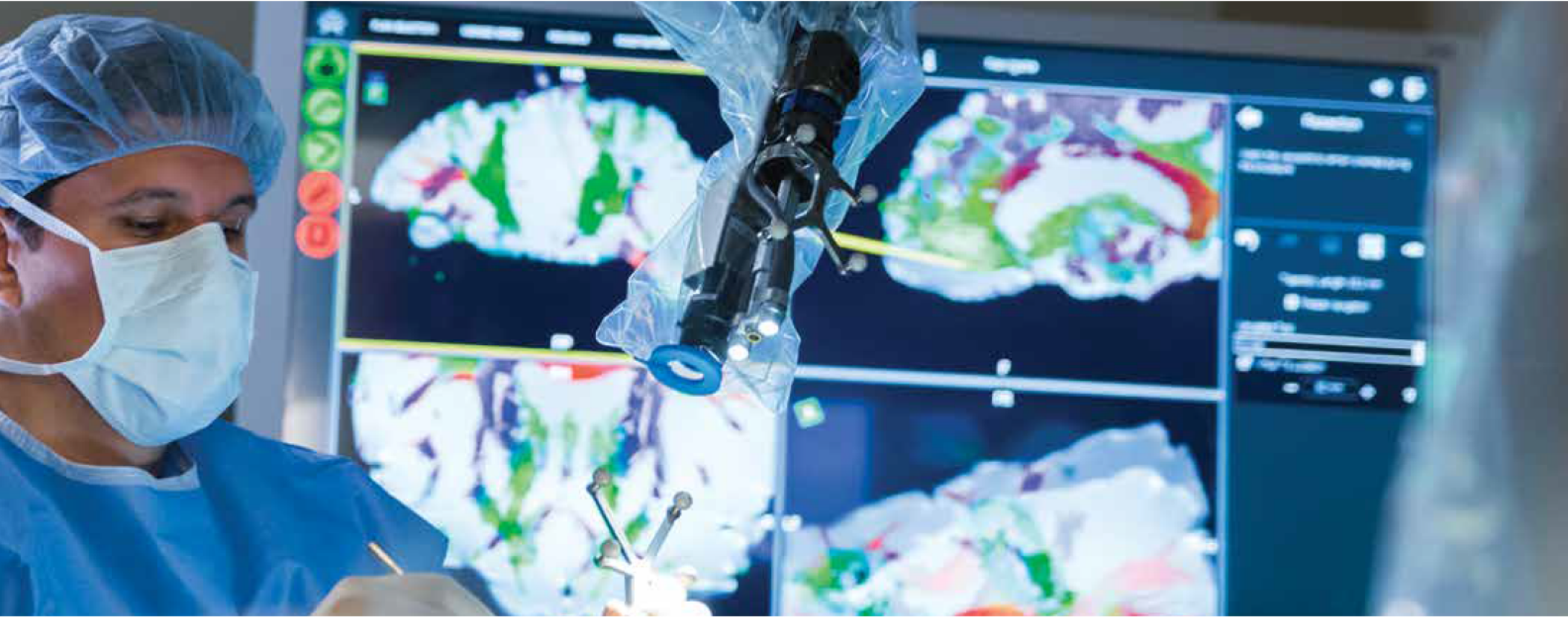




# NEUROSCIENCE

## 2015 ANNUAL REPORT





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# Message from the Chair

## WHERE IS HEALTHCARE GOING?

The health care sector is undergoing transformative changes as regulations and the market economy drive performance measures from volume to value. The failure during the past decade to meaningfully accomplish this has created a profound appetite for the transformation of health care into a risk-based value realization economy.

These changing dynamics are creating a realignment of the key traditional stakeholders:

- Patients
- Providers
- Hospital Networks
- Integrated Health Care Delivery Systems
- Insurers
- Governmental Agencies
- Academia
- Biotechnology and Device Manufacturing

And are making way for emerging, non-traditional health care players:

- Informatics Technology Agents
- Financial and Private Equity Sector

All shareholders are converging and trying to capture the value associated with the new emerging economy. This impending disruption will greatly alter the status quo, allowing new players into the health care space, effectively changing the roles of traditional stakeholders. We are witnessing unprecedented levels of activity as participants are consolidating through mergers/acquisitions or creating entirely new entities.

What is clear is that this dynamic and shifting market over the next ten years will not look like it has in the past ten years. What is equally clear is the considerable opportunity this represents. The market will be further transformed through disruptive innovation *both* in technologies and in the models that deliver them. The “volume to value” continuum is incomplete and inherently flawed as it has not been possible to effectively quantify the true definition of value ... value itself. This inability to quantitate value

has led to the failures of the past decade to transform health care, largely because value is an intermediate stop in the actual continuum, which is volume > value > risk. As is the case in many other industries, risk in health care can be effectively quantified and measured, and thereby embody the true meaning of value.

## WHO IS AURORA HEALTH CARE?

The State of Wisconsin contains about 5.8 million people with its key demographics closely mirroring the national representation. For instance, as of 2014, 14.9% of the WI population is 65+, which is nearly identical to the national makeup. Aurora Health Care primarily serves the eastern 1/3 of the state by geography, which includes approximately half the state population including the largest city—Milwaukee.

At the county level or when considering rural vs. urban areas, these demographics can change significantly. For example, the percentage of age 65+ in Milwaukee County is only 12.1%, but in Door County it is 26.4%. When designing health care offerings to best serve a particular population, the expected geographic scope influenced by a given service and the demographics within that scope should be considered and adjusted as necessary.

Aurora Health Care System represents a unique entity with a 15-hospital network and large integrated primary care and specialty service lines covering an expansive geographic region. A strong foundation has been built within the health system to include primary practice groups, numerous physical locations, as well as incredible research infrastructure. The health system has set its next and foremost requirement to expanding its network of hands-on quality service providers and specialties through a tertiary and quaternary clinical focus. Quality is a primary focus for all, as is maintaining pluralistic model and integrating existing providers where possible while maintaining this objective. The system has successfully accomplished this in Cardiac, Women’s health and Transplant and now is in the process to do the same in Neurosciences.



## HOW ARE WE RESPONDING?

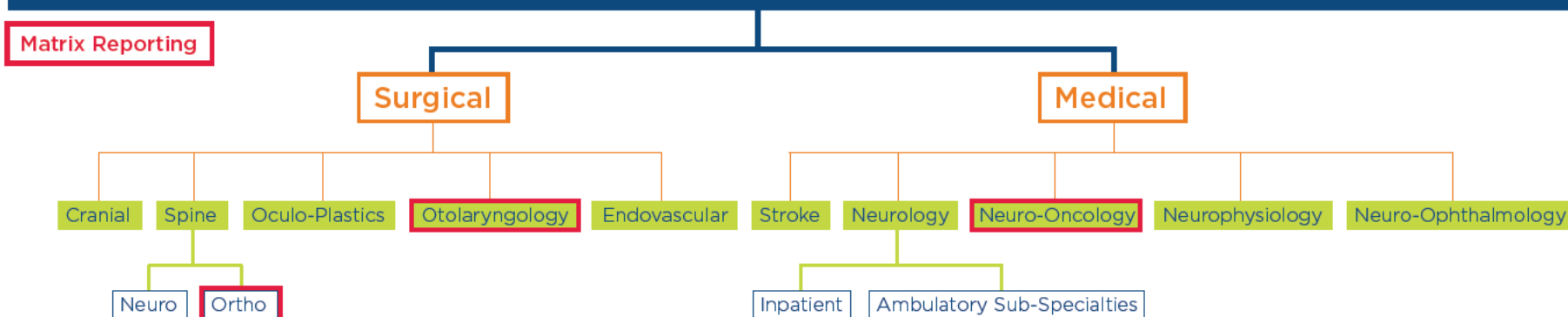
In response to the changing healthcare marketplace, Aurora Health Care poignantly recognized the need to deconstruct the divisive structure of individual services and remove the delivery silos of care. They set a formidable goal of turning the patient into the primary shareholder, establishing scope-constraint by removing patient ownership and making sure the right team member was providing the right care at the right time. This required breaking down walls and overcoming the encumbrances of legacy in health care, as well as eliminating financial barriers.

These goals led to the creation and development of the Neurosciences service line and establishment of the Aurora Neuroscience Innovation Institute (ANII). In this report, we describe the transformation that has occurred in the short span of 24 months. This development brings together neuroscientists and adjacent disciplines of all sub specialties within the

service line to provide consultation and collaborate with specialists from other departments creating a culture of collaboration where the patient is truly the central, primary focus and empowered to determine their care. Areas of focus include stroke, neuromuscular diseases, spinal disease, functional disorders, and many others. Many internationally-renowned physicians have joined the Aurora team since the service line's inception and continue to advance and progress its innovative and patient-centered purpose.

Like other medical disciplines, Neurosciences is moving toward a performance-based meritocratic market demanding increased specialization, which translates to patients often requiring multiple providers to meet their care needs. This market environment is therefore driving the need for highly integrated systems of care where multi-disciplinary delivery models are required to deliver on quality, cost, and risk-based metrics.

## Aurora Neuroscience Innovation Institute

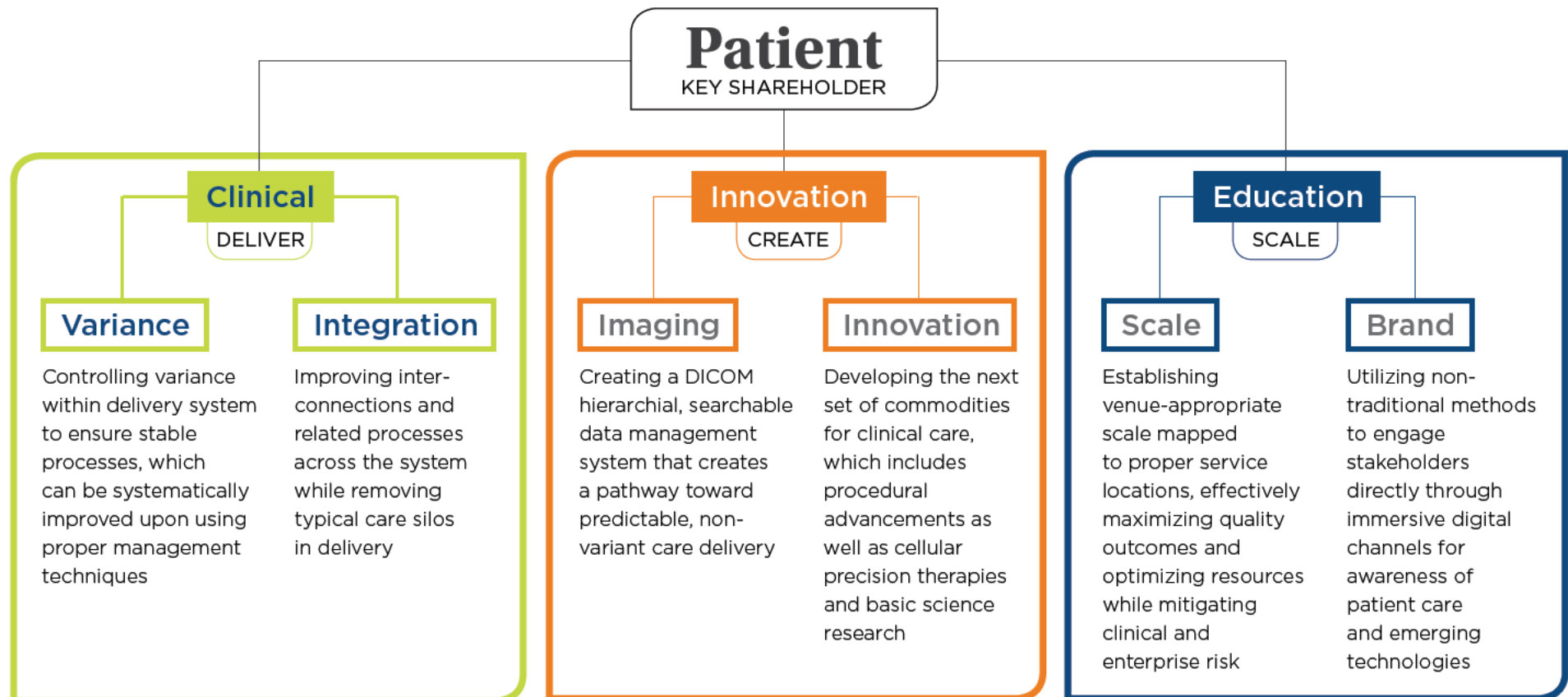


The Neuroscience Service Line embodies integration in that many of the services and providers have matrix relationships and dual-reporting to other departments and service lines, leading to effective collaboration for patients.

As we enter this new risk-based, market-driven health care economy, the Neuroscience service line at Aurora Health Care is positioning itself to be a leader in clinical care for neurology and neurosurgery, including spine, neuro-ophthalmology, and other aligned subspecialties to provide the most optimal patient experience and outcome at any of our clinic or hospital locations. At its core, this requires complete integration

across the neurosciences health continuum. As many organizations are now trying to formulate their concepts of clinical service lines, Aurora Health Care has made the successful transformation and is leading the way nationally in integrating the neurosciences health care delivery and is embodying the principle of the patient as the primary shareholder in a meritocratic-based delivery system.

## 3-Vertical Model







## Meet Dr. Kassam

**At the Aurora Neuroscience Innovation Institute, Dr. Amin Kassam leads a multidisciplinary team dedicated to advancing the field of neuroscience with defining research and advanced procedures. Aurora Neuroscience strives to provide the best possible care today while defining the best care for tomorrow.**

### A LEADER IN INNOVATION

As Vice President of Neurosciences and Chairman of the Department of Neurosurgery at Aurora Health Care, Dr. Kassam is a board-certified, world-renowned neurosurgeon whose accomplishments have advanced the field of neurosurgery. He was the driving force behind the establishment of the Aurora Neuroscience Innovation Institute (ANII), where he collaborates with an experienced team of scientists, engineers, clinicians and cell biologists. These neuroscience specialists work together to provide comprehensive clinical care and emerging research for the next wave of neurological innovation.

### SHAPING TOMORROW'S CARE

Dr. Kassam has been recognized globally as a defining neurosurgeon and has contributed to profound advancements in skull base surgery and minimally invasive approaches. During the first decade of his surgical innovation, he was one of the key international figures in redefining anatomical and surgical approaches to skull base surgery. During his second decade of innovation, he has applied the same discipline to focus on diseases of the white matter and deep subcortical spaces. This time, not only has the focus been surgical and defining technology, but on understanding the cellular development of underlying diseases, such as cancers of the brain. An equally important focus has been building service line care delivery models.

His neurosurgical breakthroughs have made medical history. The innovations that have marked Dr. Kassam's career as a neurosurgical specialist are now helping improve the quality of life for patients with brain cancer and other subcortical abnormalities. His most notable accomplishments include the following:

#### Skull Base Innovations

- The Expanded Endonasal Approach (EEA), a term he coined to describe a minimally invasive technique that uses the nose as a passageway to treat deep-seated tumors and lesions at the base of the skull and under the brain. It's also used to repair aneurysms in major blood vessels in the brain

## MEDICAL FIRSTS

Dr. Kassam has played a key role in making medical history by being the neurosurgeon that successfully performed the first-in-man of several procedures through the nose:

- The Transpalate Approach: Dr. Kassam used this modified version of EEA to successfully remove a large teratoma tumor from the skull base of a newborn baby
- Repaired a vertebral artery aneurysm through the nose using EEA
- With ENT colleagues in Argentina, reconstructed a skull base using EEA
- Removed an arteriovenous malformation in a child through the nose
- Performed surgery to remove a patient's second spinal vertebra through the nose using the EEA approach
- Was the first to describe the ability to transpose the pituitary gland through the nose to remove complex tumors located behind it

## Deep Subcortical Innovations

- The Deep Subcortical MIS Approach: Dr. Kassam developed an innovative way to treat deep subcortical brain tumors that were once considered inaccessible by many

## ADVANCING EDUCATION

In addition to having written more than 300 peer-reviewed articles and two textbooks, Dr. Kassam is sought after to speak all over the world about neurological innovation—not just about what's happening today, but also about what he envisions for the future. He has also taught countless instructional courses and been keynote lecturer at symposiums around the world. He encourages fellow doctors to think critically about the kind of care they give to each patient and to pay attention to the clinical and economic value of each new procedure.



## Redefining Patient Care

At Aurora, Dr. Kassam has pioneered a patient care model that integrates multiple specialties for complex treatment plans – all the while prioritizing the patient's comfort and authority. This innovative model is geared towards empowering the patient and removing any other agenda. Implementing this model has allowed him to partner with several exceptional physicians. As a patient, you can feel comfortable knowing that all of the neurosurgical specialists on your team are absolutely committed to providing the best care possible. Everyone on your team has the same goal, and that's getting you well soon.







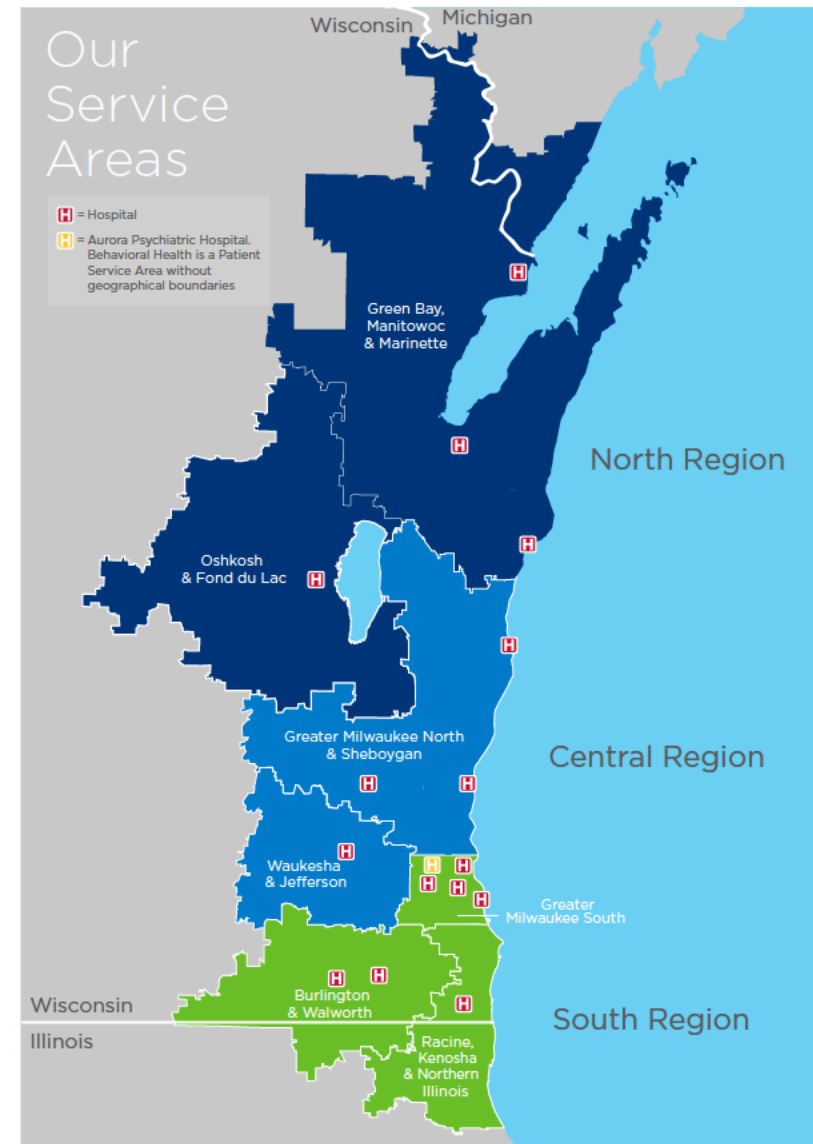
# Aurora Health Care

Aurora Health Care is an integrated, not-for-profit, all-for-people health care provider serving communities throughout eastern Wisconsin and northern Illinois. Our approach keeps people in our minds and at the heart of everything we do. We treat each person as a person, not as a patient, an illness or an appointment.

Aurora got its start in 1984 when two established Milwaukee hospitals, St. Luke's Medical Center and Good Samaritan Medical Center, came together to form Aurora Health Care. Over the years, our organization grew, allowing us to help more people and communities.

Today we serve communities throughout eastern Wisconsin and northern Illinois, with 15 hospitals, more than 150 clinics and 70 pharmacies in 30 communities. We strive to offer services that are close to home and help make the whole community healthier.

Aurora Health Care is a not-for-profit health care system serving Wisconsin and Northern Illinois with **15 hospitals**, more than **150 clinics** and **30,000 employees**. Aurora has been experiencing significant growth over the past decade, and is now a fully integrated system comprising more than 1,500 employed physicians.



# Innovative and Integrated Care Delivery Model

## ANII Neuroscience Service Line

**Our difference isn't just our innovations, but our multidisciplinary teams working together to develop a comprehensive plan specifically designed just for you. This includes a collaborative group of caregivers committed to providing precision medicine that is adapted specifically for your unique needs.**

Your nervous system carries complex messages to and from your brain, so if this is disrupted, you need an equally elaborate and complex team to understand and restore these messages. Your team at Aurora can identify the source of your symptoms, treat it with the latest procedures and guide you on your path to an individualized recovery.

From advanced diagnostic testing through treatment and recovery, trust Aurora to provide you with a personalized neurological care plan. We'll identify the best possible remedy for your circumstances and provide the follow-up care you need to get you back to living an active, healthy life. We treat our patients as empowered *leaders* of the care team, keeping them actively involved in all decision-making to ensure all questions and concerns are evaluated and taken into account. When it comes to treating neuroscience conditions and disorders, we believe the patient is the most important shareholder in the decision-making treatment process.

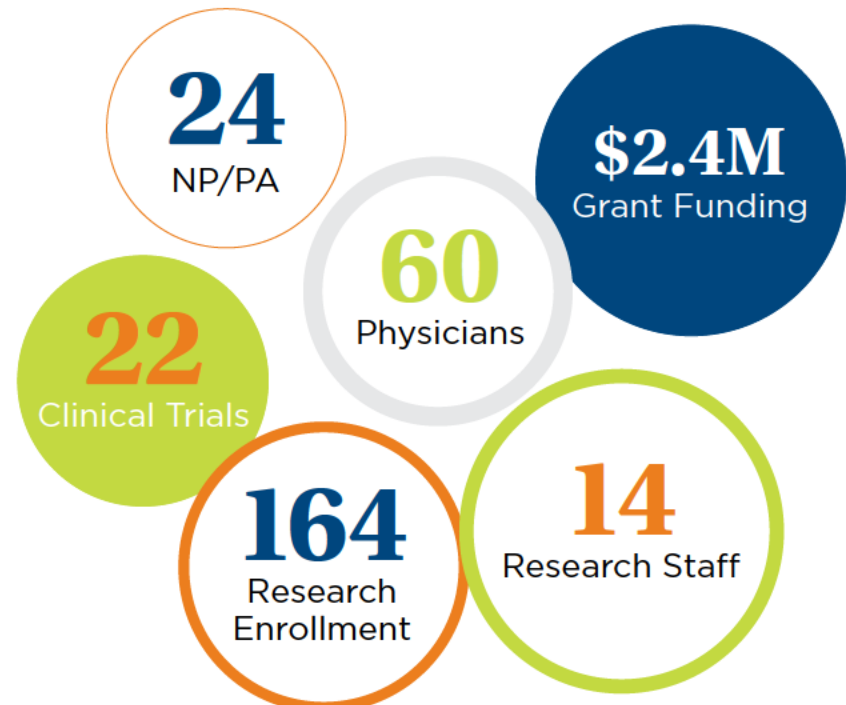
Our multidisciplinary team treats a wide variety of conditions using state-of-the-art technology and facilities. If you have a neurological disorder—like Alzheimer's, Parkinson's, a tumor or a condition that stems from trauma—you can expect innovative, comprehensive medical care with a compassionate touch.

You can trust Aurora's team of experienced neurological experts to offer the most advanced treatment options for a variety of conditions. We combine minimally invasive procedures and individual treatment plans

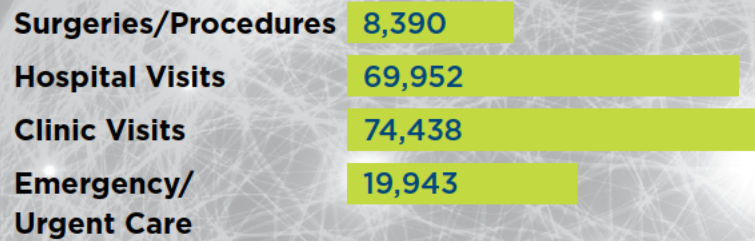
with exceptional patient care to deliver the best possible outcomes. A core commitment to providing minimally invasive surgical options for neurological diseases and disorders makes Aurora Neuroscience one of the most advanced and truly one of the few completely integrated service lines of its kind.

We continuously strive to provide the best care available today while defining the best possible care for tomorrow.

