

# minnesota MEDICINE

## Safety *first*

How anesthesiologists launched  
the patient-safety movement

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A Sleeper Career:  
Rural Anesthesiology Practice

Smoking and Chronic Pain

Ultrasound-Guided  
Regional Anesthesia





The invention of the pulse oximeter was a major step forward in patient safety, as it allows anesthesiologists to monitor oxygen saturation in a patient's blood and quickly prevent a crisis.

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Photo courtesy of Mayo Clinic

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Photo by Scott Walker

# To the Edge and Back

“You saved my life.” Anybody who has practiced medicine for any length of time has heard those dramatic words. Although I frequently think the comment is the result more of perception than reality, it is true that our patients sometimes walk the precipice between life and death and that sometimes we successfully yank them back. But occasionally, we put them on that cliff only to, we hope, pull them back to safety.

I remember the first time I participated in the cardioversion of a patient with atrial flutter. Clearly, the patient needed to be “rescued” from the rapid heart rhythm that was causing his dropping blood pressure and shortness of breath. Yet, I shuddered when, after the electrical shock was applied, his EKG showed a flat line for what seemed like an eternity. Finally, his heart kicked in with a normal rhythm that restored his blood pressure and cleared his symptoms. A few seconds of jeopardy followed by a “save.”

Luckily, primary care internists don't have to endure too many of these heart-stopping, anxiety-riling, gray-hair-promoting moments. But for anesthesiologists, this is their daily fare. Consider what happens with general anesthesia: A conscious and alert person lies down on a bed and allows a masked person in a funny-looking shower cap, whom they just met, to place them in a state of deep sleep for the next minutes or hours using toxic chemicals. They trust that this same person will have the skill, knowledge, and inclination to wake them up and restore them to their previous self. A recent *New England Journal of Medicine* review of the physiology of general anesthesia put it in stark terms: “At levels appropriate for surgery, general anesthesia can functionally

approximate brainstem death, because patients are unconscious, have depressed brain-stem reflexes, do not respond to nociceptive stimuli, have no apneic drive, and require cardiorespiratory and thermoregulatory support.”

Placing a patient in a state of brainstem death is quite a responsibility. So it's no wonder that anesthesiology has been at the leading edge of the patient safety movement. Long before “patient safety” was the buzzword it is today, anesthesiologists borrowed lessons from the airline industry and looked at what they did each day, analyzed when and why things went wrong, and built systems to prevent things from going wrong. Those systems have cut the rate of complication and death associated with all forms of anesthesia, which should make patients a whole lot more comfortable with that doctor behind the mask.

Increasingly, those masked doctors do a whole lot more than put people to sleep. Using ultrasound to find nerves long since forgotten from anatomy lessons, they administer innovative regional anesthesia, which minimizes narcotic use and shortens recovery time. The mushrooming of outpatient procedures has forced anesthesiologists to adjust and adapt, retooling the education of students and residents and bringing their equipment and skills into new environments such as interventional radiology suites and pain clinics.

Part of the drama of saving lives is the very undramatic focus on patient safety. Whether they are sitting in the OR squeezing the bag or in the clinic tackling pain, anesthesiologists will continue to teach, preach, and practice safe medicine.

.....  
Charles R. Meyer, M.D., editor in chief, can be reached at [cmeyer1@fairview.org](mailto:cmeyer1@fairview.org)

Primary care internists don't have to endure many heart-stopping, anxiety-riling, gray-hair-promoting moments. But for anesthesiologists, this is their daily fare.



Photo courtesy of Cuyuna Regional Medical Center

Having served as the only anesthesiologist in Crosby, Minnesota, since 2006, Mark Gujer is looking forward to having a colleague.

esthesiologists (ASA), only 5 percent of practicing anesthesiologists work in rural parts of the United States. Gujer wants to see that number increase and touts the merits of rural practice to job candidates, residents, and medical students.

Whether that 5 percent figure represents a shortage of anesthesiologists in rural America isn't exactly clear. A 2010 report by RAND Health found that the United States and Minnesota are experiencing a shortage of anesthesia providers including both anesthesiologists and certified registered nurse anesthetists (CRNAs). But the RAND report tells only part of the story. "In Minnesota, on paper there's no real shortage of rural anesthesiologists because no one's putting jobs out there for them to apply for," Gujer says. "People put their hands up a long time ago and said, 'We can't get them' and stopped trying."

Instead, most hospitals in greater Minnesota (most anesthesiologists in rural areas work for hospitals) began relying on CRNAs after Gov. Jesse Ventura in 2002 took advantage of a change in the federal Medicare rules that allowed states to exempt hospitals from requiring that physicians supervise CRNAs. Currently, 16 states have adopted the exemption.

Gujer believes the use of CRNAs doesn't alleviate the need for anesthesiologists. "If a hospital's goal is to build its surgical capabilities and do more complex cases so they don't have to transfer patients

to tertiary care facilities, they will have to have an anesthesiologist," he says.

And that's precisely what Cuyuna's administration wanted to do in 2006 when it hired Gujer.

### Staying Close to Home

At the time, Cuyuna was becoming known as a regional leader in minimally invasive surgery. Although its surgeons had the expertise to perform complex procedures, they were limited in the extent to which they could do them, as the hospital served a largely elderly population, many of whom had comorbidities. "They may have cardiac challenges or other health problems that make them an operative risk," says Howard McCollister, M.D., chief of surgery and co-director of the hospital's minimally invasive surgery center.

McCollister approached the hospital's board and administration about hiring an anesthesiologist who was experienced with medically complex patients—in particular those with cardiac problems—so that they wouldn't have to send them to the Twin Cities for surgery. "We needed an M.D. to bring a broader focus in dealing with people who have physiologic problems, so we could safely do operations on people that most rural facilities, including bigger ones close to us, can't do," he says.

But making the financial case for hiring an anesthesiologist to serve a rural hospital can be tricky. "They have to find a way to get more bang for the buck out of you because you might not generate the revenue

■ Rural Anesthesiology

## Sleeper Career

*Not many anesthesiologists practice in rural areas. Mark Gujer is trying to change that.* | BY KIM KISER

Mark Gujer, M.D., is preparing to sell the merits of Crosby, Minnesota. On a Friday in early January, he is getting ready to drive to Brainerd to pick up a physician from Anchorage, Alaska, who is interviewing for an anesthesiology position at Cuyuna Regional Medical Center, a 25-bed hospital in the town of 2,000.

Gujer has his work cut out for him. "We had 30 applicants and extended four interviews, which in our industry is doing quite well for a rural practice. These [positions] are difficult to recruit for," he explains.

As the only anesthesiologist in Crosby—and for that matter, one of only a handful in northern Minnesota—Gujer is somewhat of a lone wolf. According to the American Society of An-

the way a Minneapolis anesthesiologist can,” Gujer says.

The fact that Cuyuna is certified as a Medicare Critical Access Hospital made hiring one more feasible. Critical Access Hospitals receive cost-based reimbursement from Medicare in order to keep them financially viable; they also are able to hire physicians, who may not have a full-time case load, to oversee services such as surgery, the ICU, and the ambulance service.

Gujer, who met McCollister while working as an EMT in Virginia, Minnesota, before going to medical school, was hired as medical director of perioperative services—a job that involves managing patient flow in the surgical area as well as caring for patients before, during, and after surgery. (He is also designing a new perioperative suite in order to increase the hospital’s physical capacity for surgery.)

Since Gujer joined Cuyuna, the hospital has added a urologic surgeon and another orthopedic surgeon, bringing the total number of surgeons to 13; it now does approximately 4,000 procedures a year, and has gained Center of Excellence status for bariatric surgery from both the American College of Surgeons and the American Society of Metabolic and Bariatric Surgery. In addition, it is one of 117 teaching centers nationwide with a fully accredited fellowship in minimally invasive surgery.

### Comprehensive Caregiving

Gujer says his job is very different from that of many of his colleagues in urban areas. He explains that typically, urban

“In Minnesota, on paper there’s no real shortage of rural anesthesiologists because no one’s putting jobs out there.”

—Mark Gujer, M.D.

anesthesiologists come to the hospital in the morning, are assigned their room, then meet their first patient. They review the patient’s medical history, formulate an anesthetic plan, go back to the OR and put the patient under, then reverse the anesthesia after surgery and follow up with patients in recovery. Also, one anesthesiologist may see patients before surgery, another may take over in the OR, and yet another might follow up in the ICU.

Gujer’s work starts the moment a patient with complex

medical problems learns he or she needs surgery. He sees that patient before the procedure is scheduled, does an assessment, reviews their medical history, and communicates with their primary care physician. Other specialists may be brought in to consult and help formulate an operative and anesthesia plan. On the day of surgery, Gujer again meets with the patient, administers anesthesia in the OR, reverses it, and continues to monitor the patient in recovery and throughout his or her hospitalization. “It’s

very personal,” he says. “The same doc comes back every day and checks on you.”

Gujer says being able to get to know his patients personally and care for them throughout their hospital stay is what keeps him in Crosby. “I couldn’t go back to another model,” he says.

But that doesn’t mean working in a rural area isn’t without challenges.

There’s the potential for professional isolation, for example. One reason Gujer is looking forward to having a partner is to have someone to consult with and serve as his back up. “If you’re the only surgeon in town or the only anesthesiologist, you’re very isolated, you’re the only one doing what you do,” Gujer says. “It’s not sustainable.”

And anesthesiologists may have to prove themselves in ways they don’t have to in urban areas. “Anesthesiology is different from primary care,”

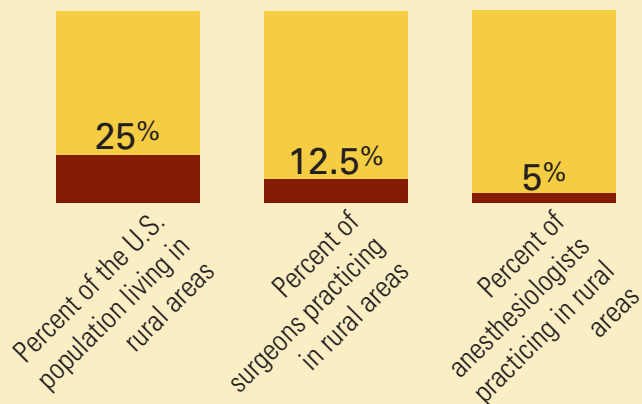
### Working with CRNAs

Although there is tension between anesthesiologists and certified registered nurse anesthetists (CRNAs) in some parts of the country, it hasn’t been the case in Crosby, Minnesota. Mark Gujer, M.D., the sole anesthesiologist at Cuyuna Regional Medical Center, has found that anesthesiologists and CRNAs can complement each other’s work in rural institutions.

Before Gujer joined Cuyuna five years ago, CRNAs were the only ones providing anesthesia services at the hospital. But surgeons in the community wanted to be able to do more complex procedures and work with sicker patients who were more difficult to treat. They convinced the hospital to hire Gujer.

Today, patients are triaged along two tracks. Gujer sees more medically complex patients. The hospital’s four CRNAs (they’re recruiting a fifth) independently handle the others. “The CRNAs may call me and ask for assistance or my opinion, but for the majority of cases, they function independently without input from me,” he says. “We have a fabulous collaboration. They’re happy, they’re fulfilled, they do a wonderful job, and they’re willing to concede that some patients are severely ill and would benefit from having a physician with advanced monitoring capabilities at the head of the table.”—K.K.

## A Look at the Numbers



Source: American Society of Anesthesiologists

says David Beebe, M.D., director of the anesthesiology residency program at the University of Minnesota. “You might go into an area and be the first anesthesiologist, and you’re dealing with nurse anesthetists, surgeons, and other doctors you don’t know. You need to show that you’re adding something.”

### Spreading the Word

Gujer, however, remains committed to promoting the positives of practicing in a rural community. Three years ago, he joined the ASA’s Rural Access to Anesthesia Committee, which established a fellowship for medical students interested in rural anesthesiology. Gujer is one of five mentors. During the last two years, he has had two medical students shadow him for four-week periods. The idea, he says, is to expose students to a side of anesthesiology they otherwise may not experience.

Jake Eiler, M.D., a 2010 University of Minnesota Medical School graduate, did a fellowship with Gujer in the fall of 2009. Eiler, who grew up in Morris, Minnesota, and

is now doing his residency at the University of Wisconsin, said the experience opened his eyes to the idea of working in a rural area. “If that experience is never one that’s provided or even available in medical school and residency, it’s hard for a person to think of it as a viable option when in actuality for me it might be the best option given the quality of life and kind of practice I want to have,” he says.

Eiler was so impressed with the experience that he and Gujer convinced the medical school to award credit to students who do the fellowship. Gujer also has worked with the university to create a rural anesthesiology rotation for residents. The three- to four-week rotation has been approved, Beebe says. He expects residents to sign up for it starting next fall.

“My goal is to reach out and get even more people interested in rural anesthesiology,” Gujer says. “I need to convince anesthesiologists that this is a viable, rewarding place to practice, and that they should be out there selling themselves to hospitals.” ■

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Photo courtesy Mayo Clinic

David Warner believes surgery is the best time for doctors to talk to patients about quitting smoking.

other drugs such as opioids following surgery.

Warner says patients are motivated to abstain when they learn that it will speed their recovery. Research—the best of which comes from Scandinavia—has shown for some time that bones heal more slowly and wounds are more likely to become infected in people who smoke. “What’s relatively new is the knowledge that if you can get people to quit, the complication rate goes down,” he says, adding that even if they quit for a brief period, their outcomes can improve.

Warner is now working to convince fellow physicians to start talking to surgical patients about quitting smoking. He says anesthesiologists and surgeons often think discussing smoking is not their job; that they don’t have time for it; that they don’t know how to help; that what they say isn’t going to have an effect; and that patients will be offended if they try to bring it up. “I spend most of my time in my research trying to knock down those misconceptions,” he says.

His research has shown that patients aren’t offended when surgeons and anesthesiologists talk to them about smoking. “In fact,” he says, “if there’s something they can do to improve their chances of having a good outcome after surgery, they want us as physicians to tell them.” And he’s identified an approach that is effective and simple for busy physicians to do. You simply ask patients about smoking, advise them to quit for as long as possible (he recommends at least a week starting the

## ■ Smoking and Surgery

# Anti-Smoking Prophet

*David Warner believes anesthesiologists can help patients quit.* | BY CARMEN PEOTA

Mayo Clinic anesthesiologist David Warner, M.D., has a message for his fellow physicians: Use the time just before surgery to encourage patients who smoke to quit.

Warner says his thinking about this began about 12 years ago when he started researching ways to reduce risk factors for lung problems in surgical patients. He quickly realized that stopping smoking before surgery was the single best thing they could do. He also learned something else: If a smoker underwent a major surgical procedure, his chances of successfully quitting were doubled, even without assistance. “There’s something very powerful about the surgical experience that motivates patients to take that step that most of them want to take anyway,” he says.

Just why that is isn’t entirely clear. But Warner thinks it’s probably because of a combination of factors, one of which is

that people facing surgery are more aware of their health and willing to take steps to improve it. Also, his research has shown that smokers have fewer cravings and withdrawal symptoms when they quit around the time of surgery compared with when they quit at other times. He speculates this might be because they are removed from things in the environment that normally cue them to smoke or because they take

## Smoke Free for Surgery

In 2006, David Warner, M.D., convinced the American Society of Anesthesiologists (ASA) to encourage its members to talk to patients about quitting smoking before surgery. With the help of a task force led by Warner, the ASA has made a number of resources for patients available on its website including brochures and information cards, a PowerPoint presentation, and a video that explain the benefits of quitting smoking. There’s also a brochure for physicians that explains how to talk to patients about smoking. For more information, go to [www.asahq.org/stopsmoking](http://www.asahq.org/stopsmoking).



## What To Say

Anesthesiologist David Warner, M.D., knows that physicians sometimes struggle with how to talk to patients about quitting smoking. He starts by asking if they smoke, even if he already knows the answer. If they say yes, he advises them to quit for as long as possible before and after surgery, or to at least try to fast from cigarettes the morning of surgery and the week after. He explains that this will help them avoid complications such as infection and lung problems. Then he tells them, "If you've thought about quitting for good, surgery is an excellent time to do it because you may be more motivated to do things to improve your health, and you may even find it easier to quit." He then hands patients a card with the telephone number 800/QUITNOW, which can connect them with free counseling. Warner says the conversation takes no more than a minute.—C.P.

night before surgery), and refer them to smoking-cessation services.

About five years ago, Warner took his ideas to the American Society of Anesthesiologists (ASA), which then launched the Be Smoke-Free for Surgery initiative. Although the ASA has embraced his ideas and a pilot study involving several private anesthesiology practices in Minnesota and around the country showed they were feasible, individual anesthesiologists haven't necessarily adopted them. "I'm not the lone voice crying in the wilderness," Warner says, but he acknowledges that the idea that anesthesiologists can help patients

quit smoking is not widely accepted.

Yet Warner remains convinced that talking to patients is the right thing to do. And he's hoping that he and others can spread this message within and beyond the anesthesiology community. He notes that patients have at least five points of contact with health care providers around the time of surgery. He'd like to see the nurses, primary care doctors, surgeons, and anesthesiologists who see them at those points all deliver the message about quitting. "It's a matter of having an opportunity at a time when we know that people are more receptive to these messages," he says. ■



### Local Anesthesia

## Warmer Welcome

Your patient will thank you for warming up that local anesthetic before injecting it. Why? The injection will hurt less. So concluded researchers from the University of Toronto, who recently studied the issue.

The researchers looked at 18 studies involving more than 800 patients and found warming an anesthetic prior to injecting it consistently reduced patients' pain, regardless of whether the anesthetic had been buffered or not, whether the shot was administered subcutaneously or intradermally, or whether the amount of anesthetic was large or small.

