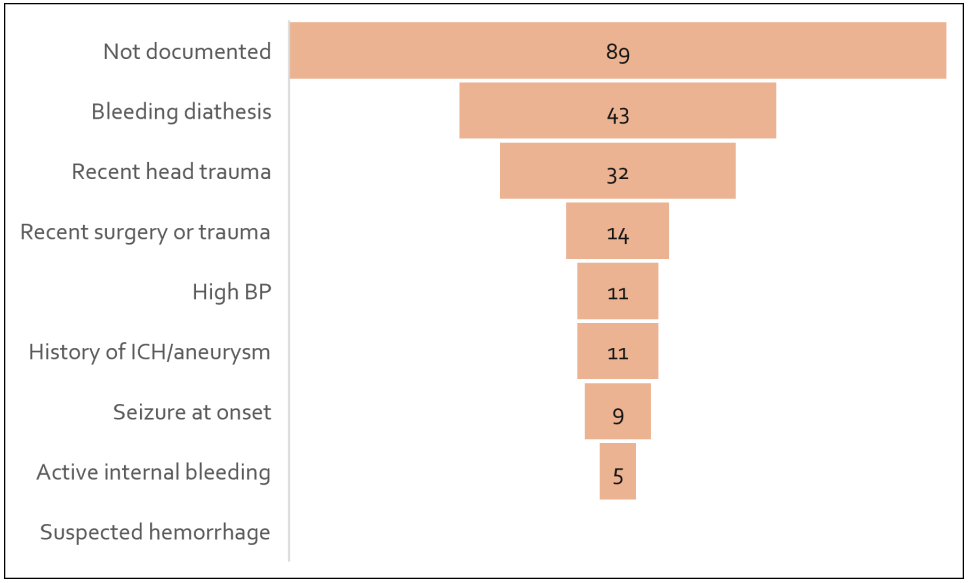


Figure 72. Number of Contraindications to rtPA Reported to ISR, 2013—2017

- Of the 214 reported contraindications to rtPA, the specific reason **was not documented** for 41.6% in these patients.
- Of the documented contraindications, **increased risk of bleeding** including platelet counts < 100,000, **PTT > 40 seconds after heparin use**, **prothrombin time > 15 seconds, INR > 1.7,** or **other bleeding diatheses** was the most reported contraindication (20.1%), followed by **recent head trauma** (15.0%), and **recent surgery or trauma** (6.5%).
- **Warnings of conditions that might lead to unfavorable outcomes** were reported for 403 patients.
    - The **specific type** of warning was not reported for 94.5% of warnings.

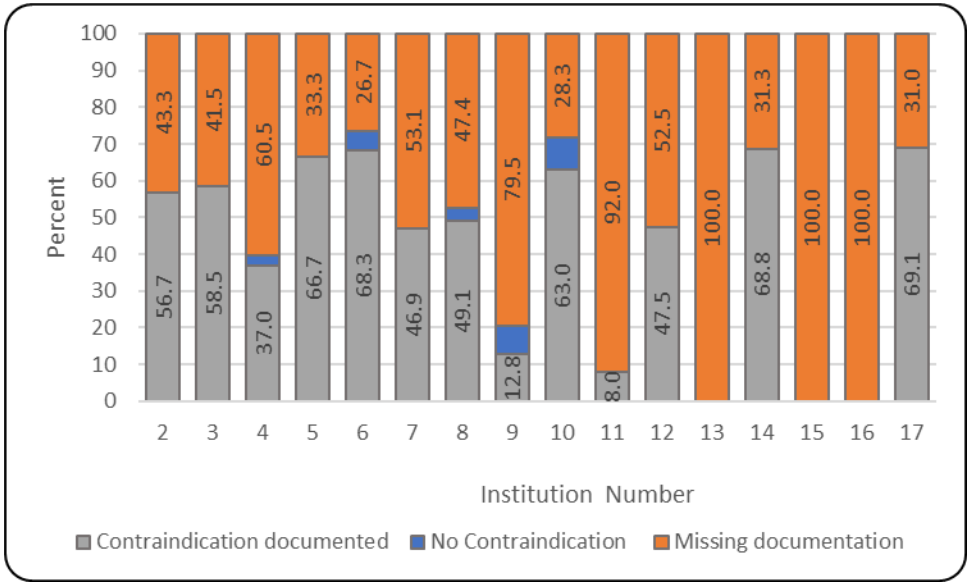


Figure 73. Documentation of Contraindications is Patients Eligible for rtPA Who Did Not Receiving rtPA by Institution

- There is substantial variability in the documentation of contraindications by institution.

Contraindications for this metric include:

- IV or IA rtPA given at outside hospital
- CT findings, including ICH, SAH, or major infarct signs
- The care team was unable to determine if patient met eligibility criteria
- Stroke severity was too mild
- Life expectancy was judged to be (1) < 1 year or (2) had severe comorbid illness (3) comfort measures only on admission
- Patient had conditions that might lead to unfavorable outcomes
    - Severe stroke severity
    - Blood glucose was <50 or >400 mg/dL
    - Presence of a left heart thrombus
    - There was a potential for an Increased risk of bleeding due to:
        - Acute or recent pericarditis
        - Subacute bacterial endocarditis
        - Hemostatic defects
        - Pregnancy
        - Hemorrhagic ophthalmic conditions
        - Septic thrombophlebitis
- Oral anticoagulants
- Arterial puncture at a noncompressible site in past 7 days
- Advanced age
- Family refused treatment
- Rapid improvement of symptoms

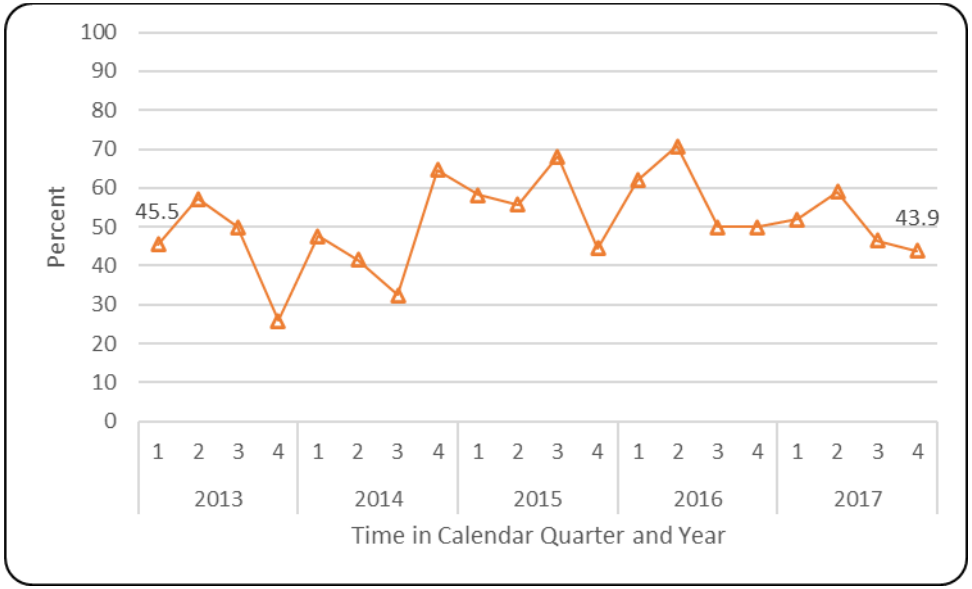


Figure 74. Quarterly Trends in the Proportion of Patients Receiving IV-rtPA Within 60 Minutes of Hospital Arrival

**Applies to ischemic strokes only*

- There is no significant trend in the number of patients **who receive rtPA within 60 minutes of hospital arrival** by quarter (p-trend=0.1350).

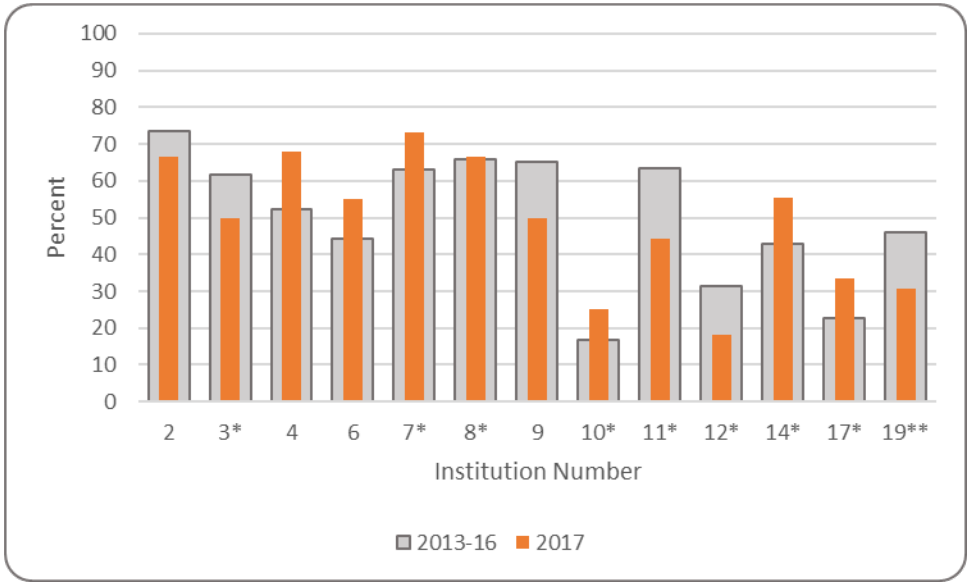


Figure 75. Comparison of the Proportion of Patients Receiving IV-rtPA Within 60 Minutes of Hospital Arrival between 2013—16 and 2017 Among Institutions (IS)

**<20 observations for 2017*

***<20 observations for both time periods*

- Seven out of 13 institutions reporting this metric saw improvement in 2017 over the 2013—16-time frame.

*Based on small numbers, these statistics should be interpreted with caution.

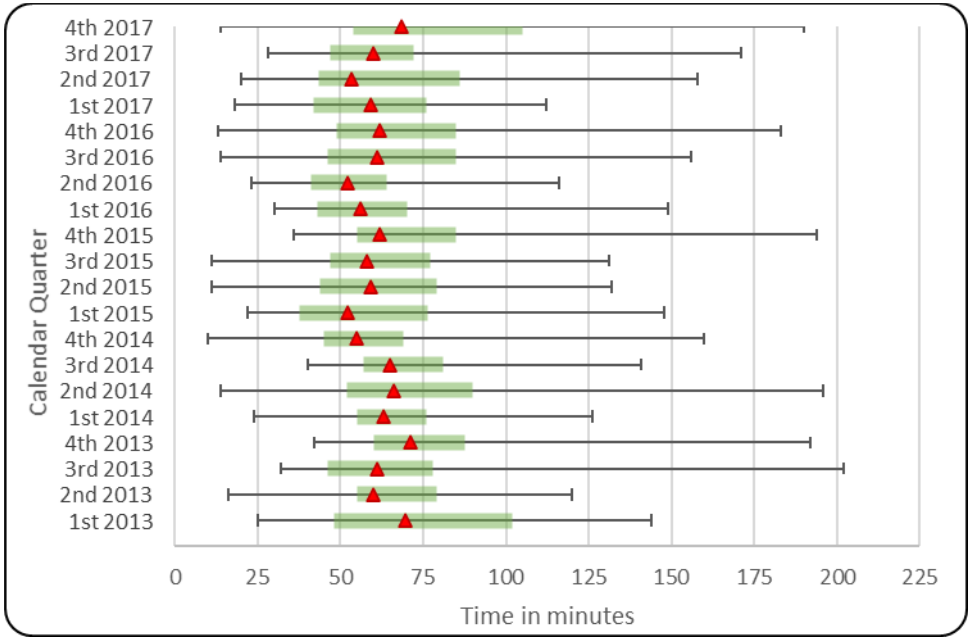


Figure 76. Quarterly Trends in Median Door-to-needle Times Among Patients Receiving rtPA (IS)

Patients transferred from other institutions and in-patient strokes were excluded.

Applies to ischemic strokes only

- There is a non-significant decrease in the quarterly **median door-to-needle times** (p=0.0602).

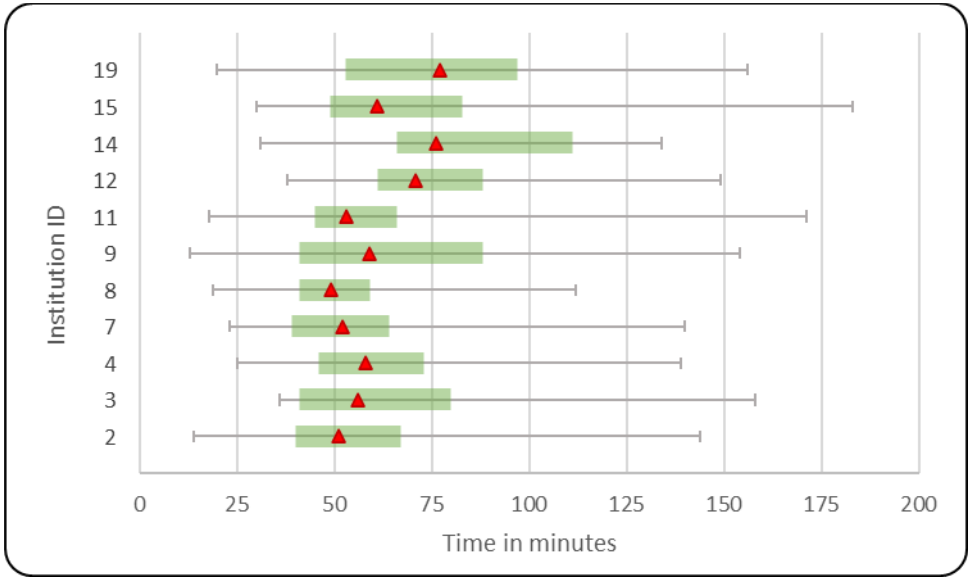


Figure 77. Median Door-to-Needles Times in Minutes, by Institution, 2013—2017

Institutions with fewer than 15 observations were excluded.
Patients transferred from other institutions and in-patient strokes were excluded.
The red triangle represents the median time from arrival to the hospital to administration of rtPA.
The green shaded area represents the interquartile range, including values from the 25th percentile through the 75th percentile.
**The width of this range may be affected by the number of observations.*
Gray horizontal lines represent the range of minimum and maximum values.

- The **overall median door-to-needle times** for all primary and comprehensive stroke centers is 60 minutes (IQR 48 to 79 minutes).
- The **median door-to-needle times** for individual institutions ranged from 49 to 100 minutes.
- Of the 11 institutions reporting more than 15 observations, 7 institutions had **median door-to-needle times** less than or equal to 60 minutes.

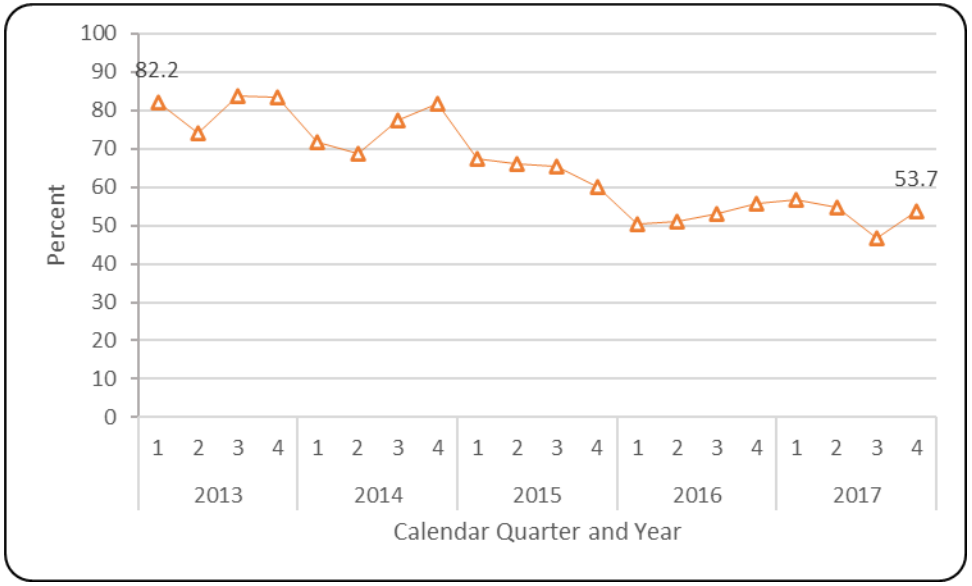


Figure 78. Quarterly Trends in the Proportion of Patients with a Recorded Admission NIH Stroke Scale Score (IS, NOS)

Applies to ischemic and strokes, not otherwise specified.

- There is a significant decrease in the proportion of patients with a recorded **admission NIH Stroke Scale Score** over time (82.2% to 53.7% (p<.0001)).

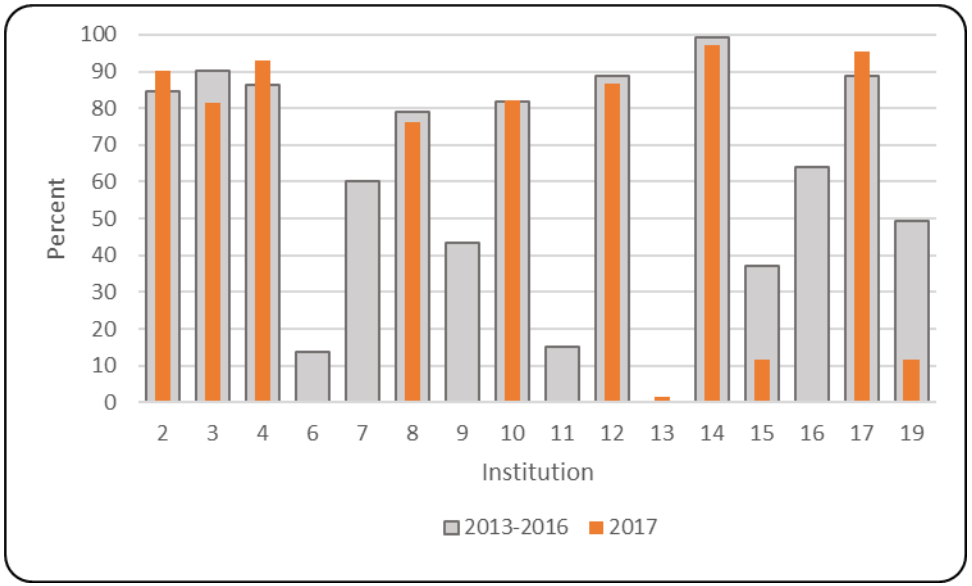


Figure 79. Comparison of the Proportion of IS with a Recorded Admission NIH Stroke Scale Score Between 2013—16 and 2017, by Institution

- Eight out of 16 institutions are consistently reporting **NIH Stroke Scale Scores** for both 2013—16- and 2017-time frames.
- Five institutions achieved reporting rates greater than 85% for both time frames.
- Five institutions have stopped **reporting NIH Stroke Scale Scores** for the 2017-time frame.

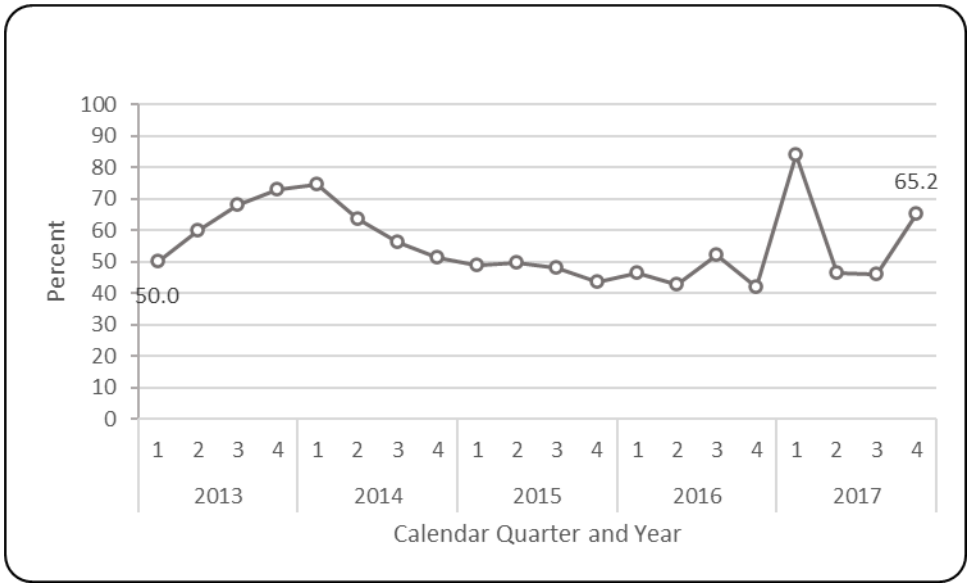


Figure 80. Quarterly Trends in the Proportion of Patients with Door-to-Physician Times ≤ 10 minutes

- There is substantial missing data so interpretation should be made with caution.