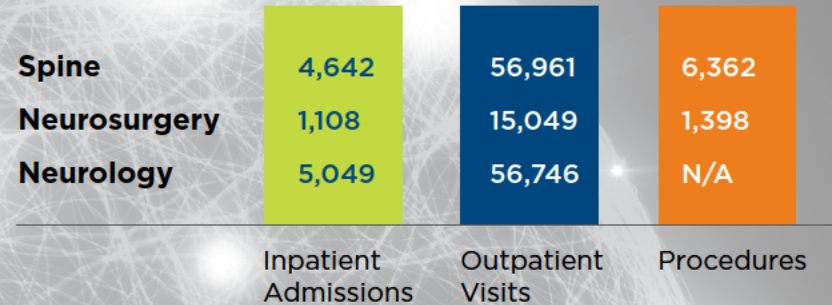
## at a GLANCE



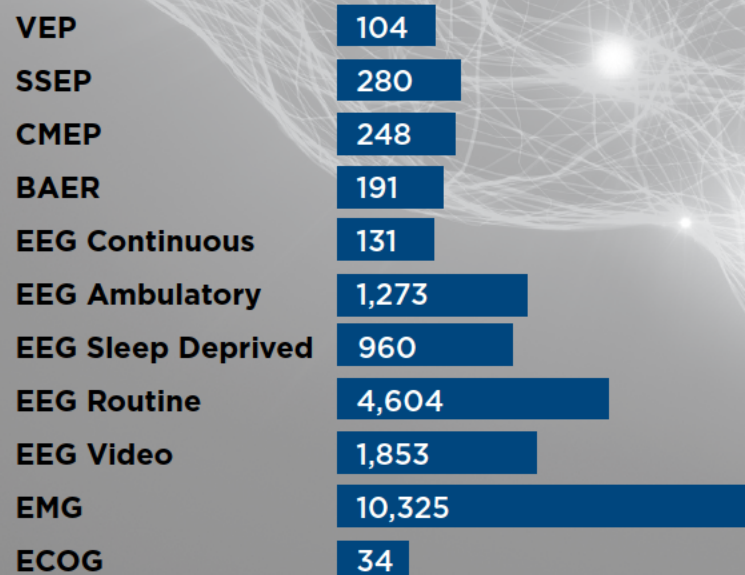
## Neuroscience



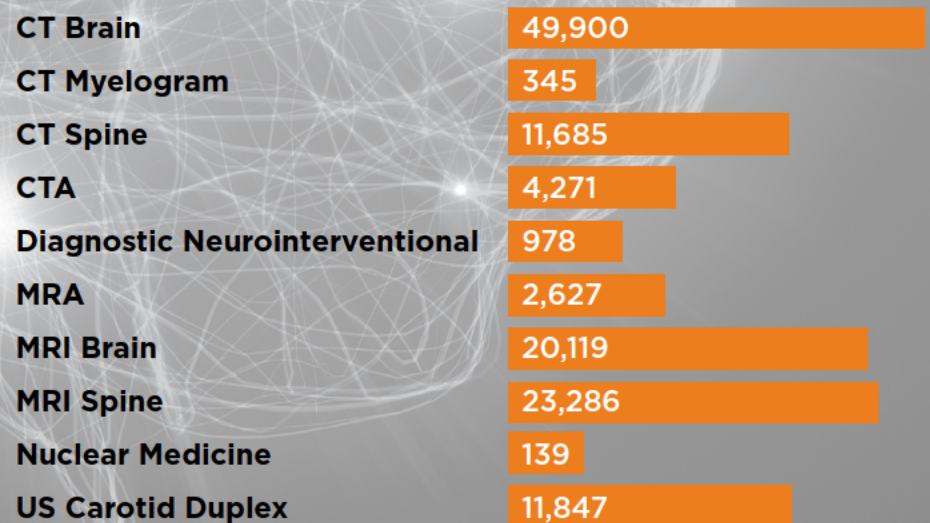
## Subspecialties



## Neurodiagnostics



## Neuro Imaging





# Quality and Patient Satisfaction

## High-Quality Care for Your Life

### What Makes “High Quality”?

For Aurora, it's about offering care for your life, not just for your health. We do this by:

- Promoting health care innovation and staying up on the latest advances
- Setting high goals for ourselves
- Keeping track of our progress as we reach those goals

You have a right to expect high quality wherever you go for health care. But how do you define it?

At Aurora Health Care, quality is our pursuit to give our patients better results than they can get anywhere else. That means we need to:

- Update our knowledge through continuous research on “best practices”—that is, how medical and nursing science prove to be the best possible ways to prevent or treat specific problems
- Set goals for ourselves based on medical science and what health care systems with the best results in the country are doing
- Keep track of our progress and continually set higher goals

## How We Deliver Quality

We continually strive to give high-quality care and results. It is a promise we take very seriously. In order to deliver high quality, we have a step-by-step approach that is carried out across our entire organization.

Our main approach to delivering high-quality care is Care Management, which is a coordinated, patient-centered approach to finding better ways of preventing and treating health problems. The Care Management approach to quality means that we work together to:

- Define the health care needs of the people we serve
- Research the best ways to meet those needs
- Design a plan of action that can be carried out by all of our health professionals
- Measure our results (against national standards)

# Risk-Adjusted Quality/Cost Outcomes

Our multidisciplinary approach is able to demonstrate a significant reduction on key metrics in comparison to risk-adjusted populations across the nation. Key products chosen reflect trends in healthcare changes as outlined by SG2® data and analytics reporting.

|                                    | Length of Stay (Days) |          | Mortality Rate |          | Readmission Rate |          | Cost/Case |          |
|------------------------------------|-----------------------|----------|----------------|----------|------------------|----------|-----------|----------|
|                                    | Actual                | Expected | Actual         | Expected | Actual           | Expected | Actual    | Expected |
| Seizures and Epilepsy              | 2.98                  | 3.07     | 0.23%          | 0.90%    | 8.92%            | 10.04%   | \$6,634   | \$8,049  |
| Headaches and Migraines            | 5.90                  | 2.82     | 0.00%          | 0.29%    | 6.94%            | 7.17%    | \$6,950   | \$7,462  |
| Degenerative Disorders             | 6.38                  | 6.04     | 1.20%          | 2.41%    | 7.01%            | 10.20%   | \$11,728  | \$11,096 |
| Multiple Sclerosis                 | 3.67                  | 3.98     | 0.00%          | 0.23%    | 5.30%            | 7.75%    | \$6,047   | \$7,747  |
| Peripheral/Cranial Nerve Disorders | 3.42                  | 3.75     | 0.00%          | 9.00%    | 12.47%           | 14.23%   | \$8,976   | \$10,078 |
| Concussion                         | 2.81                  | 2.54     | 0.00%          | 0.58%    | 5.71%            | 5.59%    | \$4,803   | \$8,642  |
| Cranial Surgery                    | 2.92                  | 4.57     | 1.98%          | 3.40%    | 7.39%            | 11.16%   | \$19,285  | \$21,173 |
| Neurotrauma                        | 4.18                  | 4.63     | 27.31%         | 13.87%   | 3.63%            | 10.31%   | \$13,734  | \$19,010 |
| Stroke (Ischemic and Hemorrhagic)  | 3.98                  | 4.25     | 3.52%          | 5.38%    | 7.71%            | 8.50%    | \$13,952  | \$15,046 |
| Other Neurological Disorders       | 3.03                  | 3.36     | 3.14%          | 1.68%    | 3.15%            | 11.34%   | \$6,561   | \$9,993  |
| Spine                              | 2.61                  | 3.63     | 0.96%          | 1.16%    | 5.44%            | 5.31%    | \$19,042  | \$22,071 |

Of **89,952** Neuroscience visits/admissions, there were only 173 deaths, just **0.19%**.

|                  | Neuroscience Service Line |          |
|------------------|---------------------------|----------|
|                  | Actual                    | Expected |
| LOS (Days)       | 3.02                      | 3.14     |
| Mortality Rate   | 2.19                      | 2.67     |
| Readmission Rate | 7.7                       | 8.14     |
| Cost/Case        | \$8,468                   | \$11,970 |

\*Data reflects medical and surgical admissions



## Patient Satisfaction

Overall provider rating for neurosurgery:  
**99<sup>th</sup> percentile.**

Access to care rating for neurology:  
**76<sup>th</sup> percentile.**

Provider communication, neurosurgery:  
**90<sup>th</sup> percentile.**

Office environment for neurology  
and neurosurgery:  
**90<sup>th</sup> percentile.**

\*Data reflects percentile rankings as compared to Press Ganey database



# Awards and Recognition





SURGICAL INNOVATION



# Aurora's motivation

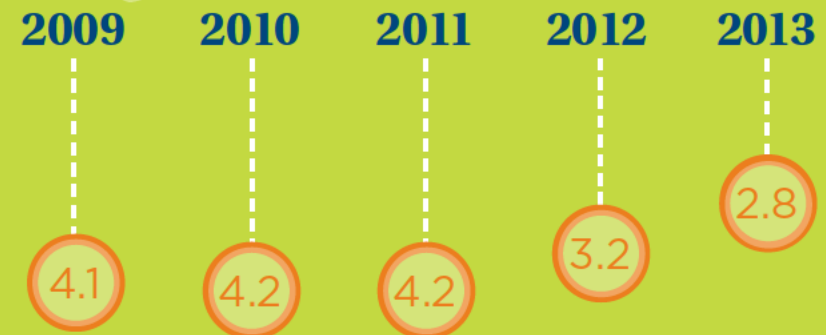
Recent innovation in the field of neuroscience has created dramatic advancements in neurosurgery through the engagement and collaboration of several unrelated disciplines joining forces. Informational technology, population health and, most recently, micro-finance and e-banking solutions, are just a few of the industrial platforms in orthogonal industries that have benefited from this type of integration that is built on parity. Neuroscience is now realizing this same value of integration and unification based on intellectual equality from diverse stakeholders like health care providers, technology agents, and even our patients. Each of these advances has leveraged intellect within the disparate areas of expertise to conceptualize and prototype solutions for real-world problems relevant to the local environment. A recurring theme in this innovation process is to bring in technology to enhance platforms not only in one's local environment, but also proving to expand it universally to benefit the system as a whole, creating non-variant care across enterprises.

The neurosurgical operating room of the future will be a space in which one of its main goals will be to gather information in the OR in real-time in order to serve patients and surgeons on a global scale. Over the course of the past 10 years, there has been exponential advancement in the ability to access information in the health care setting. Although data is readily accessible, the application of information to a point of action is especially challenging due to the high saturation of voluminous content to which we are exposed. At Aurora, we've adopted the theory that this state of information overload can be resolved by a simple understanding of the power of visualization and collection of this data in real time. A key requirement for this platform is the development of a dynamic informatics operating system to continuously learn and collect data that will eventually formulate and generate data from its own self. This will create a predictive platform that ensures patient safety and surgeon efficacy by eliminating variance. For this to be executed effectively, quality-assured data needs to be collected directly and seamlessly transferred from the imaging suites to the operating room and into the underlying operating informatics system.

According to the International Civil Aviation Organization, air travel is continuously the safest form of travel when comparing mistakes and deaths per miles traveled. Aeronautic and aviation safety is based on standards and recommended practices based on flight data, technological advancements and external factors. Aurora Neuroscience utilizes aviation methodology and the latest available technology and systems to continuously improve patient outcomes.

## Data

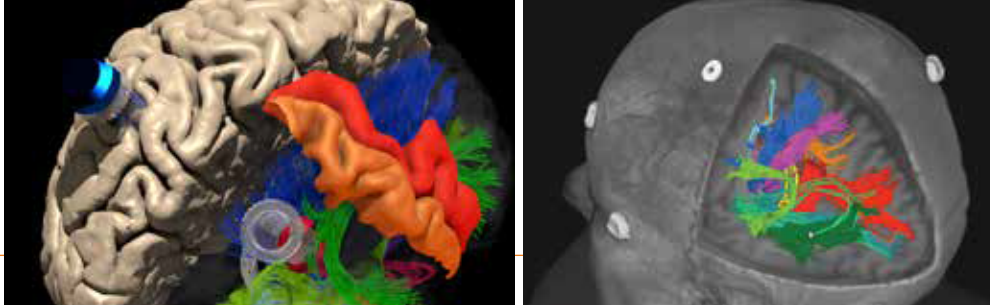
## Aeronautic Accident Statistics (world-wide)



Accidents per 1M departures







The foundational architecture of aerospace industry and innovation continues to provide guidance for the operating room of the future. Aviation safety experts measure air traffic routes for safety using quality metrics. Our new software allows us to map millions of previously unseen white matter tracts in real time, rendering them in a dynamic, three-dimensional modeling system. Like air traffic routes, we are now able to apply principles of aviation safety to the white matter tracts of the brain. The software allows the surgeon to develop and design a plan that can be fully processed and ready for execution in less than 15 minutes. Millions of fibers are now conspicuous and salvageable, and are being visualized preoperatively.

With this capability, clarity of points is also visualized in order to build an individualized and adaptable approach for each surgery, entirely dependent on specific patient anatomy. The dictation of a particular area of entry is based on what was once believed to be invisible anatomy, namely nerves. The concrete presence of white matter tracts now gives rise to the notion that we are obligated to take these visual truths into consideration when in the operating room. In comparison to many of the systems currently used, this aeronautics-like approach performs in a rapid and automated manner with little human input and resources, making this process cost-efficient and accurate. Only now can individualized surgical plans for each specific patient be generated and ready for execution.

ANII has been an international leader in this effort, recently presenting a unique three-dimensional patient-specific atlas of the human white matter. This foundational effort will force the substrate to create a dynamic living platform to allow individual, patient-specific planning for surgery. Explicitly, this means that each patient can have their individual case planned and simulated just like a flight plan – this is a critical step towards precision medicine.

The planning of each surgical case begins with precise, detailed, and advanced imaging. Information is only as good as its quality and reliability.

The complex imaging data is thoroughly evaluated by a computer algorithm that determines whether or not it is ideally suited for surgical planning. If not, the imaging is repeated before the patient leaves the imaging suite. This front-end quality assessment reduces costs and errors, but also ensures that as data is entering the iterative learning platforms, it has been validated as a source of truth. Once the surgical plan is generated, it is transferred directly to a robotically-operated video optical telescopic microscope (ROVOT-m) with a built-in navigation system. Aurora and the team at ANII were the first in the world to deploy this integrated system for direct patient care.

This system represents a single, integrated intraoperative solution to allow surgeons to accurately reach their target while protecting the eloquent white matter. The plan is displayed onto a high-definition monitor and merged with multi-modality imaging confirming alignment for a precise trajectory in order to develop an individualized corridor of entry for each patient. The harmonious integration of patient-specific, target-centric planning with enhanced surgical visualization is grounded on the primary effort to preserve every segment of brain matter as much as possible, effectively reducing patient morbidity.

The ANII care delivery model is equally unique and innovative as the technology. In order to reduce the risk and improve outcomes, the previous principles of scope constraint and patient focus are strictly adhered. The system is designed so the neuro radiologists (navigators) design the flight plans in the OR (on the runways) and are actually present during the critical portion of the procedure to provide input when needed. In addition, every effort is made to ensure that two experienced surgeons (pilot & co-pilot) are performing the key portions of the procedure together, whenever possible. Very few commercial flights operate with just one pilot to avoid errors and maximize quality assurance; we are committed to patient safety in the same manner. This has led to creating innovative models that overcome financial barriers.





Aurora neurosurgeons are now able to see the “flight plan” on this imaging platform to prepare themselves to navigate the complex anatomy of each individual patient in advance. They are able to take off and fly through the surgical space with autopilot functionality as well as have the freedom to adjust the plan while in flight if obstacles arise and if deviation is necessary. Information is being acquired in an intelligent, user-friendly manner with ability to record, capture, and share in real-time, giving rise to an iterative loop. This analytic execution subsequently gives the surgeon the advantage of transitioning from a principal technician to defining diagnoses and future therapeutics. The system feeds this captured data into an informatics platform that will allow for augmented information to yield a predictive knowledge for the delivery of precision medicine.

This robotically-guided optics platform is a unique exoscopic system that offers superior visualization—particularly in the depth of field—in comparison to existing surgical microscopes, allowing more of the image to be in focus and usable to the surgeon. The integration of this system allows for two surgeons—a pilot and copilot—to work simultaneously and collaboratively with exactly the same view in focus. This also nets an immersive view for all participants in the OR where the enriched view yields a full volume that is based on a specific and optimal payload. The hands-free positioning capabilities track the surgeons’ tools and thereby increase their surgical efficiency, allowing them to focus on the surgery at hand rather than continuously adjusting the technology.

## RESEARCH ADVANCEMENTS

The next phase of this multi-disciplinary collaboration focuses at the cellular level through next generation imaging that allows for advanced interrogation of the brain tissue and the capturing of this within the informatics system. It is the hope of our surgeons that through the marriage of technology and innovation with informatics, a movement in

neuroscience towards precision-based cell therapy including regenerative stem cell therapies will arise. The story of a cell will follow it through the entire system from the OR to the bench and back. We are already seeing the added value in trying to understand the variability in how a patient responds to a particular therapy based on individual genetic makeup. The biology of a given tumor varies, as does the biology of a patient.

At ANII, we have invested as extensively in our basic science cell regenerative laboratories as we have in our clinical efforts. The laboratory consists of 3 teams of senior PhD scientists, post-docs, and technicians. The imaging facilities include a specifically-built MRI, representing the only one in the world currently of its kind. The team has carefully procured and harvested a unique collection of stem cells from patients’ tumors. Cells are harvested from patients, grown and implanted into *in vivo* models creating the ability to interrogate the tumors in an unprecedented manner. With the use of ultra-high definition imaging to visualize and capture the structural organization and chemistry of the tumor cells, novel treatment protocols can be developed.

Cellular imaging, along with the operative note fully integrated into one digital record and location of the cell-harvesting, is projected and recorded in an overall sphere of informatics. This information is leveraged with technology and imaging to create an interface that detects and tracks individual patient patterns spanning from preoperative imaging to the cellular level of the tumor. Ultimately, this phenomenon will allow for the implementation of real change to be achieved, offering significant improvements in patient health, the care continuum, and operating efficacy. This allows for precision, adaptive treatment protocols for each patient. Several key findings have recently been reported from ANII regenerative cell laboratories to further the understanding of brain cancer.







# BRAIN TUMORS & NEURO-ONCOLOGY



With 480 new primary tumors and another 1,200 cases of metastatic brain cancer expected in the state of Wisconsin every year—including 926 new deaths from the disease—Aurora Health Care has made a commitment to the early diagnosis and innovative treatment strategies of primary and metastatic brain tumors of all kinds.

Based on American Cancer Society registry data, 7.4 people out of every 100,000 will be diagnosed with brain cancer next year in Wisconsin, which is more than the 6.6 expected across the United States. It's also more than the incidence expected of liver, myeloma, stomach, and testicular cancers, as well as some forms of esophageal, Hodgkin's lymphoma, laryngeal, oral, and thyroid cancers.

A distinctive feature of the Aurora Neuroscience program is the truly multidisciplinary approach to brain tumor management used at every stage of treatment and diagnosis. Our specialized team of neurosurgeons, neuroradiologists, neuro-oncologists, and radiation oncologists work collaboratively with the added expertise of neuropsychology, head and neck oncology, neurology, pathology, and many others, including cancer nurse navigators, neuroscience advanced practice nurses and physician assistants. We treat our patients as members of the care team, keeping them actively involved in all decision-making to ensure all questions and concerns are evaluated and taken into account. When it comes to treating neuroscience conditions and disorders, we believe the patient is the most important shareholder in the decision-making treatment process.

Our model puts you, the patient, at the center. We see you collectively so you can ask us while we are all in the clinic room at the same time any questions you may have. This is not only convenient, but also avoids the confusion of trying to interpret what different specialists may have said to you at different times. We also endeavor to have the person with the right expertise in the room at the right time. For example, we provide a neuroradiologist reviews your imaging with you as opposed to a surgeon or non-radiological specialist, whenever possible.

# at a GLANCE

## 2016 Estimates

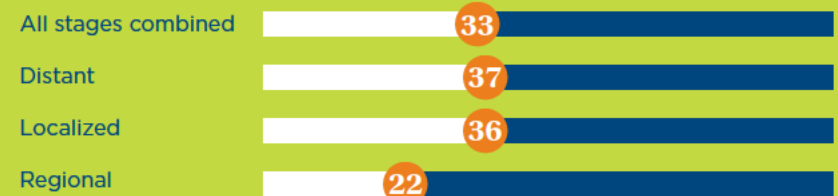
### Brain and other nervous system

Source: American Cancer Society® cancer statistics center



### National five-year relative survival rate percentage

By stage at diagnosis, 2005-2011



Among cases diagnosed from 2005 to 2011, followed through 2012  
Data sources: Surveillance, Epidemiology, and End Results (SEER)  
18 registries, National Cancer Institute, 2015

**Brain Tumors  
at Aurora**

**720**  
Hospital  
Admissions

**4,029**  
Clinic  
Visits



Complex access and treatment algorithms have been developed to ensure that all patients, primary and metastatic, are reviewed and considered by the Neuro-Oncology tumor conference team with comprehensive development of care plans. Through innovative approaches to care, the management of brain tumors at Aurora Health Care has evolved beyond just length of life, and has become fully invested in a patient's quality of life. We offer the best of the proven current treatment available today, while bringing the next generation of innovative chemo and surgical treatment applications to our commitment to precision medicine with innovative techniques that adapt to the individual patient.

## EXPANDED ENDONASAL APPROACH (EEA)

### Revolutionizing the way brain surgeons access the skull base and upper cervical spine in a less invasive way.

During endoscopic endonasal surgery, a neurosurgeon and an otolaryngologist work together to enter the skull base through the nose. This minimally invasive technique eliminates the need for external incisions and brain retraction. By removing the back half of the nasal septum and the bone in front of the sphenoid sinus, surgeons can reach the skull base.

Tumors are then removed with the help of high-definition optics and an endoscope. Finally, the skull base is reconstructed using a flap of the septal membrane—which seals off the brain from the nose—helping prevent complications.

The Expanded Endonasal Approach allows access to skull base tumors minimizing the complications that can be seen with open skull base surgery, which include infections associated with large scalp incisions and the side effects seen with brain retraction.

Many patients undergoing EEA spend only one to two days in the hospital, and recovery time at home can be much shorter than for open skull base surgery. In addition, there are many scenarios in which EEA causes less disruption of critical nerves during skull base surgery.

The Expanded Endonasal Approach is used to perform minimally invasive brain surgery for these conditions:

- Brain tumors
- Cancers of the sinus (squamous cell, sphenoid sinus carcinomas, adenocystic and metastatic)
- Meningiomas of the skull base
- Pituitary tumors (including pituitary adenomas, acromegaly, prolactinomas and pituitary apoplexy)
- Olfactory neuroblastomas
- Rathke's cleft cysts
- Skull base tumors and cysts
- Chordomas and chondrosarcomas
- Orbital tumors and Graves' disease

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## MINIMALLY INVASIVE NEUROSURGICAL TECHNIQUES

Deep brain tumors (subcortical), areas of bleeding, and cysts that were once considered too risky to operate on by many are now often removed through a precise and patient-specific corridor with our unique, integrated surgical techniques. This minimally invasive technique offers patients hope for better surgical results, as well as improved long-term health outcomes. It also allows our patients to reach the goal of zero footprint, or no long-term complications as a result of their tumor or surgery.

### Mapping

An invaluable tool for Aurora's neurosurgeons, brain mapping depicts aspects of a tumor and surrounding healthy tissue with enhanced clarity rendered in a three-dimensional space. This imaging technology allows surgeons to preplan a patient-specific, real-time surgical pathway before a brain surgery procedure even begins—which translates into improved outcomes in the operating room and a faster recovery.

### Dynamic Navigation

Neurosurgeons use a GPS-like system that gives them real-time guidance deep within the brain. Patients can see their brain tumor removal on the same computer screen that their surgeons use to track the movements of their surgical instruments.

### Safe Access

We use a specialized and innovative tool that minimizes damage to surrounding tissue by allowing neurosurgeons to safely displace the natural folds of the brain as they advance to the target site. This is a critical component of a minimally invasive treatment for brain tumors and other deep-seated neurological disorders.

### High-Definition Optics

This technology allows neurosurgeons to differentiate tissue types with unprecedented clarity from above the surgical site. Being able to separate diseased tissue from healthy tissue makes it possible to successfully remove what would otherwise be considered inaccessible brain tumors, cysts or other growths difficult to see.

### Automated Resection

Using a tool about the size of a pencil, neurosurgeons are able to remove tissue without injury to adjacent healthy brain matter. This technique is another reason Aurora can offer treatment options for conditions, such as brain tumors, that were previously deemed too risky by many.

### Directed Therapy Options

Neurosurgeons collect and preserve the brain tissue they remove in a sterile, closed-capture device for pathology, molecular and genetic evaluation. These samples provide opportunities to develop personalized treatment regimens for every patient. This is a critical step in advancing treatment paradigms. The ability to capture, grow, and implant the tumor tissue into mice enables the team to study and develop new targets for treatment that are brought directly back to the patient in an individualized manner, epitomizing our commitment to precision medicine.

All of this patient and correlated cell data is then compiled into a novel image-driven data capture system with the goal of developing predicted informatics power. Aurora was the first institution in the world to install and implement this specific image-driven informatics system.



The culmination of all of these integrated technologies allows for many of our patients to have surgery while awake. However, this is different than the way awake procedures have been commonly done in the past. Our patients often have **less** anesthesia than even routine, non-neurosurgical procedures, like a colonoscopy. Also, many patients are interacting on their phones or smart devices during surgery, and many, go home the next morning.

