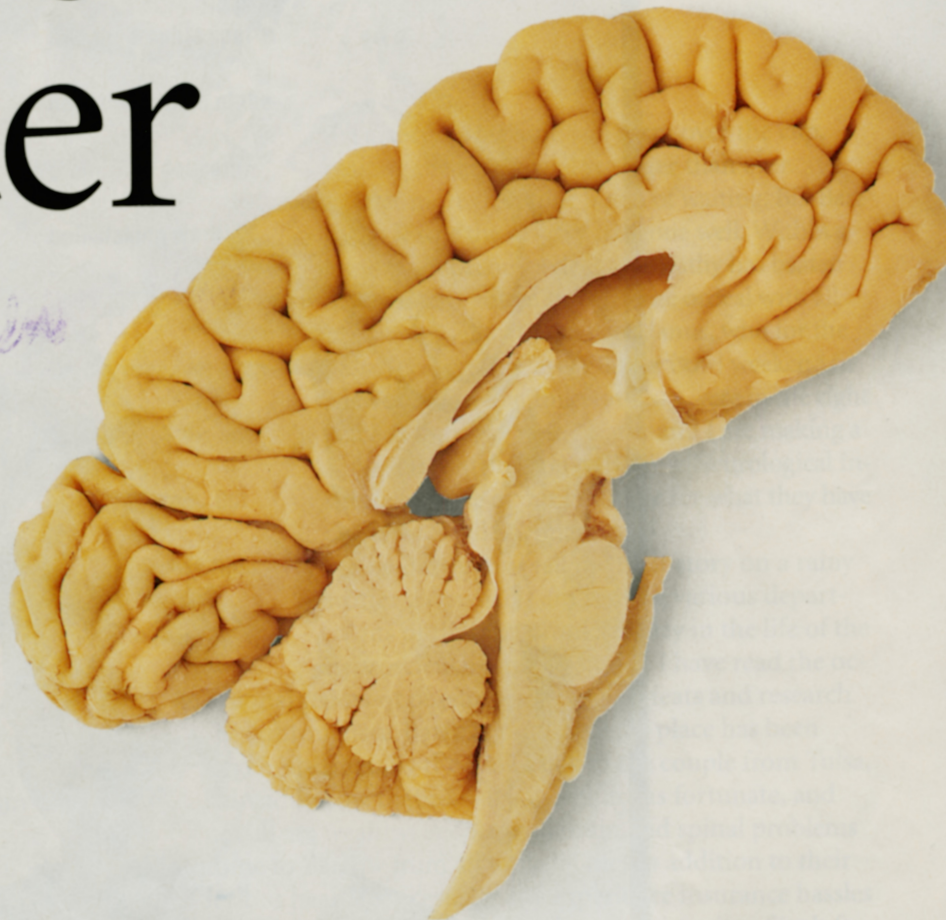


Nerve Center

*Exploring
the frontiers
of science
and
medicine
at Barrow
Neurological
Institute*



It is a glorious Arizona morning the day before the 1996 Super Bowl. Kathy Bartmann and a friend are standing in the crowd along the route of the Parada del Sol, Scottsdale, Arizona's popular Western parade. Kathy and her husband, Bill, have flown to metropolitan Phoenix for the weekend from their home in Tulsa, Oklahoma. Partners in a financial-services company, the Bartmanns have brought 74 people to Phoenix for a seminar on Friday, sightseeing on Saturday and the big game on Sunday in suburban Tempe. For a while, Kathy is caught up in the spectacle of horses and cowboys. But somewhere between the Clydesdales and the miniature horses, she feels a monstrous rush of pain inside her head. "I have to sit down," she tells her friend. "You better get the paramedics."

Fortunately, medical personnel are covering the parade and are close at hand. Scottsdale Memorial Hospital is only blocks away. Kathy is at the emergency room in minutes. There,

By Carrie Sears Bell

Photography by Sue Bennett



a doctor informs the Bartmanns that an aneurysm is bulging from an artery inside Kathy's brain. She needs surgery. "You should be across town," says the physician, "at Barrow Neurological Institute." Before long, Kathy is in a helicopter en route to St. Joseph's Hospital and Medical Center in Phoenix, the Catholic hospital where BNI was founded in 1962.