The authors did not recommend the best way to warm an anesthetic. But they listed using a baby food warmer, a warming tray, and water baths among the methods used in the studies they analyzed. The study was published in the February 11, 2011, issue of the *Annals of Emergency Medicine*.

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■ Licensure

## Doctors Only

A 1996 survey published in the *American Association of Nurse Anesthetists Journal* found that nurses administer anesthesia in 107 countries around the world, including the United States. The United Kingdom is an exception. That's because case law from the 19th century established that only physicians could administer anesthesia there. The other Commonwealth jurisdictions followed this precedent. Thus, in Canada, Australia, New Zealand, and Hong Kong, anesthetics are administered only by physicians. Japan follows a similar practice.

Sources: McAuliffe MS, Henry B. Countries where anesthesia is administered by nurses. *AANA J.* 1996;64(5):469-79.



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The Lifebox project brings pulse oximeters to hospitals in poor countries.

■ Global Oximetry Project

## The Next Little Thing

The pulse oximeter is a standard tool for anesthesiologists in wealthy countries. But it's a rarity in other parts of the world. An article last year in *The Lancet* called attention to the fact that between 60 and 70 percent of operating rooms in Sub-Saharan Africa do not have the devices, which are credited with dramati-

cally reducing anesthesia mortality. In the United States and England, for example, the rate is now one in 185,000; it remains as high as one in 133 in the world's poorest countries.

An effort known as the Lifebox project is attempting to make pulse oximeters more widely available. Its organizers, including noted writer and surgeon Atul Gawande, M.D., challenged manufacturers to come up with a pulse oximeter that was cheap (less than \$250), met International Organization for Standardization requirements, and could be used in settings with few resources. A Taiwan company's model was selected, and 2,000 of its pulse oximeters have been purchased for delivery to various countries this year. The group's ultimate goal is to deliver 70,000.



■ The Laryngospasms

## Better than Laughing Gas

Since posting a music video on YouTube, a group of singing nurse anesthetists has found fame and a lot of new fans.

| BY KIM KISER

The setting for the video is an OR at WestHealth's surgery center in Plymouth. But instead of surgeons and OR staff huddled over the body of a patient, you see a blue drape. Suddenly, five guys in scrubs pop up from behind it as the introduction to Neil Sedaka's "Breaking Up Is Hard to Do" plays. They begin to sing:

*Patients going down  
do be do down down,  
Patients going down  
do be do down down,  
Waking up is hard to do.*

The singers are strangers to neither the spotlight nor the OR. All are certified registered

nurse anesthetists (CRNAs) as well as members of the singing group the Laryngospasms.

Their schtick is parodying oldies, changing lyrics to poke fun at the serious business of medicine. For example, they've turned Jan and Dean's "Little Old Lady from Pasadena" into a song about a little old lady with a fractured femur, Johnny Cash's "Ring of Fire" into a song about the pain of hemorrhoids, and Jerry Lee Lewis's "Great Balls of Fire" into ... you get the idea.

The Laryngospasms, which got their start at a Christmas party for students at the Minneapolis School of Anesthesia in 1990, have had 15 members over 20 years and have



Photo by Jane McMullen, Lakeview Hospital

From left: Richard Leyh, Gary Cozine, Keith Larson, and Doug Meuwissen ham it up before shooting the video for "Ring of Fire" at Lakeview Hospital.

ing their third album in the spring. And they'll perform their first gig in front of a non-medical audience. "We'll test the market to see how much it appeals to the general public," he says, adding that the group gets a lot of emails from people who come across their videos.

So what keeps four middle-aged guys, who spend their days watching over sedated patients, writing lyrics and practicing their dance moves? "You get to be rock stars for a day," Leyh says. ■

## The Current Members...

And where you might find them when they're not on stage

**Richard Leyh**, Lakeview Hospital

**Gary Cozine**, the only original member, now works in Meriden, CT

**Doug Meuwissen**, Woodwinds Hospital

**Keith Larson**, Northfield Hospital

performed at meetings and conferences across the United States. The group gained a wider following after posting the "Waking Up Is Hard to Do" video on YouTube two years ago. "It went viral," says Richard Leyh, CRNA, who has been with the group since 1998, explaining that it's had more than 8 million views. That led to appearances on CNN and CBS as well as on local television stations. They auditioned for "America's Got Talent" in 2009, and 3,700 people are following them on Facebook.

This year, the Laryngospasms are scheduled to play for the American Association of Nurse Anesthetists in Washington, D.C., the Operating Nurses Association of Canada—their first international performance—in Regina, Saskatchewan, and the OR Managers' Conference in Chicago. Leyh says they plan on releas-

## Waking Up Is Hard to Do

Don't take my tube away from me  
I'm trying to breathe, oh can't you see  
Take it out and I'll turn blue  
'Cuz waking up is hard to do

I beg of you, please give me one more try  
I'm only 90 much too young to die  
I put all my faith in you  
'Cuz waking up is hard to do

*(Chorus)*

*They say that waking up is hard to do  
Now I know, I know that it's true  
Don't say that this is the end  
Instead of waking up I think my incision's opened  
up again.*

I am in such misery  
Feels like my eyes are taped and I can't see  
If I wake I'm going to sue  
'Cuz waking up is hard to do

*(Repeat Chorus)*

Now I'm awake, I can breathe and see  
My bladder's full and I've got to pee  
Now I think I'll throw upon on you  
Cuz waking up is hard to do



©istockphoto/ImagePixel

## ■ Global Warming

# Anesthesia Contributes to Climate Change

Anesthesia has an effect on the earth's atmosphere each year similar to that of CO<sub>2</sub> emissions from a coal plant or a million cars, according to research published in the online version of the *British Journal of Anaesthesia* last October.

Researchers detailed properties of gases commonly used in anesthesia to calculate their effect on global warming. Three—isoflurane, desflurane, and sevoflurane—were found to have climate-changing potential.

The worst offender was desflurane, which is used in inhaled general anesthesia. The effect of each pound that enters the atmosphere is equal to that of 1,620 lbs. of carbon dioxide. The other two gases had much less impact.

Source: Sulbaek Andersen MP, Sander SP, Nielsen OJ, Wagner DS, Sanford TJ, Wallington TJ. Inhalation anaesthetics and climate change. *British J Anaesthesia*. Published online October 8, 2010.



Photo by Steve Wewerka

## ■ Perioperative Care

# Abbott's Pain Patrol

*Anesthesiologists at one Twin Cities hospital now routinely use regional anesthesia to control pain during and after surgery.* | BY CARMEN PEOTA

Although it's a good hour before surgery, the doctors and nurses attending to the gray-haired man scheduled for a shoulder procedure on a Thursday morning in February are already focused on controlling the pain he'll face after the operation. After a nurse anesthetist does a consent check, orthopedic surgeon Frank Norberg, M.D., enters the room in the basement of Abbott Northwestern Hospital in Minneapolis and explains what the arthroscopic synovectomy he's about to perform will entail and what

the patient can expect after the surgery in terms of pain control. He tells the man he'll be sent home with a week's worth of Percocet, which he may not need. The patient already knows that he'll also go home with a pain pump the size of a grapefruit.

When Norberg finishes, anesthesiologist John Mrachek, M.D., takes his place beside the patient and injects anesthetic into his neck and places the catheter that will deliver medication after the surgery. By the time he is finished, the patient has difficulty raising his arm and remarks that his

hand has gone to sleep.

This is the second case of the day for Mrachek, director of Abbott's acute pain service, a unique approach to anesthesiology practice in the Twin Cities. The service is the realization of an idea that had been brewing for years at Abbott.

## Growing Interest

In 2000, when anesthesiologist Gerald Holguin, M.D., joined Northwest Anesthesia, which staffs two suburban surgery centers and Abbott's ORs, the group's doctors were primarily using general anesthesia. Hol-

guin, having just completed a fellowship in chronic pain management, was aware of the benefits of regional anesthesia and had done nerve blocks. He had read studies that showed that patients who underwent nerve blocks for certain surgeries tended to have less acute pain, were less likely to develop chronic pain, and had shorter hospital stays than those who received general anesthesia followed by narcotics. And if they avoided narcotics, patients also avoided their side effects—nausea, constipation, dizziness, itching, and respiratory depression.

Holguin began doing nerve blocks at Abbott and inspired a few others in the group to do them as well. "We kind of pushed each other along," he says. But the anesthesiologists struggled with the logistics

John Mrachek, M.D., in one of the rooms where he and other anesthesiologists from Northwest Anesthesia do ultrasound-guided nerve blocks.

of both doing nerve blocks, which required them to attend to patients ahead of their surgery, and directing the care of patients during surgery. Holguin realized they needed a better system.

Mrachek, who joined the group in 2006, was also interested in doing nerve blocks. By this time, anesthesiologists elsewhere were doing ultrasound-guided blocks with good results. In addition, he was interested in doing more patient care. "We put them to sleep, we woke them up, we gave them to a nurse to take care of them afterward, and that was it," he says of the way anesthesiologists had long worked. As he saw it, anesthesiologists were uniquely equipped to help patients with pain, not just during surgery but after. The others in the group encouraged him to take what Holguin had started to the next level.

### A Matter of Logistics

Mrachek, fresh out of residency, agreed to take on the project, which turned out to be a tremendous amount of work. The first issue was finding space. The anesthesiologists would need procedure rooms where they could have their equipment and do the blocks. Abbott offered a former cardiac intensive care unit next to its operating suites. In addition, the hospital agreed to purchase ultrasound equipment for the group and hire nurses to support the physicians.

## A Model to Replicate

Anesthesiologist John Mrachek, M.D., says any hospital in the Twin Cities could create a program similar to the acute pain service at Abbott Northwestern. But he cautions that it requires a commitment from the anesthesiologists. "Taking on the responsibility of these patients while the nerve catheters are in place means being available 24/7," he says. "It sounds burdensome. If I were talking to colleagues across town, this is the part where they'd be like, 'I don't know if we want to do this.'" But Mrachek says that on average, he and his colleagues receive less than one page per night (for both inpatients and outpatients). He says that's because of the extensive patient education the nurses on the team do before patients are sent home or to the wards.

His colleague Gerald Holguin, M.D., agrees. "The one thing I can't overemphasize is that this kind of a service can't happen without the help of dedicated acute pain service nurses," he says. The three nurses who support the anesthesiologists at Abbott educate new nurses on the floors about how to manage patients with peripheral nerve catheters and pain pumps, assist with pain rounds, and troubleshoot peripheral catheters that may not be providing adequate pain relief. "They allow us to efficiently manage the service in a safe and comprehensive manner," he says. "They act as our advocates and educators."—C.P.

The next step was to bring all the members of the group up to speed on regional anesthesia techniques. At first, only Mrachek, Holguin, and a few other anesthesiologists were confident in their abilities to do ultrasound-guided nerve blocks. "If we were going to deliver this service, we needed to deliver it around the clock every day of the week. To get to that point, we had to have a critical mass of docs doing this," Mrachek says. He, Holguin, and others worked elbow-to-elbow with colleagues who were less skilled, showing them what they had

learned. Mrachek also developed a four-hour session that included having his colleagues use ultrasound on live models to practice finding certain nerves.

The anesthesiologists soon realized they needed to inform the surgeons, hospitalists, and nurses who cared for patients after surgery that patients weren't going to need as many narcotics as they had in the past. "If you're used to always giving a lot of narcotics to patients who've had their knee replaced, and now we've done a nerve block and they don't require hardly any nar-

cotics, that's a major change from what they're used to," Mrachek says. Furthermore, the other staff needed to know that many patients would be sent home immediately after their surgeries.

Mrachek and his team also had to make changes in their processes, one of which was related to scheduling. Because patients would need their regional anesthetic to take effect just before their surgeons were ready to begin operating, the anesthesiologists needed to sync the timing of the nerve blocks to the timing of the surgeries. Even now, Holguin says, "it can be very stressful in terms of time management." To make it work, the nurses, doctors, and other staff intently watch monitors that track the progress of cases in each of Abbott's 45 ORs. When they see that a surgeon is within 30 to 40 minutes of starting a new case, they'll start the nerve block for that patient.

In addition, the acute pain service team has had to figure out how to inform patients about this new style of anesthesia. "A lot of patients who are coming to Abbott to have their shoulder work done might be caught off guard by an anesthesiologist who tells them he wants to stick a needle in their neck and make their shoulder numb," Mrachek says. "If you weren't anticipating that, you'd say, 'Why are you going to do that, and tell me more about it.'"

And there were a host of other smaller changes that had to be made such as revamping order sets, updating forms, and figuring out how to man a phone line 24/7. ↪

“A lot of patients might be caught off guard by an anesthesiologist who tells them he wants to stick a needle in their neck and make their shoulder numb.”

—John Mrachek, M.D.

### A Win-Win-Win

Mrachek was confident the new system would work. But other anesthesiologists needed to be convinced. He says it wasn't until many of his colleagues began to do “pain rounds” (they now visit all patients in the recovery room or on the wards, not just those who had a problem in the OR) and saw how well their patients were doing that they fully bought into the new approach. He describes patient satisfaction as “through the roof.”

Holguin says the benefits to patients are “huge.” “You minimize all the side effects of general anesthesia,” he says. He explains that patients who have regional anesthesia are less likely to develop blood clots or emboli relative to those who have general anesthesia. He says it is especially appropriate for patients with heart and lung diseases. “When you intubate someone who smokes, has COPD, or has asthma, there is greater potential for bronchospasms during or after surgery,” he explains.

Holguin adds that pain control is much better under regional anesthesia, and that patients who receive it need fewer narcotics afterward. Thus they avoid the danger-

ous side effects of those drugs such as respiratory depression, which can be particularly troublesome for people with respiratory problems.

Mrachek points out that payers and the hospital have been supportive of the new acute pain service because it reduces the length of hospital stays. He says patients require less physical therapy because they're able to do more sooner because they have less pain. And they are less likely to develop chronic pain. Mrachek explains that in sedated patients or those under general anesthesia, the cellular signaling that can damage nerves and cause chronic pain is still occurring. Doing the blocks stops those mechanisms. “If you give a 30-year-old a nerve block, you can save millions over a lifetime,” he says.

“We're doing what everyone in the world wants us to do right now—physicians, policymakers, payers. We're delivering high-quality care that is safer and is costing less. It's a win-win-win situation,” Mrachek says. And he thinks it simply makes sense: “Instead of putting a drug through your whole body, if your knee hurts, why not put the medicine in your knee instead?” ■

### ■ National Leader

## Safety Advocate

A Minnesotan is heading the American Society of Anesthesiologists (ASA) this year. Mark A. Warner, M.D., dean of the Mayo School of Graduate Medical Education and a professor of anesthesiology at the Mayo Clinic College of Medicine, was installed as president of the ASA during the organization's annual meeting last October.

Warner's focus during his term is advancing the cause of patient safety (see p. 27). He currently directs both the Anesthesia Patient Safety Foundation and the Foundation for Anesthesia Education and Research.

Warner has also served as the president of the Minnesota Society of Anesthesiology, president of the American Board of Anesthesiology, and editor of the journal *Anesthesiology*.



Mayo Clinic's Mark Warner, M.D.

Photo courtesy American Society of Anesthesiologists

## 2011 Society for Pediatric Sedation Conference

*A clearer vision of quality in pediatric sedation*



**ABSTRACT DEADLINE: MARCH 15, 2011**

Please visit [www.pedsedation.org](http://www.pedsedation.org) for submission guidelines and registration information





**Patricia J. Lindholm, M.D.**  
MMA President

Photo by Steve Weverka

We must confront  
the reality of billion-  
dollar state and  
trillion-dollar federal  
budget deficits.

# The Times Demand We All Weigh In

This winter has been colder and snowier than average in Minnesota. A good thing about this weather is that it reminds us that only by relying on each other and pulling together—as neighbors and as larger communities—are we able to thrive in this climate. That’s a lesson we as doctors can apply as we anticipate upcoming budget battles.

We face a foreboding forecast with regard to the state and federal budgets, especially in the area of health and human services. We must confront the reality of billion-dollar state and trillion-dollar federal budget deficits. The economy is slowly recovering, but we’re not likely to see huge increases in tax revenues this year. What to do? It would be nice to have the wisdom of Solomon at such a time.

Although we may not feel we have that kind of wisdom, we doctors do have unique knowledge and a valuable perspective. We need to make sure that our voices are heard and that we share our insights in order to help our legislators make wise decisions.

In January, a number of MMA members participated in the MMA Day at the Capitol in St. Paul. It was heartening to see so many physicians, residents, and medical students making time to go to St. Paul to weigh in on these and other issues that affect patients and health professionals in this difficult time.

We met many newly elected freshman legislators, who need our advice in order to make decisions about health care funding priorities. We told them the MMA is concerned about the potential weakening

of social and health care safety net programs. We are concerned about the regressive “provider tax” that has funded health care and been used in the past to balance the budget. We are concerned also that we may not be able to afford to care for Medical Assistance patients because of the low payments we receive.

In February, several MMA leaders attended the AMA National Advocacy Conference in Washington, D.C. We met with members of our congressional delegation. We advocated for eliminating the SGR formula that causes the yearly anxiety about Medicare payments and access to care for our senior citizens. Tort reform was also on the agenda. It is clear that Congress will not tackle Medicare reform in this session. But we will be watching carefully as the Affordable Care Act is challenged in the courts and the political arena.

I have been impressed with the large number of students and residents who are engaged in the political process at both the state and national levels this year. These future colleagues have wisdom and leadership skills that bode well for the future of our profession. I encourage us all to get engaged in the discussions that will affect our state and nation. And I further encourage us veteran physicians to mentor a student, resident, or new physician as we advocate for our patients.