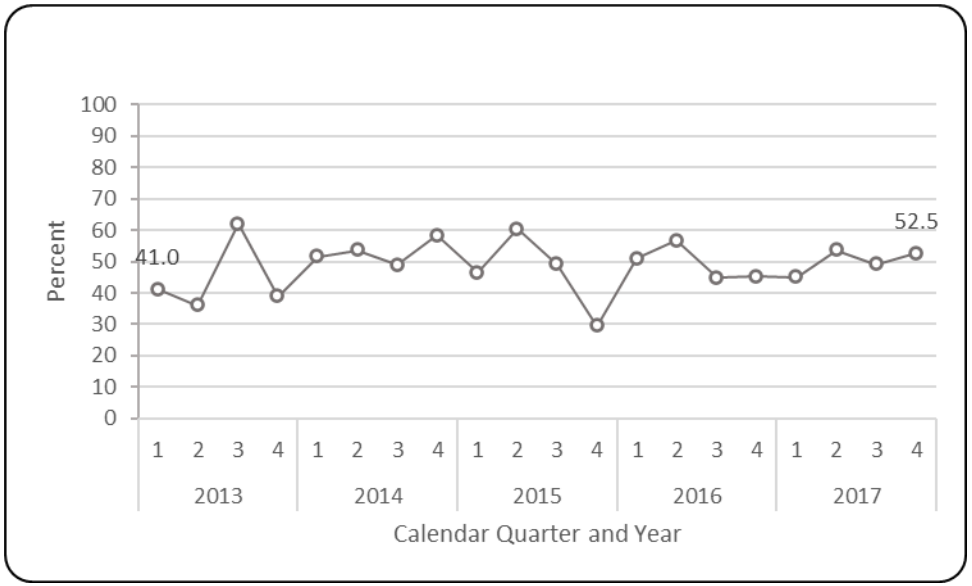


Figure 81. Quarterly Trends in the Proportion of Patients Door-to-Imaging ≤ 25 minutes

- There is no notable change over time in the proportion of patients who **are imaged** within 25 minutes of arrival to the institution (p-trend=0.06524).
- There is no significant change in the proportion of patients who **are imaged** within 25 minutes of arrival between the 2013—16-time frame when compared to the 2017-time frame (48.7 versus 49.8, p=0.6810).

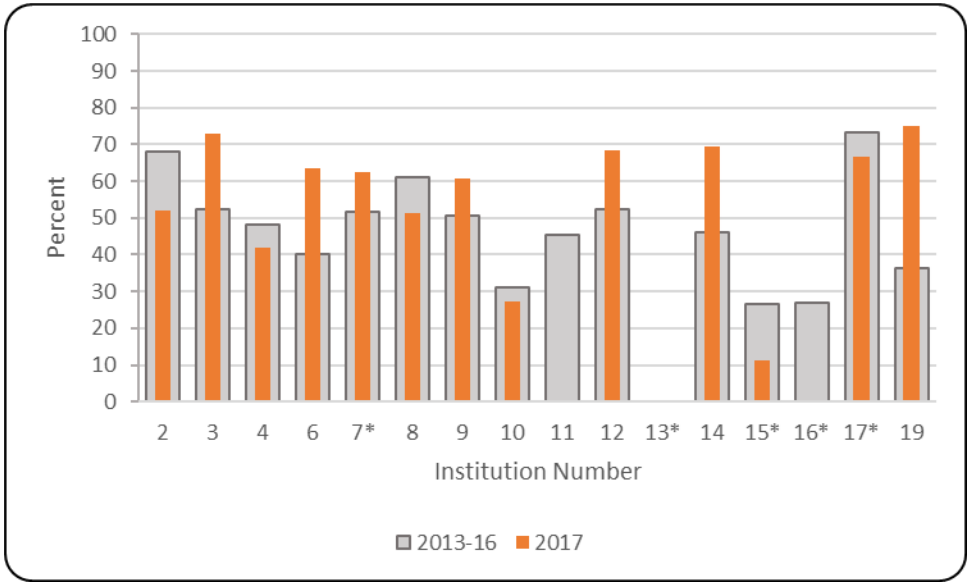


Figure 82. Comparison of the Proportion of Patients with Door-to-Imaging ≤ 25 minutes Between 2013—16 and 2017, by Institution

**Counts <20 for 2017-time frame.*

- Eight out of 17 institutions (47.1%) report **door-to-imaging times less than 25 minutes** for the 2013—16-time frame and 10 out of 16 institutions (62.5%) for the 2017-time frame.
- Seven out of 15 institutions (46.7%) reported an increase in the proportion of patients with **door-to-imaging times less than 25 minutes** from the first-time frame to the second time frame.

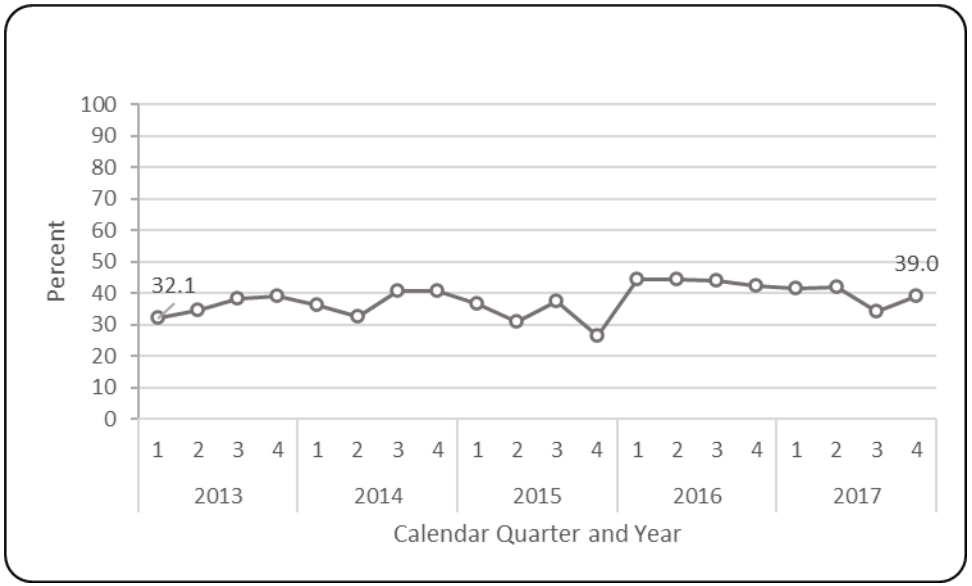


Figure 83. Quarterly Trends in the Proportion of Patients with Door-to-Image interpretation ≤ 45 minutes

- The proportion of patients who receive **door-to-image interpretation** in less than 45 minutes has remained consistent (p-trend=0.086).
- This proportion remained relatively unchanged from the 2013—16-time frame to the 2017-time frame (37.9% versus 39.3%, p0.5824).

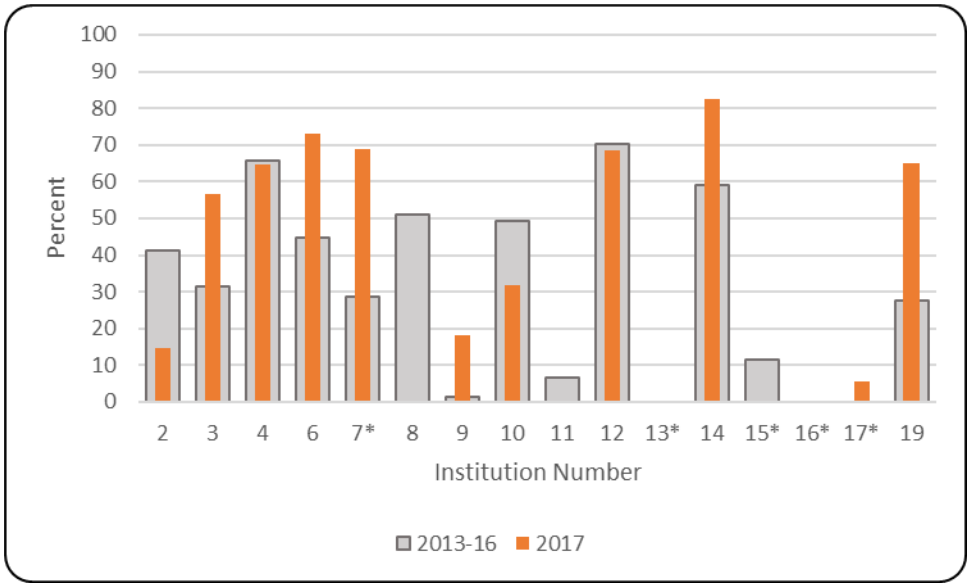


Figure 84. Comparison of the Proportion of Patients with Door-to-Image interpretation ≤ 45 minutes Between 2013—16 and 2017, by Institution
**< 20 observations for 2017-time frame*

- There is substantial variability in the proportion of patients with **door-to-image interpretation** of less than 45 minutes among institutions.
- In the 2013—16-time frame, four out of 17 institutions (23.5%) achieved greater than 50%. This number improved in 2017 to seven out of 16 institutions (43.8%).

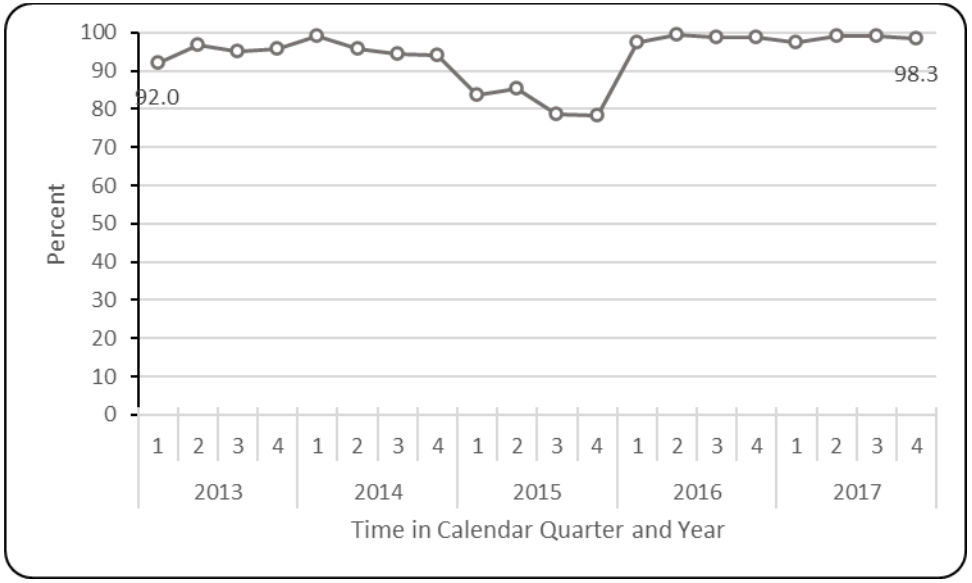


Figure 85. Quarterly Trends in the Proportion of Stroke Patients Receiving VTE Prophylaxis

Abbreviations: VTE=venous thromboembolism

- The proportion of patients receiving **VTE prophylaxis** was consistent prior to 2015 when there was a drop in the proportions. Since 2016, the proportion of patients has remained high (greater than 97%, p-trend <.0001).
- There is a significant difference in the proportions of patients receiving **VTE prophylaxis** between the 2013—16-time frame and 2017-time frames (92.1% versus 98.5%, p<.0001).

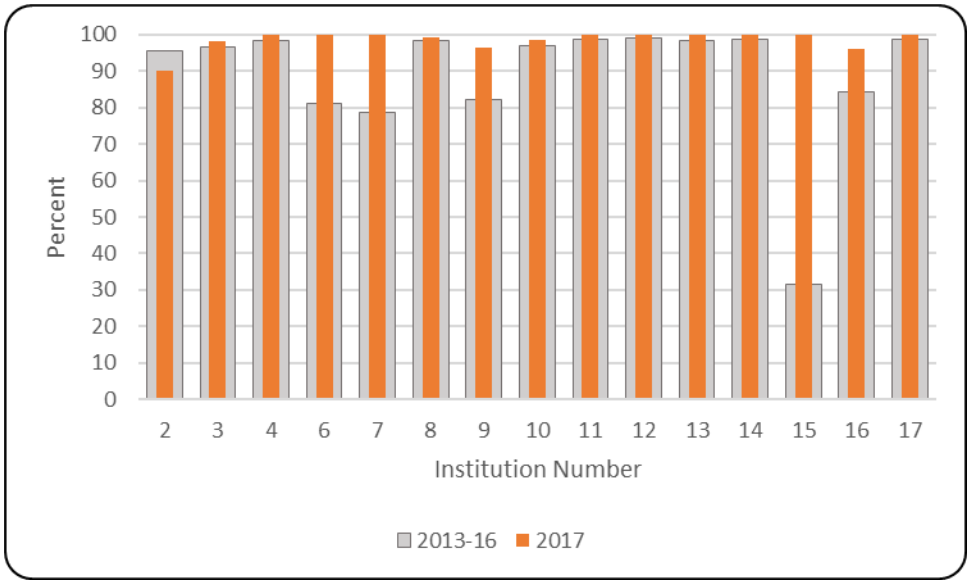


Figure 86. Comparison of the Proportion of Patients Receiving VTE Prophylaxis Between 2013—16 and 2017, by Institution

Abbreviations: VTE=venous thromboembolism

- The proportion of patients receiving **VTE prophylaxis** ranged from 31.4% to 99.0% among institutions.
- Fifteen out of 16 reporting institutions (93.8%) reported an improvement in the proportion of patients receiving **VTE prophylaxis** from 2013—16-time frame and the 2017-time frame.
- For the first period, 11 out of 16 institutions (68.8%) achieved a target of 85%. In the 2017-time frame, all 16 institutions reported achieving target goals of 85% (100%).

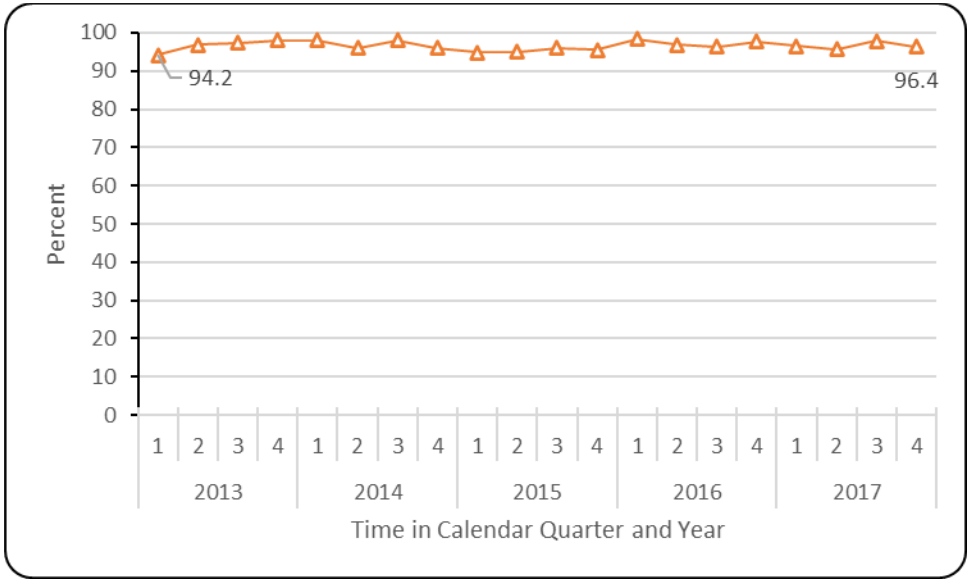


Figure 87. Quarterly Trends in the Proportion of Patients Administered Antithrombotic Therapy by the End of Hospital Day 2
Applies to ischemic strokes only

- The proportion of patients receiving **antithrombotic therapy by the end of hospital day 2** has remained consistently greater than 94% for all quarters.

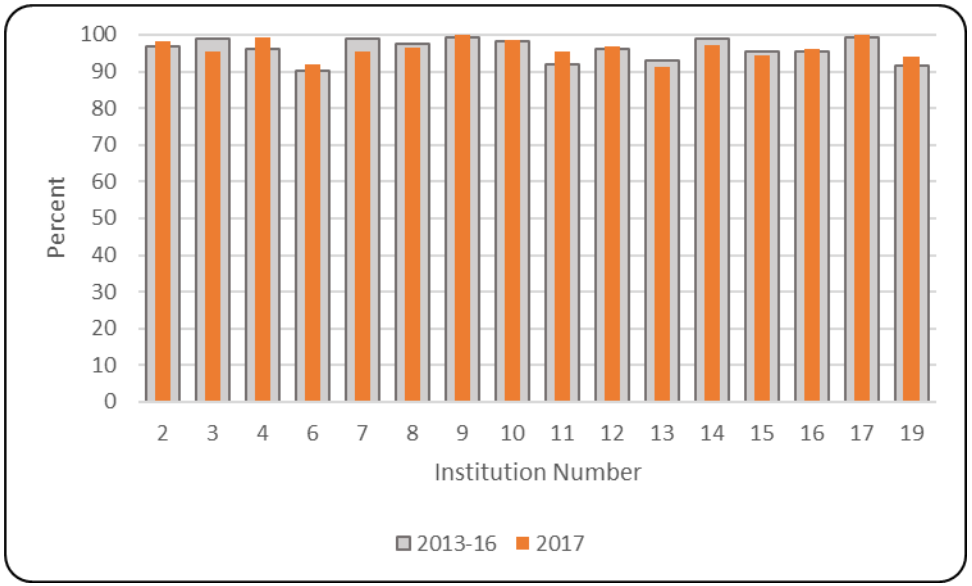


Figure 88. Comparison of the Proportion of Patients Administered Antithrombotic Therapy by the End of Hospital Day 2 Between 2013—16 and 2017, by Institution

- There's minimal variability among institutions in the proportion of patients administered **antithrombotic therapy by the end of day two**.
- Ten out of 16 institutions (58.2%) reported an improvement in the proportion of patients administered **antithrombotic therapy by the end of day two** between the first-time frame and second time frame.
- All institutions have met the target of 85% for both time frames.