One of the largest neuroscience centers in the southwestern United States, Barrow Neurological is on the cutting edge when it comes to treating afflictions of the brain and spinal cord. Nearly 1,000 patients are admitted to the 115-bed facility each year, and thousands more are treated on an

outpatient basis. They come not only for treatment of aneurysms and accidental injuries to the brain and spinal cord, but also for care related to tumors, Alzheimer's disease, epilepsy, sleep disorders, Parkinson's disease, multiple sclerosis, muscular dystrophy, headaches and a host of other neurological maladies. Though best known for its deft neurosurgeons, Barrow has a growing department of neurology and has become a center for front-line research. Some of its independently funded Ph.D.s are looking for cures for brain tumors, while others are developing new diagnostic-imaging techniques.

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cial to the success of her surgery. Magnetic Resonance Imaging scans, CT scans and angiograms allow her doctors to pinpoint the exact location of her aneurysm, at the top of the brain stem. Kathy's surgeon is Robert F. Spetzler, M.D., director of Barrow Neurological Institute and widely regarded as one of the best vascular neurological surgeons in the world. The 51-year-old doctor takes on the toughest challenges and often pulls off positive outcomes.

Kathy's aneurysm, which Spetzler labels "very, very dangerous" because of its size and location, is one that requires finely honed skills. An aneurysm, the Bartmanns learn, is a weak area in the wall of an artery that has ballooned outward from the pressure of blood flow. No one is certain why aneurysms occur, but when they rupture, blood rushes into the brain like air from a blown-out tire, almost always resulting in death. Spetzler and his team want to remove Kathy's aneurysm before that can happen.

Kathy spends the morning of Super Bowl Sunday in one of Barrow's high-tech operating rooms. Except for the small opening where Spetzler and his team are probing into her brain, she has disappeared under a sea of sterile blue fabric. The room seems almost booby-trapped by a network of cords, tubes and machines that provide support for the operation. Doctors, nurses and visitors—all wearing masks and dressed in sterile blue scrubs, caps and booties—step carefully. Overhead, TV monitors project images from a camera inside the surgeon's microscope, allowing observers to see what he is seeing.

Equipped with a powerful stereo microscope and precision tools—a high-speed pneumatic drill, fine-bladed scalpels, miniature scissors, a suction hose the width of a kite string—Spetzler and his team cut through the bone at the roof of Kathy's right eye socket and gently tunnel into the trouble spot on the basilar artery near the middle of the brain. It is delicate, painstaking work. To the untrained observer, it seems unfathomable that anyone can negotiate this convoluted terrain. But Spetzler knows right where he is going. When he gets to the aneurysm, he puts a tiny spring-loaded metal clip across its neck, sealing it off from

the artery. Scar tissue will form over the clip, making the artery wall stronger than ever.

After more than four hours of waiting, Bill Bartmann learns the surgery has gone well. Within a few days, it becomes clear that Kathy has beaten the odds and gotten through the ordeal with all her faculties intact. The Bartmanns, who for the past 10 years spent every Super Bowl weekend in Las Vegas, feel that this year, they were in the right place at the right time. "Kathy and I are making a \$100,000 contribution to Barrow Neurological Institute because of our gratitude for what they have done," says Bill Bartmann.

The Bartmanns tell me their story on a rainy winter day, when I am visiting various departments of BNI to chronicle a day in the life of the neuroscience center. Though I have read the occasional report of phenomenal surgical feats and research breakthroughs at Barrow, until now the place has been largely abstract. By the time I talk to the couple from Tulsa, I already know that not all patients are as fortunate, and not all are wealthy. People with brain and spinal problems come to Barrow from all walks of life. In addition to their serious health concerns, many experience insurance hassles and financial worries. At the same time, in spite of its lofty reputation, BNI has to concern itself with the same mundane issues that challenge health-care institutions everywhere these days, from fund-raising to cost containment to competitive pricing.

But just before 7 a.m., as I make my way past the construction site for Barrow's new neurosciences building and into BNI's modest front entrance, I am not thinking of such down-to-earth realities. Instead, I am wondering what I will learn today about the mysteries of science and medicine, and about the people here who are pushing the envelope to know more—and to help others.