Together we can support innovative policies that will help us deliver high-quality health care fairly and cost-efficiently to all of our neighbors. Don’t allow yourself to be marginalized as important decisions are being made. The MMA is counting on all of you. Let us hear your voices.

# Dayton Budget Avoids Clinic Payment Cuts

Gov. Mark Dayton's proposed budget, released in February, cuts payments to hospitals, nursing homes, and managed care plans but maintains current MinnesotaCare and Medical Assistance reimbursement levels for clinics. The budget plan relies heavily on tax increases to minimize the cuts and preserve programs and services.

The MMA commended Dayton for proposing a budget that took a balanced approach to resolving the state's \$6.2 billion deficit. "The governor's proposal seeks to balance the state budget by using a combination of new revenues and cuts—an approach that the MMA believes is preferable to a cuts-only budget fix," says President Patricia Lindholm, M.D.

The MMA is concerned, however, that Dayton's budget plan disproportionately cuts spending on health care compared with other areas. The governor's proposal includes \$12 billion for health and human services in fiscal year 2012-13, which is about 3 percent or \$350 million less than what was forecast in November. Health and human services account for about 30 percent of the state's general fund expenditures.

The budget plan also eliminates access to MinnesotaCare for 7,200 adults with incomes above 200 percent of poverty or an annual income of \$21,780.

"It is disappointing the governor did not do more to protect the health care safety net, since his proposal is the starting point for the budget discussion," says Dave Renner, the MMA's director of state and federal legislation. "It is likely that Republican lawmakers will propose even larger cuts to health and human services."

## Health Care Reform

Dayton's proposed budget includes

- \$2.5 million in state matching dollars to jumpstart a health insurance exchange

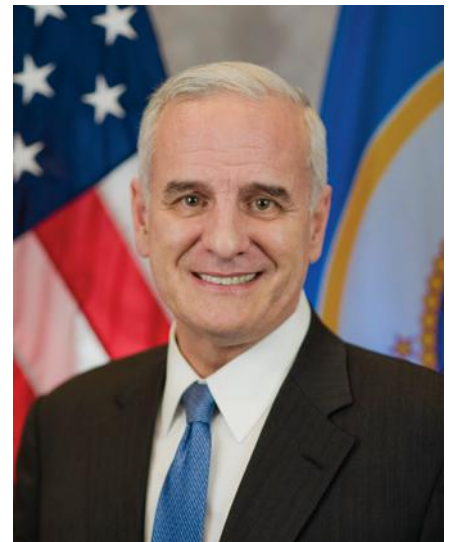
- \$20 million a year for the Statewide Health Improvement Program, a state public health initiative aimed at reducing smoking and obesity

## Indirect Effects

Although physician reimbursements were not directly affected in the budget outline, reductions in other areas could result in lower payments for doctors who provide care to people enrolled in public health insurance programs.

Specifically, the budget proposes reforms to the Medical Assistance and MinnesotaCare managed care programs that would generate savings of \$115 million over the biennium. It also includes a 2.75 percent cut in payments to health plans starting in 2012 with the assumption that the plans can recoup their losses by implementing provider payment reforms. The proposed budget also would withhold some money from health plans that would be returned to them if they reduce hospital readmissions. It is not clear whether health plans would ultimately pass along those cuts to providers.

In addition, the governor's budget would reduce payments to hospitals and nursing homes. Nursing facilities would see



Gov. Mark Dayton

"The governor's proposal seeks to balance the state budget by using a combination of new revenues and cuts—an approach that the MMA believes is preferable to a cuts-only budget fix."

—Patricia Lindholm, M.D.  
MMA President

payment rates reduced by 2 percent. Home and community-based services would face a 4.5 percent rate cut. Hospitals would lose about \$130 million due to a delay of the rebasing of payment rates in 2013-2015. The state also would cut hospitals' current outpatient service payments by 0.5 percent.

Hospitals, nursing facilities, and health plans also would face increased Medical Assistance surcharges that would generate \$627 million for the state. Providers would recoup some, but not all, of those surcharges through higher Medical Assistance reimbursement rates.



# MMA Releases Review of Medica's Associate Clinic Participation Agreement

A review of Medica's associate clinic participation agreement is now available to MMA members online at [www.mnmed.org/medicacontract](http://www.mnmed.org/medicacontract).

Medica requires providers to accept the agreement as a condition of joining its network. The agreement automatically renews every two years unless

it is otherwise terminated.

The agreement encompasses all of Medica's fully insured group and individual products and some self-insured group products.

The MMA worked with the Twin Cities Medical Society and the Minnesota Medical Group Management Association to review the agreement.

They found several items of concern:

- Language saying providers must refer members to other providers within the network;
- A prohibition against clinics contracting with or employing individuals or entities excluded from participating in Medicaid and Medicare;
- Medica's having access to patient records 10 years after the contract is terminated; and
- A requirement that clinics wanting to renegotiate or terminate their contract notify Medica at least 125 days prior to the end of the contract.

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## Board Approves Physician Wellness Recommendations

The MMA Board of Trustees approved a recommendation at its January meeting that the MMA develop a plan for promoting physician wellness. The recommendation was made by the 20-member Physician Well-Being Task Force, which was charged with exploring the topics of physician burnout, unsupportive or abusive work environments, work-life balance, and resilience, and developing recommendations on how the MMA can support, foster, and promote health and well-being among Minnesota physicians.

The plan will likely include:

- Work to improve the culture of medicine and prevent breakdowns in collegiality among medical students, residents, and physicians;
- Efforts to promote awareness of the prevalence of physician burnout and ways to prevent it and help physicians cope; and
- Educational programs for members about the importance of physician well-being.

MMA President Patricia Lindholm, M.D., who has made promoting physician health and wellness a focus of her presidency, says now that the board has taken action, the next step is to figure out the specifics of the plan.

"For me, this means that physician well-being is going to be an ongoing focus and activity of the MMA, and people who are looking for resources and help can go to the MMA," she says.

## Lawmakers Learn About the MMA

MMA Director of Health Policy Janet Silversmith testified before the House Health and Human Services Finance Committee last month about the MMA's twin goals of making Minnesota the healthiest state in the nation and the best place in the country to practice medicine.

In an effort to educate lawmakers, Silversmith shared a brief overview of physician demographics in the state and the MMA's history and mission. She also described the MMA's goals of reforming the care delivery system, promoting access to care by ensuring the financial viability of public health programs, and creating a payment system that rewards value rather than volume.

### Five Facts about Physicians in Minnesota

1. Minnesota has about 19,600 physicians.
2. Minnesota is ranked 13th in the nation in terms of number of physicians per capita, with a rate of 264 practicing doctors per 100,000 residents.
3. Minnesota's office-based physicians directly and indirectly contributed \$16.3 billion to the state's economy in 2009.
4. Each office-based physician in Minnesota supports 5.8 jobs (including his or her own).
5. Sixty-three percent of the state's physicians are in practices with more than 100 doctors.

Sources: Minnesota Board of Medical Practice; 2009 State Physician Workforce Data Book; The Lewin Group; "The Economic Impact of Office-Based Physicians in Minnesota;" and MMA Physician Database.

# Safety *first*

By Kate Ledger

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How anesthesiologists launched the patient-safety movement.

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**F**or Mayo Clinic anesthesiologist Mark Warner, M.D., one of the most harrowing moments of his career also turned out to be among the most significant. It happened in 1988, as Warner began administering an anesthetic to a 60-year-old patient who was undergoing surgery to remove bladder tumors. The anesthetic was sodium pentothal, which was then widely used in the OR. What nobody could have anticipated was that the patient would have a severe allergic reaction to the anesthetic, sending him into cardiac collapse. The OR team conducted CPR for an hour and 15 minutes, to no avail.

They were about to conclude their resuscitation efforts when Warner recalled an article he'd read just days before that offered another lifesaving tactic. It explained how a large quantity of epinephrine (more than 5 mg) could treat anesthesia-related anaphylactic shock. "It was a much larger dose than I'd ever given," Warner remembers. But he turned to this technique as a last-ditch effort to save the man's life. It worked.

For Warner, that close call in the OR underscored the importance of a new movement that was underway. Only three years earlier, the American Society of Anesthesiologists (ASA) had established the Anesthesia Patient Safety Foundation (APSF). Leaders of the two organizations had begun to gather reports of adverse events such as allergic reactions to anesthetics, equipment malfunctions during sur-



Widespread use of the pulse oximeter has led to a dramatic drop in anesthesia-related mishaps.

Photo by  
Clare Pix Photography  
[www.clarepix.com](http://www.clarepix.com)

gery, and tragic medical errors and oversights. They had begun to publish articles about those events and see them as trends requiring rigorous study. “Until then,” says Warner, who recently became president of the ASA, “incidents would happen in isolated settings. Each event might prompt a change in an approach; but nobody was pulling all the cases together and looking at entire systems and asking, What can we do better?” He recognized that unprecedented, and potentially life-saving, information was becoming available to the field. What he only could have guessed at the time was that the new focus on patient safety would have a major impact not only on the practice of anesthesiology but on other medical specialties as well.

### An Age-Old Hazard

The notable dangers of anesthesia go back to the beginning of modern surgery. In the 1920s, a patient had a one in 10 chance of surviving a procedure such as an appendectomy because of the risks of anesthesia as well as of postoperative infections. Survival rates eventually improved. But even 40 years ago, anesthesia-related mishaps in Minnesota and across the country were more common than anyone wished.

Some were the result of human mistakes. In one case from the late 1970s, a 45-year-old woman with severely disabling rheumatoid arthritis died on the operating table during an orthopedic procedure on her shoulder. The anesthesiologist had placed an oxygen tube through her nose into her trachea. At the time, physicians ascertained placement of the tube by listening with a stethoscope for the flow of air. Despite what sounded like air going in and out of the woman’s lungs, the tube was misplaced.

Other problems arose from equipment in the OR. Some had components that made it possible for an anesthesiologist to inadvertently turn on two potent anesthetic gases at once. In the 1980s, such a mishap caused the death of a 20-year-old patient who received both enflurane and halothane at once. In another case, a canister of volatile gas was knocked over and then put back on a shelf. The tipping caused too much gas to flow into the canister’s vaporizing compartment; as a result, a pediatric patient received an excessive dose of anesthesia. Similar adverse events were happening throughout the country. (In some cases, they resulted in the manufacturer swiftly making improvements to anesthesia machinery.) By some accounts, as many as 6,000 people in the United States were being harmed each year.

More common than accidental deaths were “near misses,” recalls Richard Prielipp, M.D., chair of anesthesiology at the University of Minnesota. Most anesthesiologists had stories about

narrowly avoiding an incident during surgery. “Often, patients didn’t actually suffer permanent harm, but they were very close to it,” he says, noting that the day-to-day work environment for anesthesiologists was markedly tense. “I think we had a sense that you were always close to the edge [of something unwanted happening], or not knowing how close to the edge you really were.”

Adding to the tension was the fact that liability payouts from anesthesia accidents were exorbitant. The cost of malpractice insurance for anesthesiologists was among the highest of all medical fields, ranging from \$35,000 to \$50,000 a year across the country in the mid-1980s. “Insurance was in range of other specialties that were considered high-risk, including neurosurgery and obstetrics,” says Steve Sanford, president of Preferred Physicians Medical, a Kansas company that specializes in coverage for anesthesiologists. What many anesthesiologists realized was that the burdensome rates turned talented medical students off to the discipline.

“Nobody was pulling all the cases together and looking at entire systems and asking, What can we do better?”

—Mark Warner, M.D.

### Bringing the Worst to Light

The turning point for the field occurred in 1982, when then-president of the ASA, Harvard’s Ellison “Jeep” Pierce, M.D., focused attention on what had long been an unspoken issue. Pierce had an interest in patient safety, stemming from a lecture he delivered as a junior faculty member in 1962.

He had even saved clippings over the years about anesthesia accidents. But when the prime time television program “20/20” warned consumers in 1982 about the great risks of dying or suffering brain damage from modern-day anesthesia, Pierce took the opportunity to show that his field could step up. He pushed for the creation of a safety committee within the ASA.

That same year, a seminal article appeared. It compared human error in aviation accidents to errors in anesthesia. When the paper was presented at an international conference in Boston, anesthesiologists from all over the world were captivated. A group of them, including Pierce, gathered after the conference ended and decided to create the APSF, which would be funded by the ASA along with companies that produced machines and drugs for anesthesia. The new organization would sponsor studies of anesthetic injuries, encourage the creation of programs aimed at reducing accidents, and get the word out swiftly about the causes of injuries and ways to prevent them.

A subcommittee of the ASA also established what was called the Closed Claim Project, working with insurance companies to release anesthesia information from malpractice cases. The committee reviewed hundreds of disastrous anesthesia events and began to publish articles about recurrent problems. Suddenly, in-

# Simulating Surgery

In the mid-1990s, anesthesiologists in San Francisco began developing high-fidelity computerized mannequins that stand in for patients and can be used for training. More sophisticated than the familiar resuscitation dummies used for First Aid training, these computerized models have a pulse, can open their eyes, and can make breathing motions. And they react with physical responses such as plummeting blood pressure, which can be modified by computer to represent crisis scenarios.

Use of such technology is taking off at many academic institutions around the country, and Minnesota is home to a number of simulation centers including one at Mayo Clinic, one at the University of Minnesota, and one at Regions Hospital in St. Paul, which is owned by HealthPartners.

The idea of simulation—actually practicing how to respond in the rarest of adverse events—has broadened beyond anesthesia to include



In the University of Minnesota's SimPORTAL (Simulation PeriOperative Resource for Teaching and Learning) lab, medical students, residents, and trainees in other fields practice skills that can save lives.

entire health care teams. At the university, a simulation lab offers OR personnel the opportunity to run through patient crises. The university is working to get approval from the American Society of Anesthesiologists to make the site a nationally recognized simulation training center that will draw

physicians and nurses from around the country to run through worst-case scenarios.

One event that can be simulated is a patient experiencing anaphylaxis. Another is a fire in the surgical suite caused by gases igniting in the presence of electricity. “We have a scenario that specifically teaches

people how to prevent fires by avoiding certain solutions or to employ precautionary measures like using lower oxygen flows, and then, in spite of all preventative efforts, if it happens, to react by turning the oxygen off, disconnecting the source of oxygen, and putting the fire out,” says anesthesiologist Mojca

formation was becoming available, such as the article about high-dose epinephrine that Warner had encountered.

The newly abundant and unflinching literature also led to the development of new technology designed to improve patient monitoring and safety. Two critical breakthroughs immediately became the standard of care. One was the introduction of the pulse oximeter, which had been in production for several years but hadn't yet been introduced to clinical settings. The finger-clip that detects the percentage of oxygen saturation in the blood enabled anesthesiologists to easily monitor a patient and stem a crisis quickly. The second was a device that could measure the quantity of carbon dioxide in a patient's exhalation, finally offering a scientific means to determine whether breathing tubes had been properly placed. “The decrease in the number of adverse

events was dramatic,” Warner notes of the introduction of these devices.

Information from the Closed Claim Project also led to new studies. One at Mayo, for instance, investigated more than 200,000 nationally reported occurrences of pulmonary aspiration during surgery, looking at the frequency of food and acidic fluid from the stomach entering the airways and blocking breathing or causing inflammation in the lungs. Researchers looked specifically at timing: When, in the process of surgery, did aspiration occur? They established guidelines to determine how long before surgery patients could safely eat and also found, contrary to previously held beliefs, that drinking water before surgery can be helpful for patients. In a range of anesthesia journals, researchers began publishing articles about safety issues, from dangerous,

Konia, M.D., clinical director of the anesthesiology and critical care simulation lab.

Fidelity to realism is critical, says Mayo anesthesiologist Laurence Torsher, M.D., co-director of the Mayo Clinic Multidisciplinary Simulation Center. Since it opened in 2005, approximately 31,000 health care practitioners from throughout the Mayo system have been trained at the center, which has six standard patient rooms, a task-trainer room, and three rooms that can be set up as exact replicas of an OR, an emergency room, or an intensive care unit, complete with the clinical equipment and medications found in each site. “You can read about what to do in an adverse event, but when you’re in that situation, your hands need to know how to open the medication you need,” Torsher says.

In addition to offering training in its 7,000-square-foot simulation center, called HealthPartners Clinical Simulation, HealthPartners has taken its high-fidelity mannequins and equipment

to other locations including hospitals in western Wisconsin and Maple Grove to run teams through simulated emergencies. “Besides clinical skills, we’re testing teams’ approaches to communication and how their system of care is designed in order to make it more efficient and safe,” says Carl Patow, M.D., M.P.H., executive director of HealthPartners Institute for Medical Education. Last year, HealthPartners used its simulation resources to train more than 4,300 providers and students.

Although data about whether simulation reduces adverse events is still being collected, Torsher and a team from Mayo recently published a case study in the journal *Anesthesia and Analgesia* describing what happened when a sedated patient suddenly experienced cardiac toxicity and required resuscitation in the recovery room. The team had recently practiced exactly that scenario in the simulation center. “The resuscitation of the patient went seamlessly,” Torsher says.—K.L.

volatile gas interactions to infections caused by anesthesia equipment.

## Organized and Diligent

In 1999, the Institute of Medicine recognized the APSF as an organization that had made significant advances in patient safety; in fact, the APSF became the model for the National Patient Safety Foundation, a similar organization touching all disciplines that was founded that same year.

In Minnesota, the growing national push to improve safety measures turned into specific statewide expectations for hospitals. In 2000, a committee that included representatives from the Minnesota Medical Association, the Minnesota Hospital Association, and the Minnesota Department of Health gathered to form


“There’s more awareness that wrong-site anesthesia is a reportable occurrence.”