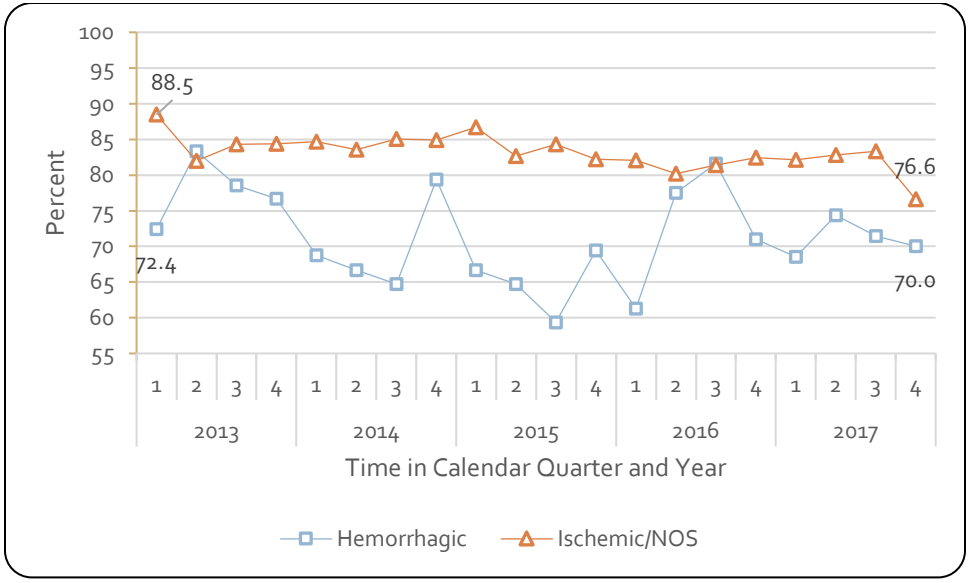


Figure 89. Quarterly Trends in the Proportion of Patients Receiving Dysphagia Screening Prior to PO Intake

Abbreviations: PO=oral intake, NOS=stroke, not otherwise specified

- There is a significant decrease in the proportion of patients with ischemic or stroke, not otherwise specified who receive **dysphagia screening** (p-trend=0.0005).
- There is substantial variability with a non-significant decrease by quarter in the proportion of patients with hemorrhagic stroke, **screened for dysphagia** (p-trend=0.6772).
- For **hemorrhagic strokes**, there were zero quarters that met the target goal of 85%.
- For **ischemic strokes**, three out of 20 quarters (15%) achieved the target goal of 85%.
- Overall, compared to **ischemic strokes**, **hemorrhagic strokes** have consistently smaller proportions of patients **screened for dysphagia**.
- The proportion of patients **screened for dysphagia** is smaller for the 2017-time frame compared to the 2013—16-time frame (80.0% versus 82.6%, p=0.0087).

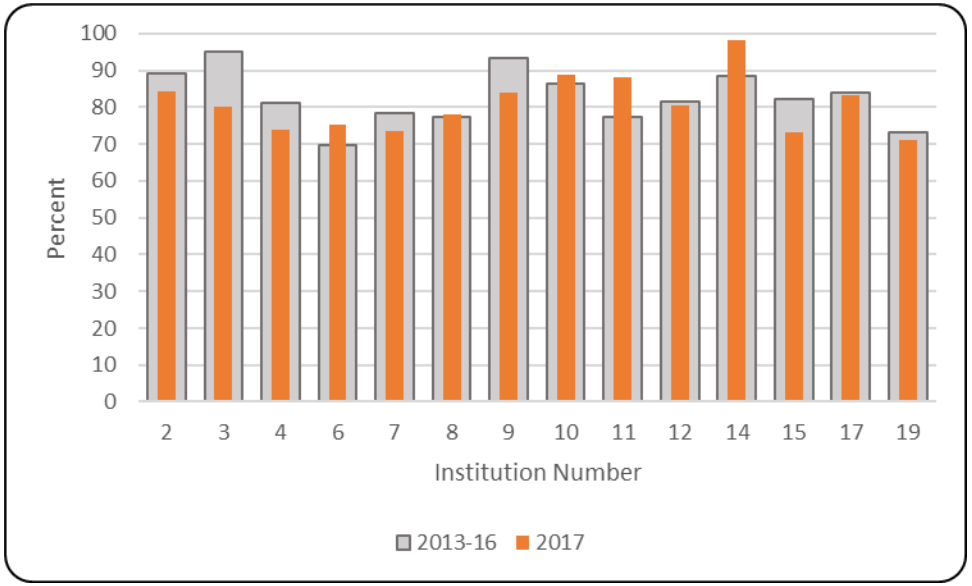


Figure 90. Comparison of the Proportion of Patients Receiving Dysphagia Screening Prior to PO Intake, Between 2013—16 and 2017, by Institution
Abbreviations: PO=oral

- There is some variability among institutions in the reported proportion of patients receiving **dysphagia screening** (range 69.8% — 95.2%).
- For the first period, six out of 16 institutions (37.5%) achieved a target of 85% compared to four out of 15 institutions (26.7%) for the second time frame.
- Five out of 14 institutions with data for both time frames, reported improvements in the proportion of patients receiving **dysphagia screening**.

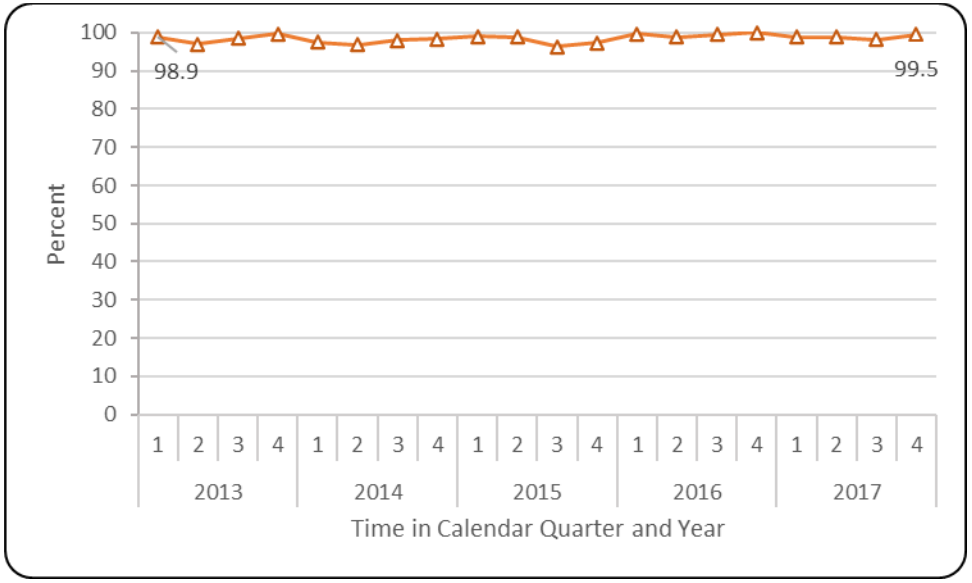


Figure 91. Quarterly Trends in the Proportion of Patients Prescribed Antithrombotic Therapy at Discharge

- There is minimal variability in the proportion of patients prescribed **antithrombotic therapy at discharge** over time (range 96.3%—100%).
- The target goal of over 85% was met for all quarters.

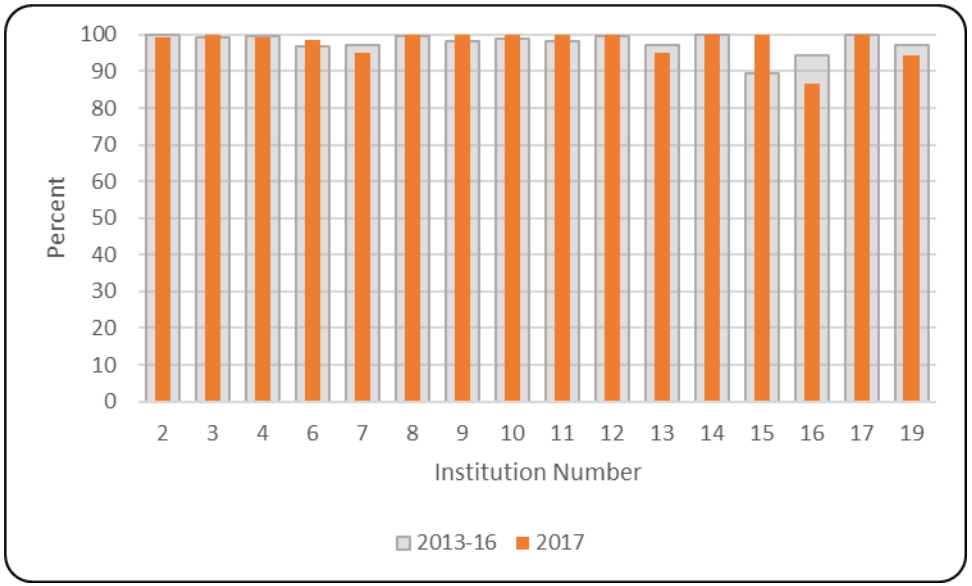


Figure 92. Comparison of the Proportion of Patients Prescribed Antithrombotic Therapy at Discharge, Between 2013—16 and 2017, by Institution

- There is a small amount variability among institutions in the reported proportion of patients receiving **antithrombotic therapy at discharge** (range 89.6—100% for the 1st time frame and 86.7—100% for the 2nd time frame).
- **All institutions** achieved a target goal of 85% for both time frames.

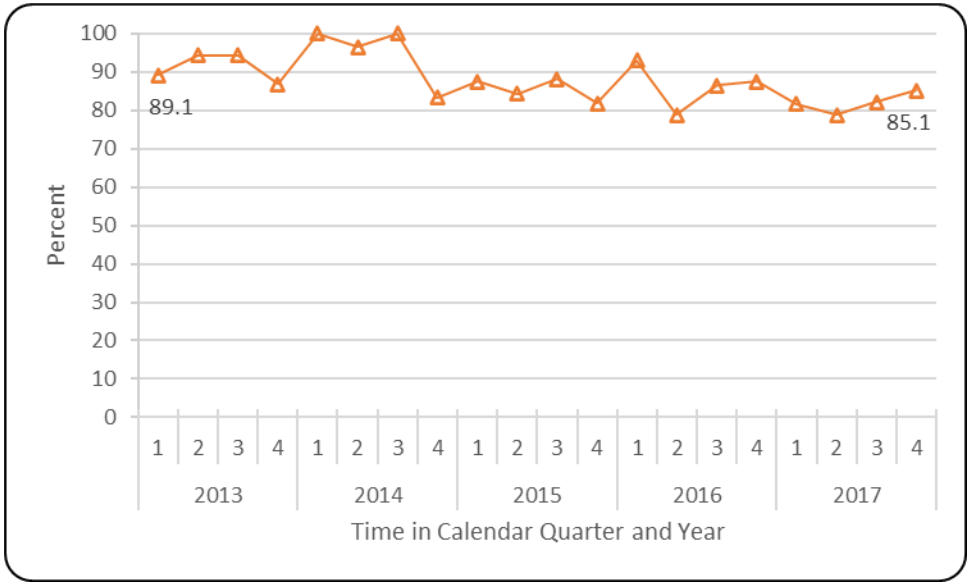


Figure 93. Quarterly Trends in the Proportion of Patients with Atrial Flutter/Fibrillation Prescribed Anticoagulants at Hospital Discharge

- There is a fair amount of variability in the proportions of patients with **atrial fibrillation/flutter prescribed anticoagulants at discharge** (range 78.9%—100%).
- The target goal of 85% was met in 13 out of 20 quarters (65%).

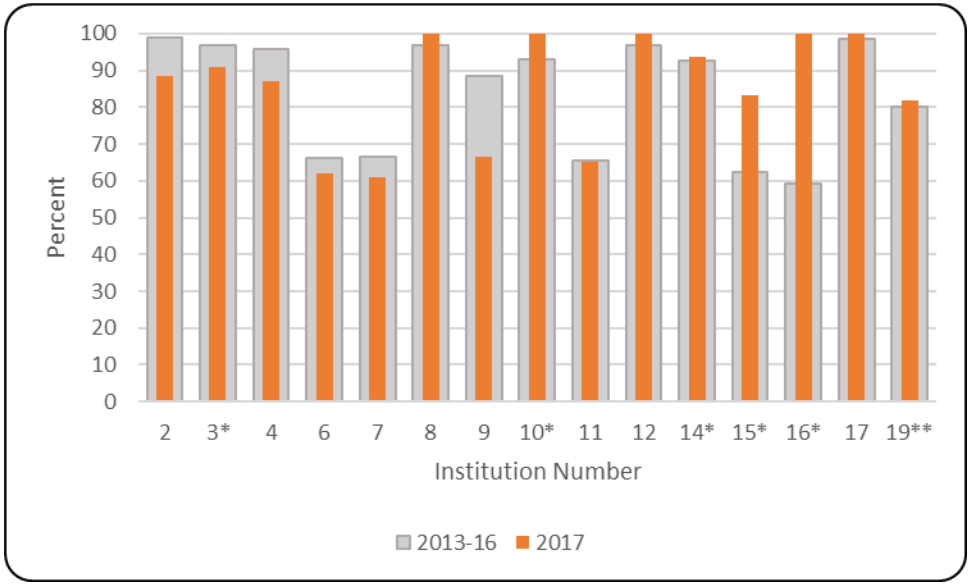


Figure 94. Comparison of the Proportion of Patients with Atrial Flutter/Fibrillation Prescribed Anticoagulants at Hospital Discharge, Between 2013—16 and 2017, by Institution

**<20 observations 2017*

***<20 observations both time frames*

- There is substantial variability in the proportion of patients with **atrial fibrillation/flutter prescribed anticoagulants at discharge** among institutions (range 59.1—100% for 1st time frame and 61.1—100% for the 2nd time frame).
- Eight out of 15 institutions (53.3%) report improvements in the proportion of patients receiving **anticoagulant prescriptions**.
- For the 2013—16-time frame, 10 out of 16 institutions (62.5%) achieved a target of 85% compared to the 2017-time frame where nine out of 15 institutions (60%) achieved a target of 85%.

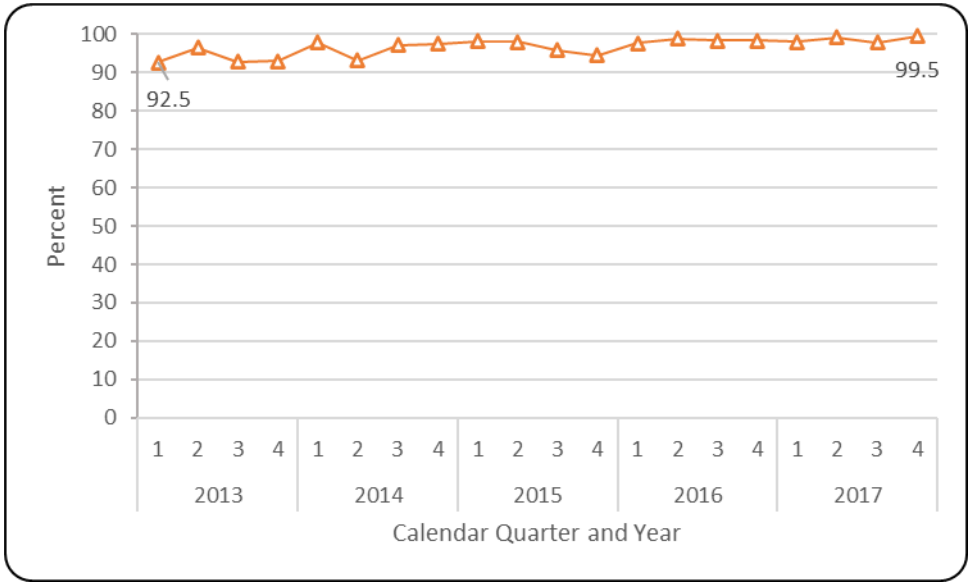


Figure 95. Quarterly Trends in the Proportion of Patients with Elevated LDL Prescribed Statin Medication at Discharge

Abbreviations: LDL=low-density lipoprotein

- There is minimal variability over time in the proportion of patients with an elevated **LDL** who are **prescribed statin medications** at discharge (range 92.5—99.5%).
- There is an increasing trend in the proportion of patients **prescribed statins** at discharge (p-trend <.0001).
- For all quarters, a target of 85% was met.

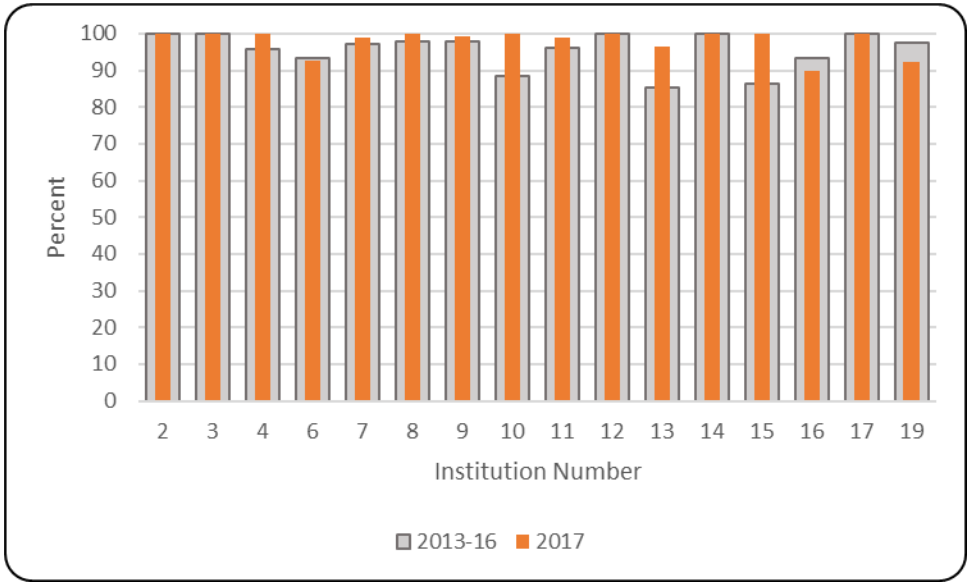


Figure 96. Comparison of the Proportion of Patients with Elevated LDL Prescribed Statin Medication at Discharge, Between 2013—16 and 2017, by Institution
Abbreviations: LDL=low-density lipoprotein

- There is a small amount of variability in the proportion of patients with an **elevated LDL prescribed statin medication at discharge** (85.4—100% for the 1st time frame and 90—100% for the 2nd time frame).
- **All institutions** achieved a target of 85% for both time frames.

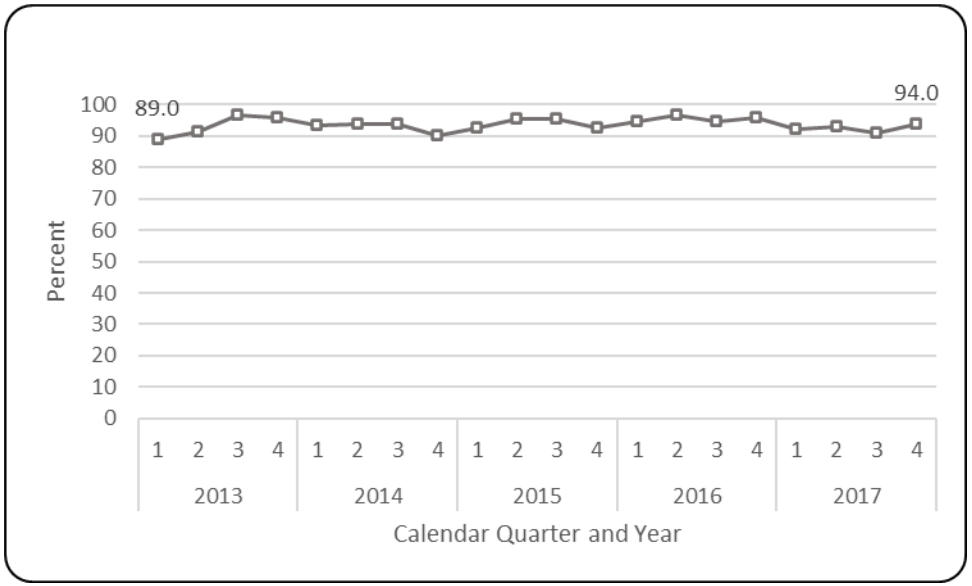


Figure 97. Quarterly Trends in the Proportion of Patients or Caregivers Provided Stroke Education Materials by Discharge

- There is a non-significant increase (0.3%) in the average percent change over calendar quarters from 2013 through 2017 (p-trend=0.9052).
- The target goal of 85% is met for all quarters.
- There is a non-significant decrease (1.6%) in the proportion of patients and/or caregivers **receiving stroke education** between the 2013—16-time frame and the 2017-time frame (p=0.0780).