7 a.m.

One of those people is 51-year-old Volker Sonntag, M.D., an internationally recognized neurological spinal surgeon who has pioneered new techniques in his field and operated on the likes of the Queen of Saudi Arabia—who had her pick of the world's top spinal surgeons. In addition to performing about 10 surgeries per week and seeing patients in

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the office, the German-born Sonntag also is vice chairman of BNI's department of neurosurgery, chairman of the spine section and director of Barrow's seven-year neurosurgery residency program. He is a busy man, but not too busy to be friendly and to reveal his sense of humor.

The doctor and his "spine team" pick me up in the BNI lobby just after 7 on their way to morning rounds, the time when Sonntag likes to look in on his surgery patients. The team, which numbers more than a half-dozen, includes BNI residents and fellows as well as observers who spend anywhere from a month to a year shadowing Sonntag. Today's group includes neurosurgeons from as far away as Hong Kong, Singapore and Switzerland.

Lean and energetic, Sonntag moves at a fast clip. Everyone follows closely as a chief resident updates him on the patients we are about to see. First on the list is a middle-aged man from Idaho who has had several back surgeries and been on disability for 12 years. His current complaint: a sudden sharp pain in the back of his neck and shoulders that occurred while he was watching TV in his motor home in southern Arizona. Ever since, he's had continuing neck and shoulder pain, along with weakness in his upper arms.

Sonntag, who's been asked to consult on the case, stops in a file room to look at pictures of the patient's MRI scan. With the film over a light box, he points out the locations of the previous surgeries, but can find nothing to account for the man's new problems.

In the patient's room, Sonntag asks questions and has the man try all types of movements. "You've got me puzzled," says the surgeon. "Nothing happened before this pain?"

"No, doc. I was just watching TV," the man answers.

"What were you watching? Maybe that's the problem," Sonntag quips. Before we leave, he tells the man he is ordering neck X-rays and an electrical test of his shoulders. Down the hall, he ponders whether psychological factors are at play in this case.

There is no such mystery about patient No. 2. He is a young man who has fallen off a roof in northern Arizona and severely fractured his spine, driving shards of bone into his spinal canal. "Yesterday, we went through his chest and

