NEUROSCIENCES





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Dear Colleagues:

We are pleased to share with you the 2013 Achievement Report for the Clinical Neurosciences Program at University of Colorado Hospital. This report highlights our clinical expertise and accomplishments in quality, safety, clinical care and research from January through December 2012.

University of Colorado Hospital is the largest provider of comprehensive neurological and neurosurgical care in the in the region. We lead the state in the amount and quality of care provided to patients with epilepsy, movement disorders, neuroimmunology/multiple sclerosis, neuro-oncology, behavioral neurology/dementia, and neuro-ophthalmology; providing more than 39,000 outpatient visits this year.

On the inpatient side, our neuroscience services include dedicated general neurology and stroke services, with the region's largest deep brain stimulation program. We offer the only neuro ICU in the state, and one of the few epilepsy monitoring units in the country that is staffed around the clock. In 2012, the neurosciences units accounted for nearly 1,900 admissions and more than 10,500 patient days.

Our neurosurgical service provides a wide scope of high quality care that ranges from providing minimally invasive outpatient surgery using the Gamma Knife and Novalis® Radiosurgery to performing complex tumor resections under stereotactic guidance. In addition, our spine and neurosurgeons offer a variety of surgeries from simple micro-discectomies to computer assisted three-dimensional surgical navigation for complex cases.

Tremendous Growth Today and Tomorrow

We've experienced tremendous growth and recognition for the entire program, with the addition of many new faculty members in neuroimmunology, critical care, neuromuscular disease, Alzheimer's Disease, epilepsy, and behavioral neurology. We started a new headache program and received several national certifications and awards.

One of the program's greatest accomplishments came in early 2013, when we were designated one of the few elite Joint Commission-certified Comprehensive Stroke Centers. This designation recognizes not only our ability to deliver advanced stroke therapies and meet best practices for stroke care, but also the deep knowledge and experience of our staff–particularly their ability to recognize and respond to the, often subtle, signs of stroke.

Growth on the Research Side

The Neurology Clinical Research program, led by Timothy L. Vollmer, MD, has continued to be a major engine of research growth, providing "bench-tobedside" translation of the newest therapeutic advances.

In 2012, we received nearly \$18 million in research grant awards, making our program the fourth largest research department at University of Colorado School of Medicine. It is also among the top 35 neuroscience departments nationwide in funding from the National Institutes of Health. The breadth and depth of these activities is highlighted in the lists of current research and recent peer-reviewed publications included in this book.

We are one of 25 national centers funded by the National Institute of Neurological Disorders and Stroke (NINDS) as part of its NEXT Program (Network for Excellence in Neuroscience Clinical Trials). Our Movement Disorders Center includes an NIH-funded Parkinson's Disease Clinical Research Program. We are one of only a dozen National MS Society-funded Collaborative MS Research Centers and we are home of the Rocky Mountain MS Center at the Anschutz Medical Campus.

We are extremely proud of the work of our physicians, nurses, researchers, and staff. Our promise is to provide exceptional, patient-centered care and the best possible outcomes. Watch for new programs and services in 2013 as we expand our commitment to research and innovation.

With best wishes,

Ken Tyler, MD *Professor and Chair Department of Neurology University of Colorado Schoool of Medicine Reuler-Lewin Family Professor*



Kevin Lillehei, MD Professor and Chair Department of Neurosurgery University of Colorado School of Medicine Director of Neurosurgery University of Colorado Hospital

THE NEUROSCIENCES CENTER AT UNIVERSITY OF COLORADO HOSPITAL

The Neurosciences Center at University of Colorado Hospital (UCH) is one of the leading centers in the country for neurological and neurosurgical care. As this book demonstrates, our outcomes are outstanding, often far exceeding state or national outcomes, while patient satisfaction rankings are consistently high.

What sets us apart, and is integral to our success, is the unprecedented collaboration between physicians, nurses, and other clinicians, as well as their teamwork with other departments throughout the hospital. For instance, the brain tumor specialists work closely with oncologists and endocrinologists to treat pituitary tumors; the spine team includes neurosurgeons, orthopedists, physiatrists, and rehabilitation experts; and every surgical patient with epilepsy receives a full examination from both neurosurgeons and neurologists to determine if the best approach is medical or surgical.

Our teamwork was on the national stage in 2012, when the victims of the Aurora, Colorado theater shooting were brought here for care. Although a terrible tragedy, the fast response and outstanding care they received meant that everyone who arrived alive, left alive.

At UCH, patients have access to the latest treatments and medical therapies, many of them developed and tested here at UCH. Those with small brain tumors can have them destroyed noninvasively on an outpatient basis using the Gamma Knife and Novalis® Radiosurgery. UCH is also the only academic center in the state with an electroencephalographic (EEG) biofeedback program for patients with epilepsy, providing a nonsurgical option for patients who do not respond to medication.

The UCH Neurosciences Center staff is not content to rest on our laurels. Here, there is a continued focus on improvement, with every subspecialty participating in at least one ongoing performance improvement project each year.



> A zero mortality rate for unruptured aneurysms treated with clipping and coiling. Nationally, the death rate is between 0.5-1.5 percent.

IN REAL PROPERTY IN COMPANY

- > Eighteen months without a single ventilator-associated pneumonia in the neuro intensive care unit (ICU).
- One of the highest 5-year survival rates for brain cancer in the country.
- More than 2,000 people with multiple sclerosis treated each year.
- > One of the most experienced centers in the US for deep brain stimulation surgery.
- > One of the few neuromuscular centers in the country that provides both pediatric and adult care, enabling adolescents to seamlessly transition with no loss in the continuity of care.
- > One of just 18 centers to offer ACGME-accredited fellowships in orthopaedic spine surgery, and spine and pain medicine.



The Joint Commission recently commended the Center for its ability to bring together various disciplines in one space, including neurointerventional and cardiovascular interventional specialists, who share office space and procedure rooms. Neurological patients are seen at a single location, with appointments coordinated for the same day to minimize any inconvenience and enable the multidisciplinary care that sets UCH apart.

Through the robust research partnership of University of Colorado Hospital and University of Colorado School of Medicine, patients have access to the latest treatments, including investigational approaches that provide options available nowhere else in the state. While other academic centers find their research funding declining, at UCH it is expanding, with more than \$18 million in research money awarded to the Neuroscience Center in 2012.

Awards, Certifications and Recognitions

The UCH Neurosciences Center has received numerous awards, certifications and other recognitions. Among them:

- » Designated as a Joint Commission certified Comprehensive Stroke Center.
- » Designated as the only National Cancer Institute Comprehensive Cancer Center in the Rocky Mountain region (one of only 40 in the United States).
- » Received the Blue Distinction® Center+ for Spine Surgery, the only hospital in the state to receive this designation.

A HISTORY OF FIRSTS

The Center has also been at the forefront of neuroscience medicine. For instance, it:

- Was first in the nation to implant an intracranial pressure (ICP) monitor
- Hired the first neurointensivist in the region
- > Was first in Colorado to perform cerebral intra-arterial lysis
- > Is the only neurocritical care and neurovascular fellowship programs in the state
- > Was one of the first graduate residency programs in nursing to be accredited by the Core Council of Nursing Facility
- > Is one of the oldest neuro ICU's in the country
- » Awarded the Society of Interventional Radiology Gold Medal Award. The award was given to Interventional Radiology Director David Kumpe, MD, one of only 34 American physicians to ever receive the honor.
- » Designated as one of only two National Association of Epilepsy Centers (NAEC) Level 4 programs in the state.
- » Certified as the only MDA/ALS research and clinical program in the state.
- » Awarded the Gold Beacon Award for Excellence from the American Association of Critical Care Nurses, one of only two neuro-intensive care units in the country to receive the award.

These accomplishments, as well as many more, are highlighted throughout the rest of this book.

QUALITY/PATIENT SATISFACTION

As healthcare continues on the pathway of reform, pay for performance and value based purchasing initiatives, the focus on patient care, quality, safety and satisfaction have increasing importance. University of Colorado Hospital continues to lead the academic health care community in advancing these efforts.

In 2012, the University HealthSystem Consortium (UHC) named University of Colorado Hospital as the highest-performing academic hospital in the US for delivering quality health care—for the second year in a row. We are the only hospital in the country to receive this award two years in a row.

UHC is an alliance of 113 academic medical centers and 254 of their affiliated hospitals, which represent approximately 90 percent of the nation's nonprofit academic medical centers. The award is given to the academic hospital with the best outcome scores in patient safety, clinical effectiveness, clinical efficiency, patient satisfaction, mortality and equity, the latter a measure of whether outcomes differ for patients of different ethnicities and socioeconomic backgrounds.