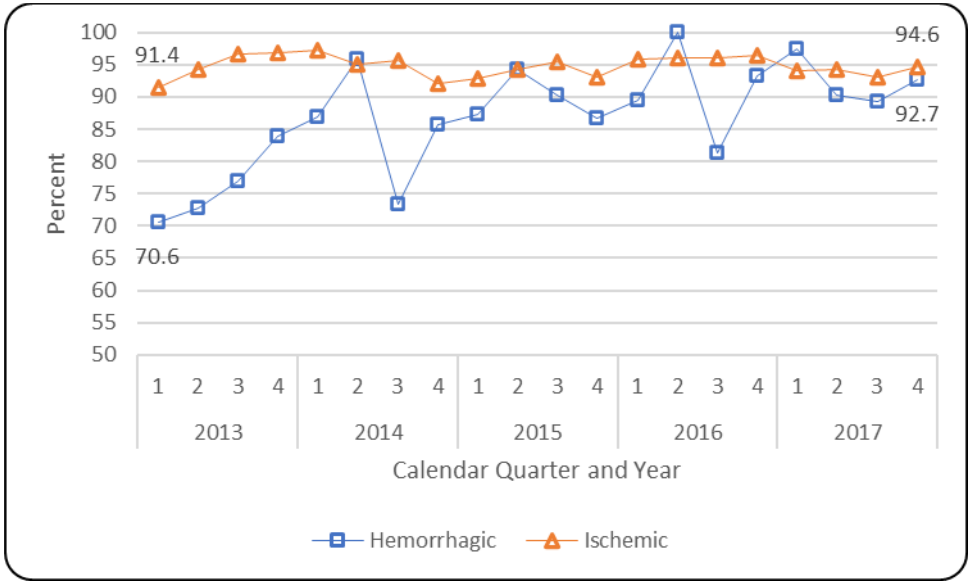


Figure 98. Quarterly Trends in the Proportion of Patients Receiving Stroke Education by Stroke Type, 2013—2017

- The proportion of **ischemic** strokes patients receiving education at or prior to discharge increased over time with an average 0.2% each quarter (p-trend=0.0047).
- For **hemorrhagic** strokes, there was substantial variability in the proportion of patients receiving stroke education by discharge over time. This variability may be a result of fewer numbers of hemorrhagic strokes. Overall, there was an average percent increase each quarter (p-trend=0.1388).

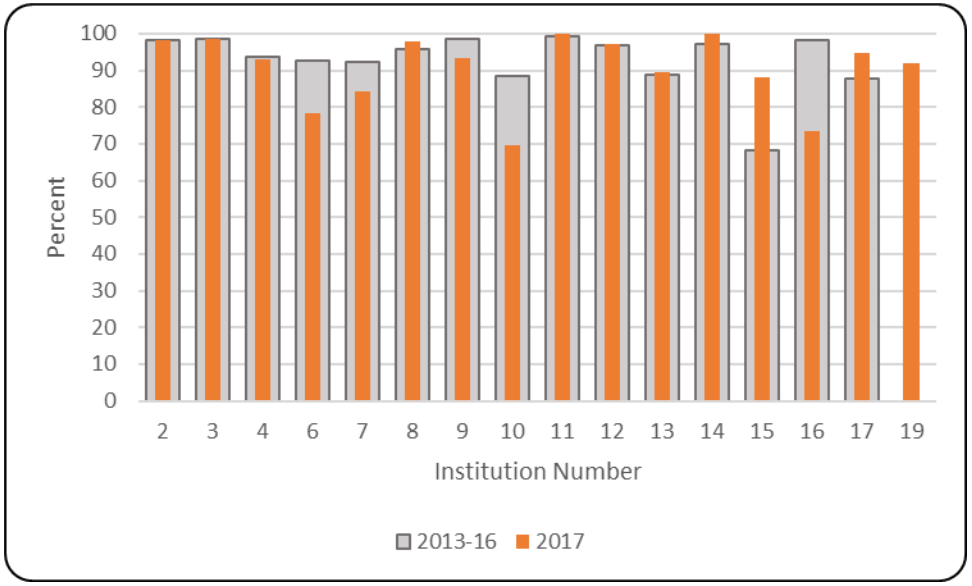


Figure 99. Comparison of the Proportion of Patients or Caregivers Provided Stroke Education Materials by Discharge, Between 2013—16 and 2017, by Institution

- There is some variability among institutions in the proportion of patients receiving **stroke education** by discharge.
- For the first period, 16 of 17 (institutions achieved a target goal of greater than 85%. For the 2017-time frame, 12 out of 16 institutions (75%) achieved the target goal.
- Eight out of 16 institutions (50%) report improvements in the proportion of patients receiving **stroke education** from the first to second time frame.

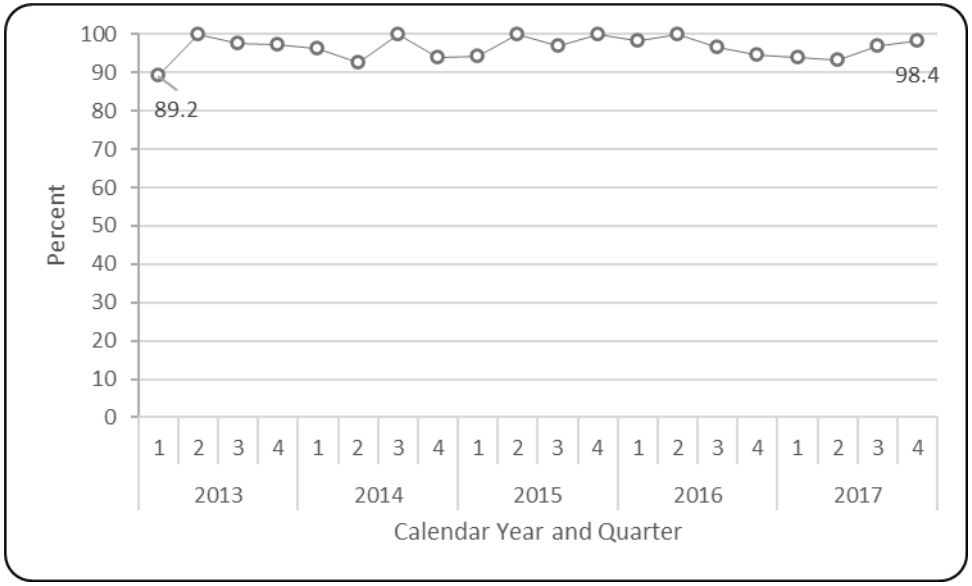


Figure 100. Quarterly Trends in the Proportion of Current Smokers Receiving or Refusing Smoking Cessation Counseling

- There is minimal variability in the proportion of patients who are current smokers and received **smoking cessation** counseling over time.
- There is a non-significant increase in the proportions over time (+1.4% change per quarter, p-trend=0.9751).
- For the 2013—16-time frame, the overall percent of patients receiving **smoking counseling** was higher than the 2017-time frame (96.9% versus 95.6%, p=0.3014).
- A target goal of 85% was met for all quarters.

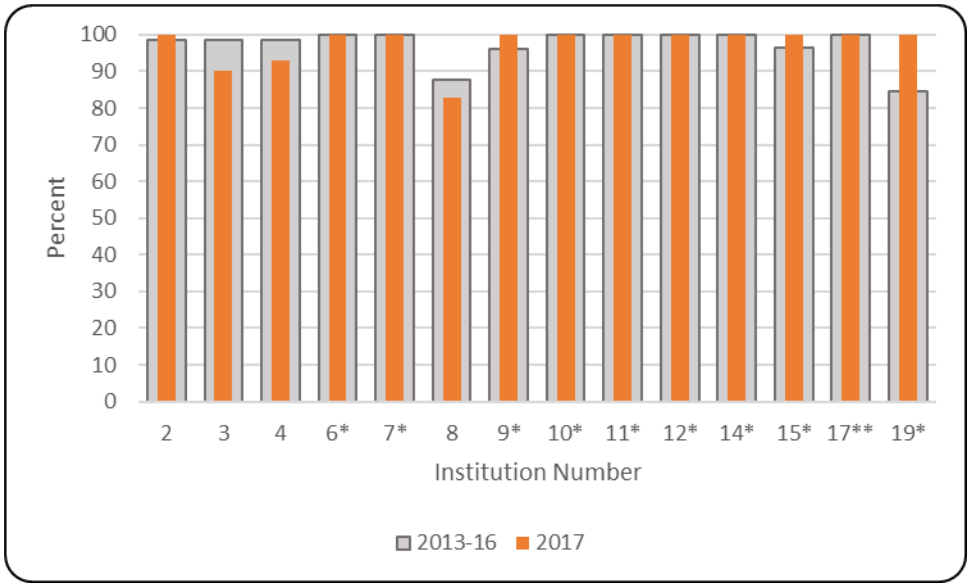


Figure 101. Comparison Proportion of Current Smokers Receiving or Refusing Smoking Cessation Counseling, Between 2013—16 and 2017, by Institution

**<20 observations for 2017*

***<20 observations for both time frames*

- Three out of 14 institutions reported an improvement in percent from the 2013—16-time frame to the 2017-time frame.
- Five out of 14 institutions (38.5%) reported 100% of smoking patients received **smoking cessation** counseling for both time frames.
- All institutions achieved >85% target goal for the 2013—16-time frame while one institution did not reach the 85% target goal for 2017.
- Interpretation of values by institution should proceed with caution due to small numbers at most of the institutions for 2017.

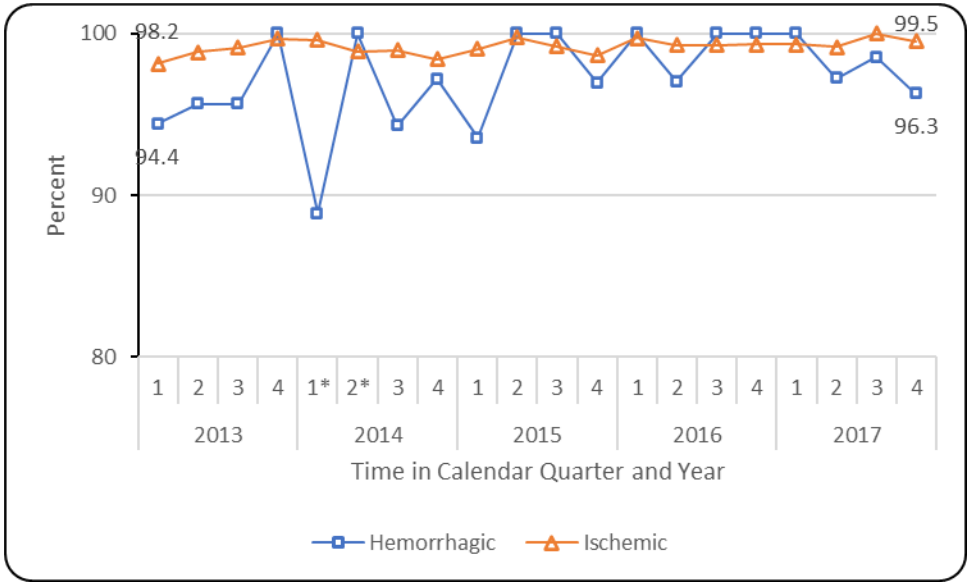


Figure 102. Quarterly Trends in the Proportion of Patients Assessed for Rehabilitation Services

**<20 observations for hemorrhagic stroke*

- The proportion of hemorrhagic strokes assessed for **rehabilitation** was lower than ischemic strokes (97.4% versus 99.2%%, p<.0001).
- The proportion of patients assessed for rehabilitation remained high at all time points for **ischemic** stroke with a minimum of 98%.

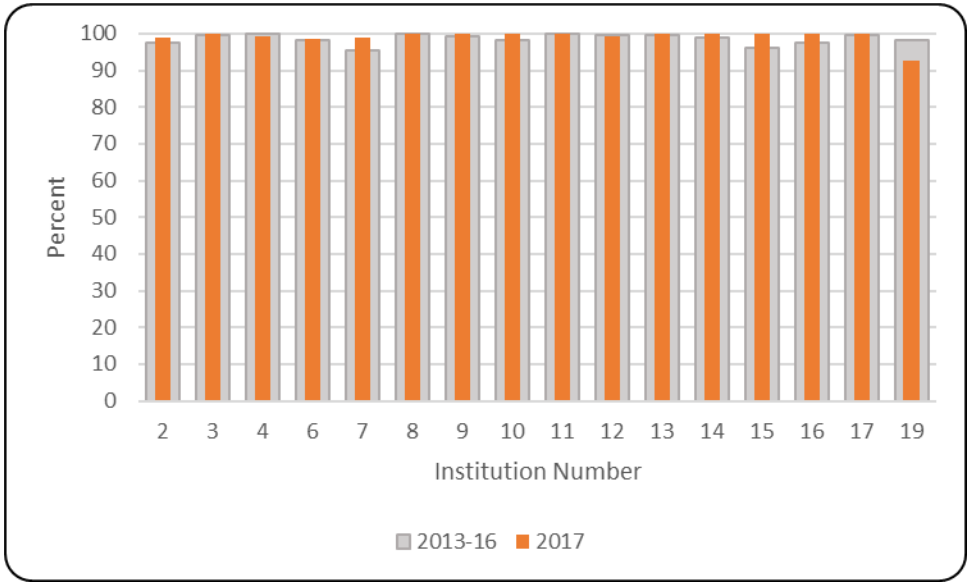


Figure 103. Comparison of the Proportion of Patients Assessed for Rehabilitation Services, Between 2013—16 and 2017, by Institution

- All institutions reported greater than 95.5% of the proportion of stroke patients evaluated for **rehabilitation** with little variability.
- Twelve out of 16 hospitals (75%) improved their performance on this metric from the 2013—16-time frame to the 2017-time frame.

Table 17. Characteristics of Ischemic Stroke Patients by IV rtPA Treatment Status

Characteristic	Not Treated n=490 (40.9%)	Treated n=745 (59.1%)	p-value
Age (years), median (IQR)	74 (62—84)	72 (60—82.5)	0.0519
<55 years	12.5%	5.1%	0.0262
45—65 years	23.5%	30.5%	
65+ years	70.6%	64.4%	
80+ years	32.5%	29.2%	0.2354
Gender, male	49.5%	51.0%	0.6445
Race and Ethnicity			
Caucasian	95.8%	95.1%	0.8616
Hispanic	1.4%	1.1%	0.4205
White, non-Hispanic	95.1%	94.3%	
Black, non-Hispanic	1.7%	2.2%	
Other	1.7%	2.4%	
Insured	99.0%	97.5%	0.1218
BMI, median (IQR), kg/m^2	28 (23.6—32.4)	28.1 (24.1—32.4)	0.6436
Arrival by EMS	68.5%	79.2%	0.0001
Rurality	17.1%	23.7%	0.0060
Prenotification by EMS	81.3%	80.7%	0.8663
NIH Stroke Scare Score			
Median (IQR)	3 (1—8)	8 (4—15)	0.0016
0	16.2%	12.6%	0.0223
1—4	53.5%	36.7%	
5—15	21.2%	36.7%	
16—20	4.0%	5.2%	
21+	5.1%	8.9%	
Missing NIH Stroke Scale Score	60.8%	35.6%	<.0001
Time of Presentation			
7a—5p	57.6%	57.2%	0.9422
5p—12a	35.3%	35.7%	
12a—7a	7.1%	7.1%	
Weekday arrival	32.7%	34.3%	0.5478
Admission glucose < 50 or > 400 mg/dL	0%	1.2%	0.1436

Characteristic	Not Treated n=490 (40.9%)	Treated n=745 (59.1%)	p-value
Reported as a contraindication	0%	0%	NA
Admission SBP >180 or DBP > 100 mm Hg	13.3%	15.2%	0.5454
Reported as a contraindication	0.2%	0.1%	0.7934
LKW to Arrival, median (IQR), min	60 (38—83)	57 (38—83)	<.0001
Door-to-imaging ≤ 25 min	47.8%	71.9%	<.0001
Door-to-imaging, median (IQR)	24 (13—47)	17 (10—25)	<.0001
Medical history			
Cholesterol-lowering medications	30.2%	37.2%	0.0128
Anticoagulant on admission	9.2%	4.1%	0.0003
Antihypertensive medication	30.6%	46.1%	<.0001
Antiplatelet on admission	21.8%	31.2%	0.0003
Hormone replacement therapy	0%	0.7%	0.5221
Atrial fibrillation/flutter	14.1%	14.6%	0.8209
Carotid stenosis	2.0%	1.3%	0.2945
Depression	0.6%	1.6%	0.1171
Diabetes	11.2%	18.1%	0.0012
Drug abuse	1.6%	2.7%	0.2282
Dyslipidemia	21.2%	27.0%	0.0231
Family history of stroke	3.1%	6.6%	0.0060
Heart failure	3.1%	4.5%	0.2011
Hypertension	28.0%	41.8%	<.0001
Migraines	1.4%	2.0%	0.4472
MI/CAD	10.8%	15.1%	0.0316
Obesity	4.5%	5.5%	0.4284
PAD	2.0%	2.1%	0.9262
Prior stroke	12.9%	9.9%	0.1076
Sleep apnea	0%	0.7%	0.1636
Renal disease	3.3%	2.8%	0.6525
TIA	5.7%	4.7%	0.4149
Valve prosthesis	1.8%	1.1%	0.3092

Characteristic	Not Treated n=490 (40.9%)	Treated n=745 (59.1%)	p-value
Symptoms			
Weakness	**22.9%**	**45.9%**	**<.0001**
Altered LOC	**7.8%**	**14.4%**	**0.0004**
Visual changes	**0%**	**0.3%**	**0.5162**
Aphasia	**14.5%**	**33.2%**	**<.0001**
Speech	**1.4%**	**6.9%**	**<.0001**
Nausea	**0.4%**	**0.1%**	**0.5710**
Dizziness	**0.6%**	**0.6%**	**0.2930**
Imbalance	**1.2%**	**0.6%**	**0.3329**
Headache	**0.4%**	**1.0%**	**0.3231**
Posterior circulation	**0%**	**0%**	**NA**
Sensory	**0.8%**	**2.3%**	**0.0665**
Incoordination	**0.2%**	**0%**	**0.4090**

Abbreviations: IQR=interquartile range, kg=kilograms, m=meters, EMS=emergency medical services, dL=deciliter, min=minutes, MI=myocardial infarction, CAD=coronary artery disease, PAD=peripheral artery disease, TIA=transient ischemic attack, LOC=level of consciousness.

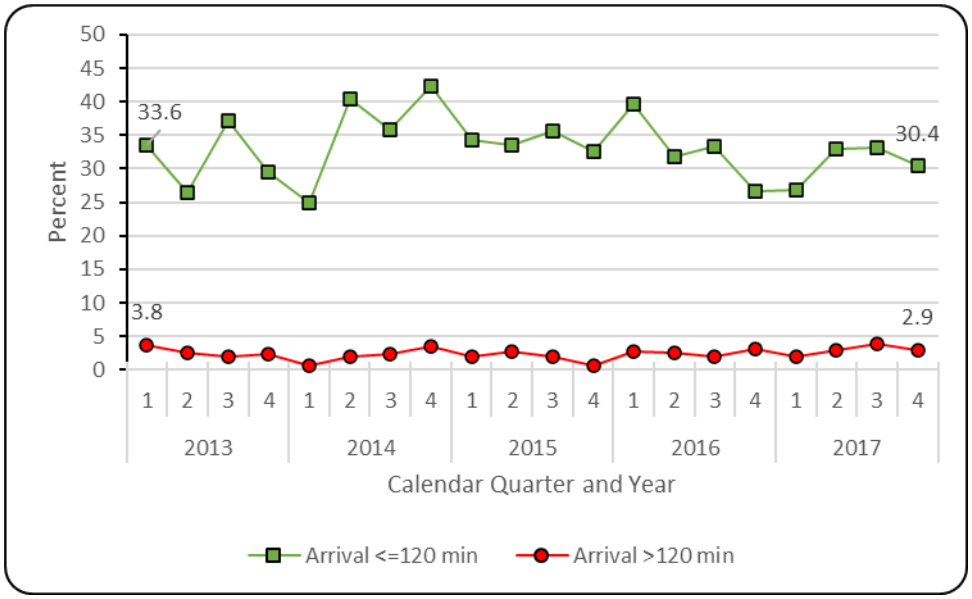


Figure 104 Percentage of Patients Receiving rtPA Based on Arrival Intervals, 2013 – 2017

- There is substantial variability in the proportion of patients receiving rtPA within **120 minutes** of arrival with a range of 17.2%.
- Arrival **after 120 minutes** of last known well shows substantial variability with a range of 3.2%.
- Based on the variability, clear trends are difficult to assess.