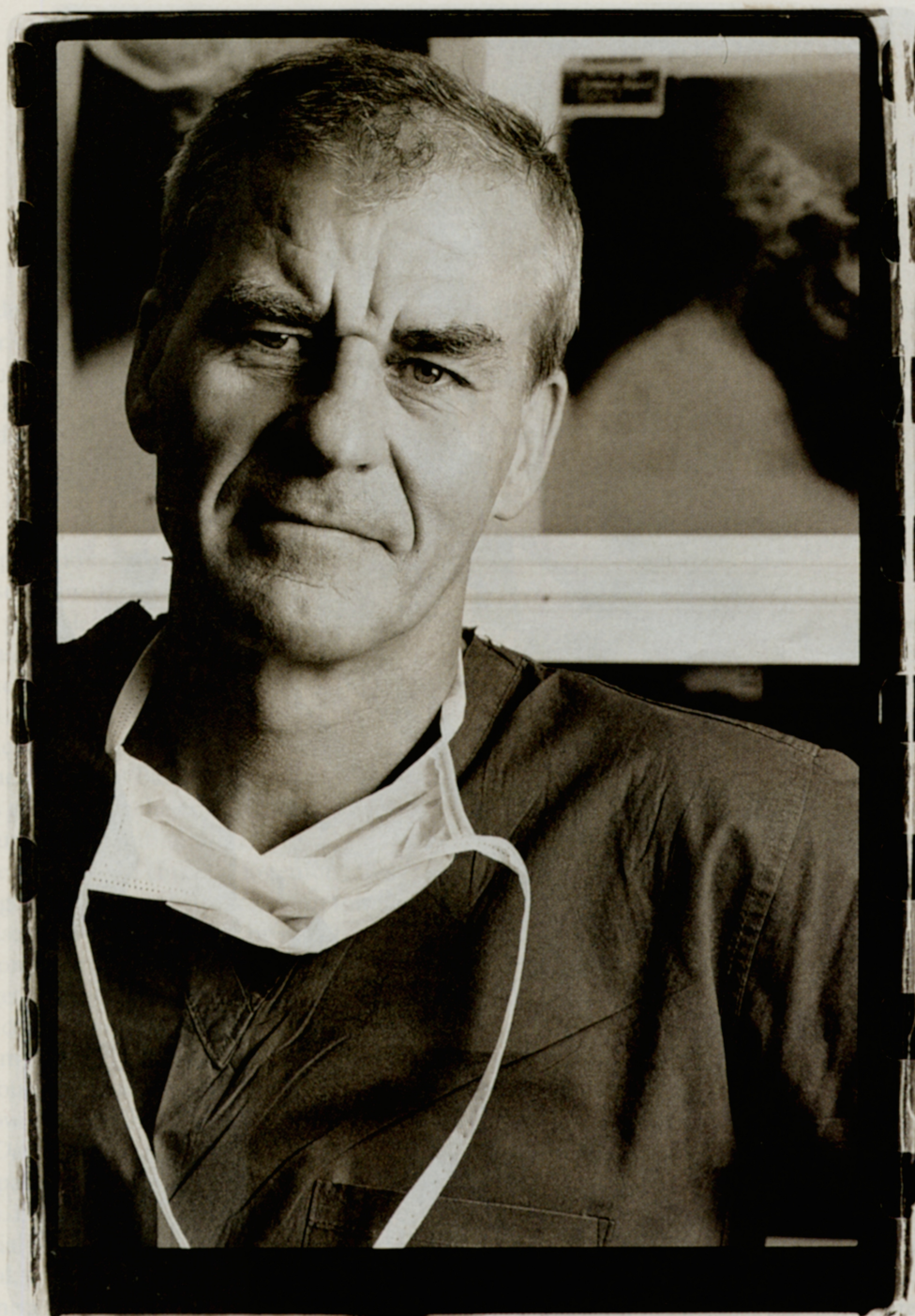
pulled the bone out of the canal," says Sonntag. "Then we put the bone in a small cage and put the cage back in [at the fracture site in the spinal column] and put a plate on top of it for stabilization." The cage technique allows the surgeon to make a smaller fusion and immobilize fewer segments of the spine than procedures done in the past, notes Sonntag. Though the patient currently has numbness in his buttock, groin and leg, the prognosis for a full recovery is good.

Next, we visit an older man and two women in their 40s who are suffering from ruptured disks, the bread and butter of spinal surgeons everywhere. When asked what causes ruptured disks, Sonntag says there is no common denominator. "It can happen turning over in bed or in an accident," he says. "It happens to people who are out of shape and to phenomenal athletes."

The last patient the team sees this morning is a 17-year-old from California who had a giant-cell tumor removed from his upper spine three days ago. In an operation that took eight hours, Sonntag went through the boy's mouth to remove the tumor, which had virtually destroyed the second vertebrae. He then used some bone from the patient's hip and some wire to fuse the first vertebrae to the third and fourth vertebra. "The wire and bone are like rebar and cement," explains Sonntag. During the 12 weeks it takes for the bone to harden, he adds, the boy will wear a "halo," a specially designed metal brace that supports the skull and spine during healing. Since removal of a giant-cell tumor is considered a cure, the teenager's future looks bright.

9 a.m.

In the basement of Barrow, far removed from the patients and physicians upstairs, I enter a vital little world almost unto itself: the neuro-oncology laboratory. Crammed into a few small rooms full of expensive microscopes, incubators, freezers, tubes, dishes and other tools of their trade, the five Ph.D.s and four technicians on staff here are like a group of detectives toiling on the most important case of their careers. The leads are slim and progress is painstaking, but there is a sense of urgency about the work. Approximately 15,000 people per year are diagnosed with malignant brain tumors. For those with the worst type of malignancy, the



median survival time is less than a year. Learning the secrets of brain tumors likely will prolong, if not save, lives.