According to UHC, the nation's top performing academic medical centers possess a core set of organizational characteristics that include a shared sense of purpose; an interactive leadership style; a system to promote accountability for service, quality and safety; a focus on results; and collaboration across clinical and administrative leadership and staff. This award is a reflection of the values that are embedded in the culture at University of Colorado Hospital and reflect the daily efforts of our physicians, nurses, ancillary care providers and staff across the organization to advance patient care.

A Mission of Patient Centered Care

University of Colorado Hospital's Neurosciences Center is committed to the mission of "healing the whole patient" and ensuring that the patient experience receives just as much attention as the clinical services. This means providing patient-centered care, involving patients in any decisions about their care, listening to their concerns, answering every question,



and ensuring patient satisfaction in everything from staff communication to the quiet of the inpatient setting. Studies show this approach not only increases patient satisfaction, but also results in higher quality care and more cost-effective outcomes.

The Hospital Care Quality Information from the Consumer Perspective (HCAHPS)

The Hospital Care Quality Information from the Consumer Perspective (HCAHPS) is a standardized survey instrument for measuring patient perspectives on hospital care. It contains 18 patient perspectives on eight key topics:

- 1. Communication with doctors
- 2. Communication with nurses
- 3. Responsiveness of hospital staff
- 4. Pain management
- 5. Communication about medicines
- 6. Discharge information
- 7. Cleanliness of the hospital environment
- 8. Quietness of the hospital environment



Overall, University of Colorado Hospital scored in the 77th percentile when patients rated the hospital a 9-10 (10 being the highest rating), and 81st percentile for patients who reported they definitely would recommend the hospital, as reported over the period of July 1, 2011-June 30, 2012. These scores exceed both Colorado and national averages.

High Satisfaction Rates with Inpatient and Outpatient Services

Another indicator of the outstanding service and customer satisfaction offered by the Neurosciences Center can be seen in our inpatient and outpatient care survey results.

Inpatient satisfaction is measured by written satisfaction surveys collected post-discharge via Press Ganey. When compared to academic hospitals, our neuroscience unit at UCH scored in the 88th percentile on the composite score, and between the 68th and 99th percentile for the individual components. Our Neuro ICU ranked in the 99th percentile among other teaching hospitals overall, with 96 percent of patients saying they would definitely recommend the hospital to others.

In the outpatient setting, our patients receive an email from the hospital's CEO one day after their visit asking about their experience.

In 2012, 98 percent of patients said they would recommend the neurology service and physicians; 98 percent would recommend the neurosurgery

service and physicians; 98 percent would recommend the spine center clinic and 96 percent the physicians. Highlights from these surveys focus on the communication with the providers, the communication with staff, and the staff's teamwork to coordinate care.

Quality, safety and satisfaction will continue to be a major driving factor in health care delivery in the years to come. While we are proud of our achievements to date, there is always an opportunity to improve. We strive every day to put our patients first, incorporate evidence-based practice into clinical care and identify areas for improvement.

We have an obligation to use our growing therapeutic armamentarium wisely, so we are developing high quality, cost effective models of neurological care.

- Steven P. Ringel, MD Vice President, Clinical Effectiveness & Patient Safety University of Colorado Hospital

PATIENT SATISFACTION

NEUROLOGY



NEUROSURGERY



SPINE



- 1. Questions answered? (Strongly Agree)
- 2. Recommend UCH? (Strongly Agree)
- **3.** Recommend Provider? (Very Likely)













HCAHPS WEBSITE DATA 2012



Patients reported...

- 1. Nurses "Always" communicated well
- 2. Doctors "Always" communicated well
- 3. They "Always" received help as soon as they wanted
- 4. Pain was "Always" well controlled
- 5. Staff "Always" explained about medicines before giving it to them
- 6. Room and bathroom were "Always" clean
- 7. Area around their room was "Always" quiet at night
- 8. YES, they were given information about what to do during their recovery at home
- 9. Patients who gave their hospital a rating of 9 or 10 on a scale from 0 (lowest) to 10 (highest)
- 10. Patients who reported YES, they would definitely recommend the hospital

information from: http://www.medicare.gov/hospitalcompare

BRAIN TUMORS

Individualized Treatments, Outstanding Success Rates

As the only National Cancer Institute-designated Comprehensive Cancer Center in the Rocky Mountain region (and one of only 40 in the United States), the specialized surgeons, oncologists, radiotherapists, neuropathologists, physicists, and nurses at the University of Colorado Cancer Center care for more patients with brain tumors than any other hospital in the region. It also has one of the highest 5-year survival rates in the United States. **UCH's 5-year survival rate for brain and other nervous system cancers is 47 percent compared to the national rate of 35 percent.**¹

The UCH Cancer Center also offers one of the largest neuroendocrinology programs in the country, where a close team of pituitary endocrinologists and surgeons treat 80 to 100 patients with pituitary tumors a year in a shared weekly clinic.

In the operating room, UCH neurosurgeons use stereotactic guidance during brain tumor surgery, an option available only in the top cancer centers in the country. This system permits threedimensional cortical mapping, enabling surgeons to aggressively resect even very small tumors while navigating around critical brain structures. Many such surgeries are performed while the patient is awake, which helps map their speech and motor cortex.

Noninvasive Radiosurgery

University of Colorado Hospital's remarkable survival rate is due, in part, to its access to two cutting-edge tools for noninvasive, outpatient radiosurgery: the Gamma Knife and Novalis[®] Radiosurgery. UCH is just one of two Colorado hospitals that can offer Gamma Knife treatment. This device focuses cobalt-60 radioactive sources into 192 guided beams, which converge in precise patterns to destroy tumors and other malformations deep inside the brain with minimal collateral damage. Approximately 300 patients a year receive treatment with the Gamma Knife at UCH. Although used primarily to destroy benign and malignant tumors, UCH neurosurgeons are among the few in the country using it to treat trigeminal neuralgia.

The Novalis[®] system is best for patients whose tumors or arteriovenous malformations (AVM) require more than a single dose of radiation. This tool shapes the radiation beam to match the contour of the tumor or lesion, which helps target the dose and avoid irradiating nearby healthy tissue. Having both options available allows clinicians to individualize treatments for each patient.

Malignant Melanoma: Meeting the Challenge

One of the largest areas of interest in the UCH brain tumor program is treating melanoma that has metastasized to the brain. While the median survival for these patients after stereotactic radiosurgery is about four months, the median survival for patients seen at UCH is more than twice that—8.7 months, with an average survival of 21 months. Six percent of UCH patients survive 10 years—a length of time rarely seen in patients with melanoma that has spread to the brain.



¹ Hatiboglu MA, Chang EL, Suki D, et al. Outcomes and prognostic factors for patients with brainstem metastases undergoing stereotactic radiosurgery. Neurosurgery. 2011;69(4):796-806





NEURO ONCOLOGY OUTPATIENT VISITS



BRAIN TUMOR LENGTH OF STAY



5

Expected

BRAIN TUMOR MORTALITY





Observed

Expected

Source: UHC

BRAIN (GBM ONLY) 5-YEAR SURVIVAL



PITUITARY GLAND 5-YEAR SURVIVAL





BRAIN (INCLUDING BENIGN BRAIN) 5-YEAR SURVIVAL



Advancing Survivorship

How one UCH tumor patient has been beating the odds for years—and what's being done to improve outcomes overall

When 37-year-old Mary Baird first began feeling tired and experiencing sinus problems, she didn't think much about them. But when those symptoms eventually gave way to splitting headaches, it got her attention.

"All I can tell you is that it sounded like the ocean pounding between my ears," Baird says.

An MRI revealed a large mass in the right frontal lobe of her brain and Baird underwent a biopsy. The diagnosis was a malignant brain tumor. Shortly thereafter, Kevin Lillehei, MD, Director of Neurosurgery at the University of Colorado Hospital, performed surgery, successfully removing the remainder of the lesion. Baird was then treated with radiation and BCNU chemotherapy.

The year was 1995, and Baird is still alive today—making her a 17-year tumor survivor—and counting.

Defying Expectations

According to Lillehei, survival is most often dictated by the grade of the tumor and the patient's age.

"Her age put her in a somewhat better group, but she had the worst pathology that you could ask for: grade IV glioblastoma."

Survival for this type of tumor is typically 18 months to two years, yet Baird continued to improve.

"Every time we saw her the scan would just look better, and it has stayed absolutely stable for 17 years," he says.