We believe this has resulted in significant improvements in cognitive outcomes, particularly those that are otherwise difficult to monitor when patients are completely asleep during surgery. This philosophy of care has been paramount to our continued pursuit of zero footprint, or no long-term complications.



## BRAIN MAPPING

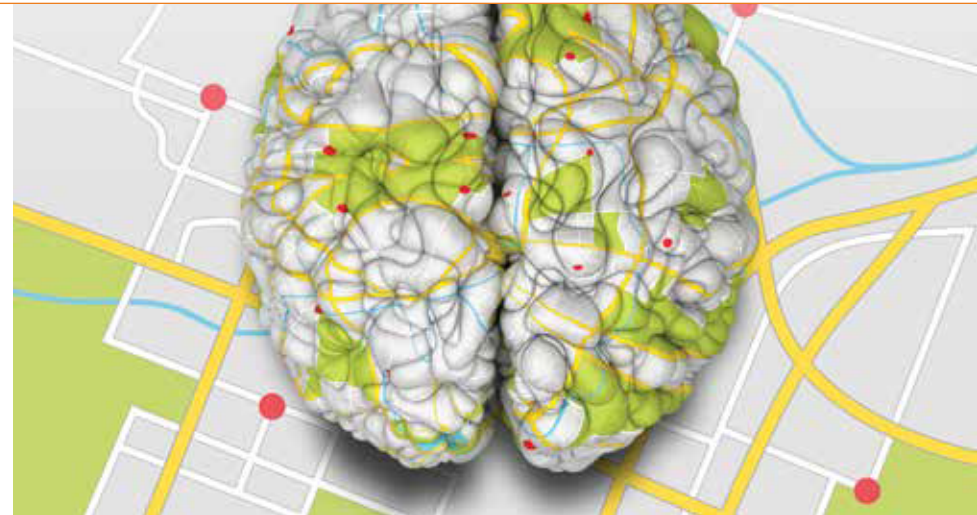
**Advanced brain mapping technology lets our team of experts see the precise location of individual brain functions—speech, memory and movement—in order to help determine the most appropriate treatment.**

Brain mapping is a critical tool used by neuroscientists to diagnose long-term, chronic conditions, like Parkinson's disease; it is also used to plan surgeries for more acute conditions, such as brain tumors.

If surgery is needed, brain imaging technology may be used before and during a procedure to differentiate healthy brain matter from diseased tissue. It can also be used to define a surgical or navigational strategy to help avoid injury to portions of the brain needed for critical functions.

Diffusion tensor imaging with white matter tractography is one type of brain mapping. It uses state-of-the-art technology to create a 3D map of the brain, which shows the location of nerve fibers that control speech, memory, cognition, and thought—all of the things that make you ... you! It provides advanced assistance with:

- Determining the best surgical approach to remove a tumor
- Diagnosing and treating a traumatic brain injury
- Finding breaks in brain fibers that may cause the loss of certain body/memory functions
- Understanding which brain connections are intact and which are damaged



- Other types of brain imaging technology that works like a GPS system during surgery, giving neurosurgeons real-time guidance deep within the brain

Brain mapping is a fundamental element of our minimally invasive methodology for treating subcortical tumors and cysts that were often considered otherwise inaccessible.

**Aurora has performed more optical robotic brain surgery than anyone in the world to date, and ANII was the first in the world to deploy a unique 3-D brain mapping platform for patient care.**

## NEURO MULTIDISCIPLINARY MODEL



**The MDC team approach is progressive and is different from most multidisciplinary teams that exist today in that it functions as one fluid unit instead of operating in specialty silos.**



### Neuroradiologist

- Uses advanced technology to diagnose diseases of the nervous system



### Surgeons

- You will see one of our world-renowned neurosurgeons who will perform any necessary procedures
- Communicates regularly with other providers on your care team



### Financial Advocate

- Answers questions about insurance coverage
- Discusses any payment or financial concerns and options



### Primary Care Physician

- Views your progress via your health record
- Sees you during the full recovery process



### Care Coordinator

- Your most regular point of contact
- Assists with scheduling appointments
- Stays in touch with NP, PA and surgeon
- Ensures you're comfortable and taking medications



### Cancer Nurse Navigator

- Makes sure you receive seamless care
- Schedules appointments with specialists
- Connects you with support groups



### Nurse Practitioner (NP) and Physician Assistant (PA)

- Specially trained advanced practice providers
- Performs daily physical exams, reviews tests and medications
- Follows you in the hospital and clinic
- Will assist your surgeon during surgery

### Other Specialists

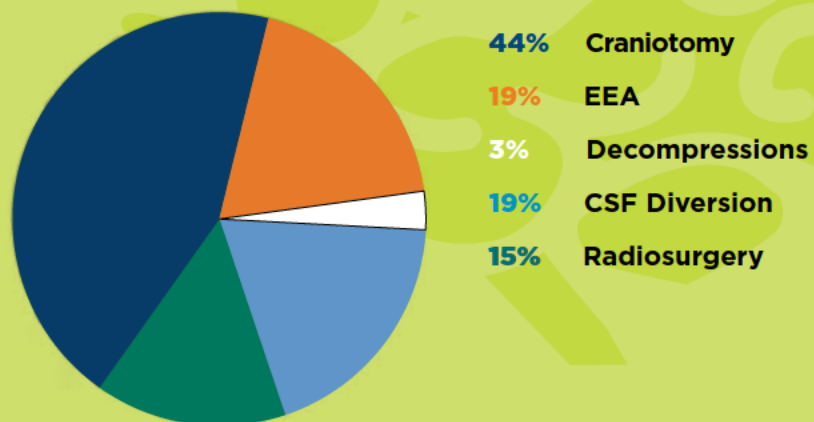
Communicate and collaborate with other care team members, including the following:

- General neurologist
- Neuro-oncologist
- Rehab specialist
- Endocrinologist
- Otolaryngologist/ENT
- Medical Oncologist
- Spine physiatrist
- Neuroendovascular specialist
- Neuropsychologist
- Neuro-Ophthalmology
- Radiation oncologist

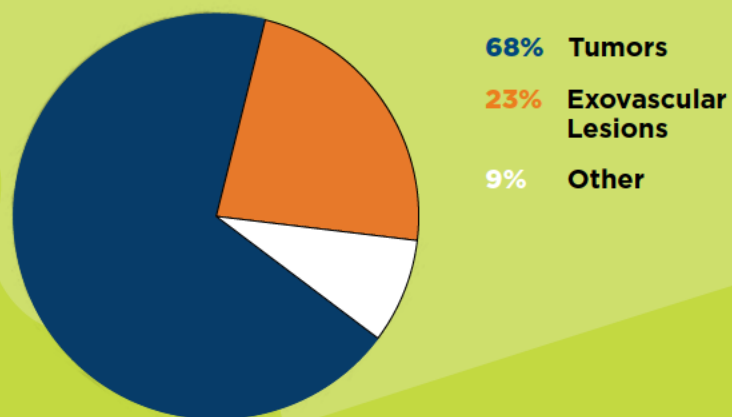
# Data

ANII Neuro MDC and Cranial clinic saw  
**1,477** patients

## Procedures



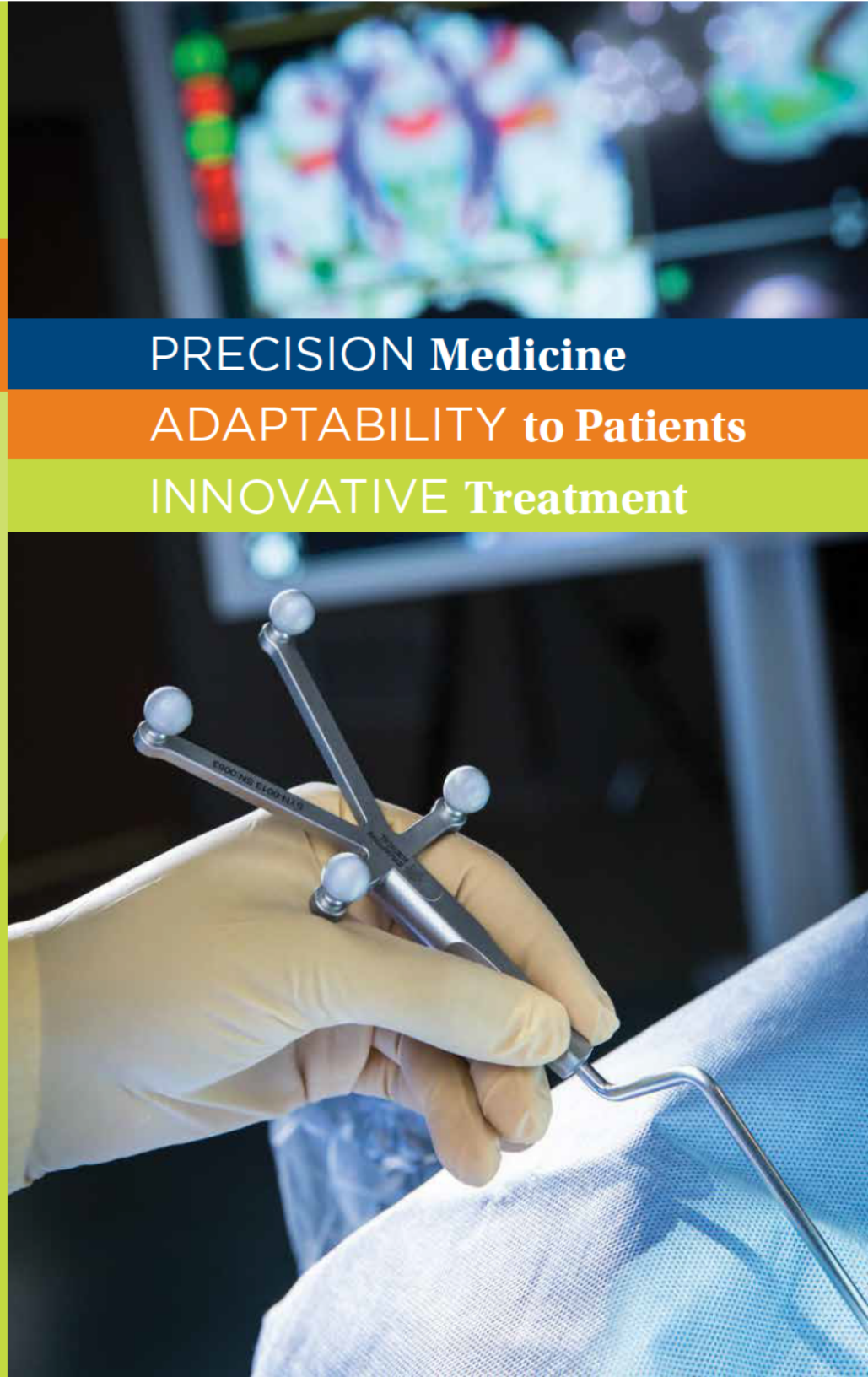
## Conditions Treated



**PRECISION Medicine**

**ADAPTABILITY to Patients**

**INNOVATIVE Treatment**





A portrait of Bradley Page, a middle-aged man with short brown hair, smiling. He is wearing a dark pinstripe suit jacket, a white shirt, and a red tie with a small pattern. The background is a blurred cityscape.

# PATIENT STORY:

## Bradley Page

### BRAIN GAIN

Bradley Page was talking on the phone to his wife, just as he'd done so many times before. Only this time, he was calling from an operating table at the Aurora Neuroscience Innovation Institute (ANII) of Aurora St. Luke's Medical Center. And he still had a hole in his head.

Mere minutes before, doctors had finished removing a cancerous tumor from the 54-year-old's brain. Page was even awake during the entire six-hour procedure on his right frontal lobe, part of the reason he could call his wife before surgeons closed.

This is the leading edge of modern brain surgery, and Page's lead neurosurgeon, Dr. Amin Kassam, is at the head of vanguard. He directed the February 19 operation while walking Page through the entire procedure. Page watched it all play out on a 52-inch TV.

"It was like being on an adventure ride at Universal Studios," says Page, who lives in Germantown and is senior vice president and general counsel for a real estate investment trust. "Country music was playing, and there was a lot of joking."

In fact, it was essential that Page be fully conscious and conversational during the procedure to make sure his surgeons were not getting too close to areas that control cognitive functioning and motor skills.

It's all part of The Minimally Invasive Approach Kassam uses. It grants access to deep-lying tumors and brain anomalies that are difficult or impossible to affect through typical methods. The approach is made possible by to-the-millimeter navigation technology and high-def optics showing the precise location of brain fibers and cancerous tissue.

But Kassam deflects much of the attention to the ANII team. It includes four neurosurgeons, four neurologists, a neuro-radiologist, an epileptologist, a neuro-oncologist, eight advanced practice providers and 15 support staff members. One of the newest arrivals is Dr. Richard Rovin, a neurosurgeon and director of clinical research for ANII, whom Kassam recruited from Marquette General Hospital in Marquette, Mich.

**“We treat each patient as if they’re the only patient we’re taking care of,” Rovin says.  
“This is not an assembly line.”**

“We use optics to see and separate the bad tissue from the good without injuring the surrounding tissue,” says Kassam, who received his medical degree from the University of Toronto and is vice president of ANII. “And the bad tissue is precious—it holds the understanding of why cancer forms.” After each surgery, Kassam and his team, with permission from the patients, use the cancerous tissue for research purposes.

“The goal is to reengineer brain cancer cells to make bad cells behave like good, healthy cells,” says Kassam, who has deeply personal reasons for being a neurosurgeon. When he was 11, his mother developed a brain tumor that left her in a vegetative state until her death 13 years later. “That is strong motivation for the work I do,” he says.

Kassam’s Aurora arrival in late 2013 has earned ANII plenty of attention, be it through Mark Johnson’s lengthy Milwaukee Journal Sentinel eyewitness feature on one of Kassam’s surgeries, or Kassam’s work teaching his procedures to surgeons around the world. He’d already built his groundbreaking reputation during stops at Ottawa Hospital Civic Campus in Ontario, Canada, and before that at the University of Pittsburgh Medical Center.

“We treat each patient as if they’re the only patient we’re taking care of,” Rovin says. “This is not an assembly line.”

That approach isn’t lost on patients. “Two days after meeting with Dr. Kassam, I met with the whole team and we went over my MRI in detail,” Page says. “The multidisciplinary approach was very reassuring.”

And such conversations are two-way streets, particularly after the surgeries. “We listen to our patients,” Kassam says, “and try to learn from them so that each surgery is better than the one before.”

But it’s hard to imagine improving on Page’s. After an initial postsurgical headache, he soon discontinued pain meds and went home the next day. He was working the next week. And though he needed subsequent radiation treatments to ensure no cancerous cells remained and chemotherapy to break the cycle of mutating cells, he expects to live at least another 20 years.

**“The members of that team,” Page says, “are angels on earth.”**



The background of the slide is a complex, artistic representation of a neural network. It features numerous blue, branching structures resembling neurons or axons, some of which are illuminated with a bright yellow or orange glow. Interspersed among these blue structures are several clusters of red, rounded cells, some of which are also glowing. The overall color palette is dominated by deep blues, purples, and reds, with the glowing elements providing a high-contrast, futuristic feel.

# NEUROLOGICAL DISORDERS



# at a GLANCE

Chronic headaches. Degenerative neurological disorders. Persistent muscle pain. At Aurora, we understand that medical issues like these require experienced, compassionate care. Our multidisciplinary team will identify the source of your neurological condition with state-of-the-art diagnostic services and provide treatment tailored to your needs and goals.

Neurologists at Aurora Health Care will partner with you to create a treatment plan for your brain injury or disorder. Our neurologists will help you deal with existing symptoms, treat your symptoms, and monitor your health to ensure you enjoy the best quality of life possible.

**Our team works to diagnosis and treat the following neurological disorders:**

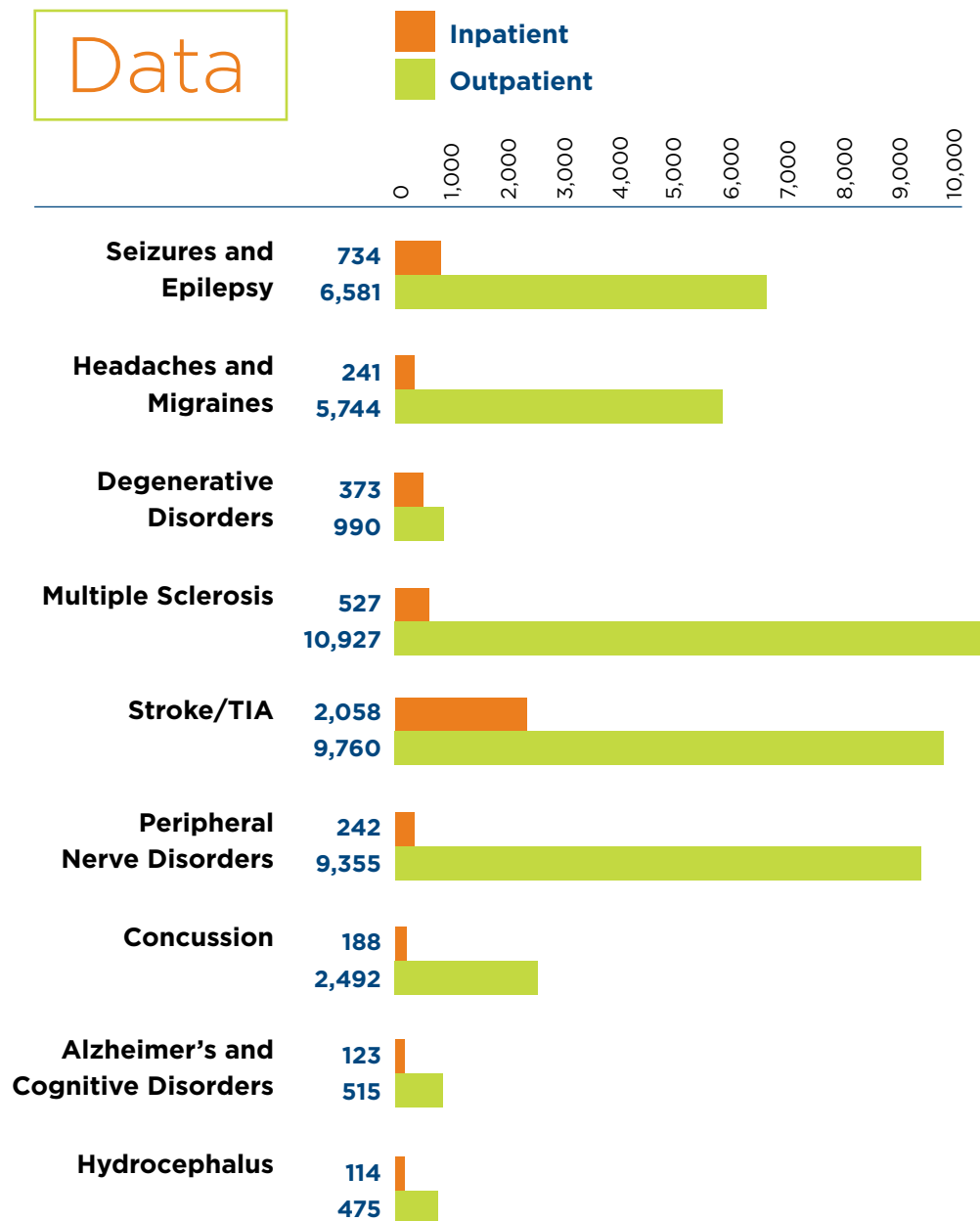
- Alzheimer's disease and other cognitive disorders
- Epilepsy and seizures
- Multiple sclerosis
- Parkinson's disease and movement disorders
- Stroke
- Headaches and migraines
- Neuromuscular disorders
- Neurodegenerative diseases

Our neurology team is part of a family of services that includes the latest diagnostic technology and proven physical rehabilitation services. Our neurologists lead and participate in clinical trials to bring our patients the next generation of treatments.

Average rate for readmissions to the hospital was **6.76%**; however, expected return was **9.83%**, showing the advanced treatment of Aurora's neurology care leading to longer-term outcomes and improvement.



# Data







**CONCUSSION**

# by the NUMBERS

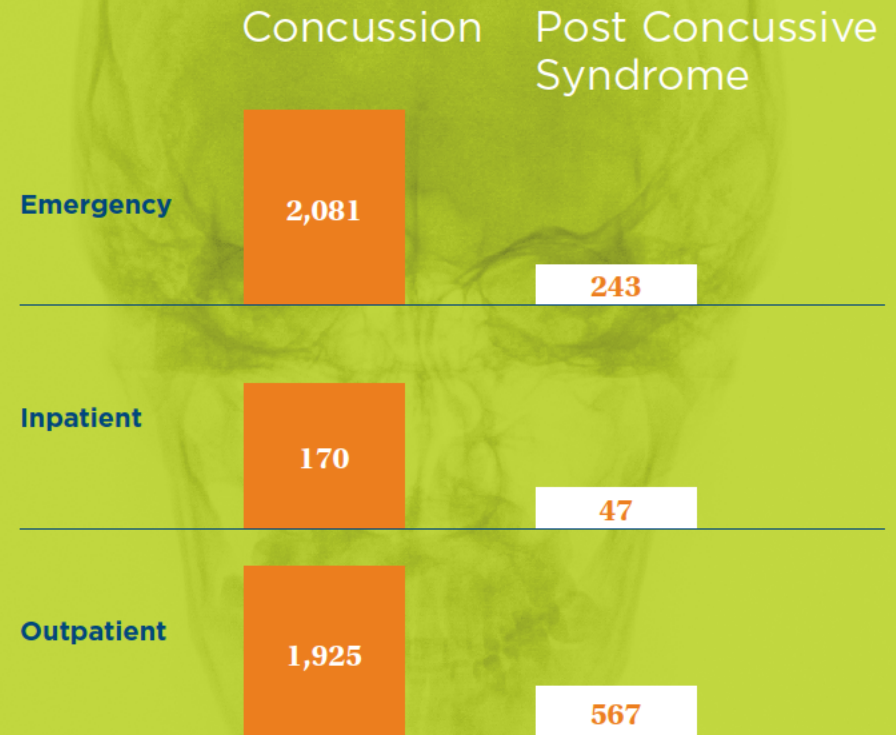
According to the Centers for Disease Control (CDC), an estimated 300,000 people under the age of 19 were treated in hospital emergency rooms for concussions related to sports and recreation activities alone last year. This number is doubled over reports 10 years prior, due in large part to the increased focus on the identification of and need for immediate treatment for concussion. This is good news, considering 90% of most diagnosed concussions do not involve a loss of consciousness (LOC). Prior to recent awareness, this lack of LOC led many parents and coaches to brush off any substantial hits or collisions as requiring medical attention.

Although the first concussion experienced can be troublesome, second, third, or more events can cause permanent and long-term brain damage. This is most often referred to as second (multiple) impact syndrome and is responsible for a 39% increase in permanent neurologic disability. Shockingly, 37% of high school athletes in 2015 who have had a sports-related concussion reported two or more in the same year.

Research presented to the American Academy of Pediatrics' annual meeting concluded that school and sports teams with athletic trainers on site have higher rates of concussion than those that don't due to their expertise in identifying the injury and its oft-subtle signs immediately.

Aurora performs nearly **6,500** baseline concussion tests to student athletes throughout the state of WI annually.

## Acute Care



*\*Data reflects acute concussion care, not follow-up rehabilitation treatment*



There are between an estimated **1.6 and 3.8 million** sports-related concussions in the U.S. every year, leading the CDC to conclude that sports concussions have reached an epidemic level.