—Julie Apold,  
Minnesota Hospital Association

the Minnesota Alliance for Patient Safety and began meeting to determine what could be done to reduce accidents and adverse events. Three years later, Minnesota became the first state in the country to require hospitals to report occurrences of 28 different adverse events (26 states have since adopted a mandatory reporting system; one has a voluntary system). “The reporting system serves to hold facilities’ feet to the fire,” says Diane Rydrych, assistant director of the Minnesota Department of Health’s division of health policy. “It also gives consumers information that they can use to ask questions about what’s being done about events and what’s being done to prevent them. But we really look at what we can learn from the data all the time; we’re always looking to see if there are trends.”

One unfortunate problem that turned up in Minnesota in recent years is conducting surgery on the wrong part of the body. Across the state last year, 31 wrong-site procedures took place. Approximately 30 percent of them were anesthesia-related problems such as performing a regional block for pain on the wrong knee. A statewide initiative is now in place to work on eliminating wrong-site procedures. More than 100 hospitals and surgery centers are currently involved.

In the past, surgeons typically marked the operating site with initials. Now, anesthesia is being brought into the loop, with anesthesiologists viewing documentation before surgery and also marking the location where drugs will be administered. What’s more, the entire OR team—surgeons, anesthesiologists, and nurses—now conduct periodic “time out” pauses in which members of the team stop what they’re doing to review the identity of the patient and the location of the procedure site.

Since the collaborative effort known as the Safe Site Statewide Initiative was launched three years ago, hospital adherence to “best practices” (the steps to reduce wrong-site procedures) has increased: The percentage of hospitals with safety steps now in place has jumped from 59 percent to 96 percent. Many believe the reason the number of adverse events has not yet dropped is that heightened awareness of the problem has increased hospital reporting of these incidents, particularly those involving anesthesia. “There’s more awareness that wrong-site anesthesia is a reportable occurrence and that we can learn from it and to try to eliminate it,” says Julie Apold, director of patient safety for the Minnesota Hospital Association. 

## Practicing Safety

There's no doubt anesthesia's focus on patient safety has produced improvements: Nationally, the number of deaths per anesthesia administration plummeted from one in 10,000 in the mid-1980s to one in nearly 200,000 today. In addition, surgeries have become safer because the drugs have improved. "We have better, shorter-acting anesthetic and adjuvant drugs with fewer side effects," says the University of Minnesota's Prielipp. With agents such as propofol that induce anesthesia quickly and narcotics and muscle relaxants that don't linger, "we can now titrate the endpoints of anesthesia much more precisely," he says. The technological advances in patient monitoring have decreased the "near misses" and improved the tenor of the work environment. And annual malpractice insurance premiums for anesthesiologists have plummeted since the mid-1980s; they now average about \$18,000 nationally. Prielipp says that has boosted interest in the field among trainees.

As an organization, the ASA has continued to actively spread its message about patient safety. As part of the World Federation of Societies of Anesthesiology, it has been trying to raise approximately \$80 million to make life-saving devices such as the pulse oximeter available in hospitals all over the world.

In this country, guidelines that involve the use of checklists, preoperative team meetings, and periodic time outs in the OR are now in place in many operating rooms, including those at the

University of Minnesota, says Barbara Gold, M.D., vice president of clinical safety with University of Minnesota Physicians. "We've adopted many proven methodologies, borrowing heavily from the aviation industry and others that have a narrow margin for safety. We've also looked to human factors analysis, a branch of industrial engineering that looks at the interface of humans and machines, how the behavior of humans can be managed to reduce error," she says. Teamwork, which anesthesia has always promoted, has evolved as a necessity for safety.

## Aiming Low

Anesthesiologists agree that there's still work that needs to be done to improve patient safety. Some changes that need to happen are simple ones such as having mandatory preoperative meetings—a sort of team huddle to review the surgical plan and to discuss any comorbidities the patient has that may complicate the case. Others are more complex such as using a bar-code reader (still in development) that verifies drugs in order to prevent the delivery of the wrong medication. "We're shooting for a zero-defect service, using the language of industry," Prielipp says, "and we won't be satisfied until no patients suffer any harm or injury associated with surgical and perioperative anesthesia." **MM**

Kate Ledger is a St. Paul writer and frequent contributor to *Minnesota Medicine*.

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# The Evolution of Safety in Anesthesiology

Standardized anesthesia care and patient monitoring have made surgery safer. The next step is for anesthesiologists, surgeons, and hospital staff to work together on pre- and postoperative care.

By Mark A. Warner, M.D.

When I first started in medicine during the mid-1970s, the risk of a relatively healthy patient dying within 24 hours of a surgical procedure was approximately one in 10,000.<sup>1</sup> That risk has since decreased at least 12-fold; the best estimates now suggest that the frequency is one in 120,000 or better.<sup>2</sup> In fact, a large Minnesota study published in the *Journal of the American Medical Association* in 1993 found that it was safer to undergo outpatient anesthesia and surgery than it was to travel to and from the surgical center by car.<sup>3</sup> I believe the increased safety of anesthesia and surgery during this period is one of the great achievements in modern medicine.

There are many reasons why safety has improved so steadily. Surgical procedures have become less invasive, and many surgical techniques now result in much less blood loss and tissue trauma and fewer postoperative complications. The drugs used intraoperatively for anesthesia, postoperatively for analgesia, and perioperatively for infection prevention and treatment also have improved remarkably. However, one significant effort stands out for its contribution to better patient safety—the work of the American Society of Anesthesiologists (ASA) to standardize anesthesia care and patient monitoring. The society's contributions were noted by the Institute of Medicine (IOM) in its 2000 treatise “To Err is Human: Building a Safer Health System.”<sup>4</sup> In fact, the ASA was the only specialty organization recognized by the IOM for its success in improving patient safety.

In 1985, the ASA instituted the Anesthesia Patient Safety Foundation (APSF). The work of the foundation and the ASA has resulted in a number of standardized practices, including the use of pulse oximetry and end-tidal carbon dioxide monitoring for anesthetized patients. These now-required practices

have markedly reduced the frequency of anoxic brain injury and other major complications.

The APSF is now in its 25th year and continues to sponsor workshops in which key stakeholders meet to share ideas on topics such as medication errors and fire safety. Through the APSF, government agencies, equipment and pharmaceutical manufacturers, surgeons, anesthesiologists, other anesthesia providers, nurses, and patients work together to review problems, develop innovative processes, and make recommendations that will likely result in safety improvements.

## Unfinished Business

With all of these efforts and the resulting improvements, why do we continue to focus on patient safety? Because we still have a ways to go. For example, each year, hundreds of patients in the United States either die or suffer anoxic brain injury from opioid-related postoperative respiratory depression. This is a problem we can solve: 1) We know many of the patient characteristics and surgical and anesthetic risk factors associated with postoperative respiratory depression; 2) we know that opioid analgesics play a role in nearly all instances of postoperative respiratory arrest; and 3) we have equipment and systems that can detect postoperative respiratory depression. Despite our knowledge and the availability of needed technology, we still have patients dying from or significantly impaired as a result of this problem. Sadly, we are missing the union of forces that is necessary to address it.

Resolution of postoperative respiratory depression will require anesthesiologists to work with surgeons, nurses, pharmacists, and health care facility administrators, as each group is responsible for overlapping pieces of the process. Anesthesiologists often use opioid analgesics intraoperatively while closely

monitoring patients but then do not insist on similar postoperative monitoring for patients who continue to receive these analgesics. Surgeons often provide oversight of postoperative analgesia, frequently using delivery systems such as patient-controlled pumps, but they do not require the use of technologies to monitor respiration. Administrators may not support the purchase, deployment, and upkeep of the number and array of monitors that would detect early respiratory depression. The problem is that no single group owns the entire perioperative period or is responsible for the entire set of steps associated with preventing postoperative respiratory depression.

We need to change that for a number of compelling reasons. First, it will prevent injuries and save lives. Second, it will save money. Complications are costly. A simple case of postoperative pneumonia has recently been estimated to cost the health care system more than \$25,000 on average.<sup>5</sup> Care for a patient who survives a pulmonary embolism has been projected to cost more than \$80,000 in the first year.<sup>6</sup>

And complications matter to facilities and health systems. It is estimated that there are now more than 1,000 online health care quality or safety rating sites. Although the validity of many of these sites is questionable, and it appears that anyone who can afford a website can establish a rating system for physicians and health care facilities and systems, there is no doubt that the public reads and uses this information. Publicly reported rates of complications are significant components of many rating systems—and they do influence patients' perception of physicians, hospitals, and clinics.

Minnesota anesthesiologists are committed to furthering efforts to reduce the complications of surgery and improve patient safety. The 350 practicing members of the Minnesota Society of Anesthesiologists strongly support the discovery of novel therapies, improvements in perioperative care, and studies that will allow the prediction of postoperative complications and development of effective interventions. They are also applying their expertise in new ways. At our major academic centers and some community hospitals, anesthesiologists are now involved in preoperative and postoperative care and work in intensive care units, hospice medicine, and palliative care programs. For example, at Mayo Clinic, 17 anesthesiologists provide primary intensive care for more than 100 patients daily. These same anesthesiologists also respond to all rapid response requests and cardiac arrests, 24 hours a day, seven days a week. Over the next several years, additional anesthesiology intensivists will begin to provide electronic oversight of critical care services throughout Mayo Health System's hospitals. This new service will provide continuous expertise in the care of critically ill patients, even in rural hospitals. Initial studies of this remote oversight model suggest that the frequency of death and severe complications such as ventilator-associated pneumonia and sepsis can be reduced by more than half.<sup>7</sup>

In addition, the ASA and APSF have made perioperative safety a priority and will start a three-year initiative this year to reduce—or, even better, eliminate—postoperative respiratory

depression, surgical site infections, postoperative thromboembolism, and medication errors. Eliminating these preventable complications will require nurses, surgeons, anesthesiologists, and others to work together in ways they have not before. No one wants patients to develop disabling or life-threatening complications. That's why we can, and we must, do better. **MM**

Mark Warner is a professor of anesthesiology at Mayo Medical School and dean of the Mayo School of Graduate Medical Education. He also is president of the American Society of Anesthesiologists.

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# Anesthesiology Education

## A New Emphasis

Why medical schools and residency programs are having to rethink their approach to training future anesthesiologists.

By Mojca Remskar Konia, M.D., and Kumar G. Belani, M.B.B.S., M.S.

Anesthesiology has long been closely linked to surgery. Major advances in surgical care have prompted major advances in anesthesia care and vice versa. Thus, for years training in anesthesiology focused mainly on intraoperative care. Now, however, both advances in surgery and changing dynamics in health care delivery are dictating that anesthesiologists play a broader role—that they serve as perioperative physicians.<sup>1</sup> As a result, anesthesia training programs have had to change. The American Board of Anesthesiology has offered subspecialty certification in critical care since 1985 and in pain management since 1991. (Both are components of perioperative medicine.) There are now fellowships in cardiothoracic anesthesia and pediatric anesthesia, and the Board is considering allowing specialty certification in these fields as well. Recently, the Society for Ambulatory Anesthesia approved a competency-based curriculum for a fellowship program in ambulatory and office-based anesthesia that includes training in business management, leadership, and informatics, as anesthesiologists often serve as directors of free-standing facilities.<sup>2</sup> Both the specialty and the programs that educate providers are having to evolve in order to adapt to changing times.<sup>3,4</sup>

One change in medical practice that has had a huge impact on the practice of anesthesiology is the patient safety movement. Anesthesiology has long been a champion of patient safety. The Anesthesia Patient Safety Foundation was the first multidisciplinary organization to focus solely on uncovering, analyzing, and eliminating risks to patients including those related to human error. To equip future anesthesiologists to further that work, anesthesiology training now stresses the value of dynamic patient monitoring, the importance of verification of drug dosing, better communication among members of the surgical team, and other practices that minimize the risk of error and improve the quality of care. In addition, as hospitals and health systems have looked for practical solutions to safety

concerns that are unique to their environment, educational programs have sought to help students and residents learn the skills involved in process and quality improvement.

Another change in medical practice that has had an impact on anesthesiology education is an emphasis on interdisciplinary teamwork and communication.<sup>5</sup> Teamwork is especially important in high-acuity environments such as critical care units and emergency and operating rooms. Thus, in the department of anesthesiology at the University of Minnesota, we are exploring ways to teach students and residents how to be valued team members. We have found one of the most effective ways of doing this is through simulation.

### Simulation as a Teaching Tool

Anesthesiologists were among the first in medicine to use computerized simulation, including interactive, high-fidelity mannequins, to train medical students, residents, and faculty. One advantage of simulation training is that it exposes students to realistic clinical situations without posing any risk to a real patient. Participants can learn techniques and practice new skills without feeling pressed for time. With repetition, they can develop proficiency that they can then transfer into real clinical environments.<sup>6</sup> In addition, students can see what happens when a situation goes awry and what they can do about it without putting the patient's life in danger.

Our department has designed its own exercises that replicate real-world clinical scenarios. In addition, our residents take part in simulation exercises developed by other departments including surgery, critical care, emergency medicine, interventional radiology, pediatrics, and neonatology. Thus, simulation is a key tool for exposing students and residents to the unique skills of other professionals and helping them understand the importance of interdisciplinary teamwork.

We also use simulation to teach providers what to do in

emergencies such as when a fire breaks out in the operating room. We have developed a simulated exercise about fire during tracheostomy that explores factors that might lead to this problem, actions that can decrease the likelihood of it happening, and what to do if such a complication occurs. We include attending physicians, medical students, nurses, anesthesia technicians, and others in this exercise.

Another benefit of simulation exercises is that they show students, residents, and physicians the importance of clear and respectful communication in high-pressure situations. Communication is especially important in settings such as the operating room, where decisions often must be made quickly.

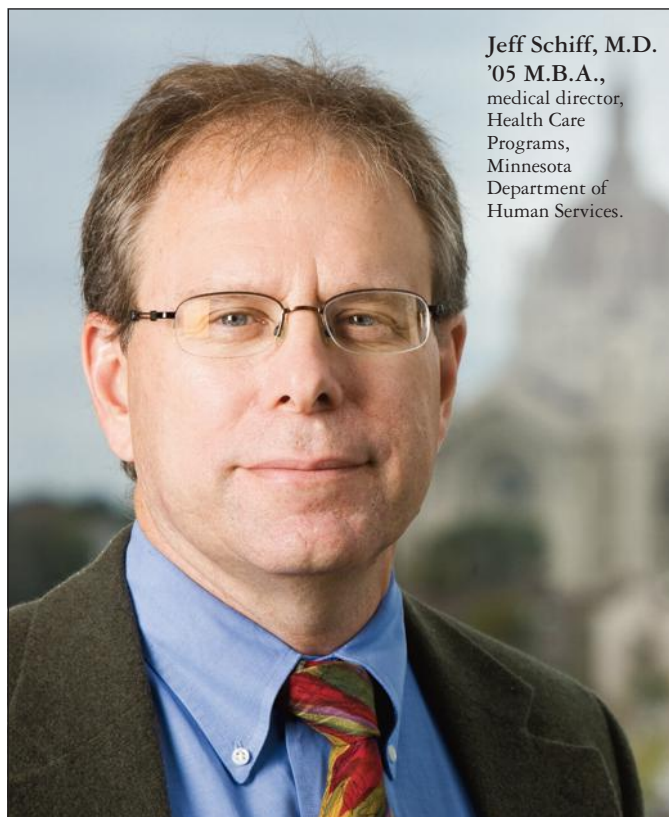
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**Changing the Culture**

Our department is striving to make a culture shift. We are trying to move from having a single-specialty focus to having an interdisciplinary view. We are making changes to adapt to what is happening in the practice of anesthesiology and in medicine as a whole. We know future anesthesiologists will be perioperative medicine physicians who will need to understand their role in promoting patient safety and preventing problems. They will need to be able to work as members of teams and to communicate clearly and effectively with the other physicians and staff involved in a patient's care. To ensure that these things happen, anesthesia training programs must continue to change with the times. **MM**

Mojca Remskar Konia is program director and Kumar Belani is a professor in the department of anesthesiology at the University of Minnesota.

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# Multimodal Clinical Pathways, Perineural Catheters, and Ultrasound-Guided Regional Anesthesia

## The Anesthesiologist's Repertoire for the 21st Century

By Adam D. Niesen, M.D., and James R. Hebl, M.D.

■ Regional anesthesia is making a comeback because of improved technology and research that shows that its use results in less discomfort for patients and shorter hospital stays. This article provides a brief history of regional anesthesia, describes current techniques for administering it, and discusses potential benefits associated with it. It also describes Mayo Clinic's Total Joint Regional Anesthesia Clinical Pathway, a comprehensive care plan for patients undergoing joint replacement surgery that uses peripheral nerve blockade and multimodal analgesia.

Total hip and total knee arthroplasty are two of the most commonly performed surgeries in the United States. Medicare pays for more of these procedures than any others.<sup>1,2</sup> Patients undergoing total joint arthroplasty experience significant postoperative pain. Failure to provide adequate analgesia impedes the start of physical therapy, which is important for maintaining joint range-of-motion, prolongs hospital stays, and increases hospital expenditures. Traditionally, analgesia following total joint replacement surgery has been provided by patient-controlled intravenous analgesia. However, the new standard for managing pain in these patients is through multimodal clinical pathways with an emphasis on regional anesthesia and the use of perineural catheters.

Spinal blocks and epidurals are probably the first techniques that come to mind when reading the words “re-

gional anesthesia.” Although these techniques are still essential tools, anesthesiologists now have at their disposal an array of options. As technology and techniques have improved and as both clinical use and indications have expanded, regional anesthesia has undergone a renaissance of sorts. The most significant advancements have occurred in the use of continuous peripheral nerve catheters (for both inpatients and outpatients) and ultrasound-guided regional anesthesia techniques.