While she suffers from fibrosis in her lungs (due to the BCNU) that has slowed her down, Baird is determined to keep moving. She still works two days a week as a dental assistant, volunteers at a local food pantry and her church, and chases after her one-year-old granddaughter. She credits Dr. Lillehei and the treatment she received at UCH for her survival.

"He knew my dreams and he knew that I wasn't going to roll over and let this thing take me in six months. I think he saved my life and I'm very grateful to him," she says.

Improving Outcomes

While Baird's longevity may be atypical, significant strides are being made to improve tumor survivorship on the whole. UCH is a national leader in the treatment of benign and malignant brain tumors, achieving a 47 percent five-year survival rate compared with a 35 percent survival rate in Colorado. The hospital employs a variety of tactics to further enhance outcomes, from administering more effective front-line treatments like Temodar (temozolomide) to targeting second-line therapies like Avastin (bevacizumab) toward genetic mutations.



(Above) Baird's children the year she was diagnosed. Her number one goal for recovery was to see them grow up. (Below) Baird with her three children today.



UCH is also re-examining how radiation is administered by studying hyperfractionated radiation regimens, Lillehei says. He credits the hospital's multidisciplinary team approach with improving outcomes—from a skull-base team of neuro and ENT surgeons treating skull base lesions, to a team of neurosurgeons and neurotologists treating acoustic neuromas, to the multidisciplinary care offered to patients with pituitary tumors.

"It's no longer one surgeon, one tumor. It's really a team approach, and we're coming at it from every angle," Lillehei says. "We're never comfortable with the normal and we're always looking for other adjuvanttype therapies for patients whose tumors recur."

Baird is living proof of this dedication to improving survivorship, and has adopted a similar resolve.

"You can't sit around and feel sorry for yourself," she says. "This is the life handed to me and I'll do what I have to do to survive and get everything I want out of it."

CEREBROVASCULAR AND STROKE

Continuously Improving and Advancing



Stroke care at UCH begins with the Primary Stroke Response Team, composed of a multispecialty group of clinicians. The team converges within minutes after a patient presents in the emergency department, with the goal of providing the best treatment as quickly as possible so as to reduce permanent neurological damage. The success of the team and the overall quality of stroke care provided at UCH is one of the major reasons the hospital was recently named as one of the elite Joint Commission-certified Comprehensive Stroke Centers in the country.

Once stabilized, patients are admitted to the hospital's 24-bed neuro-ICU for observation and intensive medical management, then moved to a dedicated neurosciences unit to begin the recovery process. Once discharged, they receive state-of-the-art rehabilitative care. The hospital also offers a stroke support group for patients and their families.

Interventional Neurology Tops in the Region

The UCH Cerebrovascular and Stroke program has one of the oldest, most active interventional neuroradiology programs in the region. It was one of the first programs to use approaches, such as endovascular treatment for stroke and embolization, and apply them to other neurological conditions. The program's director, David Kumpe, MD, is one of the most experienced interventional neuroradiologists in the country. In April 2013, he received the Society of Interventional Radiology Gold Medal Award—one of just 34 American physicians ever to receive the honor.

The Center's interventional neuroradiologists work closely with their surgical and critical care peers to provide team-based treatment for a variety of complex vascular diseases. For instance, they initiated stent treatment for idiopathic intracranial hypertension (pseudotumor cerebri). UCH remains one of the few centers in the state to use stent treatment for the condition. It is also the only center in Colorado providing such neurointerventional procedures to newborns.

Awards and Accolades

The hospital's recent designation as a Joint Commission-certified Comprehensive Stroke Center means that UCH has shown it can not only deliver advanced stroke therapies and meet best practices for stroke care, but also has knowledgeable staff capable of recognizing and responding to the often-subtle signs of stroke and providing long-term management after discharge.

In 2012, the American Heart Association (AHA)/ American Stroke Association (ASA) recognized the hospital's outstanding stroke care with its **2012 Get With the Guidelines-Stroke Gold Plus Performance Achievement Award**—its highest level. The hospital has also been named to the **AHA's Target: Stroke Honor Roll**, and was recognized at the **2013 International Stroke Conference for Target: Stroke Achievement**.

A cornerstone of the UCH cerebrovascular and stroke program is its emphasis on continuous quality improvement (QI). The approach was used to improve the percentage of eligible patients who receive clot-busting intravenous tissue plasminogen activator (tPA) during a stroke and the time frame in which they receive it. **Today, 68 percent of eligible patients at UCH receive tPA within an hour.** The overall median of 43 minutes "door-to-needle" time is far higher than the national rate.



IVR tPA ARRIVE BY 2 HOUR, TREAT BY 3 HOUR





American Heart Association and American Stroke Association "Get with the Guidelines"

MORTALITY INDEX:

Lower is better (compared to national averages from UHC Reporting Hospitals)

HEMORRHAGIC STROKE



ISCHEMIC STROKE





Source: UHC





JOINT COMMISSION CORE MEASURES



LENGTH OF STAY





American Heart Association and American Stroke Association "Get with the Guidelines"

30-DAY READMISSIONS



An Unexpected Journey

How quick action and diligent care saved the life of a man who suffered a mid-flight stroke

Being in the right place at the right time really can make all the difference. Rick Hamilton found this to be true when it saved his life twice in a single day back in 2011.

It was Halloween and the sales executive was flying from St. Louis to a client meeting in Salt Lake City. He had no idea what a difference the simple act of upgrading his seat—from coach to a first-class aisle seat on the right side of the plane—would make. But early in the flight, an attendant noticed his left arm was hanging in the aisle and that the left side of his face was drooping and called for help.

"Had I been in coach, or in a window seat, or on the left side of the plane, these conditions would likely have gone unnoticed," he says.

Recognizing his symptoms as a stroke, an ER physician on board directed the pilot to make an emergency landing in Denver, where Hamilton was immediately rushed to University of Colorado Hospital. This would be the second time that day that he'd find himself in the right place just when he needed to be there.

Targeting Stroke with tPA

UCH is one of only 31 Joint Commission-certified Comprehensive Stroke Centers that offers highly specialized surgical techniques and interventional neuroradiology procedures not available elsewhere in Colorado, with a mortality rate for ischemic strokes and intracerebral hemorrhage below that of other University HealthSystem Consortium (UHC) hospitals.

And, as Hamilton experienced, UCH's 24/7 Stroke Alert System ensures that care is provided as quickly as possible.

Within a record 18 minutes, his condition was assessed, his CT scan was interpreted and clot-busting tPA was administered. Though he had improved to an NIH stroke scale of 2 or 3, his CT scan showed an obstruction of the proximal middle cerebral, the M1 segment. Rather than use mechanical devices, interventional neuroradiologist David Kumpe, MD, opted to again use intraarterial tPA to dissolve the clot away.

"He had reasonably good collaterals at the time, but you can't trust those forever. I was worried he would deteriorate," Kumpe says. "If you break the clot up mechanically and send some of it distally, you could interrupt some of those collateral pathways."

During the treatment, the left side of Hamilton's body stopped moving and he didn't respond well to questions, which was the feared deterioration. Kumpe confirmed there was no intracranial bleeding and continued with the tPA. Soon after, the clot opened up and Hamilton began moving and responding again.

"He wound up with no extra stroke beyond what we knew he had before we started, and has done extremely well," Kumpe says.



Hamilton and West with (from left) interventional radiologist David Kumpe, MD, and Neuro ICU Medical Director Robert Neumann, MD.

Back to Normal, Feeling Grateful

While he reports some residual weakness on his left side, Hamilton still managed to get in around 100 rounds of golf last year.

"There's nothing that precludes me from living the same life I led prestroke," he says.

Kumpe cites Hamilton's case as an example of the cooperation among the stroke services at UCH.

"There's a level of trust that exists here, and it's very helpful," he says. "It's a great place to work, for that reason."

Hamilton concurs. "The leadership in the neurology area of UCH has established a culture and approach to quality care that is clearly embraced by all of the staff. They absolutely exceeded my expectations in every respect."

Patient Case Highlights

- > Man suffered in-flight stroke and was brought to UCH, assessed and given tPA within just 18 minutes as a result of Stroke Alert System.
- > UCH is a Joint Commission-certified Primary Stroke Center with a mortality rate for ischemic strokes and intracerebral hemorrhage below that of other UHC reporting hospitals.
- Patient experienced only minimal fine motor deficits and is back to his normal activities.

EPILEPSY

One of a Few Academic Centers in the Country to Offer Quantitative EEG Neurofeedback

The UCH Epilepsy program is one of the leaders in the diagnosis and comprehensive management of epilepsy, treating more patients than any other facility in the region. 2,400 patients, including 670 new patients, visited the center in 2012 for evaluation and treatment.