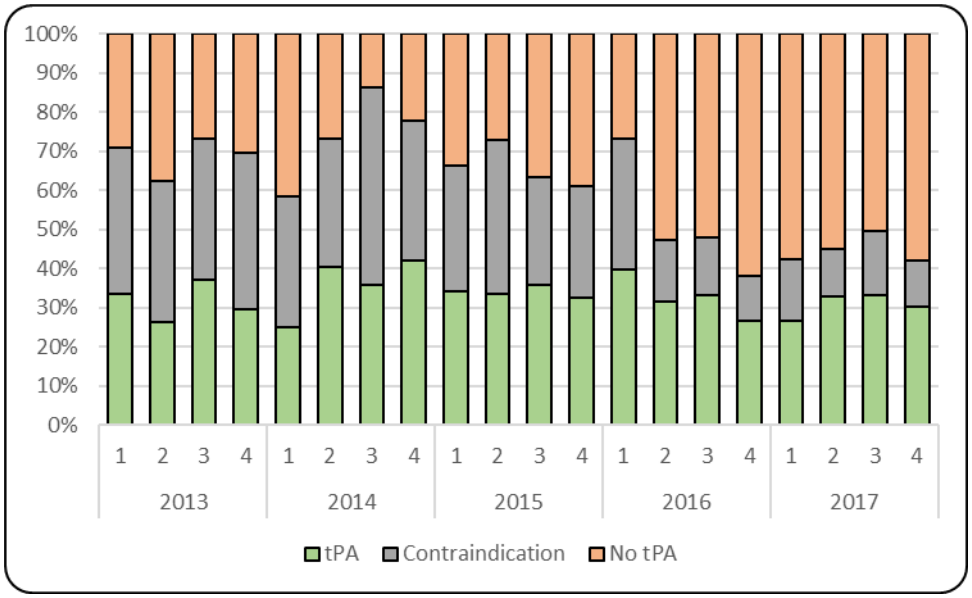


Figure 105. Quarterly Trends in the Distribution of Treatment Status in Ischemic Strokes

Abbreviations: tPA=Tissue Plasminogen Activator

The proportion of patients not treated due to a **contraindication** declined overall.
The proportions of eligible patients who **do not receive tPA** appears to be increasing over time.

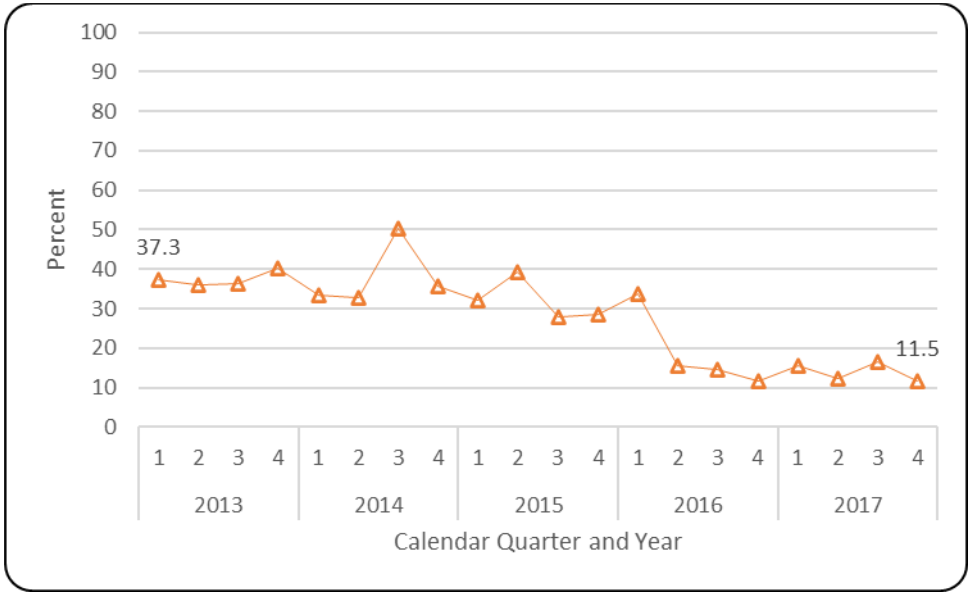


Figure 106. Quarterly Trends in the Percent of Patients with Documented Contraindications, 2013 – 2017

- The percent of patients with a documented **contraindication** to rtPA has decreased an average 2.3% quarterly (p-trend <.0001).

Table 18. Reported Treatment Complications in Ischemic Strokes Receiving rtPA

Reported complications	N	Percent
No complications	1476	62.1
Complication reported		
Symptomatic ICH	0	0.0
Asymptomatic ICH	1	0.0
Systemic hemorrhage	0	0.0
Allergic reaction	0	0.0
Angioedema	0	0.0
Other tPA complications	123	5.2
Complications unknown	29	1.2
Missing	747	31.4
Total	2376	100

Abbreviations: ICH=intracerebral hemorrhage, tPA=tissue plasminogen activator

- Complications are not a mandatory variable and subject to under-reporting.
- Based on a 2011 review of complications after receiving IV-rtPA, complications appear to be underreported.[60]

Table 19. Outcomes by Stroke Type

Outcome	Patients with Acute Stroke, by Type			
	SAH (n=720)	ICH (n=2542)	IS (n=14473)	NOS (n=1018)
Length of stay (days), median (IQR)	8 (3—15)	4 (2—8)	3 (2—5)	3 (2—5)
Ambulatory status at discharge				
Without assistance	49.8%	27.0%	53.1%	44.2%
With assistance	35.6%	51.2%	37.1%	41.9%
Unable to ambulate	14.6%	21.8%	9.9%	14.0%
Change in ambulation [a]	49.3%	69.0%	43.2%	45.4%
Discharged home	37.9%	23.0%	46.0%	48.3%
Modified Rankin Score [b]				
0			10.6%	
1			21.4%	
2			15.5%	
3			22.9%	
4			25.0%	
5			4.7%	
≤2			47.5%	
Expired [c]	19.7%	19.6%	3.5%	3.8%

Abbreviations: SAH=subarachnoid hemorrhage, ICH=intracerebral hemorrhage, IS=ischemic stroke, NOS=stroke, not otherwise specified, IQR=interquartile range
[a] Change in ambulation was calculated by comparing ambulation status prior to admission to ambulation status at discharge. Those who experienced no change or an improvement in ambulation were characterized as no change, while those who experienced a deterioration were characterized as experiencing a change.
[b] Substantial amounts of data for other types of strokes were missing so this characteristic is only displayed for ischemic strokes. [c] The percent of patients who expired after presentation to healthcare was captured by multiple variables and may not total 100% for Modified Rankin Scores of six.

Subarachnoid hemorrhages have the longest median length of stay. This may reflect the need for extended monitoring and severity of symptoms. [61]

- Smaller percentages of **hemorrhagic stroke** are **discharged to home** compared to ischemic and strokes, not otherwise specified.
- Higher proportions of **hemorrhagic strokes** expire compared to ischemic and strokes, not otherwise specified.
- There was a significant difference between the stroke types in the proportion of patients who experience a change in **ambulation status** between admission and discharge (p<.0001).
- Those with **intracerebral hemorrhages** had the highest proportion of patients experiencing a change in the **ambulation status** while ischemic strokes had the lowest proportion.

LENGTH OF STAY

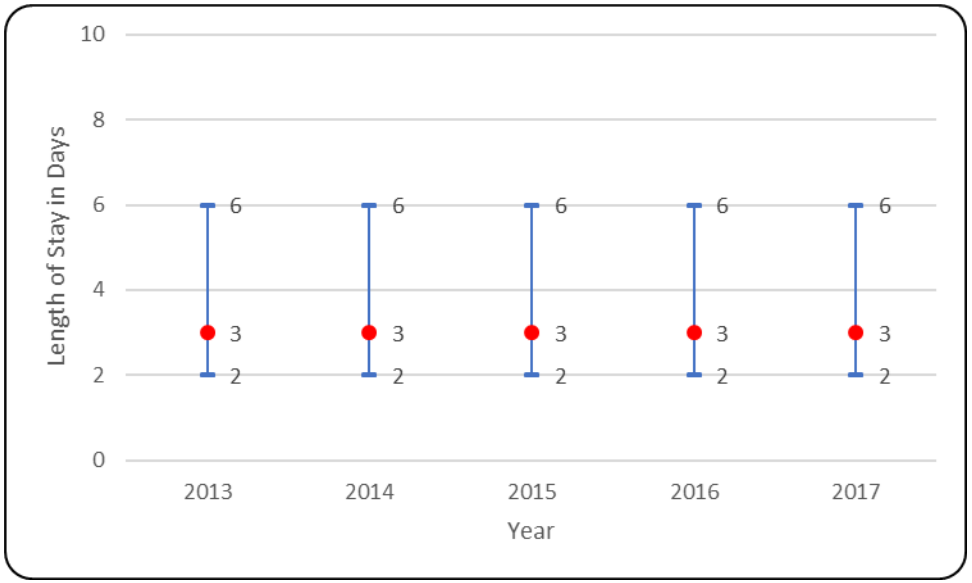


Figure 107. Time Trend in Median Length of Stay for Acute Stroke

- The **median length of stay** has remained unchanged from 2013 through 2017.

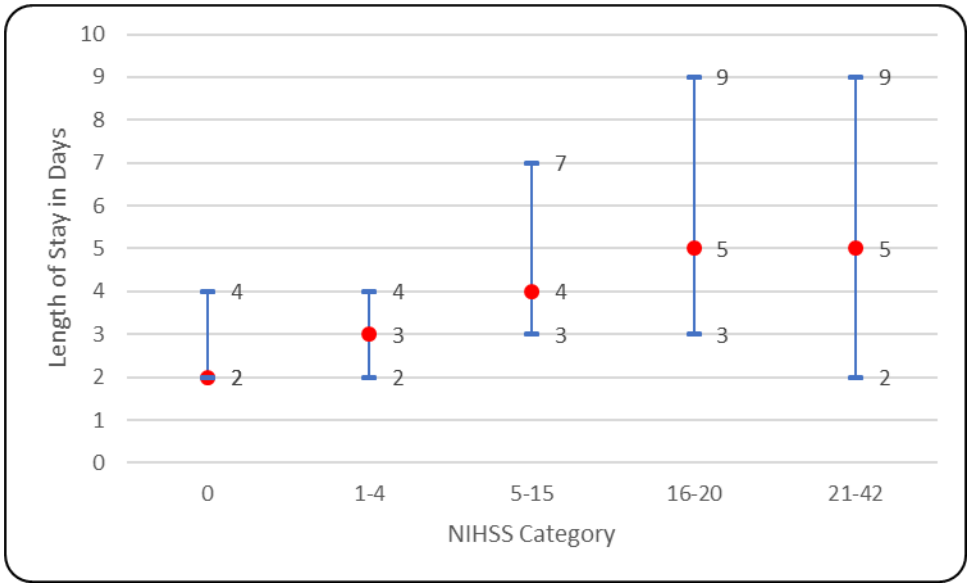


Figure 108. Median Length of Stay by Severity

Abbreviations: NIHSS=National Institute of Health Stroke Scale Score

**Excludes those who expired during hospitalization.*

- The median **length of stay** increased with increasing severity of stroke. Those with **NIH Stroke Scale Scores** greater than 15 had similar lengths of stay.

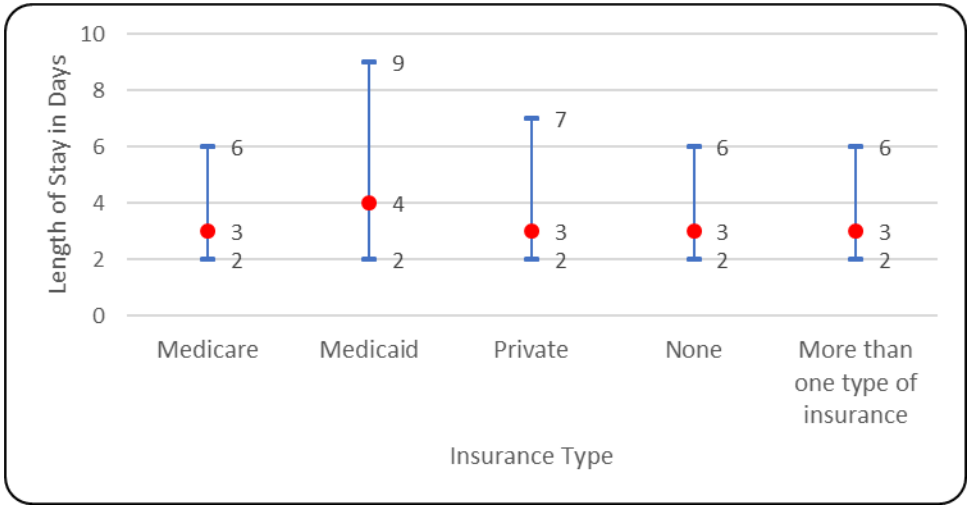


Figure 109. Median Length of Stay by Insurance Type

- **Medicaid** patients had longer lengths of stay than other patients with other forms of insurance coverage. This finding may be influenced by differences in risk factors of **Medicaid** patients compared to other insured populations and the type of stroke.
- Younger populations tend to experience subarachnoid hemorrhages requiring more intensive care. The younger populations are more likely to qualify for Medicaid.
- The state of Iowa has expanded **Medicaid** coverage of inpatient rehabilitation services [62].

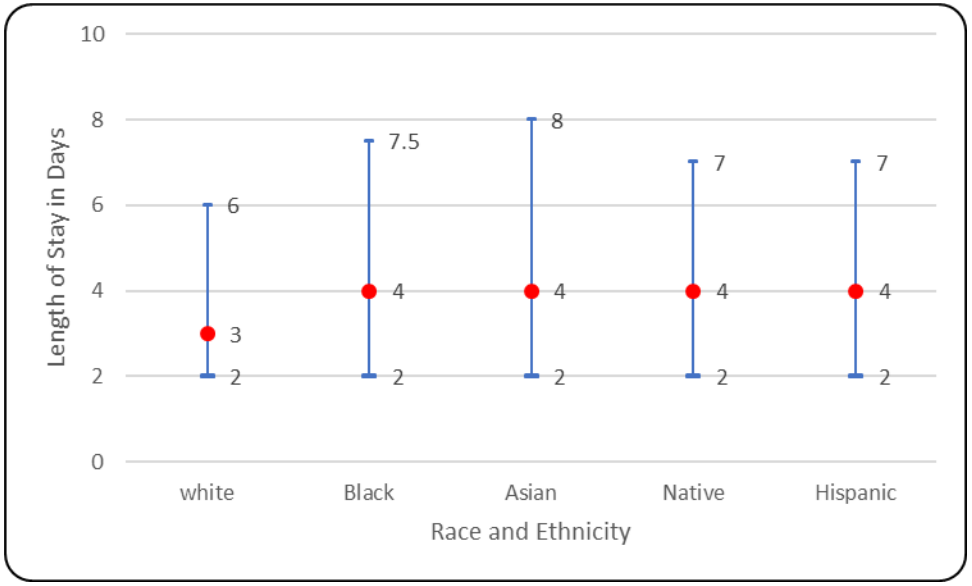


Figure 110. Median Length of Stay by Race

- **Whites** had shorter lengths of stay than **non-Whites** (p<.0001).
- The median NIH Stroke Scale score for both **Whites** and **non-Whites** were equivalent at 4 points each.

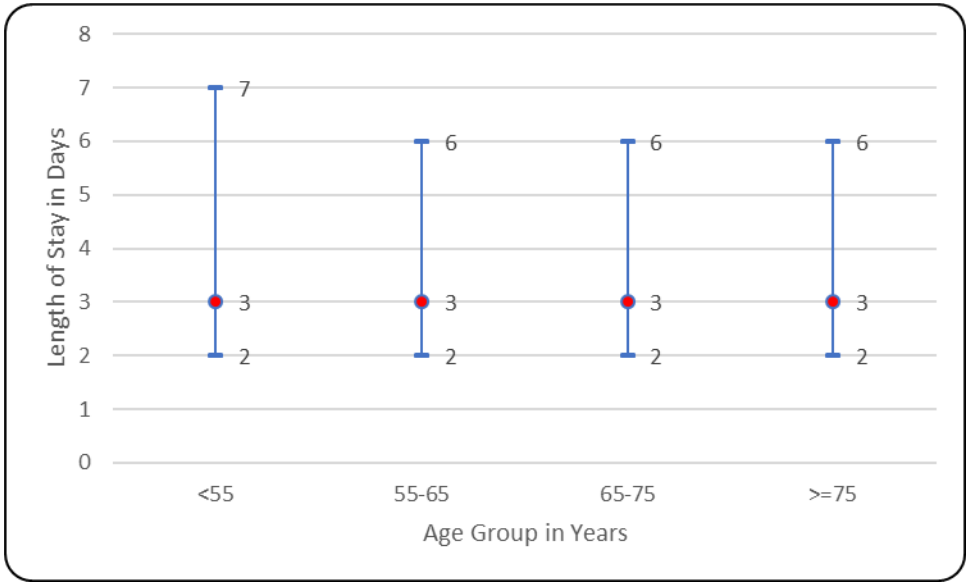


Figure 111. Length of Stay by Age Group

- The median **length of stay** did not vary by age group.

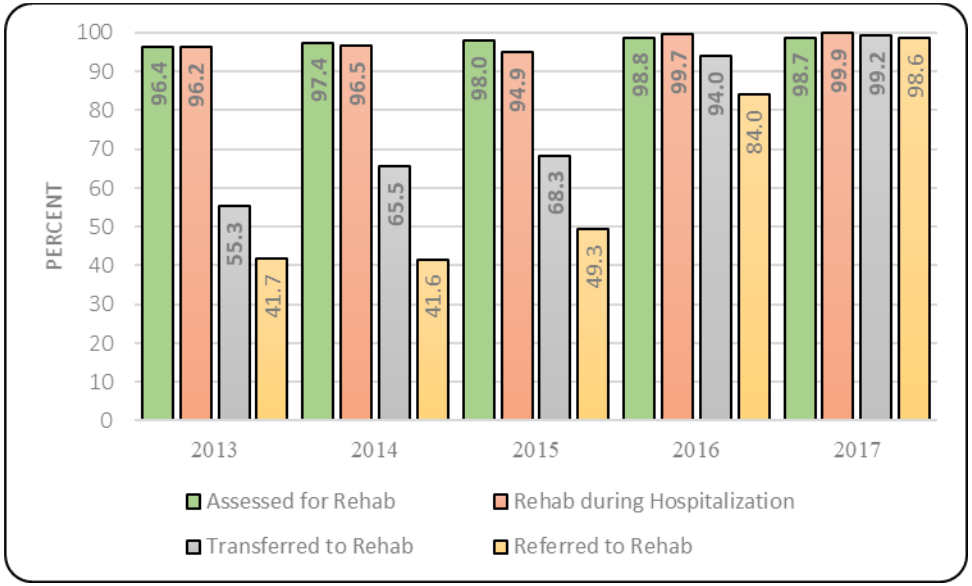


Figure 112. Trends in Rehabilitation Patterns After Acute Stroke

Abbreviations: Rehab=rehabilitation

- Patients who were assessed for **rehabilitation** or received **rehabilitation** during hospitalization remained high at all time periods.
- There were substantial improvements in the proportion of patients who were referred or transferred to **rehabilitation** improved over time.

