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South Dakota
medicine

THE JOURNAL OF THE SOUTH DAKOTA STATE MEDICAL ASSOCIATION

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Contents

July 2024

Volume 77 | Number 7

South Dakota
medicine

The Journal of the South Dakota
State Medical Association

Editorial

- 291** A Map to Learning? – Jason J. Kemnitz, EdD

Letters to the Editor

- 292** Wendell W. Hoffman, MD, FIDSA; Henry Travers

President's Comments

- 298** Mental Health Awareness – Jen Tinguely, MD, MPH

The Journal

- 300** Antibiotic Stewardship in Chorioamnionitis Exposed Neonates, A Quality Improvement Project – Jacquelyn EM Grev, MD; Mallary Van Tol, MSN, APRN, NNP-BC; Brooke Welker, DNP, APRN, NNP-BC; Bette Schumacher, MS, CPN, CNS, APRN; Lori Mulder, BSN, RNC-NIC; Andrea Dykstra, BSN, RN; Laurie Richards, MD
- 304** Case Report: Non-ischemic Papillary Muscle Rupture due to MRSA Myocarditis with Concurrent Thromboembolic Myocardial Infarction Secondary to Infective Endocarditis – Andrii Maryniak, MD; Filip Oleszak, MD; Jiannan Huang, MD; David Maziarz, MD; Tomasz Stys, MD, FACC, FSCAI; Adam Stys, MD, FACC, FASA, FSCAI, FACP
- 310** Subcutaneous and Fascial Abdominal Wall Endometriosis in the Setting of Previous Gynecologic Surgeries: Two Case Reports – Sena Uzunlar, MS IV; Alexander Haitham Turaihi, MD, PhD; Amity Peterson DO, PhD; Andrew Skattum, DO, FACS; and Thavam Thambi-Pillai, MD, MBA, FACS
- 316** Acute Osmotic Central Pontine Demyelination in an Alcoholic Patient With Normal Sodium Levels and a Vitamin B6 Deficiency – Cole D. Tessendorf, MS IV; Jared F. Hueser, MS IV; Brendan Wechsler, MD; Nessim N. Amin, MD
- 320** Anesthetic Considerations for Carbon Dioxide Emboli in Patients with Obesity – A Case Report – Andrew L. Guymon, MS IV; Donald P. Keating III, MS IV; Andrew M. Reuter, MS IV; David Fromm, MD; and Brendan Feehan, MD
- 324** Scoping Out Arthroscopy: A Concise Review of the Development and Other Important Principles in Orthopaedic Arthroscopy – Cole D. Tessendorf, MS IV; Nathan W. Skelley, MD

Extenuating Circumstances

- 330** A Hope for Life – Casey Risinger, MD; Luke Merrill, MD; David Jensen, MD; Susan M. Anderson, MD, FAAFP

Special Features

- 333** Member News
- 336** SDBMOE Board News – Margaret B. Hansen, PA, MPAS

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RETIREMENT HAPPINESS

DANIEL HAWTHORNE, CFP®, MS, Advisory Team Manager

What are the primary drivers of a happy retirement and overall wellness? MassMutual recently conducted a study on Americans' retirement happiness.

The good news? Most American retirees surveyed, 67% to be exact, reported being happier after leaving the workforce. Those who were happier were more likely to fill their free time with activities such as¹:

- Spending time with loved ones, 76%
- Exercising, 70%
- Pursuing hobbies, 63%
- Travel, 62%

What characterized the 33% who were not happier in retirement? They were less financially prepared and less healthy. And, a key finding was that nearly half of those who were unhappy reported being less sociable and lonely.¹

These findings align with an 86-year Harvard study on happiness, the longest running study of its kind. This study followed 724 people from all over the world. At two-year intervals, researchers asked detailed questions about their lives. Later in life, the participants were frequently asked about retirement. The most challenging aspect of retirement was not being able to replace the social connections they had in the workplace. They didn't miss the work; they missed the people.²

Furthermore, in 2023, the U.S. Surgeon General released an advisory raising the alarm about the devastating impact of loneliness and declared it a public health epidemic. In other words, loneliness is a public health issue.³

Finally, in 2023, The American Psychological Association released the latest "Stress in America" survey. It found that 72 percent of Americans reported feeling stressed about money at some point in the prior month.⁴

My key takeaway from all this research is that financial, mental/physical, and social health are the three primary drivers of a happy retirement and overall wellness. Because of this, it's important to invest in these areas long before retirement. This is where a financial advisor could help.

John Hancock released a report on their research around stress, finances, and well-being. They found

that people who work with financial professionals are three times more likely to say their retirement is ahead of schedule. They also reported that 86% of those who work with a financial professional to create financial plans for retirement are likely to feel good about their finances, versus only 45% for those who had none of these things.⁵

When I hear clients speak about what they value in their relationship with a trusted financial advisor, there are some common themes that come up time and time again:

1. Being able to sleep well at night (Mental/Physical Health).
2. Being able to spend more time with friends, family and doing the things they love (Social Health).
3. Valuing expert financial counsel and knowing they are on the right track (Financial Health).
4. Feeling less pressure or stress in making critical financial decisions all on their own that can impact their family and financial situation (Financial, Mental/Physical & Social Health).