The program includes access to seven fellowship-trained epileptologists (with two available 24 hours a day, seven days a week) and two specialized neurosurgeons. Patients receive multidisciplinary management, with physicians supported by neuropsychiatrists and neuropsychologists as well as certified neuroscience registered nurses.

Our program is **one of only two** designated Level 4 National Association of Epilepsy Centers (NAEC) in the state.

Level 4 centers provide the most complex forms of intensive neurodiagnostic monitoring. They also provide more extensive medical, neuropsychological and psychosocial treatment than lower-ranked programs. The NAEC recommends that patients, whose seizures have not been controlled within 12 months, seek a referral to a specialized center like the one at UCH.

A robust clinical trials program at University of Colorado School of Medicine, coupled with

progressive research, provides unparalleled treatment options for patients with some of the most challenging types of seizures and epilepsy.

Quantitative EEG Neurofeedback Services: A New Paradigm for Nonsurgical Treatment of Resistant Epilepsy

In August 2012, the Epilepsy team unveiled its new electroencephalographic (EEG) biofeedback program. Also called neurofeedback, this approach provides a nonsurgical option for the approximately 30 percent of epilepsy patients who do not respond to medication. Numerous studies find it can significantly reduce the incidence of seizures.¹

UCH's epilepsy neurofeedback service is one of the few programs in the country which operates within an academic medical center. Patients here receive intensive neurofeedback training for 20 weeks or more, with the goal of reducing seizure frequency and improving cognitive function.

Epilepsy Monitoring Unit Largest in Region

More than 300 patients a year are admitted to the Epilepsy Monitoring Unit, where continuous video EEG monitoring provides critical data about provoked and unprovoked seizures for up to eight patients at a time. The information enables clinicians to more accurately diagnose, evaluate and treat patients with epilepsy. At least two specially trained staff members provide around-the-clock monitoring, something only a handful of inpatient epilepsy monitoring units in the country offer.

Dedicated Surgeons for Epilepsy Procedures

The neurosurgeons at UCH performed 70 epilepsy related surgeries in 2012, including 14 lobectomies. The surgeons perform the full spectrum of epilepsy-related procedures, along with a unique expertise in neocortical resections for complex partial seizures. This involves resecting parts of the brain beyond the temporal lobe.

The surgeons are supported by advanced technology available at UCH. This includes a 248-channel magnetoencephalography (MEG) scan: imaging technology that uses the magnetic fields in the brain to identify brain activity. Not only is it extremely sensitive and precise, able to detect changes in brain waves within milliseconds, but it does not require the use of radiation or invasive dyes or tracers, providing a safer experience for patients. Other advanced imaging approaches available here include ictal-SPECT and PET scans.

¹Tan G, Thornby J, Hammond DC, et al. Metaanalysis of EEG biofeedback in treating epilepsy. Clin EEG Neurosci. 2009;40(3):173-9.

Leading the Country in Research on Novel Treatments for Epilepsy

UCH Comprehensive Epilepsy program is one of the leading research centers in the region. Most of the anti-epileptic drugs currently used worldwide were evaluated here and the center continues to test new compounds in the laboratory and through early- and late-stage clinical trials. Ongoing clinical trials explore novel uses for anti-epileptic drugs already on the market. This provides patients with access to cuttingedge treatments unavailable anywhere else in the region.

In 2012, the Center conducted 16 clinical trials evaluating six new and currently available drugs.

The most notable clinical trials currently being conducted at UCH include:

Trial 1: Currently there are a limited number of drugs with which we can treat medically refractory primary generalized epilepsy. At the University of Colorado, we are running a trial to determine whether a new medication on the market for complex partial epilepsy can also be used as an adjunct agent for primary generalized epilepsy.

Trial 2: Options for the fast and effective treatment of seizure clusters are limited to painful injections or administration of medication via inconvenient suppositories. At University of Colorado, we are currently running a trial to determine if an established medication, in a new and convenient formulation, can stop clusters of seizures.

In addition to clinical trials on new treatments, the clinical and research staff are investigating numerous other areas in seizures and epilepsy with a goal of improving diagnosis and treatment. These include:

- » Epilepsy after traumatic brain injury (TBI)
- » Heart rate variability and the influence on heart rate during seizures
- » The influence of sex hormones in epilepsy
- » Epilepsy in the elderly
- » Psychiatric aspects of epilepsy
- » Seizure-related physical injuries
- » Monitoring of the common side effects of anti-epileptic medication
- » Neurofeedback and its effects on seizures and common comorbidities in patients with epilepsy



Conquering Epilepsy

How one UCH epilepsy patient is no longer living with frequent seizures—and the treatment approach that is stopping seizures in more patients



When a rock broke loose from the side of a Colorado mountain, it crashed through Todd Harms' windshield and hit the right side of his head and face. The now 47-year-old man was in a coma for two weeks and spent the next five months in a rehabilitation hospital.

Then Harms developed posttraumatic epilepsy. "I had seizures all the time. I tried every medication made," he says. Harms couldn't drive and he couldn't go back to his work as a welder.

After more than four years of failing antiepileptic drugs, Harms found epileptologist Mark Spitz, MD, director of the Adult Comprehensive Epilepsy Program at University of Colorado Hospital. "The unfortunate standard of care for people with seizures is to keep trying medicines. Good data shows that after a patient has failed three medications, the chance of becoming seizure free is less than five percent," says Spitz, who is one of seven fellowship-trained epileptologists in UCH's adult epilepsy program.

Stopping Seizures

The goal of epilepsy treatment at UCH is to stop seizures. "For the right patient, that can be achieved by surgery," says Spitz. "Chances of the patient becoming seizure free are well over 50 percent. Even those who are not seizure free do dramatically better."

Through a clinical history, MRI, and long-term video EEG monitoring in UCH's 6-bed epilepsy monitoring unit, Spitz identified the right anterior temporal lobe as the source of Harms' seizures. An intracarotid amobarbital (Wada) test, conducted by individually cannulating each internal carotid artery, showed that removing the right anterior temporal lobe would not impact Harms' speech or memory.

In February 1998, Neurosurgeon Ken Winston, MD, worked in partnership with Dr. Spitz to perform the right anterior temporal lobectomy. Harms has only had a few seizures since then and takes two antiepileptic drugs as a

precaution against these breakthrough seizures. He is also working again, as a mechanical shop assistant. "I don't think I felt this good when I was 18," says Harms. "I feel fantastic."

Reducing Risk

Spitz has many patients like Harms for whom surgery is the best treatment approach. Studies show that living with medically intractable seizures is riskier than surgical complications, which occur in less than five percent of patients. "Having frequent epileptic seizures is bad not just because you can't have a driver's license. You can have a seizure in your sleep and not wake up the next morning. Seizures kill," says Spitz.

Surgery also gives patients a better quality of life and reduces depression and anxiety. Harms, for example, says he was "going crazy" when doctors told him that he couldn't work after he was diagnosed with epilepsy. Harms is happy to be working again. When he's not working, he enjoys watching his teenage son skateboard and working out in his home gym. "Dr. Spitz is my guardian angel," Harms says.

- > UCH epilepsy patient no longer has frequent seizures after temporal lobectomy
- > UCH has the most epilepsy specialists in the Rocky Mountain region

EPILEPSY OUTPATIENT VISITS



EPILEPSY LENGTH OF STAY





Expected



Observed



Expected

EPILEPSY MORTALITY

Source: UHC



MOVEMENT DISORDERS

Treating Patients with Advanced Medical and Technological Approaches

Patients seen at the Movement Disorders center at University of Colorado Hospital receive revolutionary medical and interventional approaches to treat Parkinson's disease, essential tremor, dystonias, and other movement disorders. The center's fellowship-trained movement disorder specialists and nurse practitioners manage more than 1,700 patients a year, most with complex conditions that require specialized care only available at an academic center like UCH.

The Movement Disorders center at UCH is one of the most **experienced** centers in the United States in deep brain stimulation

The center's neurosurgeons are among the most experienced physicians in the country at performing deep brain stimulation. Their extensive experience is critical, given the complexity of the procedure—which requires a comprehensive pre-surgical evaluation, at least two surgeries, and the ability to detect very fine neurological signals in the brain to ensure proper placement of the probe. The center has performed more than 400 of these procedures since 2002.

Every patient seen at the center is evaluated and treated by a multidisciplinary team composed of a neurosurgeon, a neurologist, neuropsychologists, psychiatrists, physiatrists, and physical therapists.