DISCHARGE DESTINATION

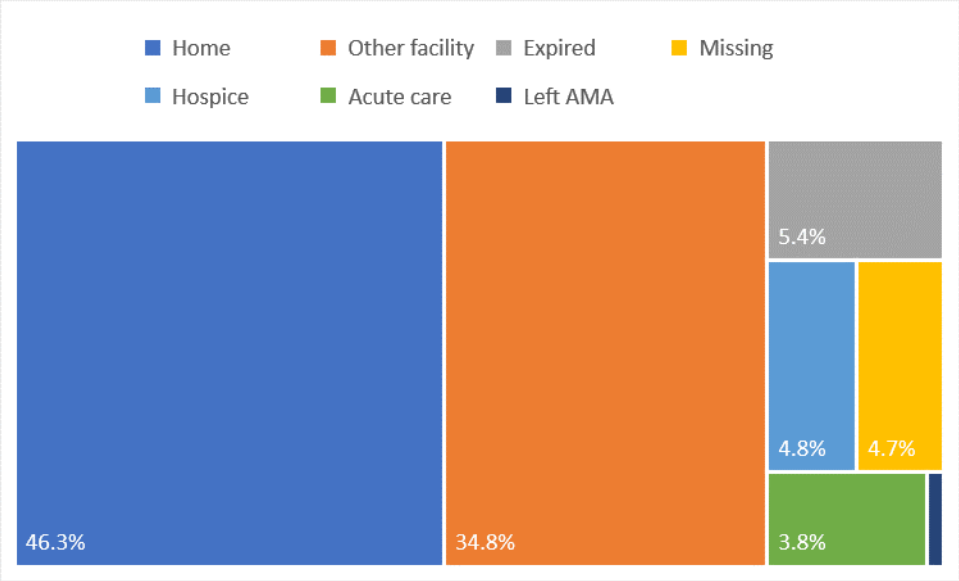


Figure 113. Discharge Destination for All Patients Evaluated for Acute Stroke, 2013 through 2017

- The highest proportion of patients who received evaluation and treatment for acute stroke were **discharged to home** (46.3%).
- 34.8% were **transferred to another facility** while another 3.8% were **transferred to another acute care facility**.
- Death occurred in 5.4% of patients and 4.8% were **discharged to hospice care**.

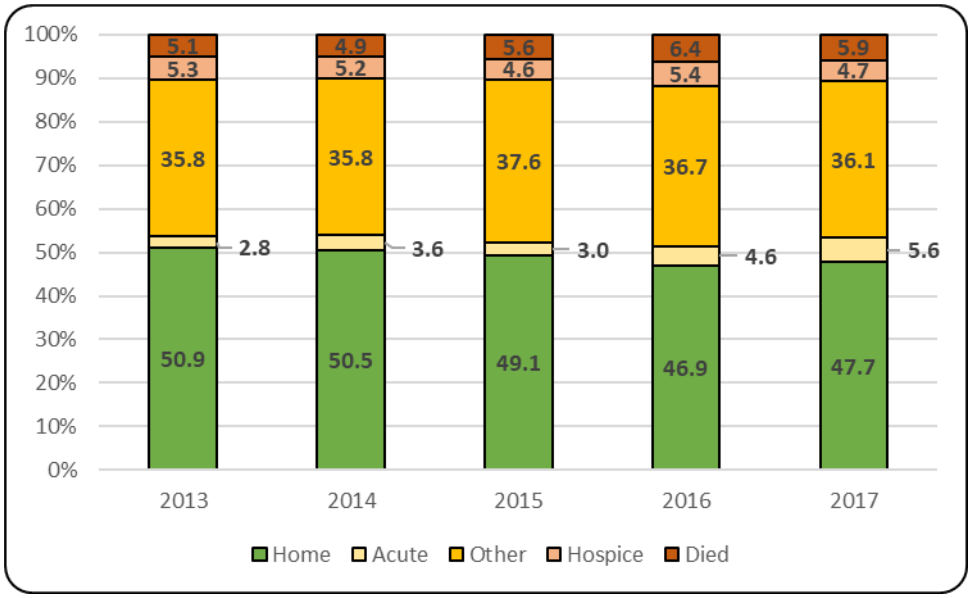


Figure 114. Discharge Destination by Year for All Patients Admitted for Acute Stroke

- The largest change in the discharge destination occurred in those discharged to **another acute facility**, which increased by an average 21.9% per year.

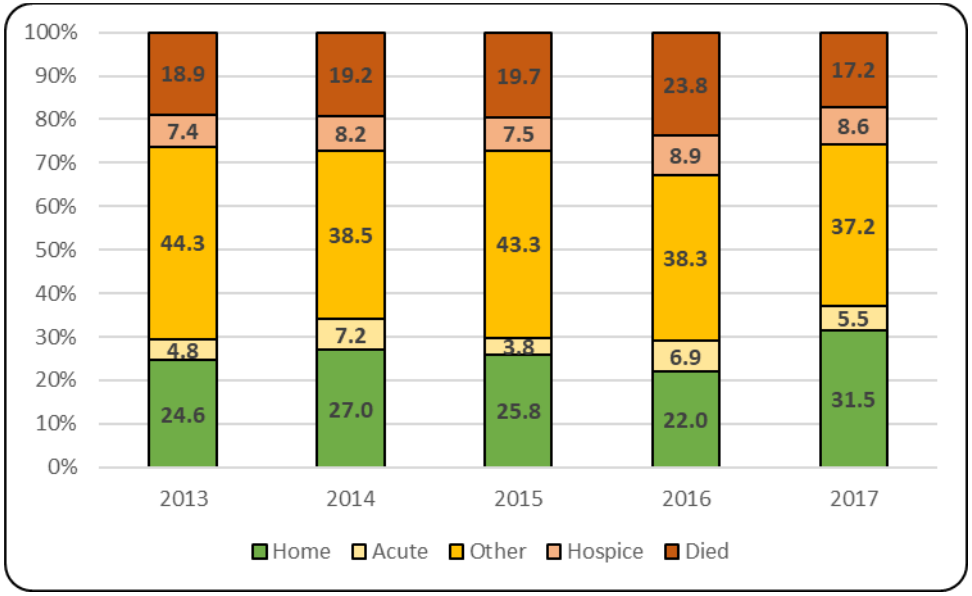


Figure 115. Discharge Destination by Year for Hemorrhagic Strokes

- Most patients with hemorrhagic strokes are discharged to other facilities.
- There is a fair amount of year-to-year variability making identification of trends difficult.

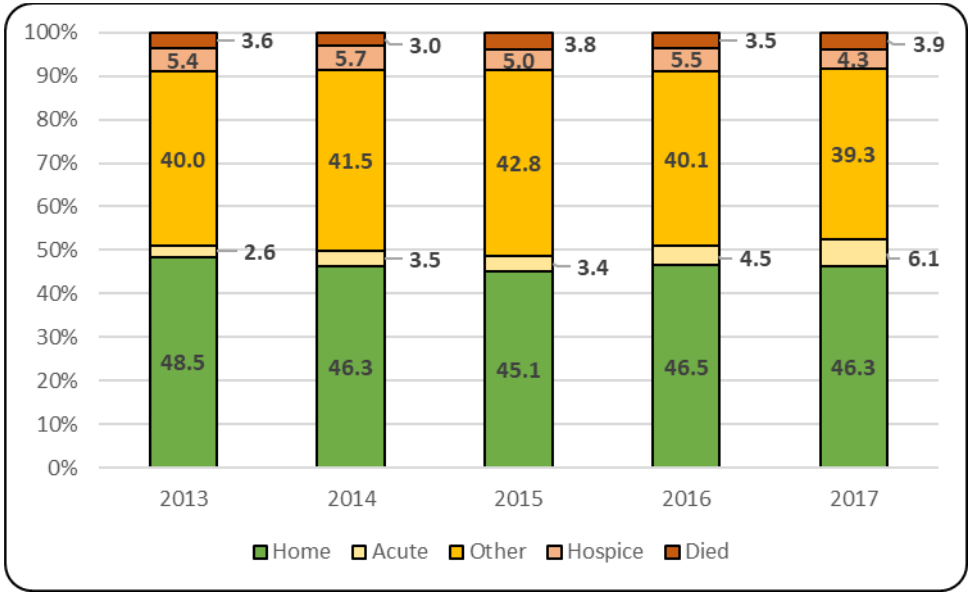


Figure 116. Discharge Destination by Year for Ischemic Strokes

- The largest change for ischemic stroke was the proportion of patients discharged to another acute care facility (25.1%).

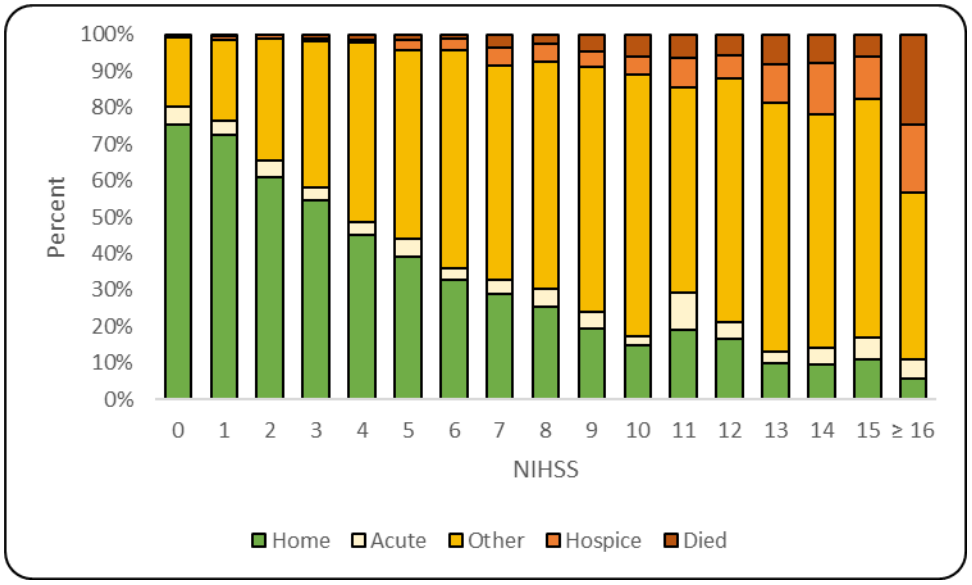


Figure 117. Discharge Destination by NIH Stroke Scale Category

- Increasing NIH Stroke Scale Scores were associated with decreasing proportions of patients who were discharged to home or self-care.
- Those patients with NIHSS above 16 were associated with the small proportions of patients discharged to home (<4%).

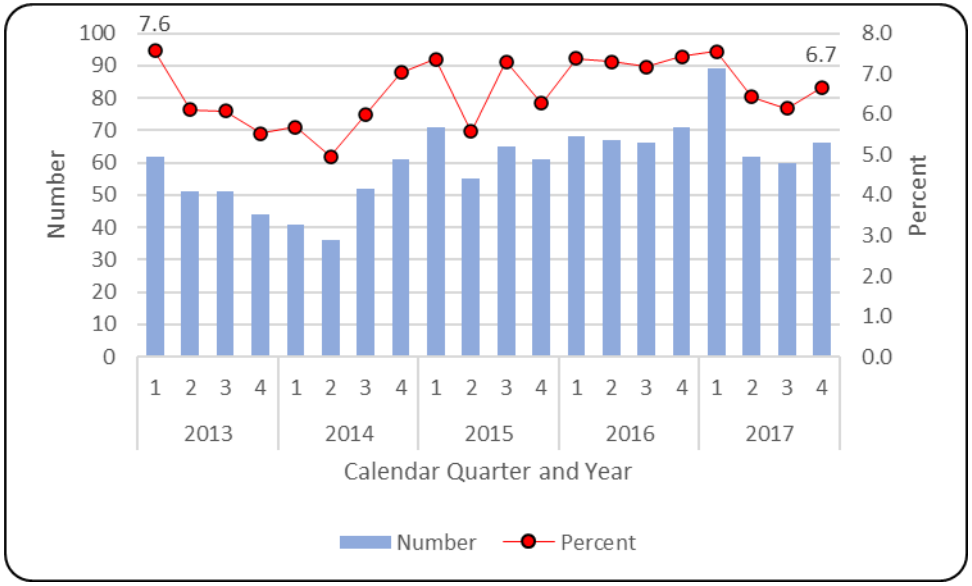


Figure 118. Quarterly Trends in the Number and Percent of Deaths in Acute Stroke Patients Occurring During Hospitalization as Reported to the Iowa Stroke Registry Between 2013 and 2017

- Between 2013 and 2017, there were 1198 **deaths** reported in patients diagnosed with acute stroke.
- Overall, on average, 6.6% (59.9) patients **expired** quarterly during hospitalization. Between 2013 and 2017, there was an average 0.3% percent change per quarter. This trend was non-significant (p=0.0923).

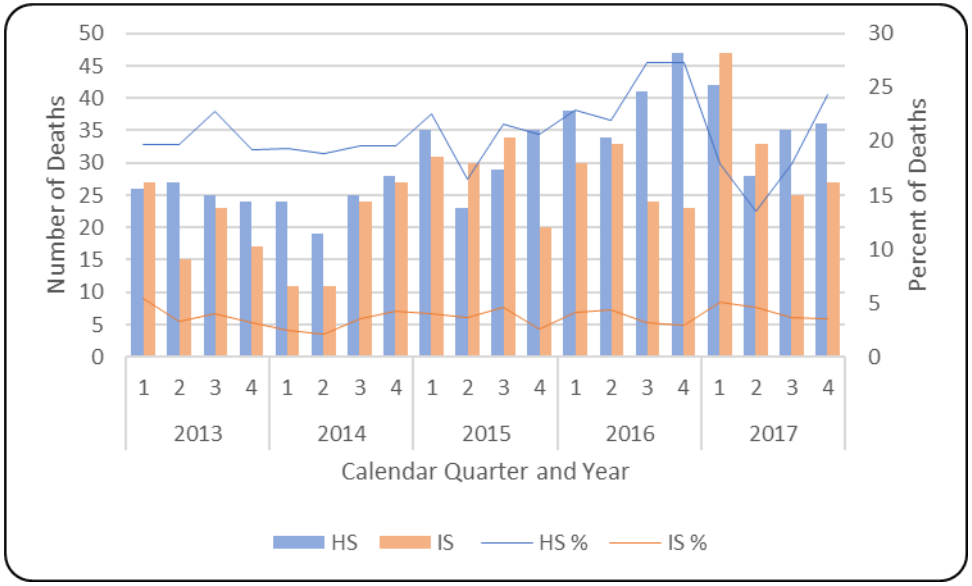


Figure 119. Comparison of Quarterly Trends in the Number and Percent of Deaths During Hospitalization Between Hemorrhagic and Ischemic Stokes, ISR

These numbers may not be representative of the in-hospital deaths due to the lack of data from institutions other than primary and comprehensive stroke centers.

- Compared to **ischemic** strokes, a higher proportion of **hemorrhagic** strokes die during hospitalization (20.5% versus 3.8%). There have been no significant trends in the proportion of deaths for either group.
- Hemorrhagic strokes are associated with a higher risk of mortality. When compared to ischemic strokes, patients with hemorrhagic strokes often experience more severe strokes and have larger lesion sizes. [63]

DATA QUALITY

SUMMARY

Data Quality

Although mandatory variables have been identified for collection, most of these variables are focused on the performance of individual healthcare facilities and may not provide an accurate picture of how the system is performing. Critical access and Acute Stroke Ready Hospitals are not required by law to submit data to the ISR registry in Iowa. The lack of data about stroke care provided to patients evaluated at these facilities impact the registry's ability to assess the care delivered to all stroke patients in the state of Iowa.

There is substantial variability in the reporting of non-mandatory variables among institutions. A systematic review of national stroke registries concluded systems with mandatory participation by all healthcare institutions, provide the best representation of care received on a system-wide basis. [64] Inter-hospital variability in reporting may reflect differences in the training and resources of those responsible for abstraction of data elements. Some institutions have dedicated positions whose only job is to collect data whereas in most institutions, data collection may be just one of many responsibilities held by the person responsible for data collection. Additionally, the training and experience of those performing chart abstraction often varies by institution. In some instances, facilities may operate with a vacancy in the position responsible for collecting this data, resulting in missing data.

Missing data can be problematic during analyses of registry data. When missing data is related to characteristics predicting an outcome, the results of a study may be biased. In one study using registry data, patients with milder strokes are less likely to have a National Institute of Health Stroke Scale Score recorded, leading to an overestimation of the score by more than two points. [65] In addition, significant missing data can limit sample sizes, making it more difficult to provide more precise effect estimates and limits the ability to draw conclusions.

It is often unclear as to why data in the registry is missing. Randomly missing data is least likely to be biasing, providing the missing data is not related to observed and unobserved data. Data may be collected prospectively based on the clinical diagnosis or retrospectively after identification of ICD9/10 codes, after patient discharge. Retrospective collection of data may increase the amount of missing or undetermined values as there is no opportunity to collect the necessary data, while prospective data collection may be hindered by the lack of available information at the time of collection. Metrics using multiple variables are more likely to be missing than metrics relying on few variables as well as those metrics which rely on time elements. [66]

The inability to differentiate between data that is missing, and data marked no/unable to determine, may result in inaccurate interpretation. The person responsible for data entry often has the choice to mark only those characteristics that apply to the patient. In the case of symptoms, some institutions mark yes/no, others mark yes (only if applicable), while other institutions do not record any symptoms. This variability between institutions may not be readily apparent to analysts without complex cross-tabulations.

Facilities receiving stroke patients in transfer may not have access to information about the care and clinical characteristics of patients prior to transfer. The ISR data is de-identified and as a result, linkage of patients transferred to other facilities poses a challenge to evaluating the care received by a patient prior to

transfer. Current methods rely on probabilistic linkage rather than deterministic linkage (directly matched and more reliable). Although probabilistic linkage may offer some privacy, linkage can be limited by missing data or limited number of patient characteristics. Without reliable linkage between records or databases, the ability to capture patient data from prehospital care through rehabilitation is hindered. [67] Recommendations about improving linkage while maintaining patient privacy has been used by other types of registries, including trauma. [68] Data on patients transferred out of state to centers offering higher levels of care are not captured by the ISR.

Data linkage with EMS services has provided challenges in the evaluation of this crucial element of the stroke system. There is no separate reporting of EMS stroke-specific data. Although feedback may be provided by the institution to the EMS provider, the data is available in the stroke registry. Documentation (EMS run sheets) varies by agency resulting in a lack of standardized elements. This lack of standardized terms impedes the ability to exchange information across systems. [67] Those responsible for data entry often lack access to EMS run-sheets. EMS data is submitted to state-level agencies after the chart is reviewed for data collection.