Lead detective on the case is Joan Rankin Shapiro, Ph.D., who left Memorial Sloan Kettering Cancer Center in New York to found BNI's neuro-oncology lab in 1989. Shapiro is a gifted researcher who also has a talent for educating the uninitiated about what she and her colleagues do. Being a good communicator comes in handy when she orients the high school and college students who do volunteer work in

the lab, as well as when she writes for grants and solicits private contributions to fund her department's research.

Shapiro, saying I need to know something about genetics before I can understand her work, launches into a crash course: Our bodies are made up of cells, and each cell has a nucleus. Each nucleus contains genetic material made up of chromosomes and genes. Each of us has a genetic code that determines everything about us. That code is present in every cell of our body, but appears altered in cancer cells. ➤



They are genetic mutants that for some reason don't get wiped out by the body's normal defense system.

Not only are cancer cells different from normal cells, but they also are different from each other. That's why some cancer cells succumb to certain therapies while others don't. Which brings us to the focus of Shapiro's research: "I isolate those cancer cells that survive even the harshest anti-cancer drugs or radiation and ask the question, 'What's different about these cells from the ones we kill?'" she says. "If we can learn what makes cancer cells resistant to

therapy, we might be able to design ways to block that resistance."

Shapiro has come up with some answers. In 1981, she was among the first to say that the cancer cells most resistant to radiation and chemotherapy are not the most blatantly abnormal ones, as previously believed, but the ones with only subtle abnormalities. She also has identified two chromosomes that appear to be significant in resistant brain-tumor cells, a finding she couldn't get published for seven years but that now is recognized as a fundamental

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observation. "I don't know why those genes are important or what they are because there are 100,000 human genes, and we've only identified 15,000 so far," says Shapiro. "My challenge to students is to find out about the other 85,000."

10 a.m.

For many people who have been hospitalized because of severe neurological injuries or illnesses, it's not possible to simply go home from the hospital and get back to the life they had before. Some have to relearn how to think, move and speak. Others have to adjust to life in a wheelchair or cope with weakness on one side of their body. At Barrow, these types of patients get the help they need in the 38-bed acute neuro-rehabilitation unit.

Ranging in age from young children to seniors, the patients here might be victims of strokes, brain tumors, brain trauma, diseases like Parkinson's, or spinal-cord injuries like the one that actor Christopher Reeve suffered. "Our goal is to get patients to the highest level of independence they can achieve," says Jill Danielson, the unit's nurse manager/program manager. "We walk a fine line between giving them encouragement to work toward their goals and letting them know what we think is realistic."

According to Danielson, a team of professionals evaluates each new rehab patient and creates a program to meet their individual needs. Each team includes a rehab physician, a rehab nurse, social workers, a neuropsychologist, and physical, occupational, speech-language and recreational therapists. "In assessing a patient, we look at activities of daily living," Danielson explains. "Those include ambulation and mobility skills, the ability to think, swallow and speak, and the patient's emotional adjustment to their disability."

Down the corridor from Danielson's office, a therapist is helping a brain-injured man re-establish his sense of direction. In a glass enclosure off of the unit's large multipurpose room, a group of patients is reading the newspaper and discussing its contents with a speech-language pathologist. Near the nurses station, a rehab doctor is preparing to discharge a car-accident victim who has spent 70 days here gaining skills he will need in his new life as a paraplegic.

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"We're here to help patients, but we tell them we want them to do things for themselves," adds Danielson, who says the average length of stay in the unit is 22 days. "That is different from what they have experienced in the hospital, and it makes some patients unhappy. But they have to agree to participate in our program or they cannot stay."

10:30 a.m.

Entering the Magnetic Resonance Imaging center, which occupies its own low-slung building just off BNI's main eight-floor structure, is sort of like going into a high-tech cave. Lots of computers and medical monitoring equipment ensconced in a subterranean semidarkness. My tour guide, Deanna Gilden, R.N., explains that technicians here get used to the dim lighting because it