### Historical Perspective

Regional anesthesia and the use of peripheral nerve blockade have evolved greatly since the discovery of cocaine as an effective local anesthetic by Austrian ophthalmologist Carl Koller, M.D., in 1884. In 1920, Charles Mayo, M.D., traveled to Paris to visit his surgical colleague Victor Pauchet, M.D., and to learn new surgical techniques.<sup>3</sup> Pauchet

had mastered the German technique of transcutaneous regional anesthetic blockade. Pauchet's pupil, Gaston Labat, M.D., was finishing his training and provided anesthesia while Mayo and Pauchet operated. Mayo was so impressed with these regional techniques that he recruited Labat to Mayo Clinic. In October 1920, Labat began his work in Rochester, where he taught regional anesthesia to physicians at Mayo Clinic and wrote the book *Regional Anesthesia: Its Technic and Clinical Application*. The popular book helped propagate interest in regional anesthesia across the United States.

Use of regional anesthesia waxed and waned during the ensuing decades; but during the 21st century it has again become popular as both the technology and the reliability of the equipment used for its administration have improved. With this resurgence has come an awareness on the part of clinicians

Figure 1

**Femoral Nerve Catheter Placement**

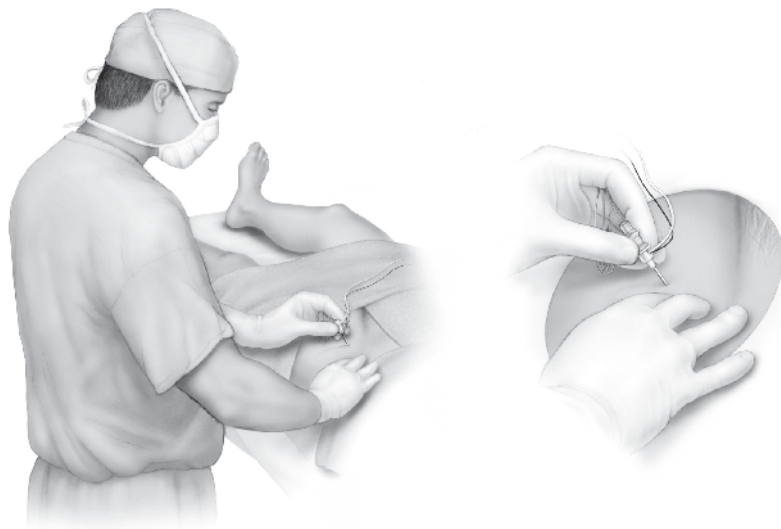
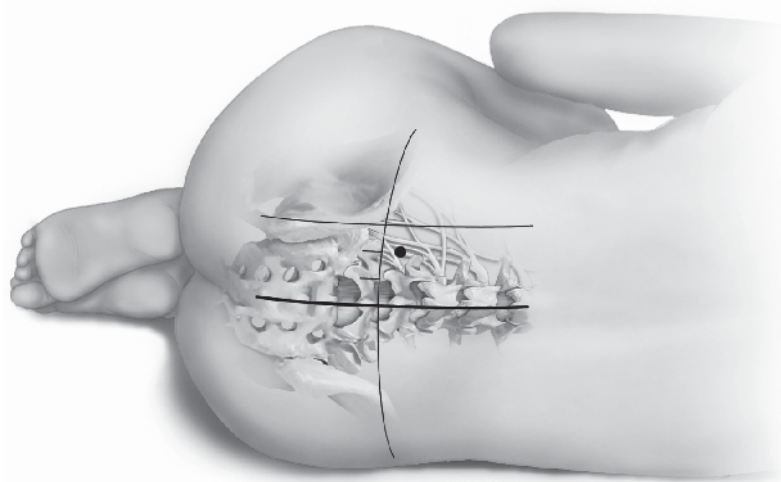


Figure 2

**Surface Landmarks for Posterior Lumbar Plexus Catheter Placement**



Source for Figures 1 and 2: Hebl JR, Lennon RL. Mayo Clinic Atlas of Regional Anesthesia and Ultrasound-Guided Nerve Blockade. Rochester (MN) and New York: Mayo Clinic Scientific Press and Oxford University Press; 2010. Reprinted with permission from the Mayo Foundation for Education and Research.

and patients of the benefits of regional anesthesia, many of which are now being described in the literature.

**Regional Anesthesia Techniques**

Regional anesthesia is categorized as central (ie, neuraxial) and peripheral based on the anatomic location of the nerve block.

Neuraxial techniques include spinal, epidural, and caudal blockade, and peripheral techniques encompass blockade in all other regions. Most peripheral techniques were initially used as a form of intraoperative anesthesia for a particular part of the body (eg, the arm or lower leg). However, with the development of longer-acting

local anesthetics and peripheral nerve catheter techniques, many of these techniques are now being used for providing postoperative analgesia for days following surgery, especially for patients undergoing orthopedic procedures.

In an attempt to maximize the benefits of regional anesthesia, the Mayo Clinic department of anesthesiology in collaboration with the department of orthopedic surgery developed the Mayo Clinic Total Joint Regional Anesthesia (TJRA) Clinical Pathway. The TJRA Clinical Pathway is a comprehensive care plan for patients undergoing major joint replacement surgery that emphasizes the use of multimodal analgesia and peripheral nerve blockade and perineural catheters. Multimodal analgesia involves the use of several analgesic agents in limited doses that act through different physiologic mechanisms. The advantage of a multimodal regimen is that it capitalizes on the synergistic effects of these medications (ie, enhanced analgesia) while minimizing or eliminating adverse side effects because of the limited doses administered.

Patients undergoing total knee arthroplasty receive a preoperative femoral nerve catheter with an initial bolus of local anesthetic (Figure 1). Select patients also receive a single-injection sciatic nerve block. Total hip arthroplasty patients receive a posterior lumbar plexus (psoas compartment) perineural catheter with an initial bolus of local anesthetic (Figure 2). Preoperative oral adjuvants include extended release oxycodone (age-dependent dosing), celecoxib, and gabapentin. Preoperative medications are modified or omitted at the discretion of the anesthesiologist based on the patient's comorbidities. Intraoperative management includes either spinal or general anesthesia, once again based on patient comorbidities and patient preference. Intraoperative opioid administration is limited and done at the discretion of the attending anesthesiologist. No intravenous opioids are administered during the postoperative period. Rather, a postoperative multimodal analgesic regimen is initiated. Options used during the postoperative period are listed in the table.

All perineural catheters remain *in situ* so that local anesthetic can be infused a minimum of 36 hours postoperatively. Most perineural catheters are discontinued on the morning of the second postoperative day.

Patients receiving the Mayo Clinic TJRA Clinical Pathway experience superior analgesia with fewer opioid-related side effects when compared with control patients.<sup>4</sup> Visual analog pain scores are significantly lower among TJRA patients both at rest and during physical therapy sessions throughout their hospital stay. Opioid requirements are also significantly less among TJRA patients. Opioid-related side effects such as nausea, vomiting, and urinary retention are also significantly reduced throughout most of the perioperative period.<sup>4</sup>

Postoperative milestones such as the ability to transfer from bed-to-chair and eligibility for discharge are achieved significantly sooner in patients receiving the multimodal TJRA Clinical Pathway when compared with those who are not given the pathway. Discharge eligibility is achieved a mean of 1.7±1.9 days sooner among TJRA patients when compared with matched controls. At the time of hospital discharge, TJRA patients have better joint range of motion than others; these gains in range of motion persist to the six-week to eight-week surgical follow-up visit.<sup>4</sup>

Severe postoperative complications (eg, neurologic injury, myocardial infarction, renal dysfunction, localized bleeding, deep venous thrombosis/pulmonary embolism, joint dislocation, and wound infection) are similar between TJRA patients and patients receiving patient-controlled analgesia. However, postoperative ileus occurs significantly more often among control patients receiving intravenous opioids, resulting in delayed postoperative feedings.<sup>4</sup> In addition, significantly fewer TJRA patients experience postoperative urinary retention and postoperative cognitive dysfunction when compared with matched controls. Approximately 15% of control patients and 1% of TJRA patients experience postoperative cogni-

Table

**Postoperative Multimodal Analgesic Options for Total Joint Arthroplasty\***

<b>Ketorolac (Toradol)</b>	15 mg IV every six hours PRN for pain rated more than 4 or patient comfort goal (maximum of four doses)
<b>Celecoxib (Celebrex)</b>	200 mg PO BID for five days (avoid use in conjunction with Ketorolac)
<b>Acetaminophen (Tylenol)</b>	1,000 mg PO three times daily (administer prior to physical therapy sessions)
<b>Oxycodone</b>	5 to 10 mg PO every four hours PRN. Give 5 mg if patient reports pain and rates their pain score less than 4; give 10 mg if patient complains of pain rated 4 or greater
<b>Tramadol (Ultram)</b>	50 to 100 mg PO every six hours (may be used in select opioid-sensitive patients)

\*Postoperative analgesic options are selected based on each patient's associated comorbidities.

tive dysfunction (defined as disorientation to person, place, or time, hallucinations, or any other cognitive condition requiring further assessment by a physician) during their hospitalization.<sup>5</sup>

**The Financial Impact of Clinical Pathways**

Changes in patient management and improved perioperative outcomes may decrease costs associated with joint replacement surgery by reducing hospital stays and services needed during hospitalization (ie, resources needed to manage side effects or complications). The cost of treating patients using the TJRA Clinical Pathway at Mayo Clinic is \$1,999 less per surgical episode when compared with the cost of treating patients who do not use it.<sup>6</sup> Analysis of the components of cost (hospital and physician charges) found that hospital-related costs were significantly less within the TJRA cohort and accounted for the majority of the total savings. The difference in hospital costs was attributed primarily to significant reductions in medical and surgical supply costs, operating room costs, and anesthesia supply costs. Although room and board and pharmacy costs were also lower among the TJRA cohort, these costs were not found to be statistically significant. Overall, physician costs were not found to be significantly different between groups. In addition, the cost savings associated with

the TJRA Clinical Pathway were found to be greatest among patients with a higher number of associated comorbidities (ie, older, sicker patients).<sup>6</sup>

The use of regional anesthesia techniques and perineural catheters is not limited to inpatients undergoing surgery. In fact, outpatients having procedures (eg, rotator cuff repair, anterior cruciate ligament repair) with regional anesthesia also have improved pain scores, decreased need for opioids, less postoperative nausea and vomiting, and fewer hospital readmissions than those who receive other forms of anesthesia. In addition, many are discharged to home hours sooner and report a higher degree of satisfaction.<sup>7</sup> Continuous peripheral nerve blockade also may be used in the outpatient setting for more painful procedures such as anterior cruciate ligament reconstruction or unicompartmental knee arthroplasty. Disposable local anesthetic infusion devices allow patients to go home after ambulatory surgery with superior analgesia lasting a prolonged period of time. The small diameter and flexible nature of perineural catheters allows them to be easily removed by the patient at the end of their local anesthetic infusion.

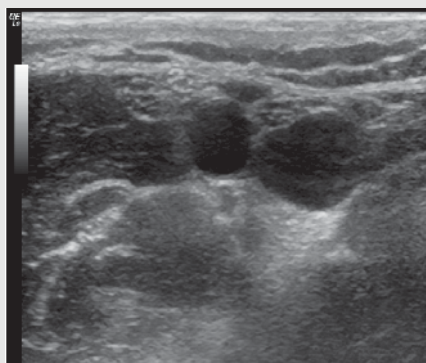
**Potential Benefits of Regional Anesthesia**

During the perioperative period, opioids and the stress associated with surgery can

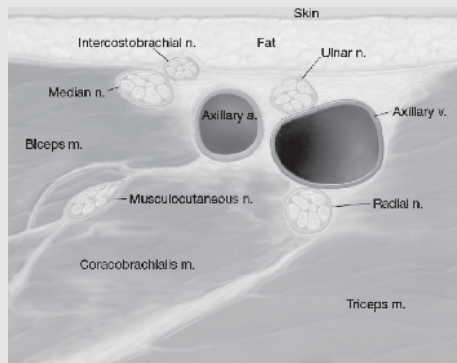
## Ultrasound-Guided Regional Anesthesia

Regional anesthesia is successful only when anesthetic can be accurately and reliably placed in the vicinity of nerves. During the early 20th century, anesthesiologists relied solely on anatomic surface landmarks to approximate neural targets, which are commonly located near vascular structures. Clinicians would deposit local anesthetic in the vicinity of peripheral nerves while hoping to avoid major vascular structures (eg, vertebral artery or subclavian artery). However, as nerve localization techniques have evolved, ultrasound guidance has become the technique of choice for many clinicians.

Ultrasound technology has advanced to the point where peripheral nerves, blood vessels, tissue planes, and other anatomic landmarks easily can be visualized (see figure). Furthermore, it allows for real-time visualization of needle advancement, trajectory angles, and the local anesthetic as it is injected around peripheral nerves. This allows anesthesiologists to accurately place the needle adjacent to neural targets while avoiding nearby anatomic structures such as major vessels or the pleura. These advantages may improve block success while reducing potential complications such as intravascular injection or pneumothorax.



Ultrasound-guided axillary blockade.



Corresponding anatomical illustration.

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suppress the immune system. This is of particular concern in patients undergoing cancer surgery, as changes in the immune system may increase their risk of cancer recurrence. Regional anesthesia is known to reduce the need for opioids. In addition, it attenuates the stress response by blocking afferent neural transmission.<sup>8</sup> Preliminary investigations have suggested that these benefits of regional anesthesia may have a significant clinical impact. For example, patients receiving thoracic paravertebral blockade prior to breast cancer surgery have been found to have a longer cancer-free survival interval and a lower incidence of cancer recurrence when compared with patients not receiving a regional technique.<sup>9</sup> Similar evidence exists for patients undergoing epidural anesthesia for prostate cancer and colon cancer surgery.<sup>10,11</sup> Although these are preliminary studies,

they suggest one more way that anesthetic technique may affect patient outcomes. Further study is needed to more clearly define the association between regional anesthesia and cancer recurrence.

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### Conclusion

Today, there is renewed interest in the use of regional anesthesia for a number of reasons. Advances in perineural catheter techniques, nerve localization, block success, and overall safety have dramatically improved patients' perioperative outcomes, satisfaction, and quality of life. Despite recent progress, additional research is needed to better define the impact of regional anesthesia techniques on major clinical (eg, cancer recurrence) and financial (eg, direct medical costs) outcomes. Thus far, however, evidence suggests a bright and promising future for regional

anesthesia.<sup>3</sup>

In 1922, William J. Mayo, M.D., wrote "Regional anesthesia is here to stay." Clearly, this prediction is as true today as it was nearly a century ago. **MM**

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# Smoking and Chronic Pain

## A Real-but-Puzzling Relationship

By Toby N. Weingarten, M.D., Yu Shi, M.D., M.P.H., Carlos B. Mantilla, M.D., Ph.D., W. Michael Hooten, M.D., and David O. Warner, M.D.

■ Smoking produces profound changes in physiology beyond those associated with the delivery of nicotine to the bloodstream. It has long been known that these changes put patients at risk for heart disease, cancers, and lung diseases. More recently, it has been discovered that smoking is a risk factor for chronic pain. Robust epidemiological evidence is showing that smokers not only have higher rates of chronic pain but also rate their pain as more intense than nonsmokers. Because the relationship between smoking and pain is of relevance to clinicians in many specialties, researchers at Mayo Clinic are examining this relationship in depth. This article describes some of what they and others have discovered in recent years about the interactions between smoking and chronic pain.

Recent evidence suggests that smokers are more likely than nonsmokers to experience chronic pain.<sup>1-6</sup> In fact, it appears that chronic pain is even more prevalent among former smokers than it is among those who have never smoked.<sup>6</sup> In addition, smokers with chronic pain indicate that their pain is more intense than that of nonsmokers and say that their pain is associated with more occupational and social impairment.<sup>7-10</sup> These observations are even more interesting given that they are contrary to what would be expected because of nicotine's known analgesic properties. Thus, the relationship between pain and smoking is a fascinating phenomenon that has a considerable number of clinical implications. Although it is not fully understood, research is beginning to shed light on how smoking and pain interact.

### The Many Interactions between Smoking and Chronic Pain

Findings from recent prospective studies suggest a causal relationship between smoking and chronic pain. For example, one study found that Finnish adolescents who smoke at age 16 were more likely to develop pain symptoms by age 18.<sup>4</sup> Another one found that adolescent smokers were at increased risk for hospitalization for low-back pain later in life and that male smokers were at increased risk for lumbar discectomy.<sup>3</sup> A longitudinal study of 9,600 twins found a dose-response relationship between the number of cigarettes smoked and the development of back pain.<sup>1</sup>

Smokers with chronic pain are more adversely affected by their pain than nonsmokers with chronic pain. Studies of patients presenting to the Mayo Clinic Pain Rehabilitation

Center, Outpatient Pain Clinic, Orofacial Pain Clinic, and Fibromyalgia and Chronic Fatigue Clinic consistently show that smokers report greater pain intensity and greater functional impairment than nonsmokers.<sup>7-10</sup> In addition, their scores on measures of life interference were worse. For example, smokers with fibromyalgia missed more days of work; reported worse sleep, greater anxiety, and depression; and had more pain, stiffness, and fatigue than nonsmokers with fibromyalgia.<sup>9</sup>

Because nicotine has analgesic properties and smoking a cigarette can blunt pain perception,<sup>11</sup> the higher prevalence and increased severity of chronic pain in smokers as compared with nonsmokers may seem surprising. Researchers are exploring this apparent paradox. They have found that nicotine-habituated animals undergoing nicotine withdrawal demonstrate increased sensitivity to pain stimuli.<sup>12</sup> They have also found that when human smokers are deprived of nicotine, they perceive pain stimuli earlier and have reduced tolerance for pain.<sup>13,14</sup> Thus, some postulate that nicotine withdrawal could increase a smoker's perception of pain and even the intensity of chronic pain.