Active Research Program

An active research program, including one of the few studies in the world evaluating the use of gene therapy to treat Parkinson's disease, provides patients with access to groundbreaking approaches unavailable elsewhere in the state. The goal is to tailor treatments—whether standard or investigational, medical or surgical to each patient's unique needs.





surgery.



MOVEMENT DISORDERS OUTPATIENT VISITS



MOVEMENT DISORDERS LENGTH OF STAY





MOVEMENT DISORDERS MORTALITY







Source: UHC

Gene Therapy:

Pushing the Boundaries of **Parkinson's Disease Treatment**

The University of Colorado School of Medicine participated in one of the first clinical studies to evaluate the use of gene therapy in patients with Parkinson's disease (PD).

The Phase 2 study, conducted in association with six other centers, randomized 45 patients with moderate to advanced PD into either the gene therapy or a "sham" surgery. Patients received an infusion of the genetic material directly into the subthalamic nucleus, a key brain region involved in motor function. They used an inert virus to carry the glutamic acid decarboxylase (GAD) gene, which was chosen because it produces an inhibitory neurotransmitter that helps "quiet" the excessive neuronal firing responsible for many PD symptoms.

Patients also were able to receive the infusion in their hospital rooms rather than in the operating room, making for a far more pleasant experience. The control group underwent the same procedure, but was injected with saline solution.

Half of the patients receiving gene therapy demonstrated dramatic improvements in their symptoms compared with just 14 percent in the control group, improvements that continued throughout the six-month follow up. The only adverse events were headache and nausea.

The results of the study were published in the April 2011 issue of The Lancet Neurology.1

Currently, the University of Colorado School of Medicine, in conjunction with UCH, has 34 active studies underway for patients with movement disorders.

¹ LeWitt PA, Rezai AR, Leehey MA, et al. AAV2-GAD gene therapy for advanced Parkinson's disease: a double-blind, sham-surgery controlled, randomised trial. Lancet Neurol. 2011;10(4):309-19.

MULTIPLE SCLEROSIS

Personalized, Patient-Centered Care Guides Treatment

More than 2,000 patients a year come to the Multiple Sclerosis (MS) center at UCH to receive innovative care from world-renowned MS experts. A robust and active research program provides patients with access to therapies and investigational treatments available nowhere else in the Rocky Mountain region.

In addition to having access to the latest research, MS patients at UCH also receive holistic care from a multidisciplinary team of MS-trained specialists in:

- > ophthalmology
- > radiology
-) urology
- **)** otology
- > speech pathology
- > physical therapy
- > behavioral neurology

That care includes treatment for neuromyelitis optica (NMO), infusions of the most advanced therapies, and, for those enrolled in one of the dozens of research studies the center conducts each year, access to investigational compounds.

Treating the Whole Patient

A major goal of all treatment is, of course, to help patients obtain and maintain remission of their MS. However, that is just part of the center's treatment philosophy. Patients with MS experience a variety of other conditions that require attention and management, including fatigue, movement and balance disorders, and vision and speech problems.

They also are prone to many of the chronic health conditions that plague people without MS, including obesity, diabetes, and hypertension, all of which increase the risk of MS-related disabilities. Thus, the team works with patients to develop personalized, evidence-based physical activity regimens that enable them to recover function and minimize the impact of the disease, while a nutritionist teaches them how to maintain a healthy weight and reduce their risk of diabetes and hypertension.

Data-Driven, Patient-Centered Care

The care provided in the UCH MS center is based on national and international guidelines, best practices, and internal data which clinicians collect and assess on the thousands of patients who pass through the center each year.

In 2013, the center launched a comprehensive outcomes assessment program in which patients evaluate their own status so clinicians can better understand how they respond to treatment.

Traditional centers base response only on clinical signs: Did the patient go into remission? Does the CT scan show fewer lesions? However, qualityof-life markers are just as important. These include employment status, pain and fatigue levels, cognition, enjoyment of life, and emotional well-being. Such components can affect clinical response (radiographic improvement, remission) to even the most effective medications.

Researchers and clinicians use this qualitative, patient-provided data together with quantitative outcomes to identify patient characteristics associated with treatment response. The information will be used to build an algorithm that will allow the team to improve its ability to match the right drug with the right patient at the right time.



MS LENGTH OF STAY

5



Observed

Expected

MS MORTALITY

0%



Expected

Observed

MS OUTPATIENT VISITS



UCH MS Center is a leader in the nascent movement to provide personalized medicine to MS patients: a philosophy that incorporates **shared decision making and an emphasis on the patient's emotional and lifestyle needs.**

Providing Access to Advanced Treatments

UCH a Leading Center in MS Research



University of Colorado Hospital Multiple Sclerosis center is one of the top research centers in the country. With more than 24 clinical trials ongoing at any one time, as well as several laboratory investigations in MS and related diseases, the center provides patients with access to progressive treatments and translational research.

The center currently is running clinical trials on new compounds, as well as combinations of new and existing treatments; developing and assessing a JCV antibody program in patients with relapsing MS who receive or are considering treatment with Tysabri®; and conducting studies on methods to improve MS-related symptoms and facilitate functional recovery.

Also under development are vaccines to prevent central nervous system disease progression in MS and, possibly, the development of MS in high-risk children.

In the lab, researchers use innovative approaches to better understand the mechanism of action of currently available and investigational immunotherapeutic agents. This will provide a rationale basis for further treatment developments and improve the ability to choose the right treatment for each patient.

Basic research also focuses on discovering potential novel therapies for patients with MS, neuromyelitis optica (NMO), and similar disorders by investigating the role of immune cells in disease initiation, progression, stability and remission.

From the Lab to Clinic and Back Again

The objective with all research is to move the research into the clinical setting as quickly as possible. At the same time, clinicians use what they learn from patients to identify new areas of research.

This translational, team-oriented approach between clinicians and basic researchers is rarely seen in other research centers. Translational research is a hallmark of University of Colorado Hospital and its academic partner, the University of Colorado School of Medicine.

The MS Center at University of Colorado Hospital is developing a vaccine that **may prevent MS in high-risk children.**

Largest Tissue Bank in the World

Thanks to years of research, the MS Center at UCH has one of the oldest and largest disease-specific tissue banks, providing brain tissue to researchers around the globe. Researchers use the repository to study, among other things, biomarkers of disease activity in MS.

Development of a novel vaccine strategy for MS

Researchers: Dr. Timothy Vollmer MD, Professor and Director of Clinical Research, University of Colorado School of Medicine and Dr. Leila Jackson Ph.D., Assistant Research Professor, University of Colorado School of Medicine

Multiple sclerosis (MS) is a debilitating disease mediated by immune attack on the central nervous system (CNS). Patients present with neurological deficits, and once diagnosed, irreversible CNS damage persists. There are several approved therapeutics targeting the immune system that partially inhibit further CNS damage (1,2). These therapies alter normal immune function and can result in serious side effects, including death, as the immune system fails to survey for pathogens normally. Additionally, these therapies do not repair the CNS damage that has already occurred, and patients are left with neurological deficits. Currently, a test to predict if an individual will develop MS is not available; therefore, a vaccine strategy is an attractive approach to prevent disease.

Pharmaceutical companies have developed vaccines based on the hypothesis that in MS patients, myelin components are the major antigen. Their approach entailed tolerizing patient immune cells to myelin antigens such as myelin basic protein and proteolipid protein with the assumption that this vaccination protocol would prevent further disease symptoms in MS. This approach was successful in pre-clinical models most likely due to the fact that disease in animals is induced with these same antigens (3-5). In clinical trials, these approaches were unsuccessful, most likely explained by two potential mechanisms.

- **1.** A tolerizing regimen only works when the immune system is at rest, as activated immune cells can interfere with tolerizing signals.
- 2. Myelin components may not be relevant antigens in MS. In fact, researchers have studied for decades the dominant antigens in MS, and have been unable to reproducibly identify the dominant antigens for this disease.

MS is thought to be a disease mediated by at least two immune phenomena: molecular mimicry and bystander activation (6,7). Molecular mimicry induces autoreactive immune cell activation when a non-selfantigen, such as a virus or bacteria, has cross-reactive epitopes to selfantigens. Bystander activation is a process by which immune cells that are activated in response to any pathogen can activate resting autoreactive lymphocytes in the vicinity, resulting in an autoimmune pathogenic response, such as that observed in MS. As all humans have autoreactive cells, it is this process that appears to result in aberrant activation of cells reactive to self-antigens or antigens that mimic self, resulting in CNS destruction and subsequent disease pathology diagnosed as MS.

Our novel vaccine approach is to alter the bystander activation mechanisms promoting disease and actively induce bystander immune deviation or bystander immune suppression specific to the CNS compartment. Rather than the immune system inducing activation of autoreactive cells, our approach is to reprogram the immune system to induce suppression or deviation diverging from this pathogenic response.