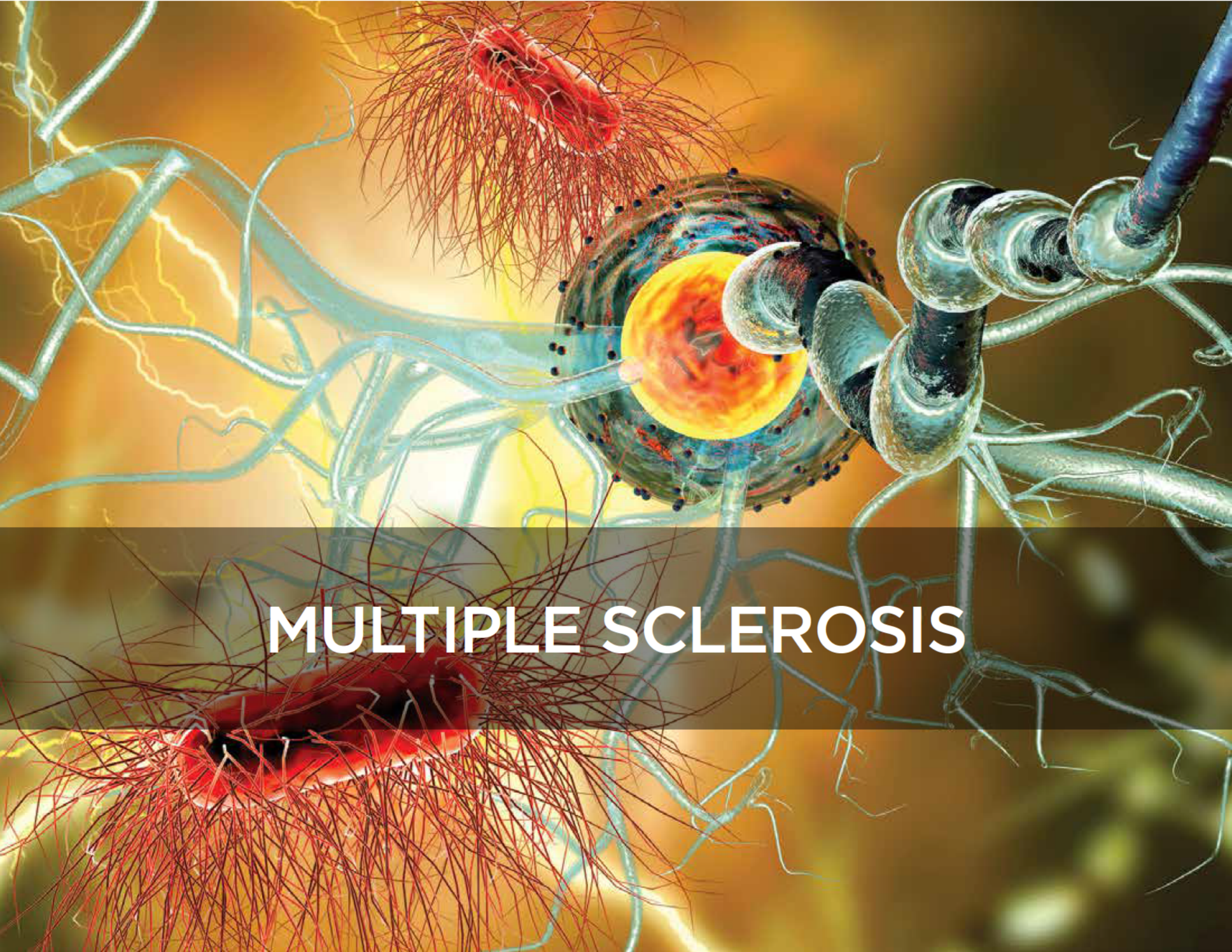
Aurora takes concussion care seriously and has been a proven leader in concussion assessment, treatment, education and prevention. Aurora is the top employer of athletic trainers in the state of Wisconsin. By providing these front-line prevention resources, Aurora's athletic trainers ensure baseline tests are administered properly, contact techniques are being safely instructed, and student athletes and parents are appropriately educated to assure that all safeguard elements are in place for all high-risk activities.

In the event of a head injury, athletic trainers have certification and state licensure that assures evidence-based practice of proper concussion management. Over 70 Aurora athletic trainers across the state provide on-field assessment using researched protocols and follow the National Athletic Trainers Association position statement on management of sport concussion. Aurora's athletic trainers work with a complete team of dedicated health professionals, including pediatricians, orthopedic surgeons, neuropsychologists, neurologists, family practice physicians, and physical therapists to reassure proper return to play.









# MULTIPLE SCLEROSIS



## MULTIPLE SCLEROSIS & DEMYELINATING DISEASE

### Comprehensive care clinic associated with the National MS Society

Multiple Sclerosis (MS) affects women more than men and most commonly begins between the ages of 20 and 40. Doctors aren't sure what causes multiple sclerosis, but it is an immune-mediated illness. Genetic factors and exposure to certain viruses are thought to be involved in the development of multiple sclerosis. No two people have the exact same effects, which can make diagnosing MS difficult at times.

Aurora's expert neurologists work with patients to determine the best way to slow or stop the destruction of the nerves' protective coating. The right treatment can significantly reduce symptoms and prevent them from becoming disabling. We'll help you cope by giving you access to the latest in MS research and treatment options.

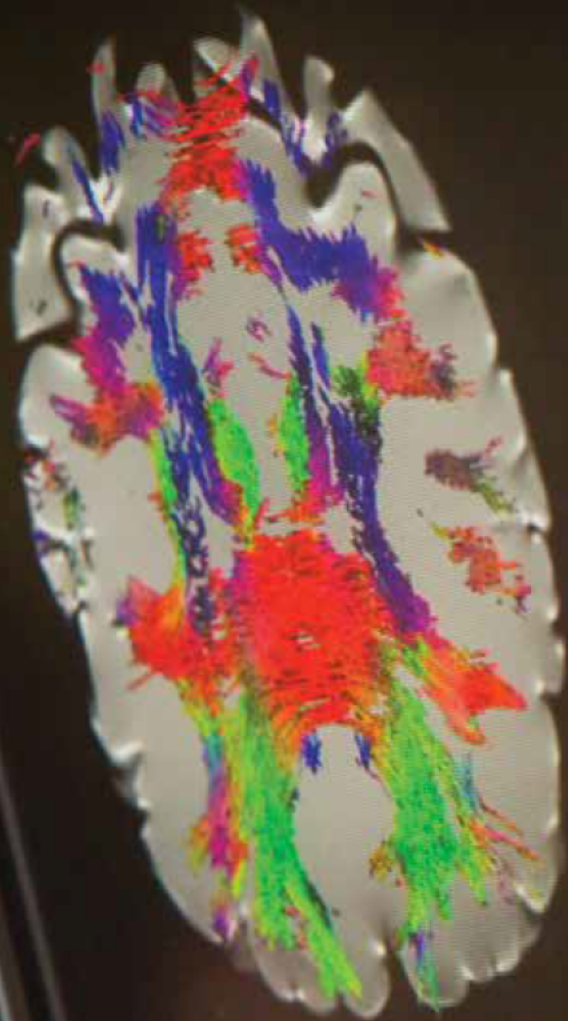
#### Collaboration with:

- Neurology
- Neuropsychology
- Occupational Therapy
- Physical Therapy
- Speech and Language Pathology

We believe in comprehensive care that treats the whole patient, including your spiritual, physical emotional medical needs. In addition, we can help you manage symptoms like cognitive deficits, swallowing and speech issues, bladder or bowel difficulties, spasticity, fatigue, depression, stress, tremors and weakness.







National standards show a **0.23%** rate of mortality for those suffering from MS; in 2015, Aurora's mortality rate was **0.00%**.

Return trips to the hospital occurred at a rate of **5.3%**, while risk-adjusted expectations were much higher at **7.75%**.

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#### Multiple Sclerosis and other Demyelinating Disease

**128**

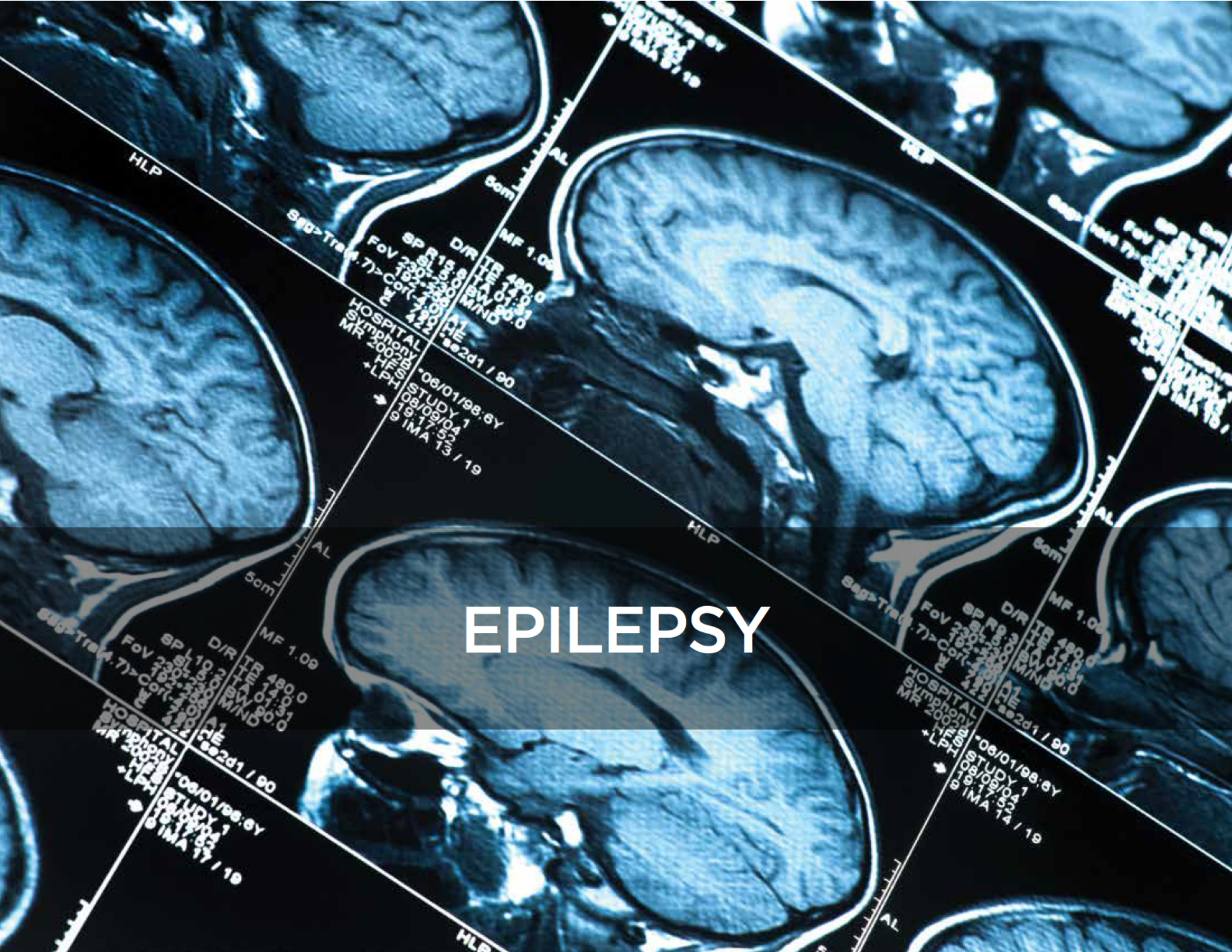
hospital  
admissions

**10,927**

clinic  
visits







# EPILEPSY

Technical data visible on the scans includes: MF 1.09, D/R, TR 480.0, TE 17.0, SE 2.0, FOV 230.0, HOSPITAL, STUDY 1, 08/09/04, 19:17:53, IMA 13 / 19, and HLP.



According to the Epilepsy Foundation, epilepsy is the 4th most common neurological condition. Every year, 48 new people of every 100,000 will be diagnosed with epilepsy, which means that 1 in every 26 people will develop epilepsy sometime throughout their life. Current statistics show that in the United States, there are roughly 2.2 million people diagnosed with and being treated for epilepsy and seizures.

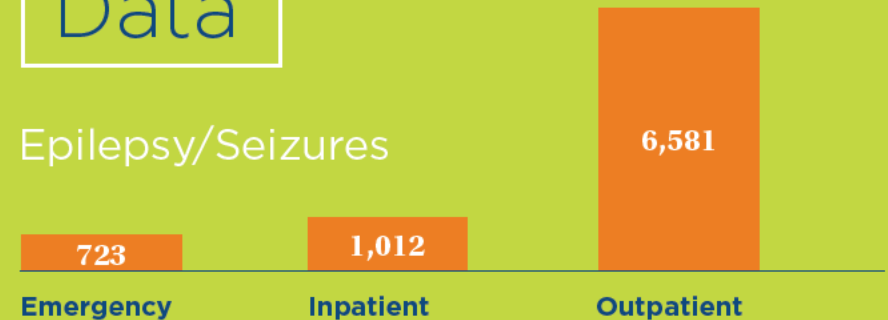
At Aurora, a seizure evaluation consists of a detailed discussion of your symptoms, a comprehensive neurologic examination and diagnostic testing. Basic testing includes an EEG, or brainwave test, to see if we can capture a seizure or see footprints of seizure activity. We may also get an MRI of your brain to see if there is an abnormality or malformation that can cause seizures. Our expert neurologists can help you manage these debilitating occurrences—regardless of their source—so you can lead an independent, productive life. We'll start by determining whether you have generalized-onset or partial-onset seizures and then develop a seizure treatment and management plan that's right for you.

Expected length of stay for an average epilepsy admission to the hospital is **3.07 days**; Aurora patients were **2.98 days**.

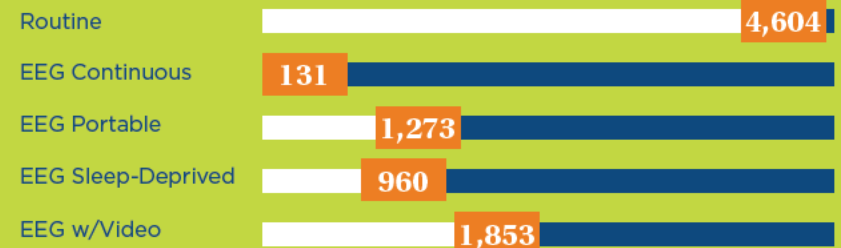
# by the NUMBERS

## Data

### Epilepsy/Seizures



### Neurodiagnostic Testing



Readmissions to the hospital are expected to occur at **10.4%**, while Aurora epilepsy patients only return **8.92%** of the time.

## EPILEPSY MONITORING UNIT

Patients whose seizures can't be controlled with medications and those who may be candidates for epilepsy surgery are often scheduled for long-term epilepsy monitoring in one of our Epilepsy Monitoring Units.

**Information from the study is used to determine if surgery is a viable treatment or if other options should be considered. This information helps to do the following:**

- Establish an epilepsy diagnosis. In most epilepsy centers, about 1 in 4 patients who have seizure-like events do not have epilepsy
- Identify the seizure type. Some seizure medications are designed to treat certain types of seizures
- Locate the source. Monitoring can help identify the brain area where your seizures begin. Lateralization and localization (finding the side and area) of your seizures is a critical first step in planning any epilepsy surgery. Seizures are videotaped because your behavior during seizures can also help to locate the source
- Determine seizure frequency. Video EEG monitoring can identify how often you are having seizures. Frequently patients have seizures and don't know unless someone tells them



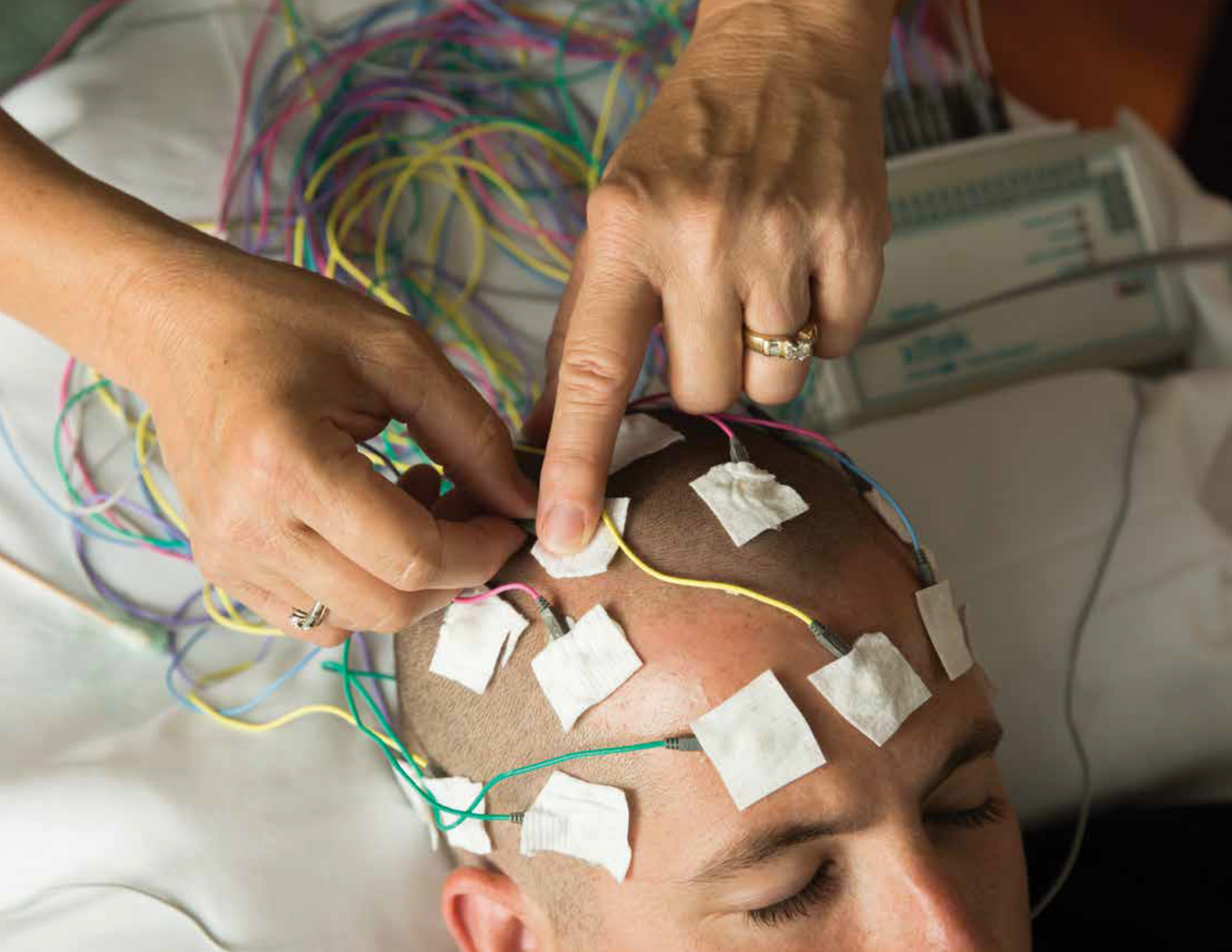
## LEVEL 4 EPILEPSY CENTER

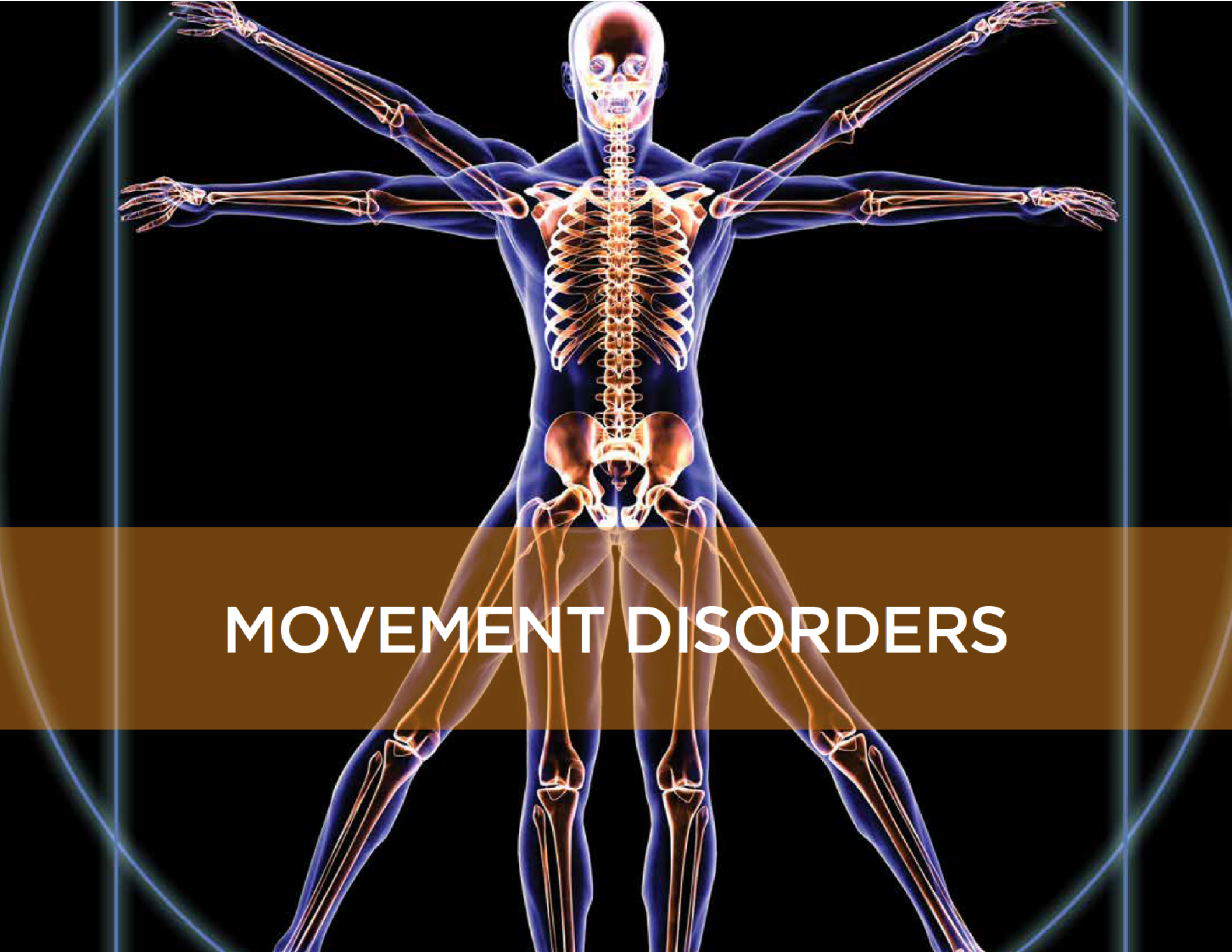
The Aurora Center for Epilepsy and Neurology has been accredited as a Level 4 epilepsy center by the National Association of Epilepsy Centers. Level 4 is the highest level of certification that a program can receive and ensures it has capabilities in the following:

- Basic range of medical, neuropsychological, and psychosocial services needed to treat patients with refractory epilepsy
- Noninvasive evaluation for epilepsy surgery, straight-forward resective epilepsy surgery, and implantation of the vagus nerve stimulator
- Complex forms of intensive neurodiagnostics monitoring, as well as more extensive medical, neuropsychological, and psychosocial treatment
- Offer complete evaluation for epilepsy surgery and a broad range of surgical procedures, including intracranial electrodes









# MOVEMENT DISORDERS

# by the NUMBERS

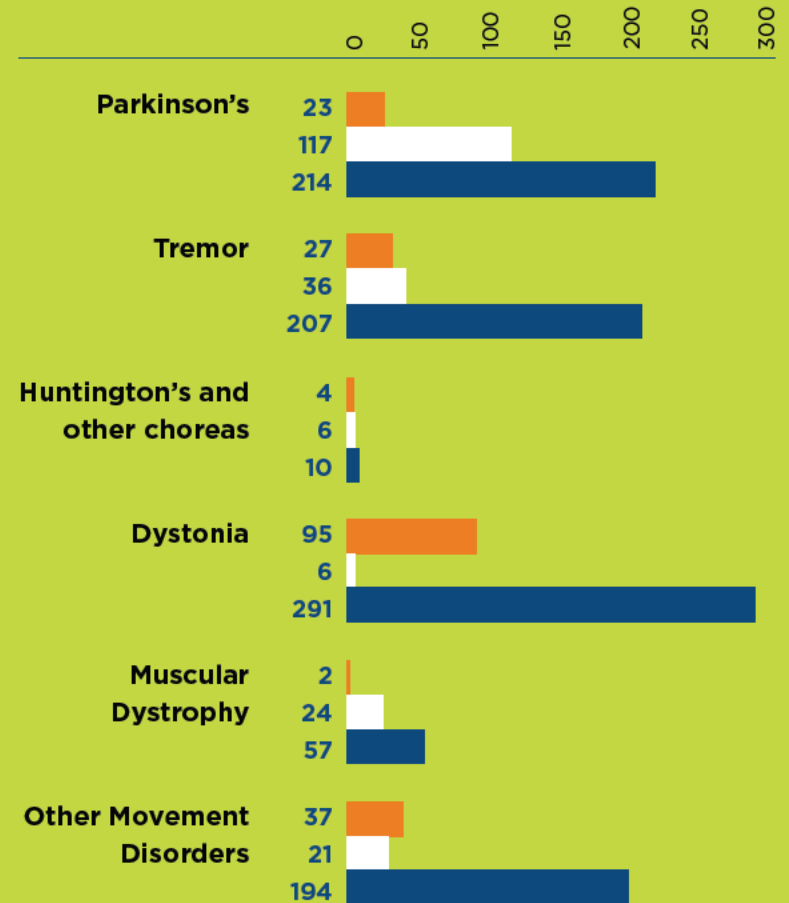
## Parkinson's disease may be part of your life, but it shouldn't define it.

Eating breakfast. Writing your grocery list. Walking to the car. Driving to the store. Most of us do these activities without a second thought. But for a person with a movement disorder like Parkinson's disease, the easiest things can be challenging—or even dangerous.