Heightened awareness of pain in response to nicotine withdrawal could, in turn, further encourage smoking because it reduces a person's perception of pain and/or helps them cope with the pain or mitigates anxiety associated with increased pain. For example, in at least one study, smokers reported that feeling pain made them want to smoke.<sup>15</sup> Current research at Mayo Clinic is examining if and how pain motivates female smokers with fibromyalgia to smoke.

Researchers are also attempting to identify the mechanisms that might lead to increased pain in smokers. Some point to the changes that occur in the neuroendocrine system

## The Benefits of Cognitive Behavioral Therapy

Smokers respond as well as nonsmokers to cognitive behavioral therapy for the treatment of chronic pain. For example, smokers who completed an intense three-week cognitive behavioral therapy rehabilitative program for patients with severe chronic pain at Mayo Clinic's Pain Rehabilitation Center experienced equal or better responses than nonsmokers and were as able to successfully taper off opioids, despite greater pain and functional impairment at program entry.<sup>1</sup> Similar observations have been made in smokers with fibromyalgia and who were treated with cognitive behavioral therapy at Mayo's Fibromyalgia and Chronic Fatigue Clinic.

1. Hooten WM, Townsend CO, Bruce BK, Warner DO. The effects of smoking status on opioid tapering among patients with chronic pain. *Anesth Analg*. 2009;108(1):308-15.

in response to long-term smoking. In the nonsmoker, the physiologic stress that results from pain activates the sympathetic nervous system and the hypothalamic-pituitary-adrenal (HPA) axis. The increased sympathetic output blunts pain perception. However, the HPA system is down-regulated in smokers, which may increase their perception of pain.

Another potential explanation may be that smoking accelerates degenerative changes such as those from osteoporosis and lumbar disc disease, and impairs bone healing. Such changes could predispose smokers to injury, impede healing, and subsequently increase their risk for future chronic pain.

Psychosocial factors also may have an effect. Current scientific understanding of biological processes and neural pathways suggests a link between depression and pain. It is known that smokers have higher rates of mood disorders such as depression and anxiety than nonsmokers and that patients with these mood disorders have more chronic pain. We also know that patients with chronic pain have higher rates of mood disorders. We recently reviewed a national data set and found that smoking increased the likelihood of pain in older adults but only in those who were also depressed.<sup>16</sup> However, in a recent analysis of patients treated at our Pain Rehabilitation Center, we found that pain severity was independently associated with depression severity but not smoking status.<sup>17</sup> Obviously, the interactions between smoking, depression, and chronic pain are not completely understood and are complex. However, the clinician who encounters a smoker with chronic pain should strongly consider that mood disorders also may be present.

Research is also examining how income and marital status play into this issue. Smokers tend to be less educated, poorer, and more likely to be unemployed and divorced than nonsmokers. In addition, as smoking rates decline, smokers are becoming increasingly marginalized in society. Weingarten et al. reported that 50% of smokers presenting to our outpatient tertiary pain clinic were unemployed or disabled, compared with 18% of nonsmokers.<sup>8</sup> These differences suggest smokers are more isolated and lacking in social support than nonsmokers. It is thought that these factors

could contribute to functional impairment from chronic pain.

Another consideration is that current and former heavy smokers are more likely to use prescription analgesics.<sup>18</sup> We observed that more smokers than nonsmokers admitted to our Pain Rehabilitation Center used opioid analgesics and used them at higher doses.<sup>18</sup> In addition, we discovered that male smokers consumed the greatest quantities of opioid analgesics.<sup>19</sup> Smokers are known to have higher rates of drug abuse, and smoking is almost ubiquitous among opioid abusers.

We also know that smoking alters the pharmacokinetics of opioids. A study comparing the effects of hydrocodone on both smokers and nonsmokers with back pain found that the smokers used more hydrocodone tablets yet continued to report greater pain. Interestingly, despite taking higher doses of hydrocodone, they had lower serum hydrocodone levels.<sup>20</sup> An explanation for this may be that the polycyclic aromatic hydrocarbons, substances in cigarette smoke, induce P450 enzymes involved in morphine metabolism. This could account for the higher consumption of opioids in male smokers with chronic pain.

## Tobacco Cessation in Chronic Pain Patients

Current guidelines recommend that clinicians advise tobacco users to quit and provide them with the assistance to do so at every encounter. Certainly chronic pain patients would benefit from stopping smoking. However, given the imperfectly understood relationship between pain and smoking, it is not clear how tobacco abstinence affects chronic pain. In the short term, nicotine abstinence has the potential to make it worse, and stopping smoking would remove a mechanism that smokers perceive as useful in coping with anxiety. Yet, in the long term, recovery from the effects of smoking might improve chronic pain.

Smokers who suffer from chronic pain have the same motivation to quit as smokers who do not have pain.<sup>21</sup> However, we found that very few patients enrolled in our Pain Rehabilitation Center who smoked could successfully quit despite receiving tobacco-intervention services.<sup>10</sup> We need to find ways to help smokers with chronic pain quit successfully. One approach might be to help them adopt coping strategies other than smoking such as relaxation techniques and behavior modifications. Clearly, we need additional research to better understand the effects of nicotine abstinence on chronic pain in order to develop effective interventions that can be readily applied in the clinical setting.

## Conclusion

Chronic pain is among the many health problems associated with smoking. When smokers develop chronic pain, their symptoms and disability are often worse than those of nonsmokers with chronic pain. The reasons for these observations are likely multifactorial; but as yet they are not clear. Clinicians should provide tobacco-cessation interventions to their patients with chronic pain who use tobacco even though more research is needed regarding how smoking cessation might affect their pain and how best to help them quit.

MM



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# Postoperative Nausea and Vomiting in Pediatric Patients

**P**ostoperative nausea and vomiting (PONV) is a common problem following surgery. In addition to making the patient feel uncomfortable, it can lead to dehydration, electrolyte imbalance, and longer hospital stays. Despite new guidelines, treatment strategies, and better anesthetics, the incidence of PONV in children and adults has remained constant (20% to 35%) over the past 30 years.<sup>1-3</sup>

Postoperative nausea and vomiting encompasses three main symptoms that may occur separately or in combination: nausea, vomiting or emesis, and retching. One of the goals of anesthesia care is to minimize the likelihood that patients will experience these symptoms. To achieve that, efforts are being made to minimize the use of opioids by adopting regional analgesic techniques and nonopioid medications for perioperative pain control, use a total intravenous anesthesia plan for those with a history of severe PONV, and adopt a prophylactic strategy for PONV prevention.<sup>3,4</sup>

In addition, antiemetics are also being widely used. Because no single drug effectively blocks all the neural inputs that may trigger nausea and vomiting, practitioners commonly prescribe two or more in combination, for example, a serotonin antagonist (ondansetron) with an inhibitor of prostaglandin synthesis (dexamethasone).

Although our understanding of PONV risk factors has improved dramatically since the early 1990s, we still have much to learn about the pathophysiology of PONV. We have even more to learn about PONV in children. Thus, it has been a focus of recent research at the University of Minnesota. The following brief articles present the findings from two studies, one of children up to 2 years of age who underwent strabismus surgery and the other of children ages 1 month to 16 years who underwent urologic procedures.

These studies looked at the incidence of PONV in both groups during the first 24 hours following surgery. The strabismus study also looked at the incidence of discomfort and emergence agitation/delirium in infants and young children.

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# Discomfort, Delirium, and PONV in Infants and Young Children Undergoing Strabismus Surgery

By Anne M. Stowman, Erick D. Bothun, M.D., and Kumar G. Belani, M.B.B.S., M.S.

■ This article presents the results of a retrospective analysis of anesthesia care and perioperative outcomes in children up to 2 years of age who underwent strabismus surgery during a five-year period at the University of Minnesota Amplatz Children's Hospital. We reviewed the charts of 74 children to determine perioperative outcomes—namely discomfort, emergence agitation/delirium, and postoperative nausea and vomiting (PONV). We found that although PONV was not an issue in this age group, as it was with older children, discomfort and emergence agitation/delirium do need to be considered during their care.

Previous studies have reported that up to 80% of children who are treated surgically for strabismus suffer from postoperative nausea and vomiting (PONV),<sup>1</sup> a serious complication that can lead to discomfort, dehydration, electrolyte imbalance, and delayed hospital discharge. Although efforts have focused on reducing the incidence of PONV in children ages 3 through 8 years, there are no published reports detailing perioperative outcomes in younger children undergoing ambulatory strabismus surgery. The purpose of our study was to summarize perioperative outcomes—namely discomfort, emergence agitation/delirium, and PONV following strabismus surgery in children up to 2 years of age.

## Methods

Our study was conducted after it was approved by the Institutional Review Board at the University of Minnesota and found to meet all applicable Health Information Portability and Accountability Act requirements. We conducted a cohort chart review of all patients up to 2 years of age who underwent outpatient strabismus surgery at the University of Minne-

sota Amplatz Children's Hospital between August 1, 2004, and July 29, 2009.

Detailed patient information was extracted from the medical record including the anesthesia record, post-anesthesia care unit (PACU) report, phase II recovery room report, and 24-hour post-discharge information obtained by telephone. The extracted information included the patient's age, gender, weight, past medical history, and American Society of Anesthesiologists physical status; laterality of the surgery; duration of surgery and anesthesia; time in the operating room, PACU, and phase II recovery room; presence of a parent during induction; medications and dosages administered including induction agents, antiemetics, neuromuscular blockers and reversal drugs, and anti-anxiety medications; method of induction; presence of pain, PONV, and emergence agitation/delirium; blood pressure and heart rate; other significant side effects; medications given; and hospital admission following surgery. Because the patients in this study were too young to report symptoms, discomfort was recorded as crying and irritation that responded to analgesic administration. Emergence agitation/delirium was recorded from nursing

notes in the PACU and phase II recovery charts. Emergence agitation/delirium was graded according to noted observations and translated to the Pediatric Anesthesia Emergence Delirium (PAED) scale, which takes into consideration the extent to which 1) the child makes eye contact with the caregiver, 2) the child's actions are purposeful, 3) the child is aware of his or her surroundings, 4) the child is restless, and 5) the child is inconsolable.<sup>2</sup>

Statistical analysis was performed using tables of descriptive frequencies with basic measures of mean, minimum, maximum, count, and standard deviation. The Student's T-test was used for evaluation of statistical significance ( $P < 0.05$ ).

## Results

We analyzed the records of 74 infants younger than 2 years of age who underwent strabismus procedures. Sixty percent were female and 40% were male, with a mean age of  $14.8 \pm 5.0$  months (range: 5 to 23 months). All patients came to the hospital on the day of surgery with their caregivers understanding that they would be discharged that same day.

The anesthesiology care team evaluated all of the patients before surgery in order to develop an anesthesia care plan. All patients followed the ASA's NPO guidelines prior to surgery. Twenty-nine (39.2%) received midazolam for anxiety orally; another 9.5% received it intravenously intraoperatively, and 9.5% received it postoperatively in the PACU to treat emergence agitation/delirium. Only three were given the anti-nausea drug ondanset-

Table

**Postoperative Problems Noted following Strabismus Surgery in Infants and Young Children (N=74)**

Outcomes	Number	% Patients
<b>Pain and discomfort</b>	53	71.6
<b>Emergence agitation/delirium</b>	33	44.6
<b>Respiratory symptoms</b>	12	16.2
Needing supplemental O <sub>2</sub>	6	8
Severe laryngospasm	2	2.7
Postextubation pulmonary edema	1	1.3
<b>Hospital admission</b>	5	6.8
<b>Tachycardia</b>	3	4.1

tron prior to surgery.

Anesthesia was induced with sevoflurane in all but one child. That child received nontriggering agents (total intravenous anesthesia with propofol, fentanyl and rocuronium) because of a family history of malignant hyperthermia. Desflurane was used as the maintenance agent in 53% of the children; sevoflurane was used in 35%; and isoflurane in 12%. Fifty-one patients received glycopyrrolate, and 12 received atropine at the onset of the procedure. The majority of children were intubated. Cuffed endotracheal tubes were used in 62 children (age 14.3±5.1 months); 10 (age 16.7±7.3 months) had uncuffed endotracheal tubes ( $P > 0.05$ ). A laryngeal mask airway (LMA) device was used in two babies. Nondepolarizing muscle relaxants were used in 47 (64%) children (rocuronium in 25; cisatracurium in 17; vecuronium in five). Of those, only 36 were reversed with neostigmine and glycopyrrolate. The ophthalmologists provided topical analgesia with tetracaine 0.5% to 30 children; six received topical lidocaine, and one received tropicamide 0.17% plus cyclopentolate.

Prior to awakening and extubation, 68 (92%) received prophylaxis for PONV. Fifty-eight of those patients received ondansetron; of those, 37 also received dexamethasone and one received dexamethasone and droperidol. Eight patients received only dexamethasone and two received only droperidol.

Intraoperatively, the anesthesia care team used fentanyl in the majority of pa-

tients (95%) for pain. Morphine and alfentanil were also used. Forty-nine percent of the patients received rectal acetaminophen postinduction. Despite receiving opioids intraoperatively, two-thirds of the children (67.1%) required additional analgesics (fentanyl 27%, morphine 23%, and acetaminophen 17%).

During emergence from anesthesia, 36 of the 47 patients given nondepolarizers were reversed in the OR and, with the exception of two patients, were extubated in the OR. Those two were extubated in the PACU.

Pain and discomfort and emergence agitation/delirium were noted in the PACU. Discomfort was noted in 53 children (Table). None had emergence agitation/delirium. There were no episodes of vomiting.

## Discussion

We found a much lower incidence of PONV in our group than earlier studies of older children. This may have been due in part to the age of our patients and because of the use of prophylactic antiemetics.

In addition to PONV, our study examined both emergence agitation/delirium and discomfort following strabismus repair. In all instances, nursing notes differentiated between crying and discomfort, restlessness, inconsolability, and agitation. We interpreted crying and irritability without agitation as discomfort. In most cases, over-the-counter medications alleviated the patients' discomfort. We determined a child was agitated when rest-

lessness and inconsolability (part of the emergence delirium determination criteria) were indicated in the nursing notes.

None of the infants and young children experienced PONV. Although we cannot be sure that none of the patients experienced nausea because of their inability to communicate such a sensation, no obvious signs or symptoms of nausea such as retching, gagging, or vomiting were documented by the nursing staff in the perioperative care units or reported by caregivers at home during the telephone follow-up. We believe the low incidence of PONV may have been the result of administration of antiemetics. Nearly all of the patients (92%) received prophylaxis for postoperative nausea and vomiting. Use of antiemetics prophylactically should be considered in future studies.

Emergence delirium was determined by the PAED scale. Although a number of patients displayed restlessness ( $n=12$ ) and inconsolability ( $n=9$ ), all had purposeful movement, seemed aware of their surroundings, and were able to identify their caregiver through eye contact.

Discomfort and agitation were most prevalent postoperatively. Agitation was experienced by 44.6% of patients, but it was never a reason for hospital admission, nor did it ever extend beyond the time in the PACU. Although all patients were administered analgesics intraoperatively ( $n=74$ ), nearly half ( $n=33$ ) experienced agitation postoperatively despite administration of opioids and/or acetaminophen intraoperatively. The absence of hypothermia, as indicated by intraoperative and postoperative arrival and departure temperature averages, discounts the idea that lowered body temperature was the reason for agitation. The idea that it may be associated with the use of a particular anesthetic agent is also less relevant, as 81% of our patients received sevoflurane. We were unable to determine whether there was a correlation between IV induction versus mask induction and agitation, as only one of our patients underwent an IV induction. The reason for high rates of agitation needs to be further investigated.

Discomfort was perhaps the biggest

concern for patients. Seventy-two percent cried on and off, were fussy, and were easily consoled by being held or rocked or having a parent present. These patients were given analgesics postoperatively and had a predictable response.

One of the limitations of our study was lack of thorough documentation in the patients' charts. Because our review was done retrospectively, details regarding the care a patient received and a patient's behavior had to be extracted from the notes taken by staff. In future studies, it would be prudent to have staff watch for certain symptoms and behaviors and consistently document them as well as the status of the patient throughout the operative and postoperative phases.

## Conclusion

This study of infants and young children demonstrates that PONV was not common following strabismus surgery and that the incidence may have been reduced through the prophylactic use of antiemetics along with insoluble newer anesthetic agents. We found that discomfort and emergence agitation/delirium during the postoperative period are of greater concern.

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# Postoperative Nausea and Vomiting in Infants and Young Children following Urologic Surgery

By Preeta George, M.B.B.S., M.D., Kumar G. Belani, M.B.B.S., M.S., and Aseem Shukla, M.D.

■ This article presents a cohort review of anesthesia-related perioperative outcomes of children undergoing ambulatory urologic surgery using a combination of general and regional anesthesia. We analyzed the charts of 123 patients who underwent hypospadias repair and circumcision between July 1, 2006, and January 2, 2009, for cases of postoperative nausea and vomiting. We found the incidence to be quite low. We believe the low incidence may have been related to the prophylactic use of antiemetics along with an opioid-sparing technique for anesthesia care.

Postoperative nausea and vomiting (PONV) is a distressing postsurgical problem in children. Despite new guidelines, treatment strategies, and better anesthetics, the incidence of PONV has remained constant (20% to 35%) over the past three decades.<sup>1,2</sup> We studied the incidence of PONV in a segment of patients undergoing ambulatory urologic surgery who received a combination of general and regional anesthesia. The goal of this study was to identify cases in which PONV occurred within the first 24 hours after surgery. The presence of PONV was defined as at least one episode of nausea (any degree, including mild) or vomiting or retching, or any combination of these symptoms.<sup>3</sup>

## Methods

Following approval by our Institution Review Board, we analyzed data from a group of pediatric patients who underwent ambulatory circumcision or hypospadias repair at the University of Minnesota Amplatz Children's Hospital between July 1, 2006, and January 2, 2009. Patients received a combination of general and re-

gional anesthesia.