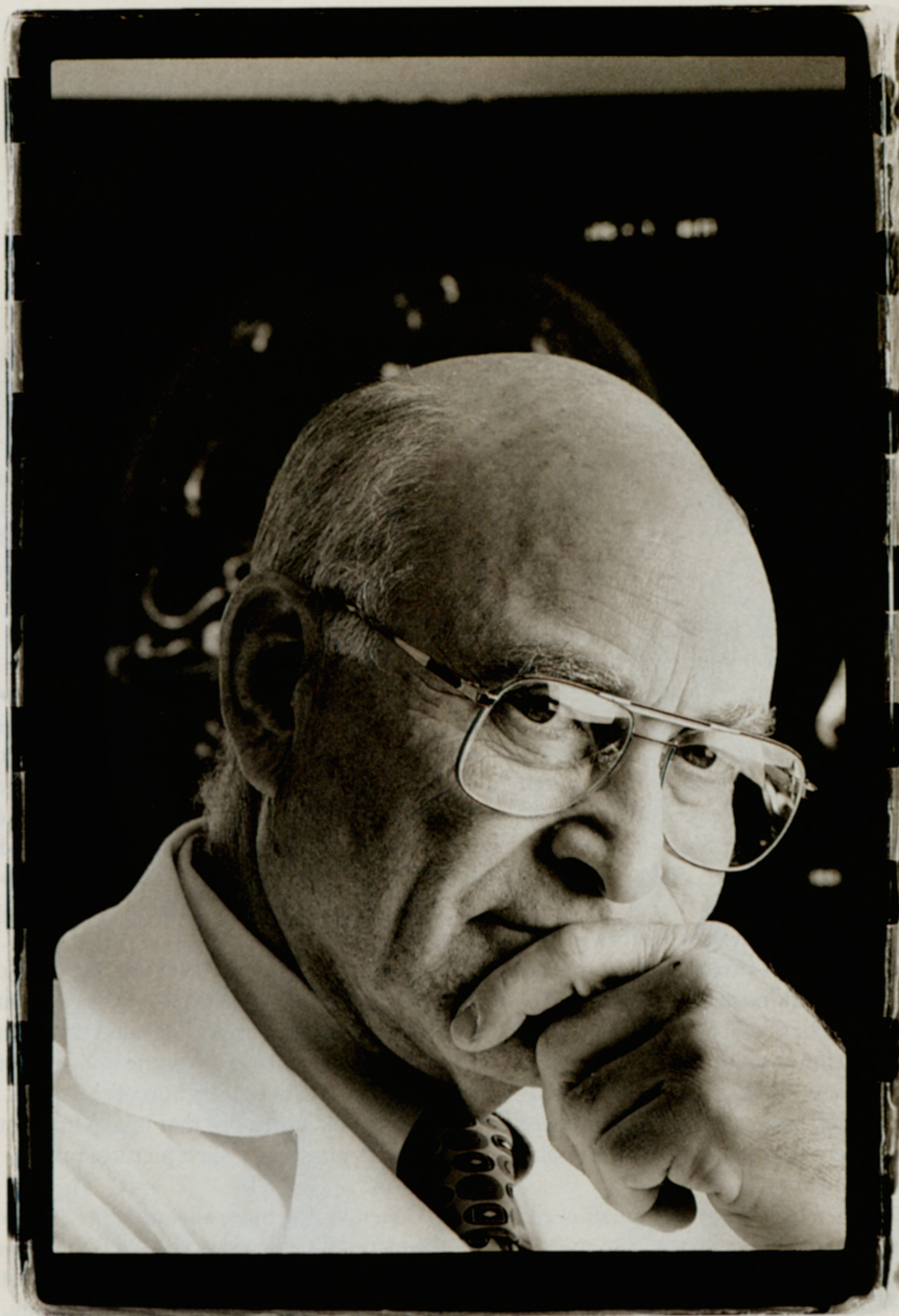
affords the sharpest pictures of MRI scans.

MRI technology, she explains, provides detailed anatomical images of parts of the body without using radioactive materials. Employing radio waves and magnets, an MRI scanner collects a volume image of a targeted area, such as the brain or a section of the spine. It is then possible to look at slices of that image from any angle. For Barrow's physicians, such pictures provide invaluable information.

Generally, the more advanced the MRI scanner, the better the pictures. Gilden says each of BNI's three machines has been upgraded in the past year. The newest scanner, capable of something called "echoplanar" imaging, is a model being used in only about a dozen medical facilities worldwide.