NEUROMUSCULAR

Providing Innovative, Interdisciplinary Care Throughout Six States

The Neuromuscular clinic at University of Colorado Hospital is one of the oldest such programs in the country, offering a comprehensive approach to the diagnosis and treatment of diseases involving the peripheral nervous system. Sponsored by the Muscular Dystrophy Association (MDA), patients from six states come to UCH, with more than 500 new patients and 1,500 follow up visits seeking services each year.

Here, clinicians provide multidisciplinary, integrated care for patients with muscular dystrophies, amyotrophic lateral sclerosis (ALS) and other motor neuron diseases, myopathies, neuropathies, and myasthenia gravis, among others. The UCH team has expertise in treating extremely rare conditions, such as familial amyloid neuropathy and critical illness neuromyopathy. The program also performs muscle and nerve biopsies on tissue sent from around the state and region.

The UCH clinic offers the only certified MDA/ALS research and clinical program in the state. Patients receive care from an interdisciplinary team comprising fellowshiptrained physicians and mid-level providers, as well as physical, occupational and speech therapists, a dietician, and durable medical equipment vendors. The team meets weekly to discuss individual patients and their care. This ensures that all patients—and their families—receive the comprehensive medical, behavioral, and social services they require.

Transitioning from Pediatric to Adult Care

The clinicians at UCH and Children's Hospital Colorado collaborate closely to help pediatric patients with neuromuscular disorders transition from pediatric to adult care, sharing information about patient cases, patient populations, and research.

Research Focused

A strong research focus underlies the clinical components of the UCH Neuromuscular clinic, enabling it to offer patients access to novel therapies. Its clinicians founded the Western ALS (WALS) study group, which runs multiuniversity clinical trials on new treatments for ALS. The clinic is also a member of the Northeast Amyotrophic Lateral Sclerosis Consortium (NEALS), a large international group of researchers that collaborates on clinical research in ALS and other neuromuscular diseases. The UCH Neuromuscular clinic has trained over 50 fellows in neuromuscular medicine. Fellows must complete a performance improvement project and may participate in clinical research. Over the years, several have conducted independent research in their second year of fellowship. Many are now academic physicians at other universities.

Continual Process Improvement— Key to Quality Patient Care

A major initiative in the Neuromuscular clinic and throughout the UCH neurosciences program is continual process improvement. Professor and Vice Chair of Neurology and Vice President of Clinical Effectiveness and Patient Safety, Steven P. Ringel, MD, leads the department's efforts in developing and managing quality and safety programs.

One such project is designed to improve the detection and management of depression in patients with chronic neurological diseases. Since depression in patients with ALS is correlated with faster disease progression and reduced limb function¹, screening processes to identify these patients and institute evidence-based management approaches should slow disease-related morbidity.

¹ Jelsone-Swain L, Persad C, Votruba KL, et al. The Relationship between Depressive Symptoms, Disease State, and Cognition in Amyotrophic Lateral Sclerosis. Front Psychol. 2012;3:542.



NEUROMUSCULAR LENGTH OF STAY

Observed

3



Expected

NEUROMUSCULAR MORTALITY

1% Observed

Expected

1%

NEUROMUSCULAR OUTPATIENT VISITS



Source: UHC

NEUROCRITICAL CARE

Recognized Nationally for Outstanding Quality

The UCH neuro intensive care unit (ICU) is one of only a handful in the country and the only one in the state. The 13-year-old unit is also led by one of the first board-certified neurointensivists in the country.

The physicians and nurses in the unit provide highly specialized critical care with an emphasis on preserving and optimizing the function of the central and peripheral nervous system. They do this with an exemplary, multidisciplinary team of highly trained clinicians and nurses. All physicians are board-certified specialists, in neurological or critical care. All nurses have received specialty training in neurocritical care. UCH also runs one of the leading training programs in the country for critical care residents and neurointensivist fellows.

Such specialized care enables the unit to take a proactive approach to patient care, anticipating complications and addressing them before they become critical.

Multidisciplinary Care Throughout the Hospital

The unit serves as a stabilizing influence for critically ill patients. Its patients range from those suffering from multiple traumas, to those with subarachnoid hemorrhage, intracerebral hemorrhage, and ischemic stroke. Other conditions treated there include subdermal and epidural bleeds, brain tumors, spinal cord injury and tumors. The staff also cares for patients with medical neurological conditions such as meningitis, myasthenia gravis, and Guillain Barre Syndrome.

In addition, the unit's medical director, Robert Neumann, MD, PhD, also co-directs the stroke service, which was recently named one of a handful of Comprehensive Stroke Centers in the country. The team also provides consulting services to cardiothoracic, transplant, pulmonary critical care, and cardiology units throughout the hospital for patients with neurologic disorders.

Among the unit's recent achievements:

- > Eighteen months without a single case of ventilator-associated pneumonia. Nationally, the incidence of VAP in critical care units ranges from 6 percent to 52 percent of intubated patients.
- > Receipt of the prestigious threeyear Beacon Award for Excellence from the American Association of Critical Care Nurses.
- Receipt of the hospital's President's Award for Leadership, for the partnership shown between the unit's medical director and nurse manager.

Clinicians are also assertive in their use of induced coma and systemic cooling to reduce inflammation and induce healing, maintaining patients in this state for weeks when necessary, while other hospitals typically only use cooling for 24 hours.



Since its move into the new hospital tower in the spring of 2013, the neuro ICU has expanded capacity to care for up to 24 patients and has access to innovative equipment. This will enable its clinicians to provide even higher quality care, including a new cerebral blood flow monitor, cooling helmets for patients who require decompression craniectomy, and a portable CT scanner.

The Beacon Award

The UCH neuro ICU is just one of two neurology/ neurosurgery units in the country to earn a three-year Beacon Award for Excellence from the American Association of Critical Care Nurses (AACN) at the "gold" designation level—the highest the organization bestows. This designation means the unit achieved the highest scores in five areas:

- » Leadership structure and systems
- » Staffing and staff engagement
- » Effective communication, knowledge management, learning and development, and best practices
- » Evidence-based practice
- » Outcomes

The scores "reflect a unit with outstanding processes that are fully applied through the unit and across key stakeholders," the AACN wrote.



2012 Neuro ICU

Admissions = **161** Patient Days = **3,538**







Called to Duty

UCH's highly specialized trauma and neurological services helped save the lives of 22 victims of the Aurora theater shooting



It's been over a year since the July 20 mass shooting in an Aurora movie theater that left 12 dead and 58 wounded. As this dark anniversary came and went, the world was undoubtedly reminded of the events of that horrific summer night. Much more worthy of remembering is what happened in the hours following the senseless act of violence.

- > UCH treated 22 trauma patients from the Aurora theater shooting—far more than any other area hospital
- > Everyone who arrived with a heartbeat, left with a heartbeat.

Ready to Respond

UCH received 22 victims and one casualty—far and away the most of any of the five hospitals called on that night. While there's never a good time for a disaster, this one was particularly problematic, according to Director of Emergency Medicine Richard Zane, MD.

"It was off hours, on the weekend and at night," he says. "There is no other time a hospital has fewer resources."

To further complicate matters, the emergency department already had more than 20 patients, and inpatient units and ICUs were at capacity. The manner in which patients arrived added another degree of difficulty: a lone ambulance transported three victims while the other 19 arrived by car or police cruiser. With no triage to prep and bandage patients, the scene quickly devolved into something shocking, even to medical professionals trained in trauma.



In the Trenches Together

With a strong history of collaborating effectively within and between departments throughout the organization, even with these immense obstacles, UCH was well prepared and equipped to meet this difficult challenge. Within 25 minutes of arrival of the first shooting victims at UCH, leaders established an incident command center and within an hour more than 80 physicians, nurses, and administrators had arrived. Of the 23 shooting victims sent to UCH, one was dead on arrival. All of the others lived.

The Neurosciences Center played a pivotal role in caring for the most critical patients. Within minutes, five patients with critical neurological injuries had arrived. Two patients were rushed to surgery with gunshot wounds to the head. Both patients were operated on by neurosurgeon Allen Waziri, MD. The Neuro ICU, already at capacity, accommodated the needs of five critically

ill patients, including those operated on by Dr. Waziri. "These patients had complex Neuro ICU courses, but both recovered and went home," said Robert Neumann, MD, director of the Neuro ICU.

The extensive expertise, training and teamwork made the positive outcome that UCH achieved possible. According to Rob Leeret, RN, UCH's Director of Emergency and Trauma Services, "Everyone that came in with a pulse left with a pulse."