Included were all infants and children between the ages of 1 month and 16 years who underwent hypospadias repair or circumcision. All surgeries were performed by the same surgeon. Excluded from the study were those patients who were not ambulatory patients. Anesthesia and post-anesthesia care records were reviewed in detail to record the anesthesia plan and the use of antiemetics. All patients had a complete clinical evaluation at least 30 days prior to surgery and were assessed on the day of surgery by an anesthesiologist. The 24-hour postoperative phone call notes by our ambulatory nurse specialist were reviewed for instances of nausea and vomiting.

## Results

A total of 72 children (ages 40±46 months) underwent circumcision and another 51 (26±43 months) had hypospadias repair. All followed the American Society of Anesthesiologists' NPO guidelines; the majority received a general anesthetic that consisted of mask induction with sevoflurane. Nine patients had intravenous induction with propofol. Desflurane or sevoflurane

Table

**Incidence of Postoperative Nausea and Vomiting (PONV) following Urologic Surgery**

Time	Total number of patients	PONV during first six hours postop	PONV six to 24 hours postop
<b>Hypospadias group</b>	51		
Nausea		*5	1
Vomiting		0	1
<b>Circumcision group</b>	72		
Nausea		4	0
Vomiting		0	0

\*P=0.487 versus circumcision group (not significant)

were used for maintenance. Nitrous oxide was used in 16 patients in the circumcision group and seven in the hypospadias group for induction only. In the circumcised group, 26 children had a laryngeal mask airway (LMA) device, 32 were intubated, and 14 were managed with a facemask. All but two of the children who were circumcised received a penile block. One did not receive a caudal; the other had no regional block. Opioids were used sparingly. Sixty-five children received intraoperative fentanyl (2.27±1.28 mcg/kg). In the hypospadias group, five children had an LMA, three received mask ventilation, and 43 were intubated. Twenty-eight received a caudal and 23 were given a penile block. Forty-three received fentanyl (2.88±3.13 mcg/kg).

Seventy-five percent of the children in each group were given the antiemetic ondansetron intraoperatively. Thirty-three percent of the children in the circumcision group and 51% in the hypospadias group also received dexamethasone. Postoperative nausea in the recovery room and before discharge was noted in four of 72 (5.6%) circumcised children and five of 51 (9.8%) children who underwent hypospadias repair (Table). No episodes of vomiting were reported. All children were discharged home. During the first 24 hours after surgery, one child in the hypospadias group had both nausea and vomiting. None returned to the hospital for PONV. Postoperative pain was mainly controlled with acetaminophen. Narcot-

ics were given only if the pain was severe. Postoperatively, five circumcised children received fentanyl, five received morphine, and two received both. Ten of the children who underwent hypospadias repair received fentanyl, six received morphine, and one received both. Upon discharge, all were given a prescription for acetaminophen/hydrocodone (500/7.5 mg per 15 mL) elixir or acetaminophen alone to be used as needed every four to six hours.

**Discussion**

The cohort review in this subset of pediatric patients was carried out because the incidence of PONV had not been exclusively studied in such children. We found the incidence of PONV to be lower than had been previously reported in infants and children.<sup>2</sup> Several factors may be responsible for this. For one thing, the use of opioids was minimized for the majority of patients because simple regional techniques were used instead. Pain and opioids work through different pathways to potentiate PONV. Hence, incorporating a regional anesthetic would circumvent both factors. In addition, approximately 75% of patients received the antiemetic ondansetron, and a good number received dexamethasone intraoperatively, both of which may have contributed to the low incidence of PONV. The majority of infants and young children received the antiemetic during the first half of surgery. Even though nitrous oxide was used in 23 infants, it was used only for induction;

this may be the reason only two of those patients experienced PONV. We did not find any association between the use of reversal and PONV.

Following surgery, patients and their families had access to a 24-hour telephone follow-up service. During the 24 hours following discharge, only one patient had an episode of nausea and vomiting. He was not treated with any medication and was managed conservatively. We also did not find a relationship between the time of antiemetic administration and the incidence of PONV. Patients who received antiemetics during the first half of the surgery had a similar incidence of PONV as those who received them during the latter half of the surgery.

**Conclusion**

We found the incidence of PONV following ambulatory urologic surgery in infants and young children to be quite low. The low incidence was most likely related to the prophylactic use of antiemetics along with limited use of opioids during anesthesia care as well as use of a caudal or penile block for perioperative pain control.

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# Safe and Sound

## Pediatric Procedural Sedation and Analgesia

By Patricia D. Scherrer, M.D.

■ Providing procedural sedation for pediatric patients presents unique challenges. Children's hospitals have protocols in place to provide safe, high-quality sedation care delivered by specialists in pediatric sedation and anesthesiology. However, the demand for procedural sedation for diagnostic and therapeutic procedures is increasing. This article describes some of the key components involved in establishing a protocol for safe and effective pediatric sedation services including screening techniques for patients at higher risk for complications and appropriate monitoring and rescue plans. We also review medications commonly used for pediatric sedation and pain management and discuss resources available to physicians who provide pediatric sedation.

**T**ommy is a 3-year-old with a history of speech delay and staring spells. His primary care physician has ordered a brain MRI to evaluate him for underlying anatomic issues. The MRI will take approximately 45 minutes and will require him to lie nearly motionless. Tommy squirms and fights when his dad tries to put him on the MRI table.

Jasmine is a 6-month-old who has failed two newborn hearing screenings. Her audiologist needs to perform further testing, which requires Jasmine to be quiet for 30 to 60 minutes. When the audiologist attempts the test, Jasmine begins to cry, and the test cannot be completed.

Anna is a 7-year-old who suffered some "road rash" on her left knee after falling from her bike. She presents to a local urgent care with an inflamed, swollen area on her knee a week later, and the

urgent care technician is concerned that she may have an abscess. Anna begins to scream and pull away when the tech tries to clean the area.

Three different scenarios, three different children who may not be able to receive the care they need without sedation and/or pain control. Such situations arise daily in medical centers around the country. Although most children's hospitals have specialized sedation programs to address the needs of their patients, many regional and rural medical centers have sporadic experience with pediatric sedation. Nevertheless, demand for sedation is growing, and many hospitals and clinics are seeking to expand their capabilities. To ensure patient safety, physicians and health systems must develop pediatric sedation protocols that recognize higher-risk situations, provide appropriate supervision and monitoring, and tai-

lor drug choices to the child's needs and the providers' skill sets.

### Initial Considerations

When planning sedation and/or pain management for a child, knowing what level of responsiveness needs to be achieved during the procedure or test is essential for choosing the appropriate medication regimen. Painful procedures that require relative immobility generally mandate a deeper level of sedation than noninvasive radiological tests. Each sedation plan should take into account the age, developmental level, and personality of the child. Seven-year-old Anna, for example, may require deep sedation for incision and drainage of her abscess; local analgesia alone may be sufficient for another child her age undergoing such a procedure.

In an effort to clarify sedation goals, the American Society of Anesthesiologists (ASA) has defined a continuum for levels of sedation.<sup>1</sup> Minimally sedated children may have an impaired level of cognitive functioning but maintain their airway protective reflexes and cardiorespiratory status. For example, for children undergoing voiding cystourethrograms, this level of sedation is often achieved through use of inhaled nitrous oxide. Moderate sedation is associated with blunted-but-purposeful responses

to verbal or tactile stimulation. There may be subtle alterations in ventilation, but airway reflexes and cardiovascular function are generally unchanged. Infants who receive chloral hydrate often reach a moderate level of sedation. In contrast, deeply sedated children may have inadequate spontaneous ventilatory drive and/or significant upper airway obstruction and may require airway intervention. During deep sedation (as opposed to general anesthesia), purposeful responses to painful stimulation remain intact. The combination of an opioid and a benzodiazepine often results in deep sedation.

The definitions of these levels of sedation remain somewhat arbitrary. Unfortunately, there is no clear physiologic demarcation between each level. Because the various levels of sedation are not specific to any particular drug or regimen, physicians must understand that it is impossible to reliably predict the effect that a given dose of a particular drug will have on a patient. Because of the potential alterations in airway and respiratory mechanics that may occur, the different levels of sedation require different levels of expertise in patient management. Therefore, Joint Commission guidelines state that a sedation provider should be able to “rescue” a patient from sedation one level deeper than that which is intended.<sup>2</sup>

For most children, titration between moderate and deep sedation can be tricky. Pediatric sedation providers should be prepared to provide airway intervention maneuvers such as bag mask ventilation (BMV) and even endotracheal intubation in order to rescue deeply sedated children. A hospital’s sedation protocol should clearly define standards of performance and competencies for sedation providers, and these skills should be demonstrated by satisfactory performance in an observed clinical or simulation setting.<sup>3</sup>

Perhaps the most important factor for ensuring safety during pediatric procedural sedation is the immediate availability of skilled rescue resources. Adverse pediatric sedation events are most common in facilities that lack adequately trained personnel and reliable emergency response

support.<sup>4,5</sup> Physicians should carefully consider the following questions before embarking on a sedation plan: What is the skill set of the team that will be with the child at all times? If the primary team needs help, who will respond? How long will it take the rescue team to arrive? Is a member of the rescue team an anesthesia specialist who is capable of providing reliable advanced airway support to children? Satisfactory answers are critical to ensuring safety.

### ..... **Patient Evaluation**

What “red flags” should providers look for when evaluating a child who would benefit from sedation for a painful or anxiety-provoking procedure? Although identifying every possible risk factor can be challenging even for the most seasoned pediatric anesthesiologist, there are specific patient characteristics that have been associated with increased complications. A thorough health history and physical examination can reveal many of them.

First, the provider should find out why the child is having the procedure or test. The provider should then find out whether the child has medical issues that could put him or her at increased risk for complications. Recent upper respiratory illness symptoms, especially coughing, wheezing, or nasal congestion, can increase the risk of airway irritability and respiratory complications, including hypoventilation, desaturation, and laryngospasm. Similarly, a history of recent vomiting or symptomatic gastroesophageal reflux can be cause for concern, as emesis during sedation, when airway protective reflexes may be blunted, could lead to aspiration and initiate laryngospasm. Significant obesity, an increasing problem in the pediatric population, may be associated with an increased risk of airway obstruction, especially with deeper levels of sedation. Overt obstructive sleep apnea symptoms are clearly associated with airway obstruction during sedation; however, many families are unable to say how frequently or how badly their children snore. Even occasional audible snoring makes the need for airway repositioning and nasopharyngeal

airway placement more likely.

Physicians should also be aware of underlying medical conditions that increase the potential for airway compromise during sedation. A number of genetic syndromes are associated with anatomic and/or developmental airway differences as well as altered respiratory mechanics; several excellent articles describe these.<sup>6,7</sup> Infants born prematurely have immature respiratory drive physiology, increasing the likelihood of sedation-related apnea in the first months of life. Currently, many sedation programs choose to monitor infants less than 60 weeks post conceptual age for a longer time period than they do older children prior to discharge. For example, at Children’s Hospitals and Clinics of Minnesota, we monitor these infants for a 12-hour period, discharging them to home only if they have not had any episodes of apnea during that time. Changes in respiratory physiology during procedural sedation can aggravate underlying asthma or bronchopulmonary dysplasia, potentially leading to bronchospasm and/or desaturation.

Physical examination should focus on findings that could affect the course of the child’s sedation. The physician should look for craniofacial abnormalities that could be problematic if the patient would need BMV or endotracheal intubation. These include, but are not limited to, facial anomalies such as retrognathia that can prevent good mask seal and interfere with airway visualization, tonsillar hypertrophy that can prevent adequate air entry, and limited neck mobility that can prevent adequate airway positioning. Physicians also should remember to look for braces and other orthodontia. Many neuromuscular disorders are associated with decreased ability to handle oral secretions; these secretions can pool in the hypopharynx and lead to coughing, laryngospasm, or aspiration when airway reflexes are blunted. Children who have obvious wheezing or other respiratory difficulties should have their test or procedure rescheduled. If the procedure or test is deemed to be emergent, an anesthesia consultation should be sought. Significant abdominal distension



can increase the risk of vomiting and aspiration.

Although the need for strict NPO guidelines for urgent and emergent sedations continues to be a topic of debate, most physicians should plan to adhere to the recommended ASA guidelines.<sup>1</sup> These suggest the following NPO times:

- Clear liquids—two hours
- Breast milk—four hours
- Infant formula, other nonhuman milk, solids—six hours
- Full meal—eight hours

For children requiring sedation who do not meet the ASA NPO guidelines, recommended options include delaying the procedure or seeking an anesthesia consultation.

### Monitoring, Equipment, and Documentation

The single best way to monitor a sedated child is continuous direct observation by one or more trained providers not directly involved with the procedure itself. Beyond this basic tenet, the frequency and intensity of monitoring depend on the depth of the sedation being performed. At a minimum, all sedated patients should be monitored with continuous pulse oximetry. The ASA also recommends that respiratory function be continuously monitored by observation, auscultation, and/or capnography. Electrocardiography should be used, and blood pressure should be measured intermittently during deep sedation.

Equipment needs are based on patient management and rescue. A number of mnemonics can help the sedation provider remember the essentials; one of the most popular is “SOAPME”:

**SUCTION**—appropriately sized large-bore suction catheters, smaller catheters for nasal or endotracheal suctioning, functional vacuum apparatus;

**OXYGEN**—adequate supply, functioning flow meters;

**AIRWAY EQUIPMENT**—appropriately sized masks, self-inflating or anesthesia BVM systems, nasopharyngeal and oropharyngeal airways, laryngeal mask airways, laryngoscope blades and handles, endotracheal tubes;

**PHARMACY**—sedative analgesic medications, reversal agents, emergency resuscitation and airway medications;

**MONITORS**—pulse oximetry, cardiorespiratory monitor with ECG and BP capability, stethoscope, end tidal carbon dioxide monitor; and

**EXTRAS**—intravenous access catheters, isotonic resuscitation fluid, emergency drug sheet, calculator.

The type of procedure being performed may also dictate other equipment needs.

Documentation of sedation encounters should include informed consent, postsedation instructions, and contact information for the parent or guardian. A focused history and physical examination should be performed and documented at the time of the sedation. The plan for procedural sedation as well as an assessment of the child’s sedation risks and ASA classification should be included in the documentation.<sup>8</sup> Time-based recording of vital signs, sedation scores, and administered medications is required. Also, any adverse events and associated interventions should be noted.

### Sedatives and Analgesics—A Potpourri of Choices

A number of medications are used for pediatric procedural sedation. There is rarely a right or wrong choice with regard to medication selection; however, the physician’s familiarity and experience with various agents are important considerations. Many of the more commonly used sedation agents have no analgesic component, so adding a medication for pain control or choosing a different regimen may be more appropriate for painful procedures.

Benzodiazepines have been a mainstay of procedural sedation for years. A drug in this class can be used as a single agent for brief, nonpainful procedures and as an adjunct in combination with opioids or ketamine for more painful ones. The pharmacokinetics of midazolam make it most suited for procedural sedation. Onset of action occurs in less than 60 seconds when administered intravenously (IV), and its duration is usually 15 to 30

minutes. Midazolam may be administered via many different routes: IV, orally, rectally, intramuscularly, or intranasally. Although the combination of midazolam and an opioid analgesic can provide excellent sedation and analgesia for painful procedures, the combination is also associated with a higher incidence of respiratory depression.

Nitrous oxide, a longtime favorite sedative/analgesic agent for dental procedures, is becoming increasingly popular as a minimally sedating agent for a variety of pediatric procedures, including IV catheter placements, VCUGs, lumbar punctures, and other brief, painful procedures. Nitrous is delivered as either a fixed 50/50 mixture with oxygen or in titratable concentrations of 30% to 70%. Onset of action generally takes place within two to three minutes, and its effect rapidly ends when the gas is discontinued. Nitrous may also be combined with an opioid analgesic for more painful procedures such as joint taps; but this combination can induce moderate or even deep levels of sedation. The incidence of nausea and vomiting following nitrous administration is approximately 5%.<sup>9</sup> Challenges with inhalation equipment and appropriate waste gas scavenging have limited the use of nitrous oxide in some locations.