Something else Barrow has that is rare elsewhere is its own MRI physicist. "My job is to make those scanners do new things," says Paul Keller, Ph.D., who has been at BNI for nine years. In 1989, Keller developed a method of MRI angiography—imaging of blood vessels—that's now practiced widely. He's also written innovative software to make BNI's scanners perform more efficiently, and programmed the scanners to take new types of pictures. "For a researcher," he says, "this is a nurturing atmosphere."

For patients, by contrast, the MRI center can seem a bit foreboding. Many worry whether they'll be able to tolerate lying perfectly still inside a scanner for the required 40 min-



utes or more. To make them more comfortable, the center provides special earphones for listening to music as well as mirrors and prism glasses that allow patients to see outside of the scanners. "We have probably one adult outpatient a day who has to be sedated because of claustrophobia," says Gilden. "But a lot of people with mild claustrophobia get through it without medication if we're patient with them."

That virtually every patient I observe today has spent time inside an MRI scanner indicates how important this technology has become to neurological medicine.

11 a.m.

As I approach the five-bed Epilepsy Monitoring Unit on Barrow's third floor, the first thing I notice is that, for patients here, privacy is rare. Facing the nurses station are five large video monitors where the staff can see each patient's every move. It quickly becomes clear, however, that privacy is the least of these people's concerns. Most suffer from severe epileptic seizures that cannot be controlled by medication. That means they can't drive, in many cases can't work, and generally don't lead normal lives. "Most of the patients here have been on four or five drugs for seizures and still

Neurology Chairman

William Shapiro's

have three to 50 seizures a month," says Joe Connolly, D.O., a graduate of Barrow's three-year neurology residency program who is now doing a clinical neurophysiology fellowship. "Our goal is to cure the seizures."

Currently, the best cure is surgery. Unfortunately, surgery is only feasible if tests show that the patient's seizures originate from one spot in the brain, and that the spot can be surgically removed without causing severe dysfunction.

To determine what area of the brain a patient's seizures are coming from, neurologists look at such things as MRI scans and electroencephalogram tracings recorded from electrodes attached to the scalp or surgically implanted in the brain. In the EMU, all the patients are wired with EEG electrodes and watched closely for four to 14 days. In that time, their spells are captured on videotape and often traced to their source in the brain via EEG.

Without this kind of costly monitoring, which is available to only the most severely afflicted patients, neurologists don't always get a clear picture of what's going on with the patient. "Among patients sent to an epilepsy monitoring unit for surgical treatment, about 25 percent turn out not to have epileptic seizures," says Connolly, noting that psychiatric spells often are mistaken for epilepsy. "At the same time, about half of the patients sent to an EMU by a neurologist who thinks they don't have epileptic seizures actually do. So it's a tricky business. The monitoring we do here puts science into it and takes some of the mystery out."

For those who come to the EMU and turn out to be inoperable, there are other possible solutions. Barrow routinely participates in the testing of new epilepsy drugs that aren't yet approved in this country, but already are being used with success elsewhere. "Of people with intractable epilepsy, 10 to 15 percent will respond dramatically to a new drug," says Connolly.

1 p.m.

Clad in blue scrubs, cap, booties and mask, I enter the neurosurgical floor and become anonymous. At the nurses station, I reveal that I am an outsider by asking which room Dr. Spetzler is operating in. A nurse points across the hall

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to a big board that tells what's going on this afternoon in each of the six operating rooms. On any given day, the surgeons here might be removing tumors from the brain or spine, repairing aneurysms or ruptured disks, stabilizing the area around a fractured vertebrae, or perhaps cutting out the source of an epileptic seizure.

Occasionally, they also take on more-challenging cases: In 1989, for example, Spetzler, Sonntag and pediatric neurosurgeon Harold Rekate teamed up to reattach a 10-year-old boy's skull to his spine following an auto-bicycle accident. Within several weeks, the boy could walk and swim. In 1995, surgeons here performed a "cardiac standstill" procedure—in which the body temperature is lowered, the heart is stopped, and blood is recirculated by machine—on a pregnant woman to remove a

dangerous basal stem aneurysm. Seven months later, she delivered a healthy baby.