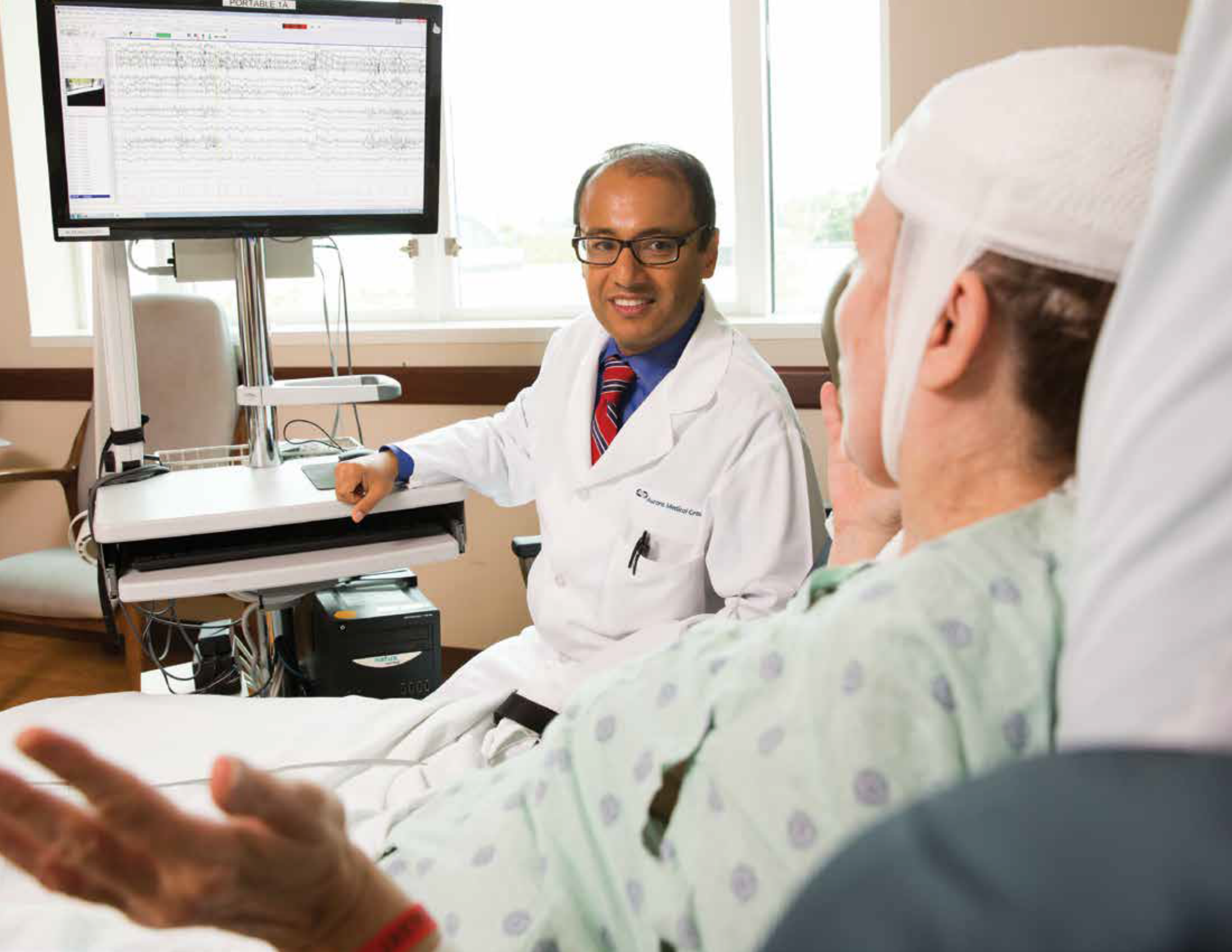
Parkinson's disease is a brain disorder that leads to shaking (tremors) and difficulty with walking, movement, and coordination. While there is no cure, treatments can reduce the symptoms and improve your quality of life. Diagnosing Parkinson's disease can be difficult, particularly in the early stages of the disease. Our team uses neurological exams, SPECT scans, and MRI to assist in diagnosis.

We also offer DaTscan to help confirm a diagnosis, which is an imaging technology that uses small amounts of a radioactive drug to help determine how much dopamine is available in a person's brain. A SPECT (single photon emission computed tomography) scanner measures the amount and location of the drug in the brain.

### Data







## EASY STREET

Easy Street is a one-of-a-kind environment and facility that provides a variety of real world experiences to aid in the recovery of our patients, specifically those suffering from neurological and movement disorders. This facility includes a grocery store, barber shop, movie theater, bus, driving range and apartments so our patients have a unique opportunity to be challenged both mentally and physically over curbs, ramps, and uneven surfaces before they face those obstacles in the communities we serve. Easy Street allows for a truly multidisciplinary approach to care by creating an environment where physician, therapist, and other medical professionals come together to focus on one priority, helping your patient regain their highest functional level and re-enter the community.

## PARKINSON'S SUPPORT

### **LSVT Big and Loud Clinic®**

For People Living with Parkinson's Disease

- Evidence-based exercise program that follows an intensive and specific protocol to provide maximal results
- Specialized treatment from certified therapists for Parkinson's disease
- This treatment has been linked with better outcomes compared to traditional therapy
- Patients learn how to move BIG and speak LOUD on a consistent basis
- Recalibrates the senses for automatic use of normal movement and voice
- Uses high effort and intensive treatment to improve everyday function

**“You all made a difficult time easier for me. I came away with a better attitude and more hope.”**

-Jerry D., Big and Loud program participant

### **Mobile and Fit Parkinson's Class**

This exercise class is designed so that people with Parkinson's disease can get better and stay better through exercise. The class targets movement deficits caused by Parkinson's disease with the goal of reducing falls, improving function, and improving quality of life.

### **Health Counseling**

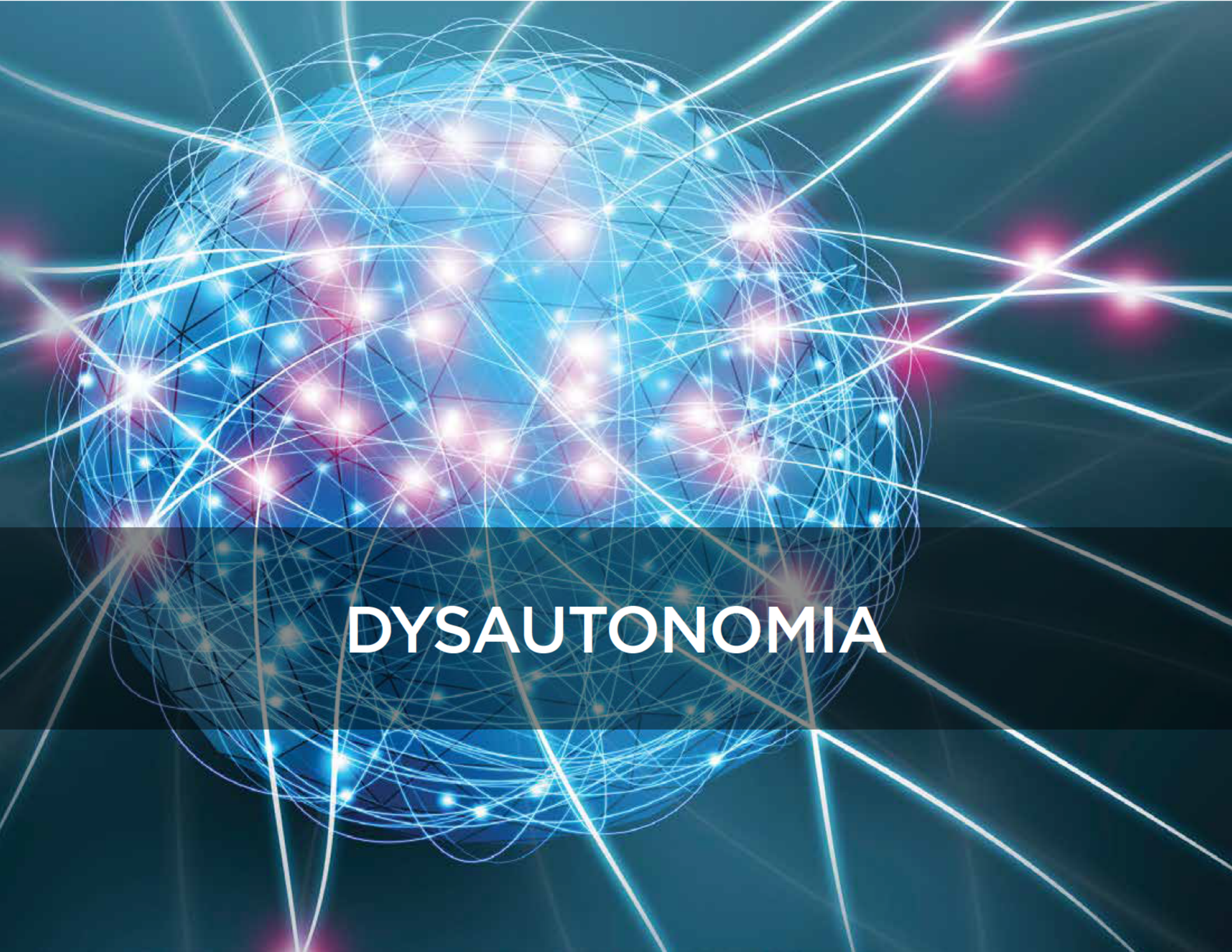
Many patients experience anxiety and depression after their diagnosis. Specialized therapy sessions can help them learn to cope with the emotional changes.

## RESEARCH

Aurora Health Care is linked to the Parkinson's Research Institute, one of only a few organizations with a sufficient database to research the causes of Parkinson's disease.

At any given time, the Aurora Health Care Regional Parkinson's Care Center and the Parkinson's Research Institute are involved with a number of studies evaluating the effectiveness of drugs and treatment methods not yet available to the general public. At Aurora, patients have access to the latest in Parkinson's research and treatment options.



An abstract digital graphic featuring a central sphere composed of a dense web of glowing blue and white lines, resembling a neural network or a complex data structure. The sphere is surrounded by several bright, intersecting lines that create a sense of dynamic movement and connectivity. The background is a deep blue gradient, enhancing the futuristic and technological feel of the image.

**DYSAUTONOMIA**



Over **1 million Americans** are impacted with a primary autonomic nervous system disorder.

Dysautonomia occurs when there's a malfunction in the autonomic nervous system (ANS), potentially affecting heart rate, blood pressure, digestion, sweating and other automatic processes in the body.

Doctors can't always pinpoint what causes dysautonomia. It may be secondary to a multitude of other medical conditions, such as diabetes, multiple sclerosis, rheumatoid arthritis, celiac disease, Sjögren's syndrome, lupus, Parkinson's disease and many others. Sometimes it develops after a trauma or a virus. It may also happen to adolescents after a growth spurt. Dysautonomia can be a mild and temporary condition or a serious long-term illness.

Dysautonomia is not rare. Recent National Institute of Neurological Disorders and Stroke data reports that over 70 million people worldwide have been diagnosed with varying forms of dysautonomia and confirms that it affects any age, gender or race. Although there usually is no cure, advanced treatments are being used every day to help patients better combat the dysfunction of their ANS. The largest issue that physicians face is the difficulty associated with actually diagnosing the condition, as it can mask itself as a number of other neurological disorders.

#### DYSAUTONOMIA CENTER

The Dysautonomia Center at Aurora Health Care is one of only two centers in Wisconsin offering specialized diagnostic testing and treatment for people with complex ANS disorders. Our multidisciplinary team approach includes medical experts in neurology, cardiac electro-physiology, psychology, gastroenterology, rehabilitation, nutrition, integrative medicine, genetics and more. Our team focuses on identifying the root causes of dysautonomia and participates in clinical trials to determine the most effective treatments and improve the quality of life for patients with this condition.

# by the NUMBERS

**731**

Inpatient  
Visits

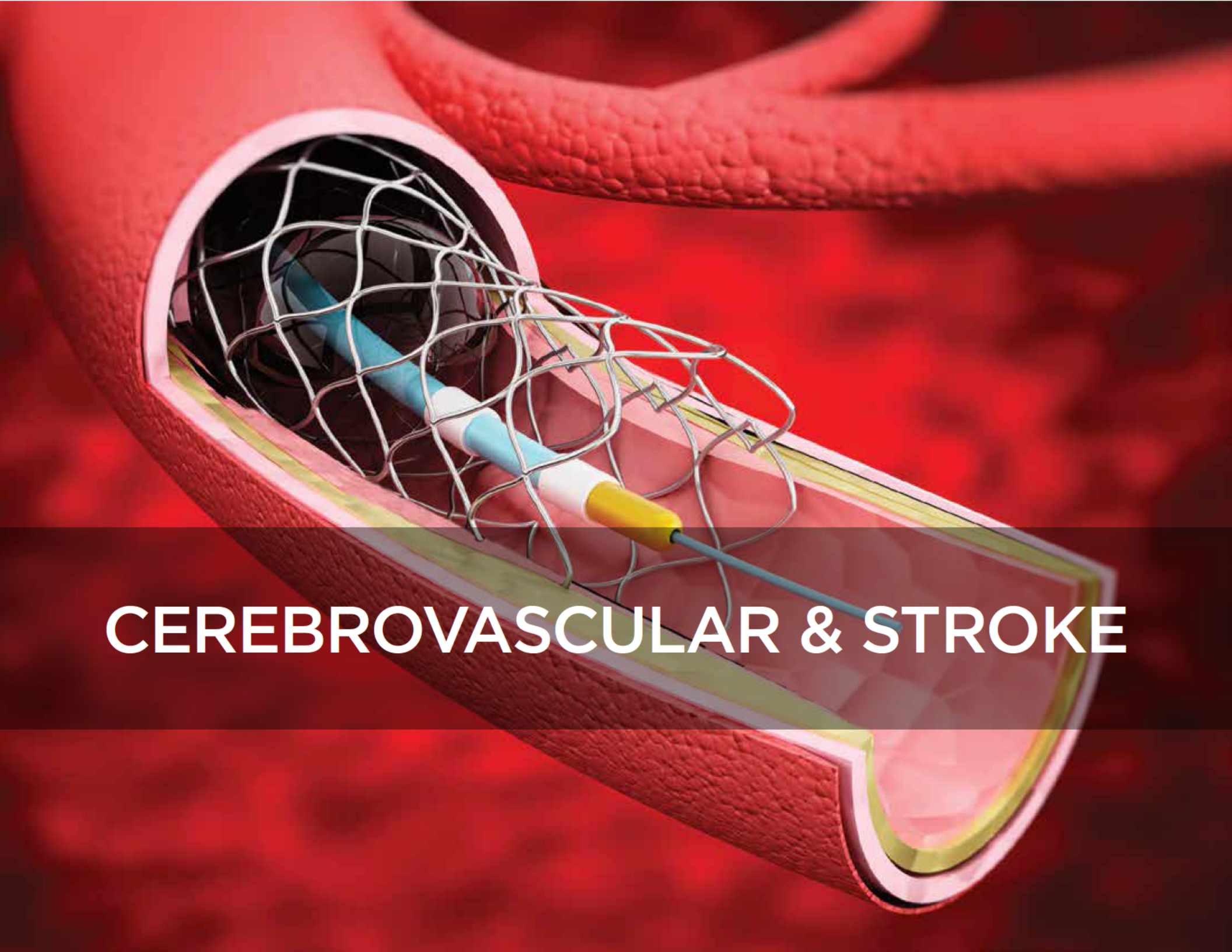
**3,022**

Outpatient  
Visits

The American Diabetes Association recommends people with type 2 diabetes be screened every year for autonomic neuropathy starting when they receive their diagnosis, and people with type 1 diabetes should begin annual screenings five years after diagnosis.

#### AUTONOMIC FUNCTION TESTING

There are number of tests that can help to diagnose and quantify the severity of autonomic dysfunctions. Some tests use deep breathing techniques to quantify heart rate and blood pressure responses to evaluate the function of autonomic nerves. A tilt table test can quantify blood pressure and heart rate responses to the stimulus of moving a person from a supine to an upright position. An advanced form of diagnosis for dysautonomia is testing of sweat function. This can be done by the quantitative sudomotor axon reflex test (QSART) that quantifies the sweat that occurs by activation of small nerves controlling sweat glands in the skin on select confined areas on the limbs. This test evaluates the peripheral component of the ANS controlling sweat function. The thermoregulatory sweat test, where patients are covered in a reactive powder that turns color when the body sweats, assesses both the central and peripheral ANS. This test shows the pattern of sweat a patient experiences, helping physicians diagnosis a number of different autonomic disorders. These two tests of sweat function in combination can help doctors localize and more precisely diagnose the type of autonomic dysfunction. The Dysautonomia Center Autonomic Laboratory is specifically designed to evaluate, quantify the severity of, and help lead to the treatment of ANS disorders.

A detailed medical illustration showing a cross-section of a blood vessel. A stent retriever, consisting of a blue and white catheter with a yellow handle and a silver wire mesh, is shown inserted into the vessel. The mesh is expanded, trapping a dark, irregular mass representing a blood clot. The vessel wall is shown in a reddish-pink color, and the background is a blurred red, suggesting blood flow. The text "CEREBROVASCULAR & STROKE" is overlaid in white, bold, sans-serif font on a semi-transparent dark red banner.

# CEREBROVASCULAR & STROKE



The American Stroke Association reports that as of 2015, stroke is the 5th leading cause of death in the United States, killing almost 129,000 people every year. Fortunately, though, due to advanced treatment options and the early recognition of stroke symptoms, the past 10 years have seen a decline in the death rate from stroke by about 34%. Still, almost 800,000 people have a stroke every year, which averages to about one stroke every 40 seconds.

The decreased rate of stroke mortality over the past decade is a major improvement in population health seen in both sexes across all age groups and races, and is largely contributed to significant improvements with cardiovascular risk factors and their control. Better management of diabetes and high cholesterol, along with smoking cessation and advanced hypertension treatments, also appear to have led to the decline in the number of stroke deaths.

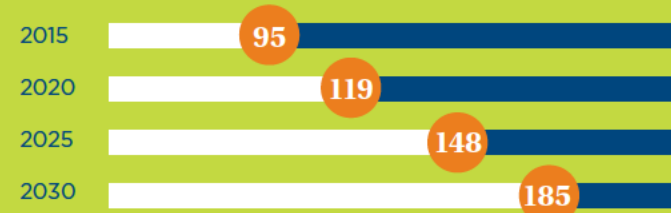
Despite the decline in deaths, the incidence of stroke is still on the rise and continues to be the leading cause of long-term disability in the United States. Furthermore, the prevalence of stroke in younger adults and even children has increased, leading to focused efforts on not only the management of stroke risk factors, but also the education of the population to identify stroke symptoms and seek treatment sooner.

In order to become and maintain our status as a leader in cutting-edge stroke treatments and protocols, Aurora Health Care has established evidence-based care guidelines at all sites for all types of stroke patients to ensure that best clinical practice is followed to maximize recovery, manage complications, and prevent long-term deficits for our patients. In addition to that, highly functional and specialty-trained teams have been constructed to guide the stroke patient through every step of the diagnosis and treatment process including neuroscience nurse practitioners, physician assistants, nurse navigators and trained stroke responders.

# at a GLANCE



## Cost of Stroke in the U.S. – \$ Billions



## Prevalence of Stroke

|       | Age   | Percentage |
|-------|-------|------------|
| Men   |       | 0.20%      |
| Women | 20-39 | 0.70%      |
| Men   |       | 1.90%      |
| Women | 40-59 | 2.20%      |
| Men   |       | 6.10%      |
| Women | 60-79 | 5.20%      |
| Men   |       | 15.80%     |
| Women | 80+   | 14.00%     |

Stroke kills someone in the U.S.

**every 4 minutes**

Stroke is the **leading cause of long-term disability**

Coupled with an extensive team of stroke, cerebrovascular, endovascular, and critical care neurologists, stroke patients at Aurora are cared for by the highest level of medical professionals available.

## STROKE CERTIFICATION

### Meeting higher standards to support better outcomes for stroke care

#### Primary Stroke Certification

Primary Stroke Certification recognizes hospitals for going above and beyond the standard of care to ensure ischemic stroke patients receive the highest level of treatment options and quality measures. In accordance with standards set by the American Stroke Association and other governing bodies, in order to achieve this certification, hospitals must meet eligibility standards that include the following:

- A dedicated stroke-focused program
- Staffing by qualified medical professionals trained in stroke care
- Individualized care to meet stroke patients' needs
- Patient involvement in their hospital care

- Coordination of post-discharge patient self-care based on recommendations of the Brain Attack Coalition and guidelines published by the American Heart Association/American Stroke Association or equivalent guidelines
- Streamlined flow of patient information while protecting patient rights, security and privacy
- Collection of the hospital's stroke treatment performance data
- Hospital team performance data
- Use of data to assess and continually improve quality of care for stroke patients

#### Comprehensive Stroke Certification

In addition to this, some hospitals may also qualify for Comprehensive Stroke Certification, which meets all of the primary requirements, as well as sets the highest standards for the care of hemorrhagic patients and the most complex stroke patients eligible for surgical or endovascular intervention. Comprehensive eligibility standards include the following:

- Availability of advanced imaging techniques, including MRI/MRA, CTA, DSA and TCD
- Availability of personnel trained in vascular neurology, neurosurgery and endovascular procedures
- 24/7 availability of personnel, imaging, operating room and endovascular facilities
- ICU/neuroscience ICU facilities and capabilities





- Experience and expertise treating patients with large ischemic strokes, intracerebral hemorrhage and subarachnoid hemorrhage

According to the Joint Commission, the governing body currently certifying the Primary and Comprehensive Stroke Centers at Aurora Health Care, the benefits of certification reach far beyond the accolades of the accomplishment. Certification signifies that our organization has established a consistent approach to stroke care, reducing the risk of error, and has maintained a consistently high level of quality using effective data-driven performance improvement.

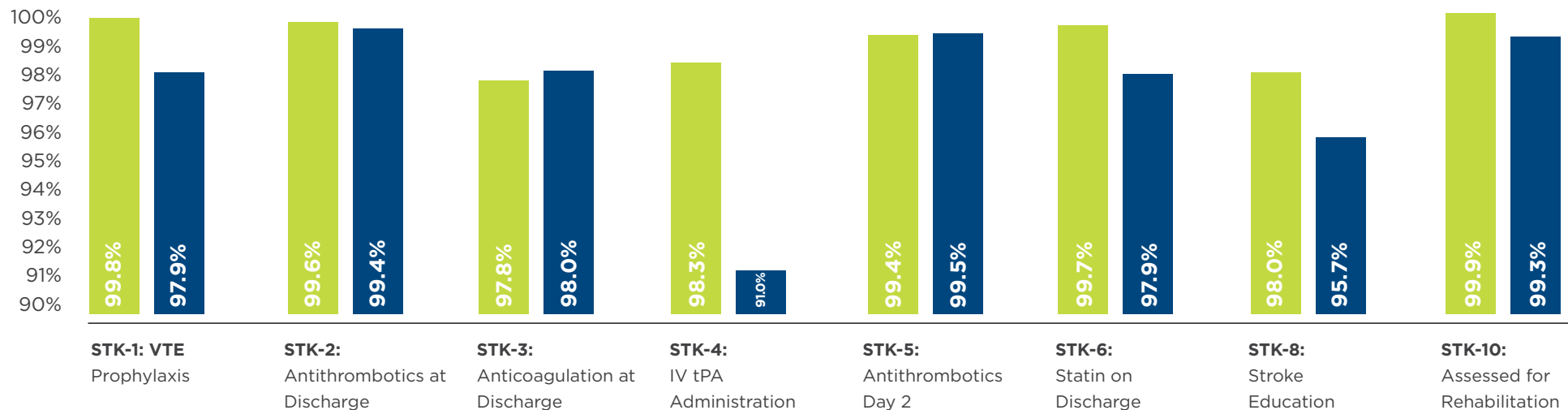
#### **Get With the Guidelines**

Aurora Health Care is proud to be a participating member in the American Heart Association's (AHA) Get With The Guidelines® (GWTG) program, an in-hospital database that promotes consistent adherence to the latest scientific treatment guidelines for stroke. Participation with GWTG allows our stroke care teams to have constant access to the most up-to-date research and scientific publication, gives us a competitive advantage in the healthcare marketplace, and provides performance feedback reporting for continuous quality improvement.