SPINE

Designated as a





An Independent Licensee of the Blue Cross and Blue Shield Association

University of Colorado Hospital's nationally recognized Spine Center provides a unique onestop approach for patients with degenerative cervical, thoracic, lumbar, and sacral spine disease, as well as spine deformities and spinal tumors.

The multidisciplinary team of surgeons, physiatrists, neuroradiologists, anesthesiologists, and physical therapists provides comprehensive care including physical therapy, spinal injections, neurosurgery, orthopedic surgery, and rehabilitation. Its physicians also work closely with the pain management and alternative medicine centers at University of Colorado Hospital. All have the same goal: to relieve the patient's pain and disability and restore full functionality.

The BlueCross BlueShield Association recognized the quality of care provided at UCH when it named the hospital a Blue Distinction® Center+ for Spine Surgery, the only hospital in the state to receive this designation. Hospitals receiving a Blue Distinction Center+ designation are evaluated on their ability to deliver high quality, safe and efficient specialty care that results in superior outcomes. The University of Colorado School of Medicine is one of just 18 centers to offer an ACGMEaccredited orthopaedic spine surgery fellowship. The Spine Center also houses an ACGMEaccredited spine and pain medicine fellowship, whose graduates work in academic institutions across the country.

Surgery a Last Resort

The entry point of the UCH Spine Center is a robust physical medicine and rehabilitation (PM&R) program. Board-certified physiatrists, fellowship trained in spine and pain medicine, are the first to evaluate new patients. Then, in conjunction with the rest of the team, they determine the best course of action for each patient. The team's decisions are guided by years of data that identifies the most appropriate course of action for each condition. This helps ensure that only those patients who absolutely need surgery, get surgery.

Patients who do need surgery see either an orthopaedic spine surgeon or neurosurgeon with expertise in that patient's particular condition. The six orthopaedic spine and neurosurgeons at the UCH Spine Center perform more than 800 surgeries a year, ranging from simple microdiscectomies to computer-assisted, threedimensional surgical navigation.

They are also the only surgeons in the state offering a full array of complete endoscopic and endoscopic-assisted procedures, including transthoracic—the minimally invasive procedure that enables patients to return home the day of the operation. UCH is the only Spine Center in the region to offer "cooled radiofrequency ablation" for patients with chronic sacroiliac (SI) joint pain. The procedure is performed with a special probe that creates targeted lesions on specific nerve branches to the sacroiliac joint, disrupting pain signals to the brain.

The Spine Center surgeons have particular expertise in:

- » Spinal deformity, including scoliosis and adult deformities
- » Revision surgery
- » Minimally invasive spine surgery
- » Disc replacement and other motion preservation techniques
- » Complex reconstruction after trauma
- » Intradural spinal tumors

Most patients present with complex spinal conditions or significant medical comorbidities that can complicate their management, and it is not unusual for surgeons to spend the entire day in the operating room working on one patient.

Access to Progressive Approaches

The Spine Center has an extremely active and dynamic clinical research program. Some of our current efforts include:

- » evaluating epidurals for spinal stenosis
- » physical therapy as a first-line option for patients with sciatica with weakness
- » new devices and materials for disc replacement
- » fusion to stabilize sacroiliac joints

SPINE LENGTH OF STAY



SPINE MORTALITY



Expected

SPINE OUTPATIENT VISITS





Removing High-Risk Spinal Tumors

How one UCH tumor patient survived a high-risk chondrosarcoma—and what's being done to treat complex cases involving the spine

When Richard Knabenbauer's fingertips started "to go numb a little bit," he wasn't worried. But his primary care doctor was, and sent the 64-year-old man to a neurologist.

After an EMG and an MRI, the neurologist found a tumor at the craniocervical junction and sent Knabenbauer to a neurosurgeon. By this time, the numbness had spread, and Knabenbauer was having problems with coordination and balance. The neurosurgeon reviewed the scans and told Knabenbauer that he needed to see the experts at the University of Colorado Hospital Spine Center. "About that time I started getting scared," Knabenbauer says.



- > UCH bone tumor patient gets complete resection of chondrosarcoma at the craniocervical junction.
- > UCH regularly handles complex tumors in and around the spine.
- > UCH employs a multi-disciplinary approach to surgical spine cases.

Optimizing Treatment

Another MRI and a CT-guided biopsy at UCH showed that Knabenbauer had a chondrosarcoma that was pushing on the craniocervical junction. "For a complex, high-risk case like this, our multidisciplinary approach provides a lot of different insights to come up with the best treatment," says neurosurgeon Michael Finn, MD. Finn presented the case to the UCH Spine Center's weekly Tumor Board Conference, comprised of radiologists and interventional radiologists, pathologists, and neurosurgeons. The resulting treatment plan involved coil embolization of the left vertebral artery, a multi-staged tumor resection, and radiation therapy. Three neurosurgeons, including Finn, performed the procedures.

Teaming Up

To enable removal of the tumor where it had draped around the lateral spine, Joshua Seinfeld, MD, performed the coil embolization. Two days later, Finn performed the first surgical procedure: posterior craniocervical tumor resection and stabilization. To resect the part of the tumor that was inaccessible with the posterior approach, about three weeks later Finn and Kevin Lillehei, MD, performed a transoral tumor resection and neurological decompression. Lillehei, an expert in skull base tumors, is chair of neurosurgery at the University of Colorado School of Medicine.

Through the two procedures, the neurosurgeons were able to debulk the tumor to facilitate the radiation therapy and relieve the pressure on Knabenbauer's spinal cord. "We do more complex spine procedures, including those involving the craniocervical junction, than anyone in the area," says Finn.



Enhancing Recovery

Although Knabenbauer did have complications due to severe tongue edema, Finn ensured that he was well enough to leave the hospital in time for his son's wedding. "Dr. Finn made sure I got out of bed and took my walks," Knabenbauer says. "He carefully monitored everything to make sure I was well enough to get home and see my son married."

Knabenbauer completed proton beam therapy at Loma Linda University Medical Center in Loma Linda, Calif., where he has family nearby. He continues to recover at home in Colorado, grateful to be alive. "I wouldn't be around today if it weren't for Finn, Lillehei and that group," he says. Knabenbauer looks forward to getting back to enjoying the Colorado outdoors.

Improving Quality of Life

How one UCH spine patient became pain free for the first time in 30 years and what's being done for patients with complex spine disorders



For 30 years, Susan Thomas's daily companion was severe hip and back pain. "There was nothing comfortable about anything I did," says the 64-year-old woman. Although Thomas had been diagnosed with scoliosis in fourth grade, she felt fine and didn't need treatment. But in her mid-20s, she started having hip pain, which worsened when she became pregnant at age 33. By the time her son was a toddler, she couldn't even lift him up.

After a CT scan showed that Thomas had spondylolisthesis and scoliosis, she spent two years wearing a body jacket. Then she had the first of three spinal fusions over 16 years. But the pain continued. By the fall of 2010, Thomas had to leave a job she loved—working the front desk for a primary care physician. "By this time, I was bent forward and to the right," she says. "I couldn't lift files. I couldn't twist or bend. It was uncomfortable to sit."

Relieving Pain and Restoring Alignment

Completing a comprehensive assessment of the two conditions affecting Susan, Vikas Patel, MD, had to consider not only biomechanics, but also lifestyle and desired functionality. After reviewing her full spine x-ray with a radiologist, Patel collaborated with an interdisciplinary team at the University of Colorado Spine Center—other orthopaedic spine surgeons, physiatrists and neurosurgeons. "The best treatment was to treat her degenerated areas: not just with adding on to the fusion as in the past, but also realigning the spine. The goal was to take away the source of the pain and allow her to stand and walk more normally," Patel says.

In December 2011, Patel and orthopaedic spine surgeon, Evalina Burger, performed a posterior spinal fusion of T10-S1 with a pedicle subtraction osteotomy at L4 on Thomas. Together, and working with an experienced OR spine team and advanced technology, the surgeons efficiently and safely performed the complex procedure. The intra-operative imaging and surgical

navigation system they used was especially important, as Thomas' earlier procedures had destroyed the typical anatomical landmarks. From the first appointment to follow-up after hospital discharge, nurse practitioner Susie Estes worked with Patel to educate and support Thomas. "She walked me through everything," Thomas says. "I could call her any time."

- > UCH scoliosis and spondylolisthesis patient now lives without pain.
- > UCH is a referral hospital for complex surgical spine cases.
- > UCH orthopaedic surgeons, neurosurgeons, physiatrists, physical/occupational therapists, anesthesiologists, and others collaborate on spine care.