Table 20. Required Data Elements for Individual Hospital Performance Metrics (Paul Coverdell)

Variable	VTE Prophylaxis	Antithrombotic discharge	Anticoagulation A Fib	rtPA given	Antithrombotic day 2	Statin discharge	Dysphagia Screening[1]	Stroke education	Smoking cessation[1]	Rehabilitation plan	rtPA within 60 minutes[1]	Median DTN[1]	NIHSS score[1]	Total Number of Applicable Metrics (%)
Admission date	x	x	x	x	x	x	x	x	x	x				10 (76.9)
Admission status[2]	x	x	x	x		x	x	x	x	x				9 (69.2)
Arrival date/time				x							x	x		3 (23.1)
Arrival mode											x	x		2 (15.4)
Birthdate[3]	x	x	x	x	x	x	x	x	x	x	x	x		12 (92.3)
Clinical trial[4]	x	x	x	x	x	x	x	x	x	x	x	x		12 (92.3)
Comfort measures	x	x	x		x	x			x	x				7 (53.8)
Discharge date	x	x	x	x	x	x	x		x					8 (61.5)
Discharge disposition		x	x		x	x		x	x	x				7 (53.8)
ED patient				x										1 (7.7)
Elective carotid intervention[4]	x	x		x	x	x	x	x	x	x	x	x		11 (84.6)
ICD Principal Diagnosis Code[5]	x	x	x	x	x	x	x	x	x	x	x	x	x	13 (100)
Last known well date/time				x										1 (7.7)
Place stroke occurred[6]	x	x	x	x	x	x	x	x	x	x	x	x	x	13 (100)
Reason for no VTE prophylaxis[7]	x													1 (7.7)
Reason for Oral Factor Xa Inhibitor[8]	x													1 (7.7)
VTE prophylaxis[9]	x													1 (7.7)
VTE prophylaxis date	x													1 (7.7)
Antithrombotic therapy prescribed at discharge		x												1 (7.7)
If no, reason documented		x												1 (7.7)
Documented atrial fib/flutter (hospitalization)	x													1 (7.7)
Documented history of atrial fibrillation/flutter			x											1 (7.7)
Anticoagulation prescribed at discharge			x											1 (7.7)
IV thrombolytic initiated				x							x	x		3 (23.1)
IV thrombolytic date/time				x								x		2 (15.4)
Reason for extending initiating thrombolytic				x										1 (7.7)
Reason for not initiating iv thrombolytic				x										1 (7.7)
Antithrombotic administered by end of day 2					x									1 (7.7)
Reason for IV thrombotic not administered by day 2				x										1 (7.7)
IA catheter reperfusion					x									1 (7.7)
Symptoms resolved[11]														1 (7.7)
In-hospital treatment delay[1]					x									1 (7.7)
Statin prescribed						x								1 (7.7)
If no, statin contraindication documented						x								1 (7.7)
Screened for dysphagia							x							1 (7.7)

Variable	VTE Prophylaxis	Antithrombotic discharge	Anticoagulation A Fib	rtPA given	Antithrombotic day 2	Statin discharge	Dysphagia Screening[1]	Stroke education	Smoking cessation[1]	Rehabilitation plan	rtPA within 60 minutes[1]	Median DTN[1]	NIHSS score[1]	Total Number of Applicable Metrics (%)
Patient was NPO							x							1 (7.7)
Stroke education[12]								x						1 (7.7)
Smoking history									x					1 (7.7)
Smoking cessation									x					1 (7.7)
Rehabilitation plan									x					1 (7.7)
NIHSS Score performed													x	1 (7.7)
NIHSS Score													x	1 (7.7)
Total Number Variables	**13**	**12**	**12**	**15**	**14**	**12**	**10**	**9**	**13**	**9**	**9**	**9**	**4**	

Abbreviations: IA: Intraarterial JC: Joint Commission PC: Paul Coverdell VTE: Venous thromboembolism. [1] Paul Coverdell Only. [2] Excludes those not admitted to hospital (PC), Includes only admitted to hospital (JC only). [3] Excludes those <18 years of age. [4] Excluded if marked yes (PC), Considered Missing if not marked (JC only). [5] Clinical diagnosis or ICD (PC)/ICD diagnosis (JC only). [6] Excludes inpatient strokes, only if indicated. [7] Must be documented if no specific VTE therapeutic is documented. [8] Must be documented if Oral Factor Xa Inhibitor is given. [9] Specific VTE therapeutic must be indicated, excluding stockings. [10] Excludes patients with NIHSS Score=0. [11] Excludes patients whose symptoms resolved. [12] All elements must be documented.

Table 21. Percent of Missing Data Among Institutions for Select Variables

Variable	Percent Missing, mean (range)	Number of Institutions Above Mean (%)	Mandatory Variable
Birthdate	~0 (0 — 4.5)	5 (29.4)	Yes
Gender	15.9 (0—74.3)	8 (47.1)	No
Race	25.3 (0—100)	8 (47.1)	No
% Classified as NS or UTC	13.0 (3.2—40.7)	10 (58.8)	No
Admission Date	0	0	Yes
Discharge Date	~0 (0—0.4)	3 (17.6)	Yes
Arrival Date/Time	1.2 (0—10.4)	3 (17.6)	Yes
Last Known Well	15.3 (0—45.3)	9 (52.9)	Yes
ED Admit	1.5 (0—28.6)	5 (29.4)	Yes
Arrival Mode	8.2 (0.6—99.5)	11 (64.7)	No
Place Occurred	12.9 (0.1—99.5)	9 (52.9)	No
Stroke Alert	4.9 (0—19.6)	3 (17.6)	No
Comfort Measures	1.5 (0—13.2)	4 (23.5)	Yes
Discharge Destination	0.5 (0—38.0)	3 (17.6)	Yes
Door to Physician Time	82.8 (49.3—100)	12 (70.6)	No
Door to Labs	78.3 (45.4—100)	10 (58.8)	No
Door to Imaging Ordered	61.3 (8.8—100)	10 (58.8)	No
Door to Image Evaluated	56.9 (5.9—100)	11 (64.7)	No
Door to rtPA Times	2.6 (0—12.1)	6 (35.3)	Yes
Door to transfer	48.6 (34.5—100)	3 (75.0)	No

Abbreviations: NS=no stroke, UTC=unable to classify, ED=emergency department; Includes data from Primary and Comprehensive Stroke Centers only.

- **Mandatory variables** have the smallest proportion of missing data.
- **Admission** and **Discharge dates** show excellent documentation with little variability among institutions.
- Substantial inter-facility variability in documentation is noted in processing times (**door-to-physician**, **door-to-labs**, etc.). Small proportion of missing **door-to-rtPA** times may reflect documentation requirements to meet stroke designations.
- As **birthdate** and **gender** are universally captured in electronic medical records, missing values are likely due to a lack of data entry to the registry rather than missing data.
- Missing **comfort measure** data may impact approximately 60% of the metrics. Most institutions have minimal amounts of missing data with some exceptions.
- The variable **ED Admit** captures whether a patient was an emergency department patient at the facility. This variable, added in May of 2016, is used by both Coverdell and Joint Commission for performance metrics. Prior to 2016, other indirect variables were used to capture if a patient was admitted to the ED department.

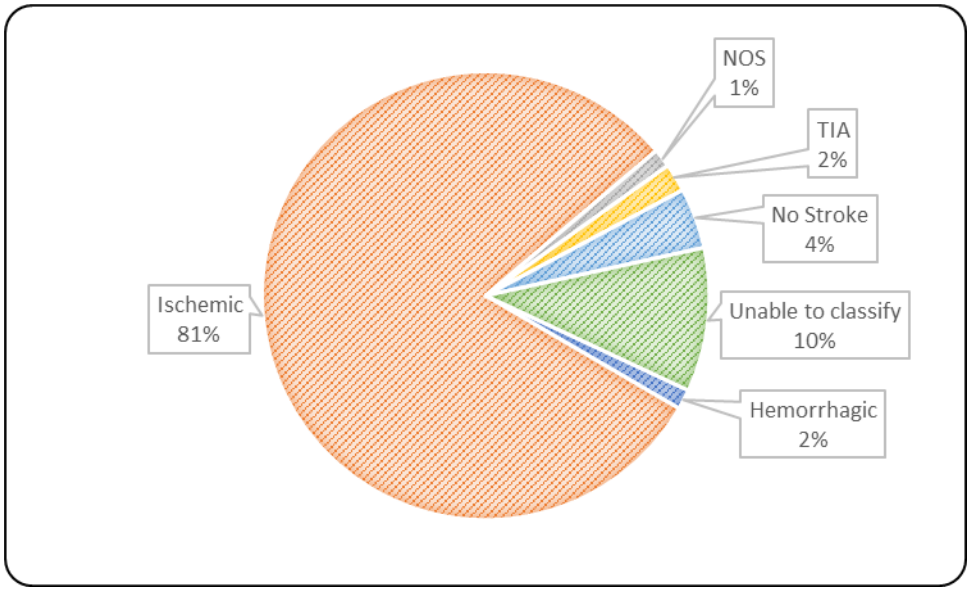


Figure 120. Distribution of Diagnostic Categories in Patients Receiving rtPA reported to ISR, 2013—2017

Abbreviations: NOS=stroke, not otherwise specified; TIA=transient ischemic attack

- For tracking hospital performance related to the administration of rtPA (both Coverdell and Joint Commission), the metrics rely on the identified diagnostic group of **ischemic** strokes (ICD9 or ICD10 codes)
- Of the patients receiving rtPA, documentation of diagnostic groups other than **ischemic** strokes resulted in an estimated 19% loss of data.
- For patients diagnosed with hemorrhagic strokes, this percentage may include those ischemic strokes with hemorrhagic conversion.
- In addition, interim diagnosis of ischemic stroke may not reflect the final diagnosis.

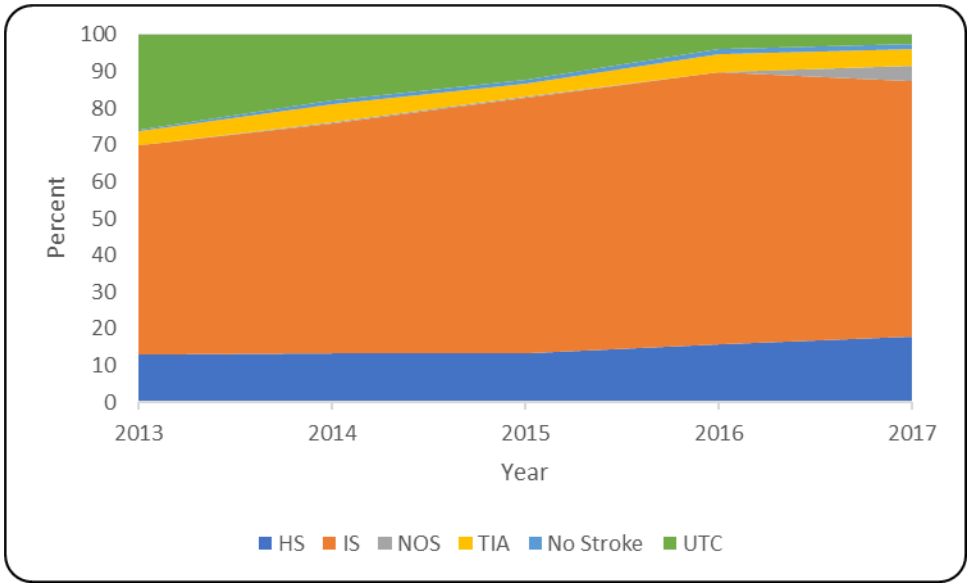


Figure 121. Distribution of Stroke Diagnoses by Year

- The proportion of patients classified as **no stroke** or **unable to be classified** has decreased from 2013 to 2017.
- Increasing specificity of stroke diagnoses may reflect improvements in diagnostic capabilities offered by facilities or may reflect changes in coding practices.

A semi-structured survey was conducted in October and November of 2018 by the **Iowa Stroke Task Force** for the purpose of characterizing stroke care delivered in Primary and Comprehensive Stroke Centers in Iowa.
There are currently four hospital accreditation options for stroke centers, including The Joint Commission (TJC) [69], DNV GL-Healthcare, Inc. (DNV GL) [70], Healthcare Facilities Accreditation Program (HFAP) [71], and the Center for Improvement in Healthcare Quality (CIHQ) [72]. Based on a survey of 16 primary stroke centers in Iowa, 75% reported certified by TJC and 25% reported certified by DNV GL.

The following figures describe key points of the survey.

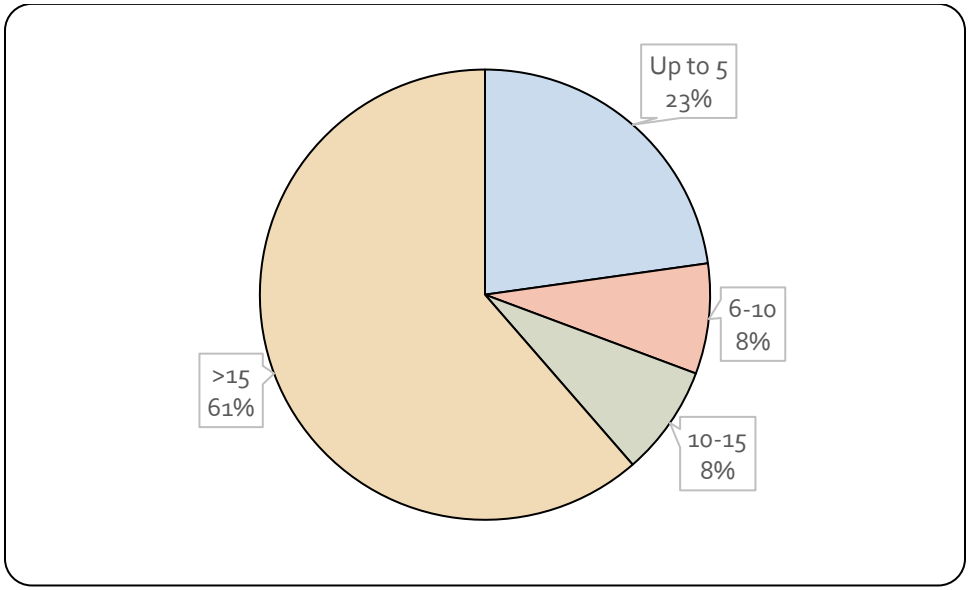


Figure 122. Number of EMS Services Serving Primary Care Centers, 2018

- Most primary and comprehensive stroke centers are served by more than 15 **EMS** companies.
- Increased numbers of **EMS** providers served by a hospital was identified as adding to the complexity of interactions within the stroke system of care.

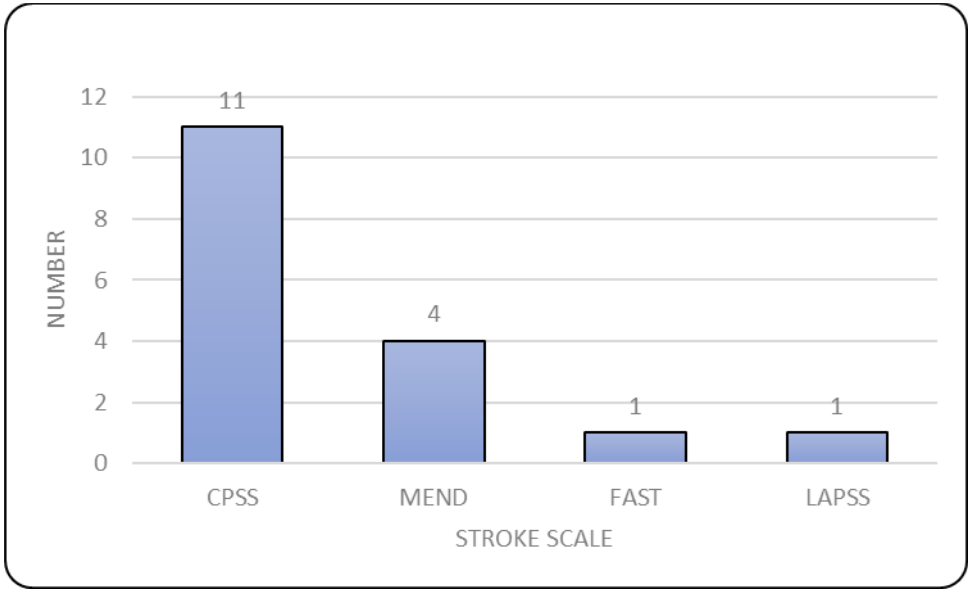


Figure 123. Type of Pre-hospital Stroke Assessment Scales Utilized by EMS

Abbreviations: CPSS= Cincinnati Pre-hospital Stroke Scale, MEND= Miami Emergency Neurologic Deficit, FAST= Face Arm Speech Time, LAPSS= Los Angeles Prehospital Stroke Scale. Each of the pre-hospital assessment scales vary in the 1) type and number of deficits assessed, 2) inclusion of pertinent patient history 3) the performance of blood glucose measurement as well as the results 4) time required to complete the assessment 5) diagnostic accuracy, and 6) strengths and limitations.

- Of the 17 reporting institutions, the Cincinnati Pre-hospital Stroke Scale (CPSS) was the most often reported pre-hospital assessment scale used (65%).

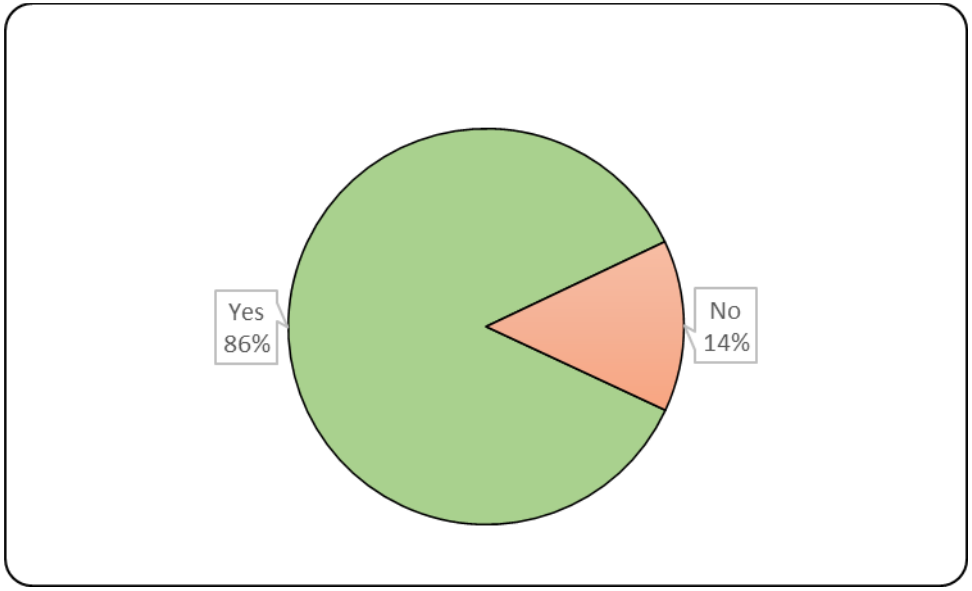


Figure 124. Percent of EMS Services Participating in Stroke-specific Annual Training

- Most EMS services report participating in **stroke-specific annual training**. This number may not reflect the training received at critical-access hospitals and more rural centers who rely on volunteer EMS coverage.
- **Stroke-specific training** improves the ability of EMS professionals to correctly identify patients experiencing a stroke.[73]

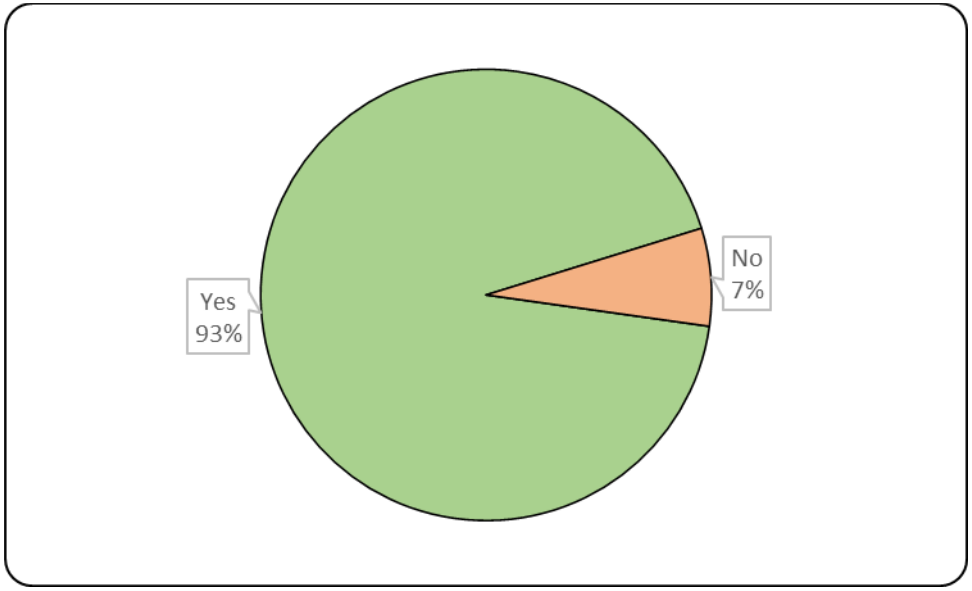


Figure 125. Percent of EMS Services Provided Prompt Patient-Specific Feedback

Abbreviations: EMS=emergency medical services

- Most institutions report providing EMS services with prompt **patient-specific feedback**.
- The feedback varied among institutions.
    - Some feedback was specific to patients receiving rtPA.
    - Feedback may rely on EMS initiatives.
- This **feedback** has been shown to improve adherence to protocols by EMS.[74]