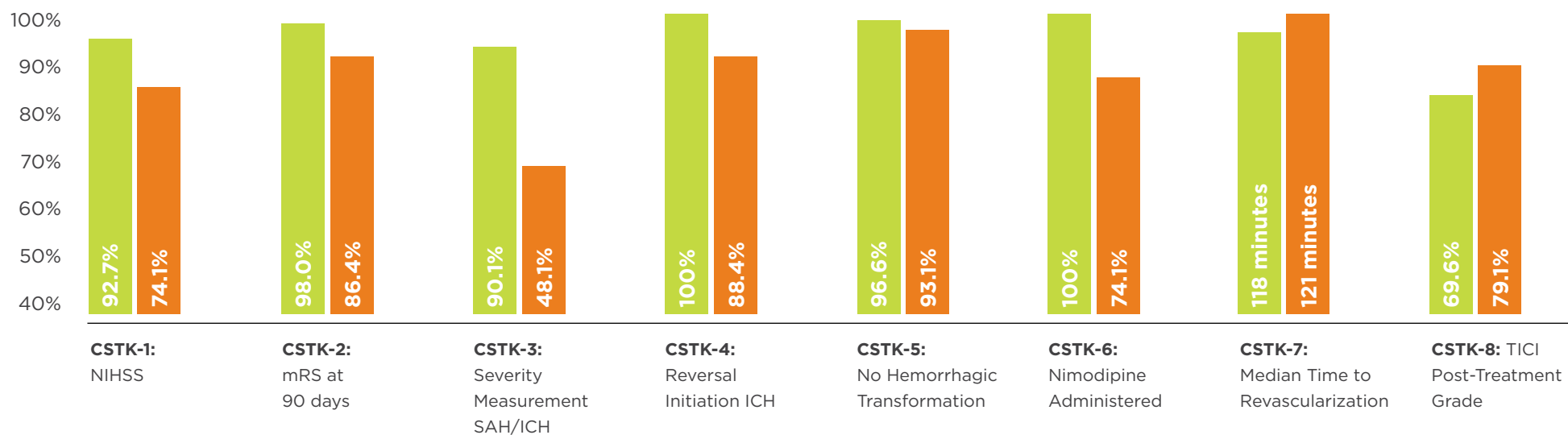
#### **Target Stroke Awards**

- **Target: Stroke Honor Roll:** Time to therapy within 60 minutes in 50% or more of acute ischemic stroke patients treated with IV tPA
- **Target: Stroke Honor Roll-Elite:** Time to therapy within 60 minutes in 75% or more of acute ischemic stroke patients treated with IV tPA
- **Target: Stroke Honor Roll-Elite Plus:** Time to therapy within 60 minutes in 75% or more of acute ischemic stroke patients treated with IV tPA & DTN, within 45 minutes in 50% of acute ischemic stroke patients treated with IV tPA

## PRIMARY CORE MEASURES COMPLIANCE: **AHC** vs. **WI Hospitals**



## COMPREHENSIVE CORE MEASURES COMPLIANCE: **AHC** vs. **All CSC**



Aurora St. Luke's  
Southshore is

**1 of only 3**

hospitals in the entire  
state of WI to win an  
Elite Plus stroke  
quality award.

### Primary Stroke Centers:

Aurora BayCare Medical Center

Aurora Medical Center Manitowoc County

Aurora Medical Center Oshkosh

Aurora Sheboygan Memorial Medical Center

Aurora Medical Center Summit

Aurora Medical Center Grafton

Aurora St. Luke's South Shore

Aurora Sinai Medical Center

Aurora West Allis Medical Center

Aurora Memorial Hospital of Burlington

Aurora Medical Center Kenosha

Aurora Lakeland Medical Center

GOLD PLUS

GOLD PLUS

GOLD PLUS

GOLD PLUS,  
TARGET Stroke  
Honor Roll-Elite

GOLD PLUS

GOLD PLUS

SILVER PLUS,  
TARGET: Stroke  
Honor Roll-Elite Plus

GOLD PLUS

SILVER PLUS

GOLD PLUS

SILVER PLUS

GOLD PLUS

### Comprehensive Stroke Centers:

Aurora St. Luke's Medical Center

GOLD PLUS,  
TARGET Stroke  
Honor Roll-Elite

Of the 40 certified stroke centers in the  
state of Wisconsin, Aurora Health Care  
locations are 13 of them, representing  
**almost 33% of the entire state.**





## NEURO ENDOVASCULAR INTERVENTION

Neuroendovascular conditions are complex conditions of the central nervous system—the brain, spine and peripheral nerves. In the past, no treatment may have existed. Today, the neuroendovascular subspecialty makes it possible for highly trained physicians to diagnose and treat these conditions, including strokes, aneurysms and arteriovenous malformations, in addition to a variety of other diseases.

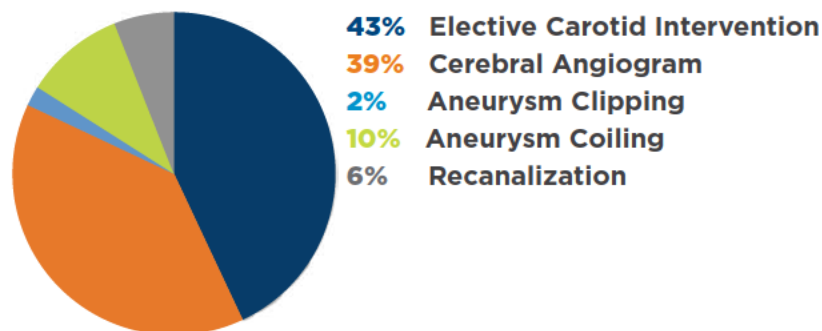
Our expert physicians at Aurora St. Luke's Medical Center and Aurora BayCare Medical Center perform the very latest procedures using first-in-class minimally invasive technology. Also known as endovascular surgical interventional neurology or neurointerventional surgery, neuroendovascular care allows physicians to use high-tech radiology to view, isolate and treat the source of a wide variety of central nervous symptom conditions.

Our innovative treatments are designed to save lives and minimize disability. High-tech, less-invasive procedures also have the benefit of shorter hospital stays and easier recovery periods.

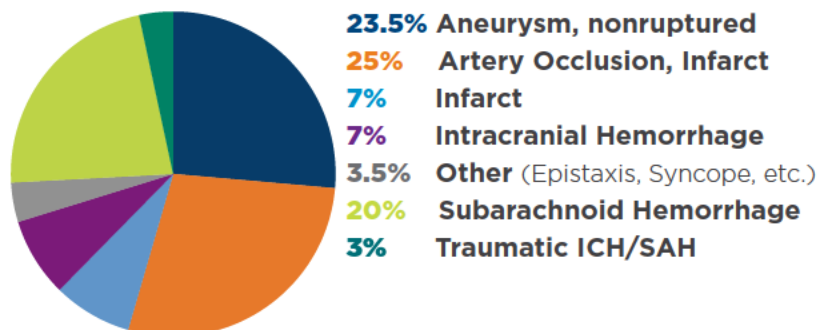
Time matters after a stroke. After a certain window of time has passed, patients who have had an ischemic stroke are no longer suitable to receive medication designed to break up the clot. With 24/7 access to neurointervention care, stroke patients at Aurora can be treated by a team that specializes in stroke care. For specific cases, a specially trained physician can use minimally invasive procedures to enter the affected brain vessels and break up or pull out the blood clot.

## Data

### Interventional Procedures



### Conditions Treated



# by the NUMBERS

Average length of stay of ischemic stroke was **3.35 days**, with risk-adjusted expectation at **3.72 days**

Mortality of hemorrhagic stroke was **2.78%**, with risk-adjusted expectation at **10.35%**

Overall readmission rate for stroke was **7.71%**, with risk-adjusted expectation at **8.5%**

Overall cost/case for stroke was **\$55,807**, with risk-adjusted expectation at **\$60,182**

## TERTIARY ACCESS PROGRAM (TAP)

### Connecting physicians to physicians to expedite patient transfer

Our goal is to find better treatment options that result in better patient outcomes. Aurora Health Care can facilitate admission of patients who need immediate attention for stroke or cerebral hemorrhage, including connection to our Neuro Intensive Care Units.

**3,488** transfers were made in 2015  
through the TAP system

**924** were neuroscience-related (**26.5%**)

The Tertiary Access Program connects experts by phone, internet, and mobile technologies. It allows physicians to work with real people (hospitalists, intensivists, or specialists), exchange information, access e-ICU care, and expedite patient transfers.

The Tertiary Access Program's dedicated critical care-trained nurses connect physicians directly to the appropriate person, creating a streamlined transfer process that results in superior quality and service for our patients. TAP connects transferring physicians to admitting physicians for direct communication, contacts appropriate hospital staff to conclude admitting processes, and follows up with the transferring physician on admission status and sends a discharge summary after a patient is discharged.

A portrait of Rachel Muench, a woman with blonde, wavy hair, smiling. She is wearing a dark blue zip-up top under a coral-colored cardigan. The background is a soft-focus indoor setting with light coming from a window.

# PATIENT STORY:

Rachel Muench

## WALKING ON HER OWN AFTER A SPINAL CORD STROKE

Rachel Muench has one message for you: “There’s hope.”

She injured herself one morning last fall, twisting at an odd angle to replace a hard-to-reach battery in a smoke detector. Moments later, she felt a stabbing pain in her back—so strong it brought her to her knees. She headed into work anyway and tried to push through the pain, but six hours later her legs had started to go numb.

By 4:30 that afternoon, she was losing the ability to walk and the doctor at her local walk-in clinic told her to go straight to Aurora BayCare’s ER in Green Bay. By the time she arrived, her right leg was completely paralyzed and she was losing all strength in her left leg and her core. That evening, Rachel was in intensive care.

The prognosis: A rare neurological condition called Brown-Sequard Syndrome caused by a spinal cord stroke. Over the next few days, additional tests revealed that Rachel had bulging disc in her spine, and fragments were blocking a blood vessel that fed her spinal cord.

Dr. James Napier, the neurologist treating Rachel, says he typically sees only two cases of Brown-Sequard a year, most often in older men. Rachel, though, was an active 30-year-old.

She remembers those first few days, trying to absorb what was happening. “The condition is so rare, no one could tell me not to worry. No one knew,” she says. “But I understood I might never walk again.”



### Small Goals, Big Progress

Not surprisingly, Rachel and her family started to do their research. “The best information we could find, which Dr. Napier supported, was that somewhere between 11 percent to 50 percent of patients regain the functional ability to walk,” Rachel says. “And that just means you’re using a walker or double canes.”

But Rachel was young and healthy and, perhaps most importantly, a competitive person. After transferring to Aurora BayCare’s inpatient rehab, she was determined to get back as much function as she could, constantly challenging herself to meet new goals.

“My right leg was paralyzed for 10 days before it started to move,” she says. “But once that started, every day something big happened. Dr. Danzhu Guo, physical medicine and rehabilitation physician, would come in and say, ‘Show me what’s new today. Show me your tricks.’”

Twenty-five days after her arrival in the hospital, Rachel was discharged from rehab—a full 10 days ahead of schedule.

“I’m pretty sure they thought they’d be fitting me for a wheelchair before I left, but I walked out on my own, using a walker,” Rachel reports.

### Reconciling to a New Normal

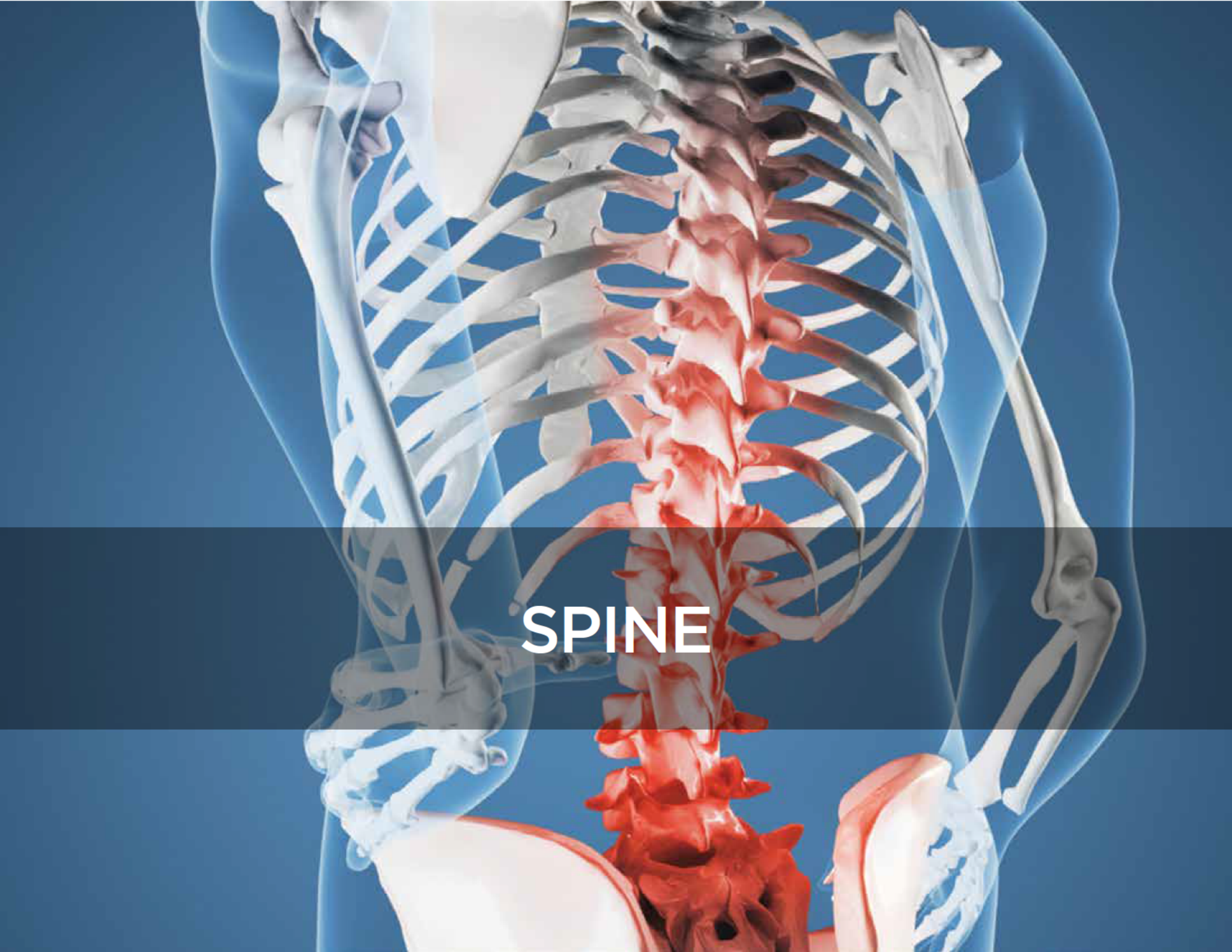
She’s still not back to full mobility and probably never will be. Because of nerve damage, she has near constant pain in her legs combined with a loss of sensation in her left leg and her feet. And if she tries to move quickly, her muscles go rigid.

But she can walk unassisted, without a cane. A waitress before her accident, Rachel is trying to get back to work—building up her strength with one limited lunch shift a week. She and her husband still went on their planned trip to Vegas (six weeks after injury), and she just took on care of a new puppy whom she’s training to be a pet therapy dog.

“I’m not who I used to be. I’m learning to operate with my new normal,” she says. “But compared to what I thought it was going to be ... it’s perfect.”

And that’s what she wants other people with Brown-Sequard Syndrome or a spinal cord stroke to know.

“I want them to look at me and push themselves. I want them to keep going,” she says. “I want them to stay positive.”

An anatomical illustration of the human torso, showing the ribcage and spine. The spine is highlighted in a reddish-pink color, while the ribs and other bones are in a light grey/white color. The background is a solid blue color. A semi-transparent dark blue horizontal band runs across the middle of the image, containing the word "SPINE" in white capital letters.

SPINE

# at a GLANCE

## COMPLETE MANAGEMENT FOR SPINE CONDITIONS

Four out of every five Americans struggle with neck or back pain due to an accident, injury or just everyday wear and tear. This is pain that often makes it hard to enjoy work and hobbies.

Aurora spine care is a comprehensive approach for a full range of spinal conditions, including injuries, degenerative conditions, spinal fractures and tumors.

We offer the most advanced spine care available for back pain and neck problems, and are recognized as innovators in the region. We were the first to use minimally invasive spinal fusion and artificial disc replacement to treat degenerative disc disease. In addition, we offer complete management for spine conditions—everything from common low back pain and disc problems to spinal injuries and tumors. Our treatments include minimally invasive surgery, spinal reconstruction and fusion procedures.

Aurora's comprehensive back and spine programs make it easier for you to get back to the things that matter most. With a care coordinator to guide your care, you'll be connected to an integrated team of specialists all working together on your personalized treatment plan.

Aurora saw almost **14,000** emergency room and urgent care visits related to neck and back pain in 2015.

Did you know that **80% of people experience back pain** at some point in their lives?

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In its first year, the Aurora Back and Spine program saw about **800 new patients**; that number more than **doubled last year to 1,635**.

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If you're suffering from a spinal disease or have developed back pain as a result of a tumor or an injury, our talented team of specialists can help you **regain mobility and return to your daily activities**.

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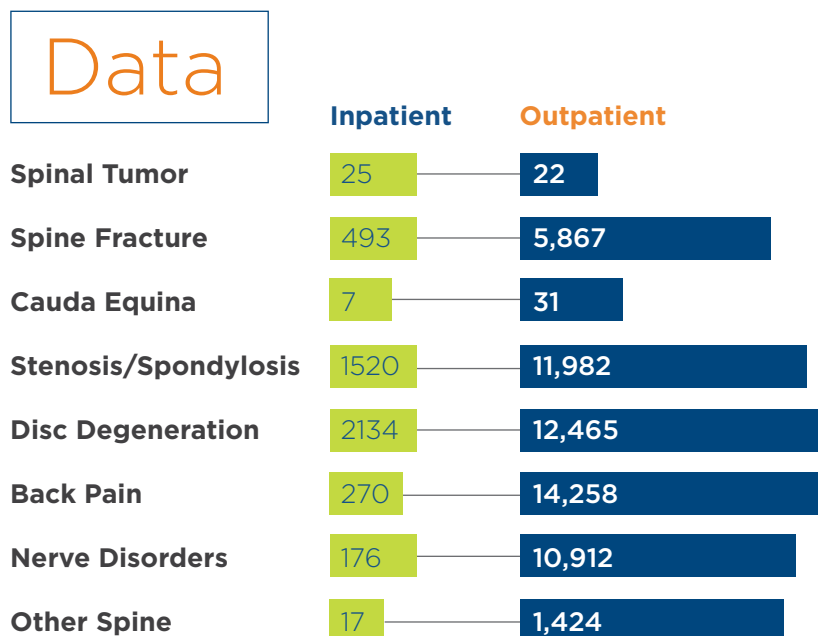
Risk-adjusted mortality for spine patients in 2015 was 0.28%, **but Aurora's mortality rate was 0.00%**.



## AURORA BACK AND SPINE PROGRAM

**In most cases, back pain can be managed conservatively and without surgery. The Aurora Back and Spine program provides treatments that will help provide a solution to back pain and get patients back to an active life.**

With one call you'll be connected to our team of experts led by a spine nurse navigator that guides patients through every step of the diagnosis and treatment process.



Aurora Back and Spine is part of an integrated health system that treats not just the spine, but the patient as a whole person. Combining medical history, lifestyle, and patient desire, we seek treatment options that work best for each individual patient.

### Treatment options might include the following:

- Physical therapy
- Behavioral health
- Orthopedics
- Neurosurgery
- Pain management
- Integrative therapy
- Chiropractic

## SPINE CERTIFICATION

### Meeting higher standards to support better outcomes for spine care

Joint Commission Spine Center Certification confirms that a spinal surgery program is in compliance with consensus-based national standards; has an effective and consistent use of appropriate, evidence-based clinical practice guidelines for the discectomy, laminectomy, and spinal fusion patient populations; and performs collection and analysis of spinal-specific performance measures. Aurora Sheboygan Memorial Medical Center has earned this distinction for their outstanding care of spine patients.

Aurora performed more optical robotic spine surgeries in 2015 **than anyone else in the world.**



BCBS BLUE DISTINCTION®



### Evaluating what matters

Blue Distinction Center designations are awarded to health care facilities based on a thorough, objective evaluation of their performance in the areas that matter the most—quality care, treatment expertise and overall patient results, just to name a few. The criteria are established with the help of expert physicians and medical organizations. Blue Distinction Centers have a proven history of delivering better quality and results than health care facilities without these recognitions.

Blue Distinction Centers for Spine Surgery provide comprehensive inpatient spine surgery services, including discectomy, fusion and decompression procedures. Research confirms that designated health care facilities in this area have lower readmission rates and fewer reoperations than nondesignated facilities.

#### BCBS Blue Distinction Centers:





**NEURO REHAB**



# A Team Approach

**Aurora Health Care's neuroscience rehabilitation team provides some of the most advanced rehab care possible through a team approach to medical services and physical, occupational, speech, recreational and psychological therapies.**

## THE AURORA DIFFERENCE

- Private rooms, a rehab gym, an apartment that simulates the home environment, access to a healing garden and much more
- Advanced rehab technology, such as Bioness NESS and LiteGait mobility devices, Nintendo Wii systems, Kay Digital Swallowing Workstation and Video Stroboscopy System, VitalStim, and interactive metronome, acupuncture, Dynavox
- State-of-the-art facilities accredited by The Joint Commission.
- Functional EASY STREET Environment®
- Accredited by the Commission on Accreditation of Rehabilitation Facilities (CARF), including a specialty accreditation in stroke rehabilitation. CARF accreditation is the “gold standard” for rehab programs
- One of 18 hospital systems in the U.S. with four-time Magnet designation, demonstrating the highest level of excellence in nursing care, quality and patient satisfaction

## Restoring independence

The goal of neuro rehab is to help restore activities of daily living—mobility, strength, balance, swallowing, speech, memory, thinking, coping, etc.—so that patients can remain active and independent.

The Aurora inpatient rehab team measures improvement using a tool called the Functional Independence Measure. This tells how much help is needed with things such as eating, grooming, bathing, dressing, using a toilet, walking, using a wheelchair, getting in and out of chairs, using stairs, talking and thinking skills. On admission, patients usually need a lot of help to complete a task. At the time of discharge, nearly 100 percent of our patients show improvement on the Functional Independence Measure.



# Inpatient Rehabilitation by the NUMBERS

## A team approach

We bring together a dedicated team with broad clinical expertise to provide you with personalized care. Your team members may include the following specialists:

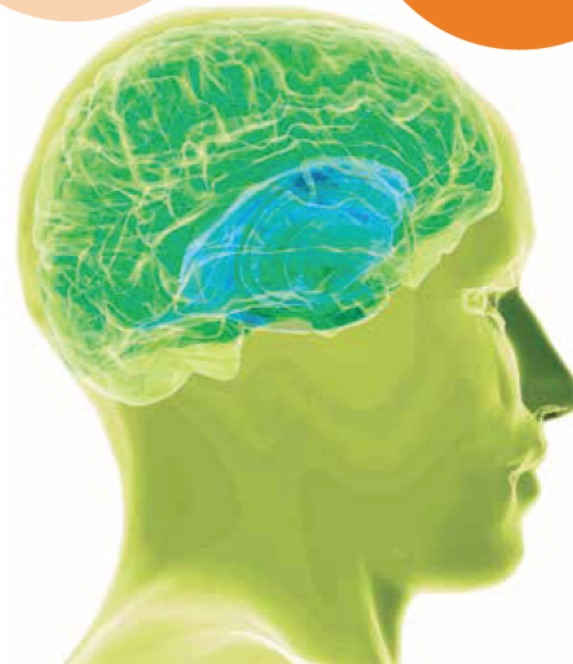
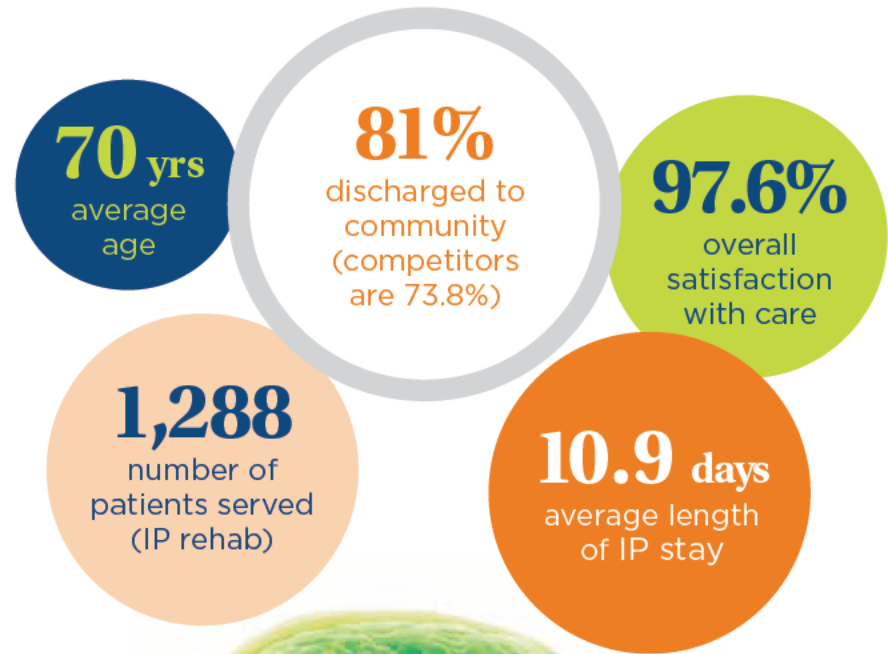
- Rehab physician
- Physical therapist
- Speech pathologist
- Social worker
- Care coordinator
- Rehab nurse
- Occupational therapist
- Recreational therapist
- Rehab psychologist
- Any other specialist needed to provide medical care

Many team members have additional specialized education to treat neurological and other disorders that require an inpatient or outpatient rehab program. Our nurses have advanced education in rehab nursing techniques.

## Scope of services

Aurora Health Care's Neuro Rehabilitation Program provides care to people with the following diagnoses/conditions:

- Brain injury
- Multiple sclerosis
- Orthopedic and spinal conditions
- Stroke
- Neuro-oncology
- Neurological conditions
- Parkinson's disease
- Spinal cord injury
- Other functional and/or cognitive decline



## INPATIENT NEURO REHAB

### An interdisciplinary team approach to treatment

The professionals of Aurora Health Care's inpatient rehabilitation programs work with patients and use the latest therapies, techniques and technologies, in friendly and positive settings. Our purpose is to help our patients recover to their fullest functional potential.