Standing Tall

Thomas returned home upright and pain free. "It was the first time I've been out of pain since 1981," she says. To continue her recovery, Thomas began riding a stationary bicycle and walking on a treadmill, progressing to a daily, hour-long workout of aerobic exercise, core exercises on a ball, weight training, and stretching. "I feel great," she says. "I'm in better shape now than I have been in 20 years." Thomas is also back to riding her bike on local bike paths and spending more time with friends.

RESEARCH & INNOVATION

Epilepsy

IIP - Eye Witness Study - investigator-initiated, IRB 09-0556 *The Accuracy of Seizure Descriptions from Patients and Eyewitnesses* Principle Investigator: Mark C. Spitz

Movement Disorders

IIP - fMRI in Parkinsons' Disease

Functional Connectivity of the Motor Network in Two Major Subtypes of Parkinson Disease Principle Investigator: Brian D. Berman

IIP - fMRI in Primary Focal Dystonia

Functional Connectivity of the Basal Ganglia in Primary Focal Dystonia: A Pilot Project Principle Investigator: Brian D. Berman

IIP - Fatigability/Cognitive Performance

Fatigability of Cognitive Performance in Older Adults: Objective Measures and the Impact on Quality of Life and Activity Level Principle Investigator: Jessica Bernard

IIP - Friedreich's Ataxia - Investigator Initiated (11-1141)

An objective double blind evaluation of bupriopion and citalopram in an individual with Friedreich ataxia Principle Investigator: Olga S. Klepitskaya

IIP - MER *Review of number of microelectrode recording passes performed during subthalamic nucleus deep-brain stimulation surgery* Principle Investigator: Olga S. Klepitskaya

IIP -White Matter

The Burden of Cerebral Diffuse Ischemic White Matter Disease, Measured Quantitatively on MRI, as a Possible Predictive Factor of Cognitive Outcomes after STN DBS Surgery for Parkinson Disease Principle Investigator: Olga S. Klepitskaya



IIP - Acupuncture - Naïve Study: Investigator Initiated - MJ Fox (11-0975)

Does prior acupuncture experience bias subjects' perception of real versus sham acupuncture treatments? Principle Investigator: Benzi M. Kluger

IIP - Acupuncture Study - Investigator Initiated - MJ Fox (10-0533)

Acupuncture as a Symptomatic Treatment for Fatigue in Parkinson's Disease Principle Investigator: Benzi M. Kluger

IIP - Cognitive Dysfunction in PD

Cognitive Dysfunction in Parkinson's Disease Principle Investigator: Benzi M. Kluger

IIP - MD Database - Investigator initiated (09-1125)

Movement Disorders and Behavioral Neurology Research Database Principle Investigator: Benzi M. Kluger

IIP - Neurophysiology of Central Fatigue - Dept of Defense (10-0539)

Study of the Neurophysiology of Central Fatigue Principle Investigator: Benzi M. Kluger



IIP - PET Scans Accuracy of PET Scans in the Diagnosis of Dementia in the Community Setting Principle Investigator: Benzi M. Kluger

IIP - RTMS Research Registry

University of Colorade Denver Depression Center Repetitive Transcranial Magnetic Stimulation (RTMS) Research Registry Principle Investigator: Benzi M. Kluger

IIP - Volitional Action

Functional Neuroimaging of Volitional Action Using Magnetoencephalography and Functional MRI Principle Investigator: Benzi M. Kluger

NINDS - Risk Factors for PSP

Genetic and Environmental Risk Factors for PSP Principle Investigator: Benzi M. Kluger

NIH - Memantine FXTAS

Memantine Treatment in Fragile X-Associated Tremor/Ataxia Syndrome Principle Investigator: Maureen A. Leehey

NINDS - NET-PD

NET-PD LS-1 Creatine in Parkinson's Disease Principle Investigator: Maureen A. Leehey

IIP - 3,4-DAP

Use of 3,4-Diaminopyridine, and Investigational new drug, in Lambert-Eaton Syndrome Principle Investigator: Steven P. Ringel

MS

CD40 (08-0613) *The role of TH40 cell in Multiple Sclerosis and Type 1 Diabetes* Principle Investigator: John Corboy

NINDS - Estriol NINDS = National Institute of Neurological Disorders and Stroke

Principle Investigator: John Corboy

NMSS - MS Tissue Bank

Rocky Mountain MS Center Tissue Bank Principle Investigator: John Corboy

Biobank For MS And Other Demyelinating Diseases - ACP (Accelerated Cure Project)

Large-scale, Multi-disciplinary Sample and Data Repository for Multiple Sclerosis and Related Demyelinating Diseases Principle Investigator: Augusto A. Miravalle

NPMSC PeMSDD Database

Pediatric Multiple Sclerosis and other Demyelinating Diseases Database (PeMSDD Database) Principle Investigator: Teri Schreiner

Biogen TYGRIS

The Global Observational Program on the Safety of Tysabri Principle Investigator: Timothy Vollmer

Neuromuscular

NIH - Oxidative Stress COSMOS

Multicenter Als Cohort Study of Oxidative Stress And Disease Progression Principle Investigator: Yvonne Rollins

Neuro-Ophthalmology

IIP - Microvascular Etiology

Prospective Study to Determine the Proportion of Patients with Isolated Third, Fourth, and Sixth Nerve Palsies of Microvascular versus Non-Microvascular Etiology Principle Investigator: Jeffrey L. Bennett

Alzheimer's Association - AWARE

Virtual Reality Assessment of Visuospatial Disorientation in Alzheimer's Disease Principle Investigator: Victoria S. Pelak

IIP - Neuroadaptation

Neuroadaptation of Multifocal Intraocular Lenses After Cataract Surgery Principle Investigator: Victoria S. Pelak

IIP - Visual Perception after DBS in PD

Virtual Reality Assessment of Visuospatial Disorientation in Patients Undergoing Deep Brain Stimulation (DBS) Principle Investigator: Victoria S. Pelak

NIH - Testosterone & Spatial Domain Chan

Functional and Neuroanatomical MRI Correlates of Spatial and Other Cognitive Domain Changes Associated with Testosterone Supplementation in Healthy Older Men Principle Investigator: Victoria S. Pelak

NIH - Visual Perception in AD

Development of Visual Perception Tests for Normal Aging, Mild Cognitive Impairment, and Alzheimer's Disease Using Computer Based Graphics and Virtual Reality Application Principle Investigator: Victoria S. Pelak

Neurosciences

IIP - LP Simulations

Lumbar Puncture Simulation Training for University of Colorado Hospital Residents in Post-Graduate Year 1 (PGY-1) Training Principle Investigator: Victoria S. Pelak

Spine

Cell saver

Prospective Analysis of Cell Savor Transfusion Related Morbidity and Coagulopathy in Spine Surgery Principle Investigator: Evalina Burger

0-arm

Prospective Study of Pedicle Screw Placement Using the O-arm and Navigated Instrumentation Principle Investigator: Vikas Patel

MJ

Survey Of Medical Marijuana Use in a Tertiary Spine Surgery Clinic Principle Investigator: Michael Finn

HCOL

Prospective Analysis of Spine Surgery Outcomes Principle Investigator: Emily Lindley



Stroke

NINDS - ICTuS 2/3

Phase 2/3 Study of Intravenous Thrombolysis and Hypothermia for Acute Treatment of Ischemic Stroke - CO not listed as a participant; our location is not listed on NCT01123161 Principle Investigator: William Jones

NINDS - POINT study

Platelet-Oriented Inhibition in New TIA Platelet-Oriented Inhibition in New TIA (POINT) Trial - CO not listed as a participant Principle Investigator: Jennifer R. Simpson

SELECTED PUBLICATIONS

Neurology

Arellano B, Hussain R, Zacharias T, Yoon J, David C, Zein S, Steinman L, Forsthuber T, Greenberg BM, Lambracht-Washington D, Ritchie AM, Bennett JL, Stüve O. "Human Aquaporin 4281-300 is the immunodominant linear determinant in the context of HLA-DRB1*03:01: relevance for diagnosing and monitoring patients with Neuromyelitis Optica." *Arch Neurol.* 2012 Sep;69(9):1125-31. doi:10.1001/archneurol.2012.1300. PubMed[citation] PMID: 22751865

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Braun CN, Hughes RL, Bosque PJ. "Reversible cerebral vasoconstriction syndrome 3 months after blood transfusion." *J Stroke Cerebrovasc Dis.* 2012 Nov;21(8):915.e1-5. doi: 10.1016/j.jstrokecerebrovasdis.2012.01.013.
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