Chloral hydrate has been employed as a sedative hypnotic agent for more than 100 years. It is particularly useful for inducing a sleep state in children younger than 2 years of age for a nonpainful procedure such as a CT/MRI scan or an auditory brainstem response test for hearing. Chloral hydrate is administered orally, with an onset of action usually within 20 to 30 minutes, although onset can be somewhat variable. Duration of action can be even more unpredictable. Most children sleep for 60 to 120 minutes, but the long elimination half life of chloral hydrate occasionally can result in prolonged sedation states that can last more than 12 hours. Because of the unpredictable duration of action, there have been reports of serious adverse events and even death following discharge for children who received chloral hydrate for sedation.<sup>10</sup>

Rates for successful sedations are between 85% and 95%. In rare instances, younger children never achieve the depth of sedation required to complete the associated procedure. The rate of failed sedation increases markedly for children over the age of 3 years. Although chloral hydrate administration is generally associated with a moderate level of sedation and rarely with respiratory depression, the incidence of respiratory complications is higher in infants, especially those younger than 2 months of age.<sup>11</sup>

Barbiturates, most commonly pentobarbital, have also been mainstays of sedation for nonpainful pediatric procedures in the past. Although the use of pentobarbital has been largely supplanted by newer agents such as propofol and dexmedetomidine, it is still used for moderate sedation for procedures such as MRI scans. Advantages of pentobarbital include its one- to two-minute IV onset time, the ability to provide repeat dosing in as little as five to 10 minutes, and limited respiratory and hemodynamic effects in otherwise healthy children. However, children with underlying respiratory or cardiovascular issues may be more susceptible to associated cardiopulmonary instability. Although children can become quite deeply sedated, and even anesthetized, with pentobarbital, it does not provide any analgesic effects. The disadvantages of using pentobarbital for procedural sedation include its potential for prolonged deep sedation and unpredictable recovery time, which can range from 60 minutes to more than 12 hours, as well as its association with recovery dysphoria and agitation (unaffectionately labeled “pentobarb rage”).<sup>12</sup>

Dexmedetomidine is a relatively new highly selective central alpha 2 agonist with both sedative and analgesic properties. Already in use as an ICU sedative analgesic, dexmedetomidine has migrated to the procedural sedation arena, where it is a preferred agent for many providers because of its limited effects on respiration. Dexmedetomidine is generally associated with a moderate level of sedation that, according to electroencephalogram, mimics normal sleep. Therefore, many pediatric

neurologists prefer dexmedetomidine for children who require sedation for successful completion of EEGs. Dexmedetomidine has also proven to be useful for sedation of children with autism or other developmental concerns; as the recovery period seems to be associated with a much less troublesome emergence.<sup>13</sup> Most often, dexmedetomidine is administered as an IV agent, with a slow initial bolus over five to

### Resources for Physicians

Pediatric sedation is an evolving specialty. Currently, the practice of sedating children crosses many disciplines, and this can generate confusion, fear, and even conflict within medical systems. In an effort to provide multidisciplinary leadership in the advancement of pediatric sedation practice, the Society for Pediatric Sedation was formed in 2007 to promote safe, high-quality care, innovative research, and quality professional education. The society's membership is composed of physicians and nurses from pediatric anesthesiology, pediatric emergency medicine, pediatric critical care medicine, and pediatric hospital medicine. It also includes pediatric dentists, child life specialists, and a variety of other individuals. Its website, [www.pedsedation.org](http://www.pedsedation.org), offers a number of resources for providers and parents including article reviews, practice guidelines, and links to other programs and references. The society's 2011 meeting will be held in Minneapolis in May and is co-sponsored by Children's Hospitals and Clinics of Minnesota.

10 minutes followed by a continuous infusion; it also can be given orally or buccally with good success. Dexmedetomidine can be associated with clinically significant cardiovascular effects, especially bradycardia, because of its effects on cardiac conduction times.

Many children's hospitals have built their sedation programs around the sedative/anesthetic agent propofol. By far the

most commonly utilized agent for pediatric procedural sedation, it is used both as a single agent for nonpainful procedures such as CT, MRI, and ABR testing, and in combination with analgesics such as ketamine and fentanyl for a variety of painful procedures. Propofol is administered intravenously, and its many advantages include onset in 30 to 60 seconds, offset generally in five to 15 minutes, and ease of titration to effect. For longer procedures, bolus propofol is used for induction, and deep sedation is maintained by a continuous IV infusion. Propofol use is associated with a high incidence of respiratory depression, and induction can easily lead to rapid loss of airway reflexes and apnea.<sup>14</sup> Physicians who administer propofol must be able to rescue patients from a general anesthetic state and have expertise in both BVM ventilation and endotracheal intubation. Because of the risk of rapid respiratory decompensation, some hospitals restrict use of propofol to anesthesia providers. In addition, propofol can lead to bradycardia and hypotension, although these effects are typically mild and do not become clinically significant in otherwise healthy children.

For decades, opioids have been the most commonly administered analgesic medications. Although they have no inherent amnestic qualities and limited sedative effects when used independently, they may be used in combination with sedative/hypnotic agents to facilitate deep sedation for painful procedures. Fentanyl is the most commonly used procedural opioid because of its pharmacokinetic profile and low cost. The onset of an IV dose of fentanyl occurs within two to three minutes, with peak effect at five minutes. This more rapid onset allows for more titratable dosing for procedural analgesia than morphine, which has an onset of action of five to 10 minutes. As with all opioids, fentanyl leads to dose-dependent respiratory depression, especially when used in combination with another sedative agent.

Ketamine is a favorite medication to facilitate sedation for painful procedures in the emergency department. Ketamine

is a derivative of phencyclidine, and it is uniquely associated with sedative, dissociative, amnestic, and analgesic properties. At lower doses, ketamine leads primarily to anxiolytic and analgesic effects. With higher doses, ketamine produces antegrade amnesia and a dissociative state of sedation/anesthesia. Upon awakening, children often report having experienced very vivid dreams or hallucinations. Ketamine may be administered via IV, intramural, oral, rectal, or nasal routes. Deep levels of sedation are generally achieved. Typically, patients maintain spontaneous respiratory drive and adequate airway protective reflexes, although ketamine is a sialagogue, and the additional saliva it produces can increase the risk for laryngospasm. Ketamine also leads to increased heart rate, blood pressure, and cardiac output in previously hemodynamically stable children. Unique side effects associated with ketamine include a potential increase in intracranial and intraocular pressure as well as negative neuropsychiatric effects with emergence delirium and significant agitation. The incidence of vomiting with ketamine sedation ranges from 12% to 25% but does seem to be decreased with co-administration of midazolam and/or ondansetron.<sup>15,16</sup>

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**Postsedation Recovery and Discharge**

Ongoing monitoring and observation are critical during recovery from procedural sedation and should continue until the child's vital signs and level of interaction have returned to their presedation baselines. Significant adverse events can occur during emergence, especially if medications with longer half lives were used. The recovery area should be equipped with the same monitoring and resuscitation equipment as the sedation and procedural area itself, and the same rescue resources should be available. Children should be discharged only when they have met specific pre-established recovery criteria and after the family has received detailed instructions for postsedation care, including instructions about how to seek

follow-up medical care if needed.

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**Conclusion**

Pediatric sedation requires careful consideration of the balance between the patient's risk factors, the procedure being performed, and the provider's experience and expertise. With appropriate preparation, physicians can offer safe and effective procedural sedation to meet the needs of their pediatric patients. Minnesota is home to a number of institutions whose physicians have extensive expertise in pediatric sedation and anesthesiology. These specialists should be considered a resource for providers who seek to establish a pediatric sedation protocol or who wish consultation for a specific pediatric sedation case.

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# Pediatric Chronic Pain

## There Is Hope

By Tracy Harrison, M.D.

■ Chronic pain is prevalent in children and can limit their ability to attend school, socialize with peers, and participate in physical activity. This article describes the advantages of using a multidisciplinary approach to evaluating and treating children with chronic pain and discusses medications and techniques for managing pain and restoring functionality.

Chronic pain is prevalent in the pediatric population. It has been estimated that between 25% and 46% of patients younger than 18 years of age throughout the world have experienced pain on a daily basis for more than three months.<sup>1</sup> Although no specific figure is available regarding the cost associated with treating chronic pain in the pediatric population, it is reasonable to estimate that it is significant because the medical cost for adults with chronic pain is nearly \$70 billion per year. When factoring in the lost productivity that results from their inability to work, the annual overall cost for adults with chronic pain climbs to \$140 billion per year.<sup>2</sup>

Research on children who were seen at a pediatric chronic pain clinic suggests headache, abdominal pain, and musculoskeletal pain are the most common complaints.<sup>3</sup> In addition, investigators found that adolescents who experienced pain for more than one year also had anxiety and depression.<sup>3</sup> The quality of life for children with chronic pain has been compared to that of young people with cancer and other chronic diseases.<sup>4</sup>

Suffering from pain daily can limit a child's ability to attend school, socialize with peers, and participate in physical activity. In fact, well-meaning health care providers and school personnel often recommend that children not attend school or participate in other activities while they are attempting to manage their pain. Ironically, this can exacerbate the child's pain. When children don't attend school, they can feel stress both because they are isolated and because they are worried about keeping up with their schoolwork. The added stress can make their pain worse. In addition, for children who are used to being active, physical inactivity can lead to deconditioning, which may cause a child to feel dizzy and lightheaded when moving from a supine to upright position. This subsequent increase in sympathetic nervous system activity may cause pain to increase as well.

Clearly, chronic pain often starts a vicious cycle of social isolation, avoidance of school and physical activity, and further pain. Thus, it is not surprising that evaluating and treating a patient with chronic pain can be challenging.

### Evaluating Chronic Pain

Children with pain usually present first to their primary care physician. If their pain proves to be chronic and is beyond the scope of their primary care provider, they should be seen by a specialist with experience in evaluating and treating particular pain syndromes to rule out life-threatening or readily treatable conditions. For example, children with chronic headaches should be evaluated by a neurologist, those with abdominal pain by a gastroenterologist, and those with musculoskeletal pain by a rheumatologist or neurologist. If pain continues despite a negative workup, patients and providers often may insist on further evaluation with the thought that a treatable condition may have been missed. Thus begins a cycle of extensive workup and more medical treatment that may prolong debility and further convince the patient that he or she is sick.

One of the challenges in dealing with patients who have chronic pain is that the symptoms may not have a specific physical cause. For that reason, they may benefit from being seen at a pediatric chronic pain center, where they can be evaluated by an interdisciplinary team of specialists who view pain and disability as a complex and dynamic interaction among physiologic, psychologic, and social factors.<sup>2</sup> At Mayo Clinic, for example, pediatric chronic pain patients

may be evaluated and treated by a team that includes pain physicians, clinical psychologists, clinical practice nurses, physical therapists, pharmacists, biofeedback technicians, and occupational therapists (see box).

### A Multimodal Approach to Treatment

Medications alone are unlikely to significantly benefit children with chronic pain. For that reason, it is important to take a multidisciplinary approach to treatment early on. A number of modalities from various specialties can benefit patients with chronic pain. These modalities need to be applied concurrently for the greatest effect.

A number of medications can be used to manage chronic pain. A physician initially should try over-the-counter medicines before prescribing more potent drugs. The World Health Organization analgesic ladder recommends starting with over-the-counter analgesics such as acetaminophen and nonsteroidal anti-inflammatory medications for mild pain. It is important to remember that these medications may not eliminate pain. In addition, with some pain syndromes such as headache, continuous use of these medications may contribute to rebound pain and, in effect, perpetuate the problem.

Studies of adults have found opioids such as oxycodone, hydrocodone, ultram, fentanyl, and morphine can lead to a 40% to 50% improvement in chronic pain.<sup>5</sup> However, opioid medications may affect the patient's short-term memory, ability to retain information, and reflexes. Patients also can become physiologically dependent on these medications. There is currently controversy among pain management providers regarding the use of opioids for chronic nonmalignant pain in adults (there is no literature pertaining to opioid use for chronic pain in children). These medications appear to be beneficial for some adult patients. However, few studies have looked at whether their use leads to improvement in functioning (ie, return to gainful employment, ability to perform activities of daily living). There-

fore, before prescribing opioids, the benefits and the risks need to be evaluated for each patient—both adult and pediatric.

Medications such as tricyclic antidepressants and anticonvulsants can be safely used for analgesic purposes in the pediatric population under the guidance of an experienced provider. (Their use may be beyond the scope of many providers.) Patients using these medications must be monitored, as these drugs can be associated with side effects such as increased suicidal thinking. A thorough history should be obtained before prescribing them. In addition, these medications take time to work. Usually, a six-month trial is prescribed. During that time, health care providers and family members should be vigilant about watching for development of adverse side effects.

In addition to oral medications, steroid injections may be indicated to minimize suspected inflammation around a nerve that may be responsible for pain. These are usually performed by pain physicians, primarily anesthesiologists, physiatrists, or neurologists. Injections are often used in conjunction with physical therapy to lessen pain so patients can work on gaining mobility and strength. In a subgroup of patients with complex regional pain syndrome, for example, epidural infusions may facilitate more active involvement in physical therapy. For headaches, supraorbital or occipital nerve injections may be considered. Patients with abdominal pain often have a musculoskeletal component to their pain and may benefit from a trigger point injection.

Various nonpharmacologic strategies also can be helpful to children who have chronic pain. Techniques including diaphragmatic breathing, guided imagery, progressive muscle relaxation, and biofeedback have proven helpful for alleviating headache, nausea and vomiting, and other conditions.<sup>6</sup> These make use of the patient's own ability to alter their physiology to minimize their pain and involve bringing the sympathetic and parasympathetic nervous systems into balance. It is recommended that a consultation with a psychologist take place to introduce

### Treating Pediatric Chronic Pain Patients at Mayo Clinic

Children with chronic pain who come to Mayo Clinic are evaluated by providers with a special interest in pediatric pain management. Children whose pain is relatively new and who may not have been exposed to many treatment modalities are usually seen in the Pediatric Chronic Pain Clinic by a team that includes a pediatric anesthesiologist who completed a pain fellowship, an adolescent psychologist, and a physiatrist in an outpatient setting.

Those patients who are more functionally disabled from their pain may be referred to the Pediatric Pain Rehabilitation Program. Staffed by a team that includes a pain physician, clinical psychologist, clinical practice nurses, physical therapists, pharmacists, biofeedback technicians, and occupational therapists, the program primarily serves patients between the ages of 13 and 20 years whose pain has limited their ability to attend school and participate in physical activity and negatively affected their mood and psychological functioning. The three-week hospital-based outpatient program introduces a variety of strategies and activities to restore functionality and minimize the effect of pain on patients' lives. Of the 150 patients who successfully completed the program during the past three years, virtually all returned to school full time immediately after. They also report improvement in measures of depression, anxiety, and pain catastrophizing, and increased activity.

these strategies and that patients practice them daily.

Finally, returning the patient to physical activity is an important part of treating their chronic pain, as it reverses deconditioning caused by inactivity and results in improved functioning. Activity should be reintroduced gradually under the supervision of a physical therapist so that the patient does not overdo it.



**Conclusion**

Chronic pain can have a significant impact on a child's ability to attend school, interact with peers, participate in regular physical activity, and lead the kind of life he or she wishes. It cannot be treated in the same way as acute pain. Waiting for the complete resolution of pain before having a child return to school or regular physical activity can lead to great debility and increased stress, which increases pain.

Chronic pain is best approached by a multidisciplinary team that specializes in treating pediatric pain patients. In all cases, parental involvement is imperative and attention should be paid to other stressors that may affect pain. Pain and disability should be viewed as a complex and dynamic interaction among physiological, psychological, and social factors, and the goal of treatment should be restoring function, rather than alleviating pain. MM

Tracy Harrison is an instructor in the department of anesthesiology, director of the pediatric acute pain and palliative care service, and medical director of the pediatric pain rehabilitation center at Mayo Clinic.

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# A Look Back

The role of the nurse anesthetist at Mayo Clinic.



Photo courtesy of Mayo Clinic

Alice Magaw administering anesthesia during surgery. Charles Mayo called her the “mother of anesthesia.”

The debate about who should administer anesthesia was already underway in this country by the time William J. and Charles H. Mayo began doing surgery at Saint Marys Hospital in Rochester in the late 1800s. At the time, anesthesia was administered by medical students, nurses, interns, general practitioners, and surgeons themselves. The Mayo brothers were among those who decided to enlist nurses to do the work—a decision that may have unwittingly fostered acceptance of the idea of the nurse as anesthetist. William Worrall Mayo, founder of the Mayo Clinic, launched one of the country’s first formal training programs for nurse anesthetists in 1889.

Alice Magaw, who served as the Mayos’ primary anesthetist from 1893 until 1908, gained such expertise that she lectured and wrote on the topic. Her first paper appeared in 1899 in the medical journal *Northwestern Lancet*, a precursor to *Minnesota Medicine*. These excerpts offer a glimpse into the techniques of the day and the relationship between nurses and doctors in the OR.—Carmen Peota

Having been educated only as a nurse, I am not expected to make the choice of an anaesthetic. The Drs. Mayo prefer ether as the anaesthetic of choice; they, as well as many other surgeons, believe ether to be safer. Chloroform is given as a rule to old people and children, also when there is pulmonary trouble and in most cases where there is kidney disease. Whenever

there is high arterial tension from any cause chloroform is selected. Ether should be given as an anaesthetic pure and simple and not combined with asphyxia, as has been recommended and is now practiced in many hospitals ... If given with plenty of air, there will not be the cyanosis and stertorous breathing which too often characterizes its use. ...

The face is anointed with vaseline, a

thick pad of moistened cotton placed over the eyes, and the anaesthetic preferred by the surgeon commenced. The inhaler we use at present and have for some time is the Esmarch mask with two thicknesses of stockinette. We sent to the mills and had a bolt of stockinette woven loosely for this purpose; it has more body than the regular surgeon’s gauze. We usually put two thicknesses of the gauze over the mask and get both ether and chloroform ready, and give whichever is best for the conditions observed. If we start out to give ether we commence with the drop method as carefully and with as much air as though it were chloroform, until the patient’s face is flushed, when we have a large piece of surgeon’s gauze of several thicknesses and about the size of a towel convenient, and keep adding a few more layers of the gauze and giving the ether a trifle more faster until the patient is asleep, then remove the gauze and continue with the same covering as at the start and the drop method. ...

The great secret of giving an anaesthetic of any kind is not to feel hurried and to have the operator say occasionally, “there is no hurry, lots of time.” There is such a difference in patients; some will be as calm and fall asleep as easily and quickly as babes, while others are nervous and can not give up and when you try to crowd the anaesthetic you are lost. Nothing is ever made by crowding the anaesthetic; I have tried it: rather than crowd ether, it is best to give a few drops of chloroform. The surgeon should not hurry the anaesthetist, neither should he begin the operation until the patient and the anaesthetizer are ready. ...

MM

Sources: *History of Anesthesia with Emphasis on the Nurse Specialist* by Virginia Thatcher. “Observations in Anesthesia” by Alice Magaw, *Northwestern Lancet*. 1899;19:207-10.