*Consider an inpatient rehabilitation program referral if all of the following are present:*

#### Functional needs

- Patient is making progress in mobility and self care, but is not at baseline
- Patient will need at least two therapies (occupational therapy, physical therapy and/or speech pathology)
- Patient would benefit from, and will be able to tolerate, three hours of intensive therapy at least five days per week

#### Medical needs

- Patient has issues that require an inpatient stay and close physician involvement

**89**  
IP rehab  
beds across  
system

**5**  
IP rehab programs  
in SE Wisconsin,  
one of them the  
largest in state

#### Social support

- Patient has the ability to return home from a rehab stay at his/her previous level of function
- Patient has social support such that family/friends can provide needed assistance in order for the patient to return to a community setting with help

One of the benefits of our inpatient rehabilitation programs is an interdisciplinary team approach to treatment. Our team works closely with referring physicians to keep them informed every step of the way. We offer patients a broad spectrum of clinical expertise.

## IP Neuro Rehab Patients

|                                           |     |
|-------------------------------------------|-----|
| Stroke                                    | 443 |
| Brain                                     | 242 |
| Neurologic (MS, PD, GB, neuropathy, etc.) | 143 |
| Spinal Cord                               | 127 |



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## OUTPATIENT NEURO REHAB

### **Provides exceptional therapy services for people who live at home and have experienced physical limitations caused by stroke, neurological disorders, or other reasons**

The outpatient neuro rehab program is backed by an experienced team of professionals from the following areas:

- Occupational Therapy
- Physical Therapy
- Speech Pathology
- Nursing and Social Work
- Physiatry
- Psychology
- Therapeutic Recreation
- Integrative Medicine

While in our care, the team meets on a regular basis to discuss the patient's progress and treatment plans. We communicate with the patient and their family and/or home caregivers along the way.

The outpatient neuro rehab program is different from traditional outpatient therapy because it is designed to provide treatment by several experts located all in one area. Sessions are scheduled to meet the individual needs of each patient. Sessions may be more frequent at first and then lessen. This spreads the sessions over a longer period of time for greater benefit. When appropriate, a patient may benefit from rest breaks, time for meals, or time to

practice a home program with supervision in the clinic, but outside the one-on-one therapy session. We are also able to provide aquatic therapy using an off-site swimming pool. A recreation specialist is available to help patients recover skills for the things they enjoy doing during their free time.

#### **Individualized treatment**

Our team of rehab specialists assesses a patient's needs to create a treatment plan that's right for them. Individualized patient goals are established using a team approach to do the following:

- Assist the patient and family with adjusting to a new lifestyle
- Challenge people to reach their best physical, emotional, speech, social and community potential
- Educate each person and their family about therapy and what each member of the team does
- Maintain or improve each patient's level of independence after treatment through community resources

### **Comprehensive care provided**

The comprehensive treatment program consists of sessions that emphasize the following:

- Balance
- Safety
- Fine motor skills
- Home program instruction
- Communication and cognition (such as speaking, problem solving and memory)
- Functional mobility and transfer training, including gait training (walking and getting around at home and in the community)
- Self-care abilities & home management

Other areas of treatment may include the following:

- Aquatics
- Community reintegration and leisure skills
- Driving skills through our driver assessment program
- Low vision/visual-perceptual skills
- Swallow therapy (including electrical stimulation)
- Vestibular rehabilitation
- Gender-specific therapy for bladder/bowel incontinence

In addition to our comprehensive outpatient neuro programs Aurora Health Care offers neuro rehab across eastern Wisconsin. This includes a connected network of over 30 clinics with therapy experts dedicated to neuro rehab.

### **COGNITIVE REHABILITATION AND ACTIVITIES PROGRAM**

#### **A therapy-based, multidisciplinary assessment and treatment program designed for patients in the early stages of dementia or cognitive decline**

The Cognitive Activities Program, provided by occupational and speech therapies in an outpatient setting, is focused on adapting strategies, compensatory methods and restorative therapies the individual and/or family members can use in the client's home environment.

Patients are assessed for motor functioning, visual perception and acuity, performance of IADL (activities of daily living), memory, medication management, financial management, language and social interaction.

Cognitive skills, such as attention, memory, executive functioning, problem solving, organization and sequencing are also explored as part of the evaluation and treatment process.

The goal of the Cognitive Activities Program is to facilitate and maintain the highest possible level of independence for individuals and continued success in their home environments, as well as to provide the client, their family and caregivers the tools needed to achieve the following:

- Education about cognitive weaknesses and strengths to build awareness
- Development of skills through enhancing attention
- Use of internal and external compensatory strategies
- Application to everyday life via functional activities training

Speech therapy will focus on memory, language, social interaction, reasoning and problem solving. Occupational therapy will focus on visual perception, acuity, activities of daily living, medication management, financial management, home safety and cognitive skills related to driving.

### LSVT BIG AND LOUD®

LSVT Big and Loud Clinic is specialized treatment from certified therapists for Parkinson's disease. This treatment has been linked to better outcomes compared to traditional therapy.

Through the LSVT Big and Loud® Clinic, patients are taught the following:

- How to move “BIG” and speak “LOUD” on a consistent basis
- How to recalibrate their senses for automatic use of normal movement and voice
- How to use high effort and intensive treatment to improve everyday function





## LOW VISION PROGRAM

The Low Vision Rehabilitation Program provides comprehensive treatments from therapists specializing in treatment to assist persons with low vision due to eye diseases (diabetic retinopathy, macular degeneration, cataracts, glaucoma) or acquired/traumatic brain injury (diplopia, visual field cut, visual inattention). Our goal is to help patients use their remaining usable vision and learn strategies to compensate for visual loss during daily activities.

## VESTIBULAR AND BALANCE REHAB

Aurora Rehabilitation Center's Balance and Vestibular Program is recognized as a regional leader in the rehabilitation of balance and vestibular disorders. Our physical therapists have extensive training and experience in this specialty. The interdisciplinary team approach to rehabilitation involves close communication between the physical therapist and the patient's PCP, an otolaryngologist, and other specialists as needed.

The SMART Balance Master® system is part of Aurora Rehabilitation Center's comprehensive balance program, treating patients with impaired balance related to conditions including vertigo/dizziness, post-concussion syndrome, peripheral neuropathy due to cancer and diabetes, and neurological and orthopedic conditions.

The SMART Balance Master utilizes a dynamic force plate with rotation capabilities to measure center of gravity position and postural control. Additionally, it uses a dynamic visual surround to measure the patient's use of visual information to maintain balance. It provides assessment and retraining capabilities with visual biofeedback on either a stable or unstable support surface and in a stable or dynamic visual environment.





### **Parkinson's Disease Skills Class**

Available for anyone who has attended the LSVT Big and Loud® Clinic and is looking to review exercise skills.

### **Stepping On**

A Wisconsin Institute for Healthy Aging research-based workshop that helps older adults prevent falls by teaching them healthy behaviors to improve their ability to manage their own health and improve their quality of life. The goal of the program is to teach older adults safety strategies they can use in everyday life. The content covers falls and risk, strength and balance, safe footwear and walking, vision and falls, home and community safety, medication review and management.

## **CLASSES AND SUPPORT GROUPS**

### **Brain Workout Class**

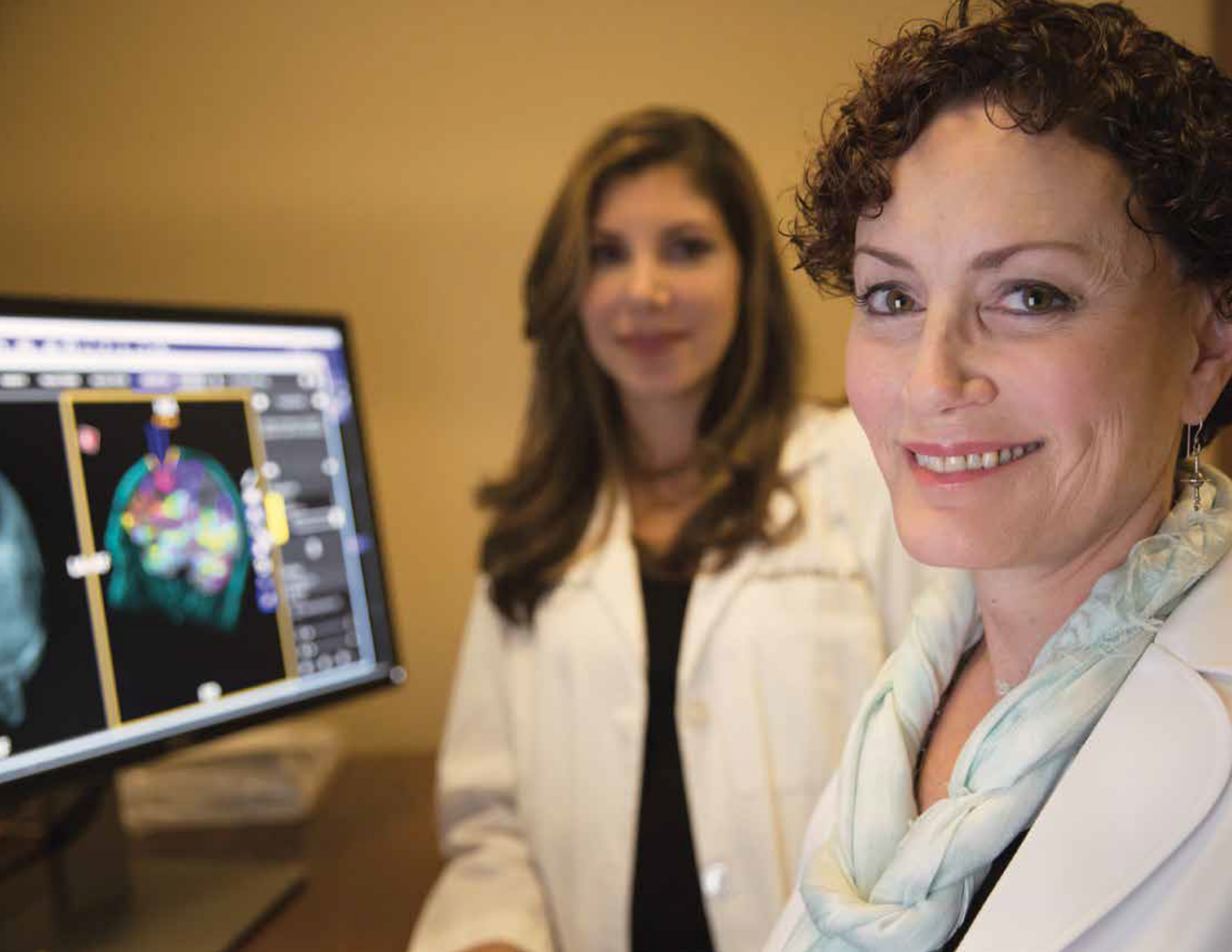
Classes are designed to challenge different areas of the brain to help maintain and improve memory, attention and problem solving.

### **Driver Readiness Program**

The normal aging process, a medical condition or a disability can limit a person's ability to drive. We provide a state-of-the-art evaluation given by specially trained occupational therapists addressing reaction time, strength, vision, thinking, memory and attention to help patients regain and maintain their independence.

### **Stroke Support**

Many different stroke support groups are conducted to bring together stroke survivors and their families along with medical professionals to offer emotional and social support, as well as to view presentations about topics related to stroke/brain attack and its recovery. Groups are geared toward elderly survivors, specific family support, and stroke at midlife, a unique group targeted toward survivors ranging from young adult through midlife age.







*Aurora Health Care Foundation®*

**Together, we have the power to transform care and create a stronger community.**

Gifts to the Aurora Health Care Foundation impact countless lives and help more people in our community live well. These donations enhance programs and services that directly affect people and communities served by Aurora Health Care.

**With gifts to Aurora Health Care Foundation, people are helping our exceptional physicians and caregivers to do the following:**

**LEAD** Quality health care is people-powered. Thanks to you, our caregivers are able to continually advance their skills, knowledge and expertise.

**INNOVATE** Your gift helps expand investments in new technologies, create better ways to deliver care and make discoveries that bring the latest in medicine to the forefront of our practices.

**THRIVE** You help provide the latest resources that empower the people we serve, so that every person has the opportunity to live well—before and after receiving care.

**ENGAGE** Together, we create a stronger community where access to quality health care is attainable, especially for those who need it most.

# Transforming care and creating a stronger community

Aurora Health Care is committed to making sure that all patients, regardless of income, have access to the best care possible. That includes health care for the un- and underinsured, services for survivors of sexual and domestic violence, substance abuse treatment, and other supportive services for some of the most vulnerable people in our community. Donors to Aurora have the ability to have a major impact on these same issues through the programs Aurora provides, spanning the organization's service area and serving tens of thousands of people each year.

Donor support also helps Aurora access the latest technologies and research to improve patient outcomes and enhance the quality of care we provide. Your gifts help to advance clinical trials, foster investigator-initiated research, and promote medical education and awareness through publications that reach more than 100 countries all over the world.

At Aurora Health Care Foundation, we believe that together, we have the power to transform care and create a stronger community.

## VINCE LOMBARDI CANCER FOUNDATION

### VLCF Gift Spurs Neuro-Oncology Research

Last year, in honor of its 45th Anniversary, the Vince Lombardi Cancer Foundation presented Aurora Health Care with the largest annual gift in its history, totaling over \$2 million. \$1 million of that gift was set aside for the Neuro Anatomy Lab to research and develop new therapies for brain cancer patients.

Dr. Richard Rovin, the director of clinical research at the Aurora Neuroscience Innovation Institute, also received an Aurora Research Institute Cancer Research Award. Dr. Rovin is studying the best way to isolate cancer stem cells from metastatic brain tumors to better understand why tumors spread to the brain, aiding in cancer prevention and the development of new treatment options.

Over the past year, Aurora Neurosciences has put that \$1 million gift to good use, hiring a senior research scientist, a technologist and a post-doctoral fellow. The Aurora Research Institute also opened a new laboratory facility and vivarium (animal facility) at Aurora Sinai Medical Center.

"This gift is ... a reflection of the investment the Foundation is making in the **major advancements happening in cancer care and research** at Aurora Health Care across the state." — Erin Hareng, Executive Director, Vince Lombardi Cancer Foundation

Research is currently focused on characterizing tumor stem cells. Since tumor stem cells are the cause of recurrence and therapy resistance in patients, this research is essential for studying new cancer therapies. Characterization of the cells includes multimodality imaging technique, such as Magnetic Resonance Imaging (MRI), Raman Spectroscopy (RS) and Optical Coherence Tomography (OCT). These imaging modalities help identify differences between healthy and unhealthy tissue at molecular and structural levels.

Thank you Vince Lombardi Cancer Foundation for your commitment to raising funds for leading-edge cancer research and compassionate care at Aurora Cancer Care. We are proud to be on your team!







# AURORA RESEARCH INSTITUTE



# Helping people live well through innovative research

Research specialists at Aurora Research Institute are committed to conducting cutting-edge bench and clinical research, integrating this knowledge at the patient's bedside and communicating valuable patient-centered results to the community. Beneficial patient-centered outcomes are the focus of medical research at Aurora Health Care.

There are two primary areas of patient-centered research throughout Aurora: investigator-initiated research and clinical trials. Investigator-initiated research includes projects and programs that Aurora physicians and scientists develop within their special interest areas. Clinical trials are industry- and government-sponsored projects that provide opportunities to present new treatments to the community.

To foster investigator-initiated research, the institute offers multiple services, including protocol design and review, regulatory submissions, research contracting and agreements, study coordination, data collection and statistical analysis. The Sponsored Programs Office offers pre-award project planning and development and post-award management.

Aurora researchers conduct patient-centered research studies in the areas of cardiovascular disease, oncology, neurosciences, and women's health care, among others. In 2015, Aurora Research Institute was actively involved in 296 clinical trials with 81 full-time dedicated employees. The health care system incorporates cutting-edge research and evidence-based best practice into high-quality patient care. With hundreds of active clinical trials and investigator-initiated study

protocols at any given time, Aurora patients can choose to participate in a variety of studies, including those focused on treatments, prevention, diagnostics, screening and quality of life.

Both research areas are supported by specialized research centers, which allow physicians and scientists to focus on core areas and provide the best patient-centered outcomes. Medical residents and fellows also have the opportunity to learn from leading physicians and scientists. Aurora also offers researchers informatics support through novel data-mining techniques, which is viewed as an integral part of Aurora's ability to take advantage of its resources to enhance provider clinical quality, individualize treatments and improve financial performance. In addition, Aurora investigators have access to the organization's Institutional Review Board to ensure compliance with all applicable human subjects protection guidelines.

Neuroscience is not only a service line where incredible treatment happens, but also where continual research and education occur. The neurosciences team is committed to making the latest diagnostic and treatment options available, as well as sharing new discoveries every day. We educate surgeons from abroad, teaching them about the advanced technologies that have become an integral part of the treatment for neurological disorders. In its short existence, ANII has hosted over a hundred surgeons and allied health providers to facilitate learning in addition to starting a cranial fellowship program. We know our medical advancements today will help countless patients in the future, and in neuroscience institutes around the world.

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## REGENERATIVE MEDICINE CENTER

Regenerative medicine represents a form of medicine that accelerates the body's own healing process to generate new tissue and fully restore the health of damaged tissues and organs. Stem cells, genes and engineered cells/tissue are some of the tools used, sometimes in combination with drugs or devices, to improve function and quality of life with a minimally invasive approach. The Regenerative Medicine Center is building on more than 20 years of experience in cellular therapy for patients with cancer to research and develop innovative, regenerative therapies to improve outcomes in patients with cardiovascular and neurological disease.

Through the Regenerative Medicine Center, a pipeline has recently been initiated where patients who are undergoing surgery to remove brain cancer can consent to donate their tissue samples to establish a bank for tumor cells and tumor stem cells in our Biorepository and Specimen Resource Center. The establishment of the bank is an instrumental resource of high-quality cells and linked medical data for local research and academic communities within and beyond Aurora Health Care, industry partners, and pharmaceutical companies. Ultimately, the generation of a brain tumor stem cell bank has established an infrastructure that is needed to further understand these cells, which is critical to developing personalized treatment for patients with glioblastoma and other tumors.

A related project is the research and development of new therapeutic, targeted viral vectors for patients with brain cancer. These viral vectors are specifically targeted to the brain tumor stem cells. Preliminary data has shown that cell-based treatment can produce an 80% control rate for growth of primary brain cancer in mouse models. It is expected that this cell-based treatment will have similar therapeutic benefit in patients with brain cancer.

Ongoing support for the Regenerative Medicine Center includes an initial core group of scientists and supplies for pilot experiments as well as developments to provide multiple technical modalities and expertise to move this potential new therapy from the laboratory into the clinic:

- Imaging equipment to study the characteristics of tumor surfaces and differences between normal, healthy tissue and tumor tissue
- Imaging equipment to study development of brain cancer in animal models and to determine the efficacy of the viral vector therapy
- Image analysis software to visualize the tumor and compare and contrast images
- Supplies to conduct the preclinical experiments in animal models and in the laboratory
- Experts in tissue imaging and analysis to conduct these experiments
- Experts in xenotransplantation (growth of human tumor tissue in animal models)

# by the NUMBERS

**29%**

of Aurora's  
neurosciences  
research is  
investigator-  
initiated

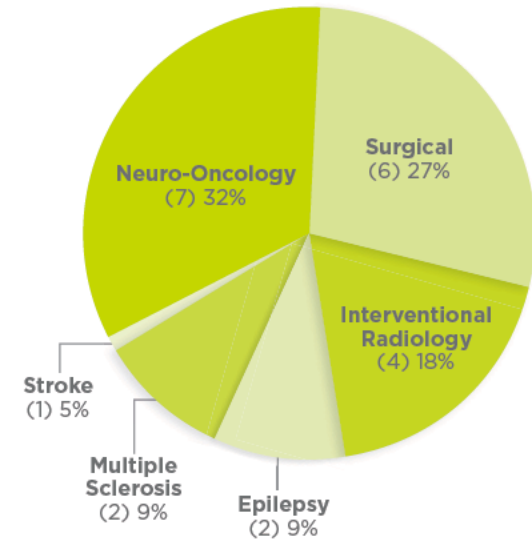
**6%**

of Aurora's  
research is  
neurosciences-  
related

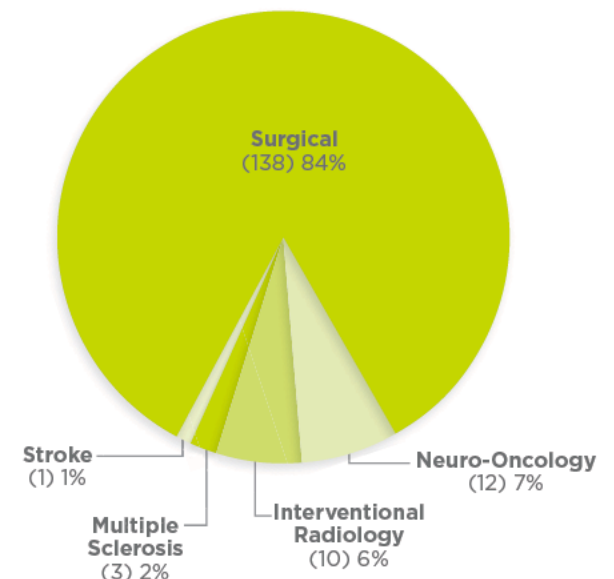
**\$1.7 million**

in external grant funding  
awarded for investigator-  
initiated neurosciences  
research studies

**22** neurosciences clinical trials open to  
accrual and follow-up as of Dec. 31, 2015



**164** total neurosciences clinical trial  
enrollments in 2015







### Setting the standard for innovation and patient-centered neurological care

Eighteen months after joining Aurora Health Care to lead the system's neurosciences service line, neurosurgeon Amin Kassam, MD, realized his vision of a state-of-the-art facility to treat and study complex brain procedures.

Opened in May 2015, his reality – **Aurora Neuroscience Innovation Institute**—includes a multidisciplinary clinic, education suite, neuroanatomical laboratory and four neurosurgical operating suites featuring first-in-the-world technology at Aurora St. Luke's Medical Center.

With more than \$1.4 million in equipment granted or donated by a variety of medical device companies, the neuroanatomical laboratory is equipped with surgical stations and imaging tools that replicate a neurosurgery suite to enable mock surgical procedures on cadaver specimens for training and research purposes. Dedicated anatomic teams have been created to focus on redefining and visualizing previously invisible anatomy using specifically-designed visualization technology.

New imaging technology allows scientists to visualize intricate anatomy in the brain that has never been seen before and will lead to the discovery of safe approaches to access deep-seated lesions in the brain without disrupting normal brain anatomy.

After refining them in the neuroanatomical lab, Aurora researchers and clinicians will translate advanced neurosurgical techniques to the operating room, making surgical procedures more accurate, less invasive and safer for patients.

### PUBLICATIONS/PRESENTATIONS

In 2015, the ANII team shared its research findings through manuscript publication in peer-reviewed journals and abstract presentation at national and international meetings.

Sharing their expert knowledge through textbook chapters, ANII team members literally wrote the book on endonasal endoscopic surgery of skull base tumors.







## CLINICAL TRIALS

Innovation through clinical trials at Aurora Health Care provides the latest techniques and technologies to our patients before they're available anywhere else. Clinical research is vital to advancements in the field of health care. Research is the cornerstone for investigating disease prevention, treatment using drugs or medical devices and other interventions. Aurora currently has more than **300** active clinical trials. Approximately 60 percent of these trials are focused on oncology, 25 percent on cardiovascular and the remaining 15 percent consist of neurology, gastroenterology, orthopedics and women's health.

Aurora patients can participate in several types of clinical trials including the following:

- Screening/prevention trials: Seeking methods of early detection or prevention of disease and looking for better ways to prevent reoccurrence.
- Diagnostic trials: Finding better tests or procedures for diagnosing a particular disease or condition.
- Treatment trials: Testing new therapies (drugs and/or devices), combinations of drugs and/or devices) or approaches to medical procedures.
- Quality of life trials: Exploring ways to improve comfort and the quality of life for individuals with a chronic illness.





### High standards for Aurora's clinical research trials

Aurora's research staff collaborates with many highly-respected universities in Wisconsin and throughout the nation. Researchers work closely with the National Institutes of Health, the U.S. Agency for Research and Health Care Quality, as well as the U.S. Department of Health and Human Services. Aurora also has participated in many multicenter clinical trial programs, working to answer questions posed by other doctors and scientists and contributing data to the approval of new drugs and devices.

Every clinical trial at Aurora is conducted according to the highest ethical and professional standards to ensure the protection of the individuals who volunteer to participate. Aurora is proud to be one of the first medical organizations to have a research subject protection program accredited by the Association for Accreditation of Human Research Protection Program.

### DISCOVERY LAB

In Aurora Research Institute's Discovery Laboratory, scientists work from the molecular to cellular levels to find innovative ways to improve care and patient outcomes for cancer, cardiovascular diseases, neurological disorders and other special focus areas.