Nothing that dramatic is scheduled for today, however. At the moment, Spetzler is removing an aneurysm near the brain stem of a woman who is about the same age as Kathy Bartmann. Inside the OR, I watch him work while Chief Resident Karl Greene, M.D., tells me about how this operation compares with the more difficult Bartmann case. At one point in the procedure, when Spetzler needs to concentrate intensely, he asks everyone in the room not to speak. Once he has successfully set the clip at the base of the aneurysm, conversation resumes.

When Spetzler is through, I go down the hall and enter the room where Dr. Sonntag is working. He is removing a benign spinal tumor from the back of a 76-year-old woman. Anesthetized and lying on her stomach, she is invisible under sterile fabric except for a section of her back where her spinal cord has been exposed.

A doctor from Singapore who's been observing tells me the woman had a tumor removed from the same spot 20 years ago. As often happens, it grew back. Looking through an intraoperative microscope, Sonntag probes inside the covering of the spinal cord and gently pulls out bits of the tumor. The job is slow going because of scar tissue from the old surgery. "I've never seen anything like this," says

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Sonntag, tugging at little round lumps of tissue attached to nerves around the tumor. "These look like salmon eggs."

Some of the "egg"-infested tissue he removes, but some is left behind, along with remnants of the tumor. The woman already has weakness on her left side, and Sonntag doesn't want to make the situation worse by damaging more of her nerves. "It's always the surgeon's dilemma: How much to take out?" he says.

3 p.m.

My last stop of the day is the neurology clinic, located in an office building across the street from BNI. There, I meet up with Dr. Joan Shapiro's husband, Neurology Chairman William Shapiro, M.D., a specialist in brain tumors and cancer of the nervous system. In practice for nearly 30 years, William Shapiro refers to himself as "a grandpa of the brain-tumor business."

Almost seven years ago, Shapiro came to Arizona from Memorial Sloan Kettering Cancer Center, where he was a department chair and a professor, to take on the challenge of building up Barrow's then-modest department of neurology. His vision was to create a neurology program where drug companies and government agencies could do clinically based research and patients could have access to the newest treatments for their disease.

Because Barrow is one of only a few neuroscience centers in its region, Shapiro felt certain it could attract the large numbers of patients needed for participation in major studies. But he would have to hire several more neurologists with expertise in various disciplines. And that he did. "We now have 20 physicians on staff and are looking to add several more this year," says the doctor, who has seen much of his plan for Barrow realized. "We also are the first- or second-largest contributor to national studies and clinical trials of anyplace in the country."

Though Shapiro wears many hats as department chairman, he still manages to see patients four full days a week and also to consult on MRI scans and medical records sent to him from all over the country.

This afternoon, I sit in on a few patient visits and learn firsthand what happens to people who have brain tumors.

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First, we see a man in his 40s who had surgery to remove part of a temporal-lobe tumor two months ago. For now, Shapiro has no plans to treat what's left of the tumor. Once regularly scheduled MRI scans show that it is starting to grow, however, the doctor will consider more surgery or radiation. With luck, that won't happen for three or four years.

Things don't look as good for the next patient, a younger man who is receiving radiation therapy for a large inoperable tumor. Radiation might not do much to contain his tumor, which Shapiro describes as "out of control."

Finally, we see a man in his 40s with two horseshoe-shaped scars on the left side of his head. He has recently had his second brain-tumor surgery and is undergoing chemotherapy. After his first surgery, the patient's tumor was in remission for three years and

he led a fairly normal life. Since the second surgery, he has become more aggressive and moody—something that often happens after brain surgery.

Though today's cases involve three men in the same age range, Shapiro assures me that brain tumors strike men and women of all ages. "Brain tumors are the second most common form of cancer in children," he says, "and the disease seems to be growing among the elderly. For some reason, people in their middle years have the best outcomes."

4:30 p.m.

As I get into my car to go home, I look back toward BNI. This morning, that building represented the unknown. Before going in, I felt like I was about to peek into a parallel universe where the life-forms possessed knowledge and abilities beyond that of the people in my world. Once inside, however, I found that the life-forms are real people, and the work they do is based on the latest hard science, not science fiction. ♦

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