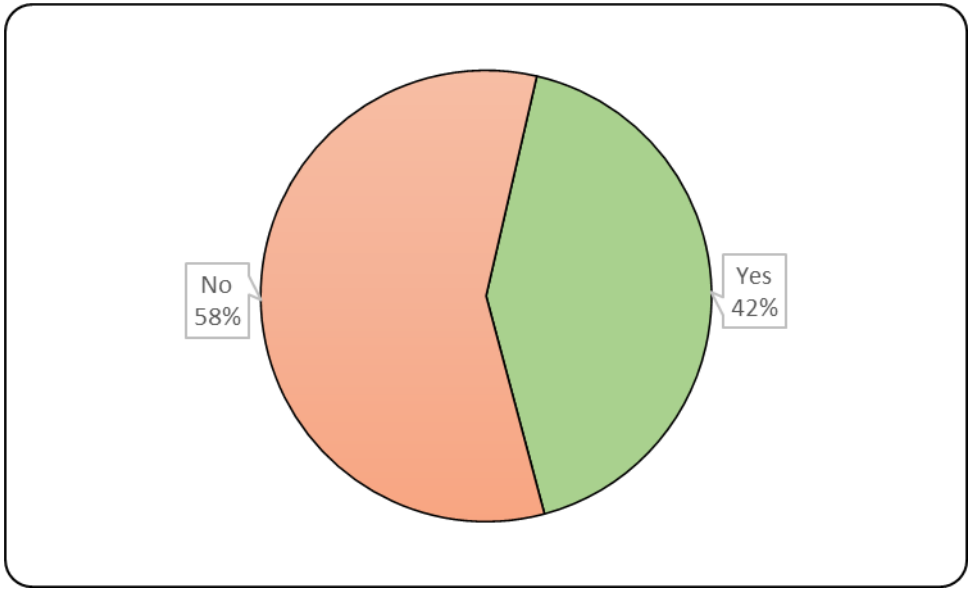


Figure 126. Percent of EMS Personnel Provided with LVO Training

Abbreviations: LVO=Large vessel occlusion; EMS=emergency medical services

- Most **EMS** personnel (58%) are not provided with **large vessel occlusion (LVO) training**.
- **LVO** is associated with worse outcomes when accompanied by a delay to a transfer to thrombectomy-capable centers[75].
- Direct transport to endovascular facilities has been shown to reduce treatment times and improve outcomes [76].
- Prehospital Identification of acute ischemic strokes with **LVO** is imperative to appropriately triage to thrombectomy-capable centers.
- All institutions report having a formal Stroke Alert.
- All institutions report having a formal algorithm or protocol to care for patients with an acute stroke.
- Although only 8% of facilities report having a different LVO (large vessel occlusion) alert, several institutions responded “working on” developing a LVO alert.
- Sixty-nine (69%) of institutions reported having a consistent approach for LVO assessment.

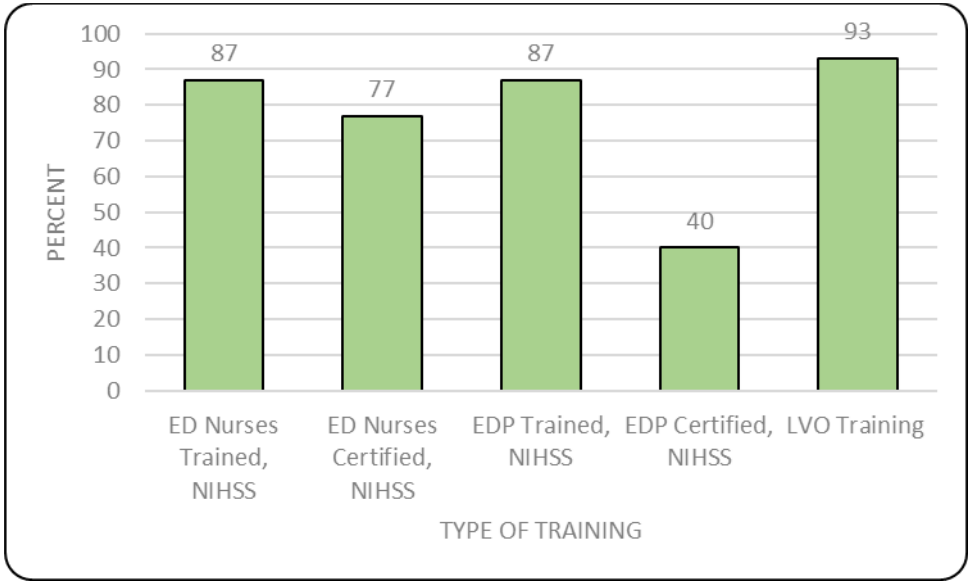


Figure 127. Percent of ED Personnel Provided with Stroke Education

Abbreviations: ED=emergency department, NIHSS=National Institute Health Stroke Scale, EDP=emergency department physician, LVO=large vessel occlusion

- Most **emergency department physicians** and **nurses** are trained in National Institutes of Health (NIH) Stroke Scale (NIHSS) assessments.
- Joint Commission requires a full NIHSS assessment prior to patients receiving tissue plasminogen activator (tPA).
- Most report receiving **LVO training**.

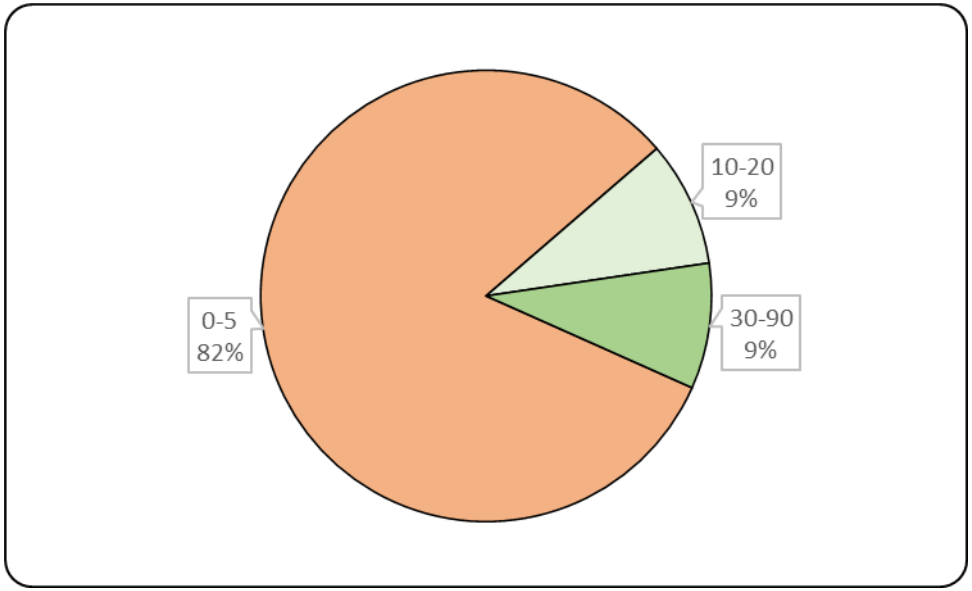


Figure 128. Percent of Stroke Nurses with Neuro Care Certification

Abbreviations: SCRN=Stroke Certified Registered Nurse, CNRN=Certified Neuroscience Registered Nurse, NVRN=Neurovascular Registered Nurse, CCRN=Critical Care Registered Nurse

This includes SCRN®, CNRN®, NVRN®, and CCRN®

- Most facilities (82%) report fewer than five percent of the staff were certified in a specialty relevant to acute stroke care.

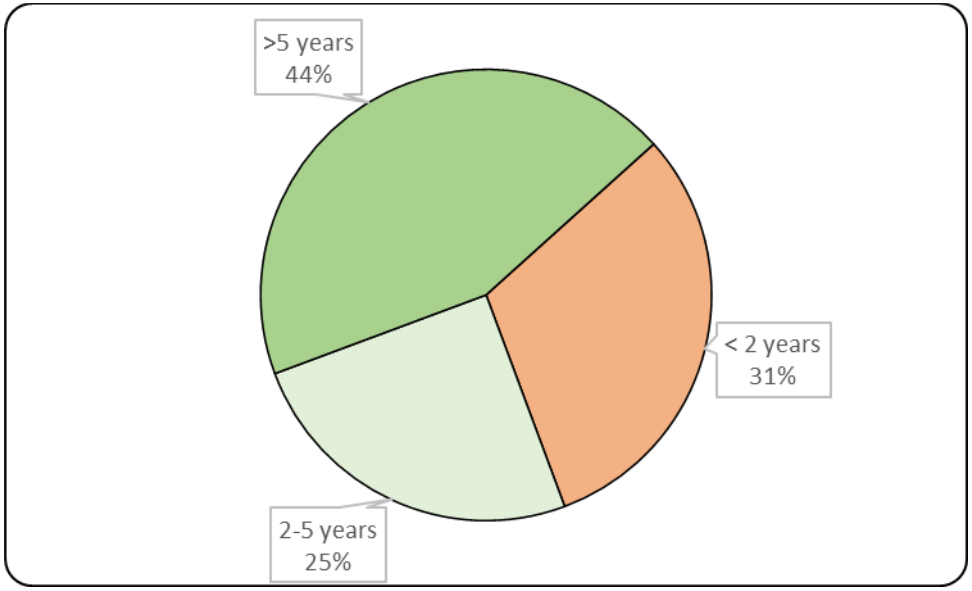


Figure 129. Reported Years in Current Role as Stroke Coordinator

- Almost one-third of stroke coordinators report less than two years of experience as a coordinator.

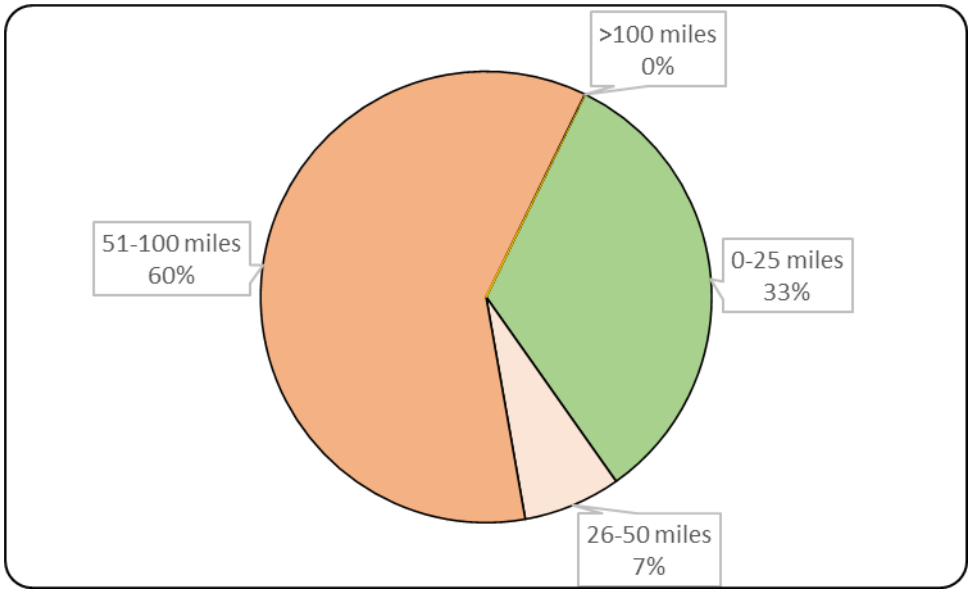


Figure 130. Reported Distance to Nearest Comprehensive Stroke Center

- Sixty percent of primary stroke centers are located more than 50 miles from the nearest comprehensive stroke center.

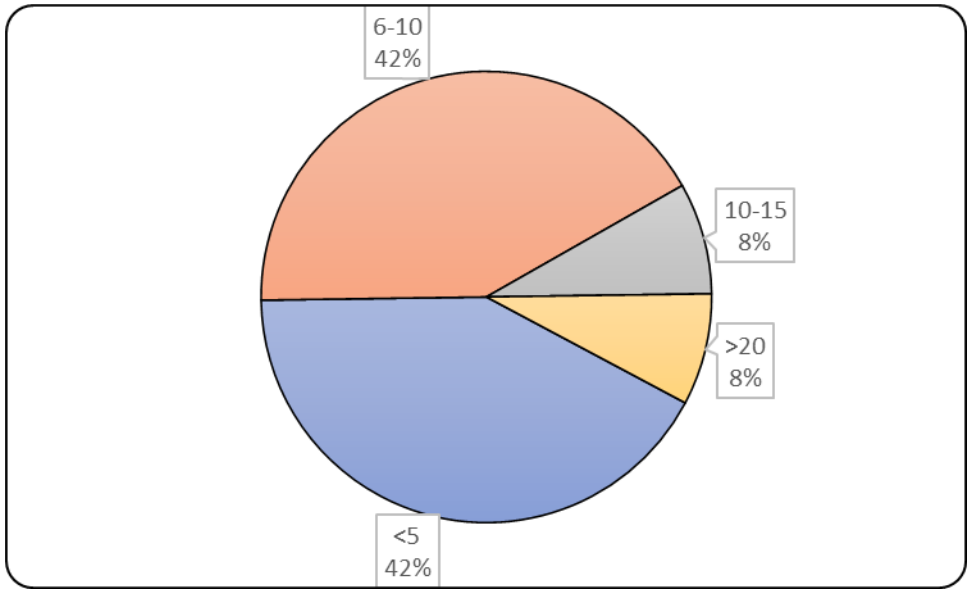


Figure 131. Number of Critical-access Hospitals Served by Institution

- Most primary stroke centers report working with more than five critical access hospitals.
- 82% of primary stroke centers report having outreach programs to educate critical access hospitals on stroke alerts, large vessel occlusions, etc.

PUBLICATIONS AND REPORTS

PUBLICATIONS

- Abstract W P268: Developing a Stroke Coordinator Consortium: Past, Present, and Future[77]
- Abstract T P144: Rural Stroke System Development and Patterns of Arrival[78]
- Abstract TP231: Predicting Emergency Medical Services Use in a Rural State[79]
- Abstract TP305: Geographical Dispersion of Patients Referred to a Comprehensive Stroke Center in a Rural Setting[80]
- Abstract P408: Ischemic Stroke Risk Factor Differences and Their Changes Over Time Among Young (45 years or Less) Persons in a Rural State: 2012—2017[81]
- Poster: Rural stroke patient differences between primary stroke centers and comprehensive stroke centers[82]

REPORTS

- Iowa stroke mortality trends
- Use of ICD9 and ICD10 Coding
- Transfer distance mapping
- Age trends in stroke
- Changing risk factors by age
- rtPA administration and reasons for no rtPA
- Timing metrics and windows of opportunity
- Hospital variability in indicators and outcomes
- Rural-urban differences in stroke
- Hospital capabilities

STROKE SYSTEM OF CARE: CURRENT AND FUTURE DIRECTIONS

This report provides a snapshot of the Iowa Stroke System via the Iowa Stroke Registry from 2013 through 2017. The Paul Coverdell Acute Stroke Program (PCNSR) grant provided support for development and assessment of the EMS and acute stroke care components of the system. The organizational and educational components of the PCNSR were conducted via the Iowa Department of Public Health. The College of Public Health Department of Epidemiology designed and implemented the Iowa Stroke Registry based on the PCNSR data requirements. An agreement with AHA was utilized to transfer the GWTG data into the Iowa Stroke Registry. Additional data provided by IDPH was EMS run sheet data, Iowa Hospital Association Discharge Data and Death Certificate data. The Registry at the University of Iowa continued through 2017. A key monitoring of system performance was by the development and oversight by the State Quality Improvement Monitoring Subcommittee (SQIMS) based on Coverdell metrics, Iowa system metrics and development of an Iowa Stroke System Logic Model. The interaction with CDC also featured a comprehensive evaluation program of performance of components of the stroke system.

In 2018 Stroke Care Reporting was enacted in Iowa Administrative Rules (Chapter 146 ARC 3748C) establishing a joint database of Primary Stroke Centers and Comprehensive Stroke Centers at the Iowa Department of Public Health using the AHA Get with the Guidelines stroke module.

Stroke prevention was also continued by the IDPH Heart Disease & Stroke Prevention – Program featuring the Million Hearts Priorities. The Department of Health and Human Services in 2012 through CDC, NHLBI, CMS and several organizations including AHA launched the Million Hearts Collaboration. Its 2022 goals are to focus “on the priorities of keeping people healthy, optimizing care, and reaching priority populations to achieve the goals listed below to meet the aim of 1 million fewer heart attacks and strokes in the next 5 years: 20% reduction in sodium intake, 20% reduction in tobacco use, 20% reduction in physical inactivity, 80% performance on the ABCS Clinical Quality Measures, and 70% participation in cardiac rehab among eligible patients.”[74] Coordinated by IDPH, several agencies and stakeholders are participating in a current 2018-2022 plan.

The 2018-2022 Iowa goals specifically for stroke include: [75]

4.2.3: Work with U of I College of Public Health and AHA Get With the Guidelines to monitor the number of stroke instances and mortality for Iowans ages 35 to 64.
4.3.1: Community Health Partners will work with providers to increase referrals of patients who have had a heart attack or stroke to the Community Health Partners nurse navigation support system within central Iowa YMCAs. Medically-referred patients will have access to confidential and personalized support from the nurse navigator throughout their participation at the YMCA.
4.3.2: Continued reach to National Stroke support network members through newsletter and local integration to events and activities.
4.3.3: Continue work with Iowa Stroke Taskforce and STEMI Taskforce and other groups to identify stroke and heart attack survivors so that they can be given information and resources.

CDC funding has since changed to target states with high stroke mortality and incidence. Also, several states supported through the PCNSR have enacted model programs to inclusion of all components of acute stroke prevention, care, and recovery. Partly this is funded through the heart disease and stroke prevention initiatives and partly by state legislation.

The system in Iowa is at a crossroads. The CDC funding through the PCNSR facilitated the recognition and the challenges on developing a stroke system in a rural state Several states have used their CDC funding and state support to launch comprehensive stroke systems. In Iowa, the Iowa Trauma System could serve as a model of education, protocols, and quality improvement for stroke. For Iowa, a stroke system with components of education, protocols, capability assessment, data collection and monitoring needs restoration and enhancement. A comprehensive view of the stroke system by stakeholders should include critical access and acute stroke-ready hospitals, EMS services, telestroke and rehabilitation facilities. A regional approach should be based on distance and time to acute stroke care treatments. A comprehensive registry including EMS, all stroke and stroke rehabilitation facilities is needed to evaluate stroke patterns of care across entire state and variations between regions and centers to evaluate performance, areas for quality improvement and research. Quality control will be needed to improve data quality to allow better monitoring of the systems of care. There needs to be continuous assessment of the stroke awareness and knowledge of the care needs and capabilities by the public, EMS, public health departments, health care providers and facilities. Also, there is need to develop new strategies and tools for stroke education and system integration for recognition, emergency response, triage protocols, and liaisons between local and stroke specialty hospitals state including collection, integration, and analysis focusing on identified areas needing improvement or further research. In summary, this report demonstrates that Iowa has unique challenges: an aging population, a high prevalence of risk factors for stroke, the distribution of primary and comprehensive stroke centers creates the problem of distance and time for acute stroke, the utilization of EMS for transport, and the variation in hospital performance. With challenges there is a need for resources. These can come from grants such as the AHA Mission Lifeline for Stroke, core funding support of the administrative, education, data collection and monitoring functions, and funding in prevention of stroke and the rehabilitation and recovery of stroke.

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