The space-saving layout of the Discovery Laboratory features shared work stations and communal core equipment. This efficient design avoids duplication found in traditional pod-like laboratories and enhances communication among researchers. The tissue processing and microscopy area is equipped for preparation, staining and analysis of slides. Typically this service is outsourced, adding cost and time to research projects. An enclosed area at biosafety level 2 allows for genetic manipulation using viruses and other microorganisms to

develop new immunotherapies. A refrigerated room allows for cold-temperature experiments. A separate room houses deep-freeze cryogenic equipment for storage of tissues, cells and supplies at -20, -80 and -150 degrees. Rounding out the laboratory are traditional human and animal cell and tissue preparation and culture spaces.

### Discovery Laboratory features include:

- Imaging Laboratory with some equipment not found anywhere else in the world
- Experimental Optics Laboratory
- Microscopy/Histology Laboratory
- Cell Biology Laboratory
- Flow Cytometry Laboratory
- Virology Laboratory
- Protein and Molecular Laboratory

Aurora Research Institute's Discovery Laboratory has the tools and technologies to make an impact in special focus areas of neuroscience, which include the following:

- Viral vectors: Determining whether genetic material delivered into cancer stem cells reduces the rate of tumor growth.
- Malignant gliomas: Developing cellular therapies and ways to diagnose this common and aggressive brain tumor earlier.

# First in the world to use a robotic optical microscope

In a breakthrough with the potential to improve outcomes and reduce the risks of complex brain surgeries, the neurosurgical team at Aurora St. Luke's Medical Center, successfully completed a first-in-the-world procedure with newly Food and Drug Administration-cleared technology for planning and resection on April 20, 2015.

The operation utilized the entire suite of Synaptive Medical Neurosurgical Solutions: BrightMatter™ Guide, Plan, Vision and Servo. This system is comprised of four technologies: advanced optical visualization with efficient light delivery to the surgical field, automated positioning of the optical system at the command of the surgeon, visualization of interaction of surgical tools with medical images and three-dimensional tractography planning. As a result, the procedure was successfully performed with an awake anesthetic technique and minimal risk to the patient's brain function.

Aurora Neuroscience Institute neurosurgeon Dr. Michael J. O'Connell, MD, and Aurora Neuroscience Institute neuroradiologist Melanie Fukui, MD, worked closely with neurosurgeons Amin Kassam, MD, and Richard P. Johnson, MD, to plan and perform the procedure.



## MAKING LEMONADE: WOMAN ENROLLS IN TRIAL TO FIGHT CANCER

When faced with a lemon-sized tumor in the right side of her brain, Heidi Zellmer of Cedarburg began a journey that would lead the wife and mother of three boys to enroll in a clinical trial testing an investigational combination of chemotherapy for glioblastoma multiforme, a fast-growing brain cancer.

One fall day a few months before her 50th birthday, Zellmer completed a five-mile hike along the bluffs of Devil's Lake in south central Wisconsin. About a week later, she went to the emergency department at Aurora Medical Center in Grafton with stroke-like symptoms.

It wasn't a stroke though. A CAT scan revealed the tumor.

### One-two punch

After being transported via ambulance to Aurora St. Luke's Medical Center, Zellmer spent about a week in the neurointensive care unit undergoing tests before Amin Kassam, MD, performed the awake craniotomy to remove the tumor. George Bobustuc, MD, took over her cancer care, which included six weeks of chemotherapy and radiation at Aurora Grafton.

Near the end of her treatment cycle, Dr. Bobustuc informed Zellmer about a clinical trial testing whether temozolomide chemotherapy is more effective with veliparib at improving overall survival in subjects with a particular genetic indications (National Cancer Institute, [clinicaltrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT02152982) identifier: NCT02152982). Acting as a one-two punch, the chemotherapy damages the cancer cell and the veliparib, a PARP inhibitor, prevents the body from producing a protein that would repair the cell, thereby making it easier to kill.

As part of the research protocol, subjects are randomized to receive the chemotherapy and PARP inhibitor or the chemotherapy and placebo sugar pill. Zellmer agreed to enroll in the trial, even though she couldn't be sure she would receive the PARP inhibitor.

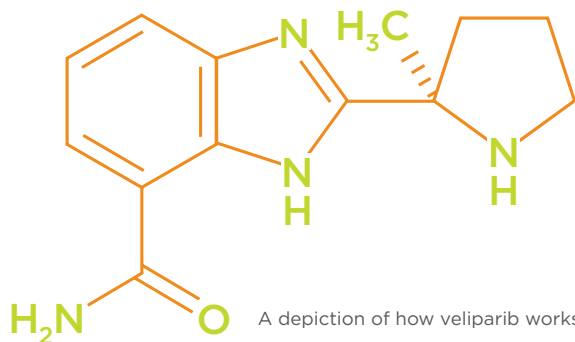
"If it could extend my life, why not?" Zellmer said.

### Surrounded by beauty

The family's vacation to Hawaii, originally planned for Christmas, transformed into Zellmer's 50th birthday celebration in February. Though she didn't want to feel ill from the therapy during the trip, she didn't want it looming over her head either. She started the first round of the study treatment, an oral therapy, in Hawaii.

"It was still worth it," Zellmer said. "Being in Hawaii, being outside surrounded by beauty, was very good for my well-being."

Feeling ill the first two days, she checked in with research study coordinator Lynda Yanny, BSN, who told her how to "stay ahead" of the symptoms.



A depiction of how veliparib works in the fight against cancer.

### Support and care

A spiritual person, Zellmer has relied on her Christian faith, positivity and extensive support system to carry her through. Not only has her immediate family—husband, John and sons, Zachary, 22, Benjamin, 10, and Aaron, 8—stepped up, but her mother and sister in Washington, her brother in Alaska and friends and neighbors—"people we didn't even know"—are pitching in.

And she couldn't say enough about her care team throughout Aurora Health Care. "I feel like I'm getting the best care I can get," she said.

### Looking forward

Zellmer takes one day at a time. She's looking forward to seeing Zachary graduate college in Seattle this June. Study treatments wrap up, though she will be followed for 10 years.

"I think medicine has changed a lot," Zellmer said. "I'm thankful it is the decade we live in now and hope there are more studies to cure this."

Walking a mile a day, Zellmer hopes to hike the bluffs of Devil's Lake again this fall. She goes for an MRI every eight weeks to see if the tumor has grown back. Her scan in March was clear of tumors.

Zellmer is participating in a trial being conducted by Alliance for Clinical Trials in Oncology. Alliance is a member of the National Cancer Institute National Clinical Trials Network and serves as a research base for the NCI Community Research Oncology Program. Aurora St. Luke's Medical Center is member of the Alliance NCTN network. Zellmer's experience should not be used to predict outcomes of the clinical trial. Data collection continues.



## Researchers kick-start neuro-oncology research program with funds from Vince Lombardi Cancer Foundation

With a generous \$1 million grant from Vince Lombardi Cancer Foundation, vice president of Aurora Neurosciences Amin Kassam, MD, is leading the development of a neuro-oncology research program.

### Stem cell bank

Access to human brain tumor samples is essential for a successful neuro-oncology research program to thrive, since the stem cells derived from the samples will be used to test new cancer therapies in the lab.

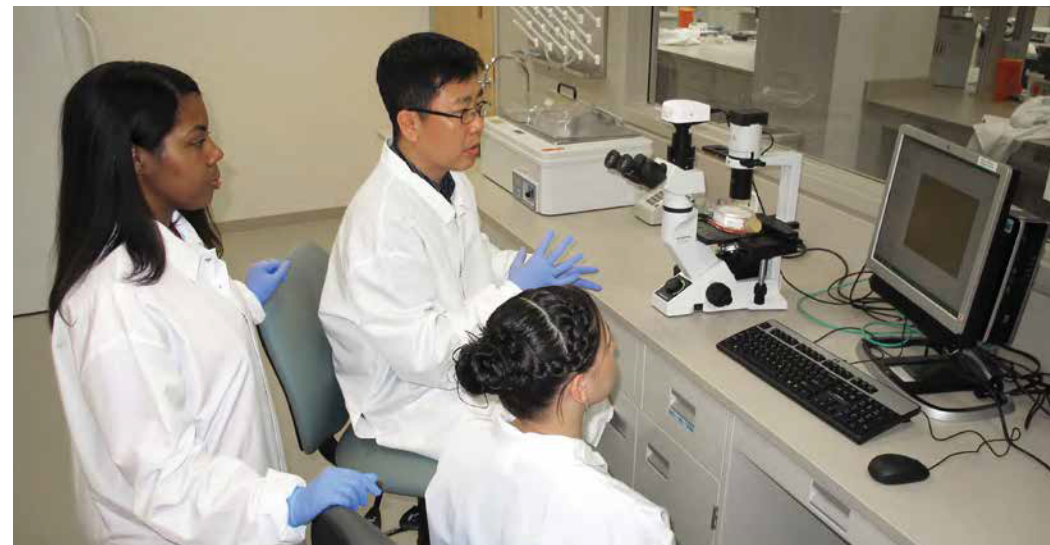
With an initial Aurora Cancer Care Research Award in 2014 and continued funding in 2015—totaling \$50,000—Kassam established a brain tumor stem cell bank. The research award program is generously supported by Vince Lombardi Cancer Foundation.

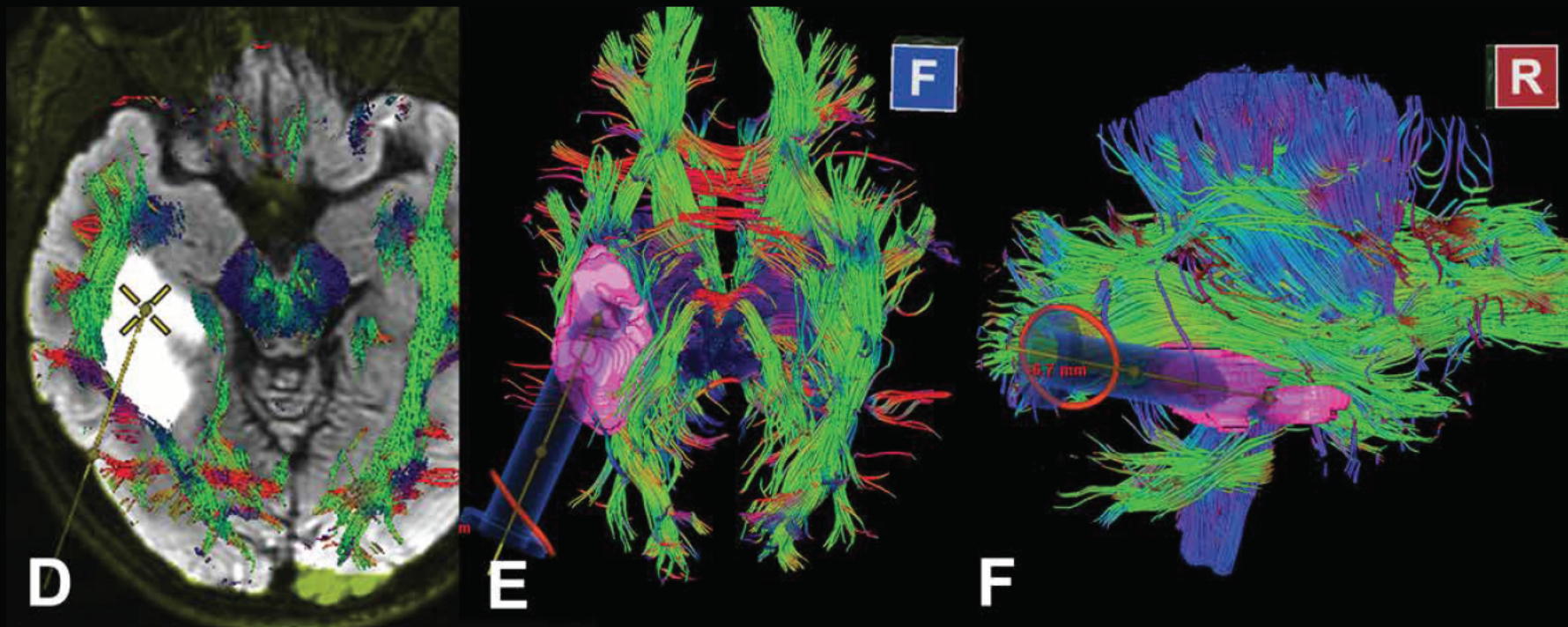
Using residual tissue from surgeries to remove brain tumors, researchers are collecting samples to grow and store stem cells. The project was initiated in an existing laboratory in the Regenerative Medicine Center at Aurora St. Luke's Medical Center. The proximity of the lab to the operating rooms was advantageous to facilitate effective communication between the study team, operating room staff and pathology, as well as efficient transfer of the tumor tissue from the operating room to the lab.

Coordination and streamlining of the process required the collaboration of neurosciences research nurse coordinators, representatives of the Biorepository and Specimen Resource Center, researcher scientists and technologists, and the surgeons.

Researchers collected 76 samples of a variety of brain tumors from 60 patients. The research team developed a novel method to culture the tumor stem cells with an exceptional success rate. Tissue collection is ongoing.

Researchers collected **76 samples** of a variety of brain tumors. Using a novel culture method, the team has demonstrated exceptional success rates.





## Animal models

After construction of Discovery Laboratory and the vivarium at Aurora Sinai Medical Center, the neuro-oncology researchers moved into the state-of-the-art facility, setting up shop and beginning the next phase of the research—characterization of the cells in animal models.

Led by research scientists Santhi Konduri, PhD, Chang-Hyuk Kwon, PhD, and Paul Mintz, PhD, neurosurgeons Richard Rovin, MD, and Amin Kassam, MD, and neuro-oncologist George Bobustuc, MD, the goal of the laboratory research is to determine whether the cells are able to reinitiate tumor growth in mice, since this stem cell characteristic of self-renewal contributes to tumor recurrence in humans.

In 2016, researchers are using new methods of Magnetic Resonance Imaging (MRI), Ramen spectroscopy (RS) and Optical Coherence Tomography (OCT) to identify differences between healthy and unhealthy tissue at molecular and structural levels.

MRI uses strong magnetic fields to create detailed images of tissues by detecting protons in water molecules. OCT is a “light” ultrasound that measures tissue topography and structure. RS uses light to measure tissue chemistry, akin to chemical fingerprinting.

Researchers are using these highly specialized imaging technologies before and after the tumor is removed from the patient, before the tumor stem cells are injected into mice and after the tumor has regrown in the mouse. The team has already identified novel targets for further exploration that they will be presenting at several international meetings in the coming year.

The next phase of the program is to test new therapeutics on the tumor stem cells and in tumor-bearing mice using the imaging modalities to detect tumor shrinkage or elimination. One method includes reengineering brain tumor stem cells and redeploying them using viral vectors, the most effective means of gene transfer.



# AWARD HIGHLIGHT

## Neurosurgeon believes cancer cure is possible

"We, like you and President Barack Obama, believe we can cure cancer."

In an open letter, neurosurgeon Richard Rovin, MD, invited Vice President Joe Biden to check out the clinical and basic science research being conducted at Aurora Health Care, particularly in Aurora Research Institute's new Discovery Laboratory.

Dr. Rovin, recipient of a \$25,000 Aurora Cancer Care Research Award, is studying two methods to isolate and characterize cancer stem cells from metastatic brain tumors. The research award program is generously supported by Vince Lombardi Cancer Foundation.

To study these cancer stem cells in the lab, they need to be separated from the rest of the cells in the tumor. There are several different methods to do this, but none have been used to grow cancer stem cells from metastatic brain tumors. The purpose of this research is to find a reliable and efficient way of growing cancer stem cells from metastatic brain tumors by comparing the two different methods.

Five patients with breast or non-small cell lung cancer who underwent brain surgery at Aurora St. Luke's Medical Center have provided metastatic brain tumor tissue for the study. Enrollment continues with a goal of 25 subjects. A collaborative effort, the Biorepository and Specimen Resource Center is assisting with collecting and storing of the tissues.

This research is the first step toward the long-term goal of finding the molecular and genetic changes that take place in the stem cells of metastatic brain tumors. This knowledge will help explain how and why tumors spread to the brain. It will also help researchers find ways to prevent metastasis and to treat tumors once metastasis has happened.

**Finding an efficient way to grow stem cells from brain tumors is the first step.**





# Clinical trial spotlight

## Researchers track outcomes of new multiple sclerosis drug

Recurring attacks, or relapses, of neurological symptoms are common in multiple sclerosis. The drug dimethyl fumarate cuts down on the number of relapses.

James Napier, MD, is leading an observational clinical trial at Aurora BayCare Medical Center to track serious adverse events that lead to the discontinuation of dimethyl fumarate in patients with relapsing multiple sclerosis (ESTEEM, clinicaltrials.gov identifier: NCT02047097).

## The drug dimethyl fumarate cuts down on the number of relapses.

Sponsored by the drug's manufacturer, Biogen Inc., the global study will follow about 5,000 subjects for five years. Researchers will track different serious adverse events, including infections, hepatic events, malignancies and renal events.

Jennifer Homa, MS, is serving as site coordinator.

## Targeted treatment

### Testing new precision cancer therapies

Developing new strategies to treat the most frequent forms of brain cancer is the driving force behind the research of senior research scientist Santhi Konduri, Ph.D., and neuro-oncologist George Bobustuc, MD.

Patient-derived cancer cells are tested to identify different markers associated with glioblastoma multiforme and meningioma brain cancers. The long-term goal is to understand molecular changes that occur during tumor development and to use these molecular markers as therapeutic targets, individualizing treatment to the patient's specific genetic make-up.

The ultimate goal is to design a safe, effective system allowing for use of a combination of drugs and therapies unique to each patient.

## NEURO RESEARCH COMMITTEES

### Neurosciences Research Committee

|                            |                              |
|----------------------------|------------------------------|
| George Bobustuc, MD        | Nina Garlie, PhD             |
| Juanita Celix, MD          | Santhi Konduri, PhD          |
| Srikant Chakravarthi, MD   | Chang-Hyuk Kwon, PhD         |
| Denise Coley               | Amber Lacrosse, PhD          |
| Monica Cucciare            | Natalie Polinske, MS         |
| Deb Donohoe                | Richard Rovin, MD (co-chair) |
| Amin Kassam, MD (co-chair) | Sarika Walia, MD             |
| Melanie Fukui, MD          |                              |

### Clinical Innovation Committee

|                          |                              |
|--------------------------|------------------------------|
| Juanita Celix, MD        | Amin Kassam, MD (co-chair)   |
| Srikant Chakravarthi, MD | Sammy Khalili, MD            |
| Shannon Clark, MBA       | Nathaniel Kojis              |
| Martin Corsten, MD       | Richard Rovin, MD (co-chair) |
| Melanie Fukui, MD        | Sarika Walia, MD             |
| Nina Garlie, PhD         |                              |
| Jonathan Jennings, MD    |                              |

### Neuroscience Clinical Trials Research Committee

|                            |                              |
|----------------------------|------------------------------|
| George Bobustuc, MD        | Jenn Mathieu                 |
| Srikant Chakravarthi, MD   | Richard Rovin, MD (co-chair) |
| Martin Corsten, MD         | Lori Schwingshaki, RN        |
| Gary Dennison, CIP         | Carol Tutino, BSN, MS        |
| Melanie Fukui, MD          | Sarika Walia, MD             |
| Nina Garlie, PhD           | Valerie Werner, BSN          |
| Carol Halliday, RN         | Lynda Yanny, BSN             |
| Tonya Holtrith, RTE (MR)   |                              |
| Amin Kassam, MD (co-chair) |                              |



# Academic Summary

## Research, Clinical Trials, & Grants

Richard A. Rovin, MD. Brain Tumor Oncomodulation, 2005 – 2015; Co-Investigator: Robert Winn, Ph.D. Professor, Department of Biology. Northern Michigan University; Marquette, Michigan.

Rose Marie Dotson, M.D. Aurora Cardiac Research Award. “A Novel Pathophysiology-Based Approach to the Management of Postural Orthostatic Tachycardia Syndrome; 5% effort; Co-Investigator; Principal Investigator Ryan Cooley, M.D., 2015.

Darkhabani, MZ. Platelet-Oriented Inhibition in New TIA and Minor Ischemic Stroke Trial (POINT), Essentia Health Fargo. Primary Investigator (2013-2015)

Darkhabani, MZ. Study of the Penumbra Coil 400 Systems to Treat Aneurysm (ACE), Essentia Health Fargo. Primary Investigator (2013-2014)

Vince Lombardi Cancer Foundation, Establishment of Brain Tumor Stem Cell Bank, Period 1: 2015-2016

Martin Corsten, MD. Aurora Cancer Care Research Award: “Inflammatory markers and oral HPV infection: is there a correlation?” 2014.

Martin Corsten, MD. Canadian Institutes of Health Research: “Combining Mevalonate Pathway and EGFR-TKIs”. 2014.

## Peer-Reviewed Publications/Articles

Prevedello DM, Ditzel Filho LF, Fernandez-Miranda JC, Solari D, do Espírito Santo MP, Wehr AM, Carrau RL, Kassam AB. Magnetic Resonance in imaging fluid-attenuated inversion recovery sequence signal reduction after endoscopic endonasal transcribiform total resection of olfactory groove meningiomas Surg Neurol Int. 2015 Oct 7;6:158. doi: 10.4103/2152-7806.166846. eCollection 2015.

Dae-Hee Lee, Ying Zhang, Amin B Kassam, Myung-Jin Park, Paul Gardner, Daniel Prevedello, Stephanie Henry, Craig Horbinski, Jan H Beumer, Hussein Tawbi, Brian J Williams, Mark E Shaffrey, Merrill J Egorin, Roger Abounader, Deric M Park: Combined PDGFR and HDAC inhibition overcomes PTEN disruption in Chordoma. PLoS ONE 08/2015; 10(8). DOI:10.1371/journal.pone.0134426

Daniel M. Prevedello, Domenico Solari, Ricardo L. Carrau, Paul Gardner, Amin B. Kassam: Endoscopic Endonasal Approach for Craniopharyngiomas. Volume 26, Issue 3, July 2015, Pages 363–375, doi:10.1016/j.nec.2015.03.013

Daniela Iancu, Cheemum Lum, Muhammad E Ahmed, Rafael Glikstein, Marlise P Dos Santos, Howard Lesiuk, Mohamed Labib, and Amin B Kassam: Flow diversion in the treatment of carotid injury and carotid-cavernous fistula after transsphenoidal surgery. Interventional Neuroradiology 05/2015; 21(3). DOI:10.1177/1591019915582367

Amin B. Kassam, Mohamed A. Labib, Mohammed Bafaquh, Diana Ghinda, Joseph Mark, David Houlden, Melanie B. Fukui, Thanh Nguyen, Martin Corsten, Cameron Piron, Richard Rovin: Part I: The challenge of functional preservation: an integrated systems approach using diffusion-weighted, image-guided, exoscopic-assisted, transulcal radial corridors. 01/2015; DOI:10.1515/ins-2014-0011

Amin B. Kassam, Mohamed A. Labib, Mohammed Bafaquh, Diana Ghinda, Melanie B. Fukui, Thanh Nguyen, and Martin Corsten: Part II: an evaluation of an integrated systems approach using diffusion-weighted, image-guided, exoscopic-assisted, transulcal radial corridors. 01/2015; DOI:10.1515/ins-2014-0012

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6 Pillar Approach: Parafascicular Surgery of the White Matter; with emphasis on: Economic Resource Optimization through Surgical Biometrics, Milwaukee, Wisconsin. Kassam, Amin B., Pradilla, Gustavo, Rovin, Richard. September 18-19, 2015.

Pituitary and Anterior Skull Base Workshop. Kuala Lumpur, Malaysia. Prof. Vicknes Waran, Prof. Dr. Prepageran Narayanan, Prof. Dr. Amin Kassam. August 7-17, 2015

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Incidence of Differentiated Thyroid Cancer in Canada by City of Residence. (Co-Author; presented by Dr. Matthew Hearn) Presented at the 68th Canadian Society of Otolaryngology – Head and Neck Surgery Annual Meeting, Ottawa, ON, May 2014.

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Finseth, Taylor A. *Case and literature review of stroke in cryptococcal meningitis*. Stroke Conference, University of Colorado Neurology Department. February 2015.

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Eric F. Maas, MD. National Multiple Sclerosis Society, Wisconsin Chapter, "MS Summit – Panel Discussion", 2015

Martin Corsten, MD. Canadian Society of Otolaryngology – Head and Neck Surgery 69th Annual Meeting. Winnipeg, MB June 2015

Martin Corsten, MD. 8th Milano Masterclass in Endonasal Skull Base Surgery Milan, Italy May 2015

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# Physician Listing



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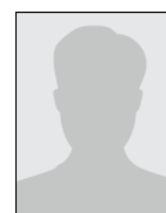
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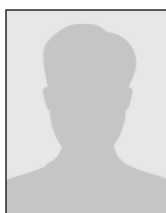
**Jonathan E. Jennings, MD**  
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**Robert Goldman, MD**  
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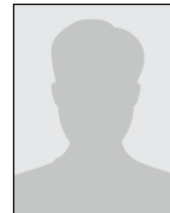
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and Epilepsy



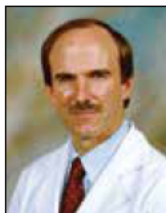
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### Data Sources:

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American Brain Tumor Registry  
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American Heart Association  
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Centers for Disease Control  
International Civil Aviation Organization  
Joint Commission, Get With The Guidelines  
National Association of Epilepsy Centers  
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