People who work with financial advisors are making long-term investments in their financial, physical/mental, and social health, as well as ultimately a happy retirement.

I chose to become a financial advisor because it's a profession that touches so many facets of life. I get to make meaningful differences in our clients' lives by caring for them and delivering wise financial counsel. In my opinion, it's a noble and rewarding profession.

If you'd like help in planning for a happy retirement, Foster Group is here to help. Give us a call.

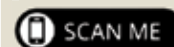
¹ MassMutual: Retirement Happiness Study

² Harvard: Happiness Study

³ Surgeon General Advisory: Loneliness

⁴ APA: Stress in America

⁵ John Hancock 2023 Financial Stress Survey: <https://retirement.johnhancock.com/us/en/financial-stress-survey>



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A Map to Learning?

Jason J. Kemnitz, EdD

Sometimes stepping into the field of medical education can feel like you are standing in the middle of a foreign country, in which you don't speak the language and you need to find your way home. To survive, let alone thrive, you need to gain knowledge of the many acronyms that are spoken daily. Terms like UME, GME, CME, LCME, AAMC, ACGME, ACCME, and many others can be confusing when they are spoken like everyone knows what they mean. Add to that our specific curriculum, and terms like Pillar 1, 2, or 3, LIC, and ice week can further muddy the waters.

One of the terms embraced by medical education and education in general is SDL or self-directed learning. SDL carries enough weight in medical education that the LCME (Liaison Committee on Medical Education), our accrediting body, has standards devoted to making sure it is included in any medical education curriculum. Unfortunately, the concept of SDL is often misunderstood. Teamed with the phrase "adult learner," SDL often becomes a license for a busy instructor to leave the learner to their own devices. The idea that a self-directed learner should figure it out on their own because they are "self-directed" is often harmful, as without direction the learner is left to figure out complex topics to which they may or may not have had exposure.

To help alleviate this thought process I offer the Staged Self-Directed Learning Model. SSDL aims to add some guidance into the SDL process by assuming the ability to be self-directed is situational: one may be self-directed in one subject, a dependent learner in another. Further, there is nothing wrong with being a dependent learner - one who needs to be taught. 1 Understanding the stages and applying them to where our learners are in the current situation will allow the educator to help the student as efficiently as possible.

Stage 1 learners are dependent learners. They often lack relevant knowledge, skills, or experience to reach their educational goal. This does not mean that as an educator you need to "spoon-feed" them. Rather, working with these students to set small learning goals between the times that you spend with them may be effective. You could also try coaching the students and offer immediate feedback. In this

instance, the instructor acts as the expert.

Stage 2 learners are interested learners. These students are often what you would call "a good student". They are eager to learn and bring enthusiasm to the learning environment. They may not have a dedicated skill set or a consummate grasp of the base knowledge, but they are willing to learn. The best way to help a stage two learner is to get them involved. This will help them identify knowledge gaps that they will need to address as self-directed learners. In this instance, the instructor acts as a motivator.

Stage 3 learners are involved. In this stage, learners have skills and knowledge but may need help with developing the self-concept and direction. As the instructor in this situation, you become a facilitator helping the students develop their critical thinking skills and initiative.

Stage 4 learners are truly self-directed. They can set their own goals and only need some fine-tuning. Essentially the instructor becomes a consultant.

The catch to all of this is to take the time to get to know your students so you can understand where they are at in the learner continuum. Once you have an understanding of the type of learner they are you will have a better idea of how to help them direct their learning. I would love to be able to tell you that an M1 is this type of student or an M3 is this type of student, but the truth is that all learners travel the continuum at a different pace based on confidence and subject matter, it is up to us as educators to help them along that path.

While the vernacular of medical education can feel like being lost in a foreign land, we do have maps. And, while frustrating at first, with time, the foreign becomes common and comfortable. Hopefully armed with a map of learners, we can better navigate the idea of SDL.

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Think Again: Science as Subjectivism

Wendell W. Hoffman, MD, FACP, FIDSA

"It was a bright cold day in April and the clocks were striking thirteen." – Geroge Orwell, 1984

"This might suggest that the so-called imaginary time is really the real time, and that what we call real time is just a figment of our imaginations...So it is meaningless to ask: which is real, 'real' or 'imaginary' time? It is simply a matter of which is the more useful description." – Stephen Hawking, A Brief History of Time

"My favorite bias is the 'I'm not biased' bias...It turns out that smart people are more likely to fall into this trap. The brighter you are, the harder it can be to see your own limitations. Being good at thinking, can make you worse at rethinking." – Adam Grant, Think Again: The Power of Knowing What You Don't Know

Medicine is passing through a challenging time where the benumbing mantra "follow the science" has ironically undermined trust. While Science is well known for its "smart" watch, the public is losing confidence in its ability to tell time. It is therefore incumbent on physicians to argue backwards and explore/question how an inexorable erosion of our thinking has evolved. Indeed, "Contrary to the cliché, you can turn back the clock, and you should, whenever it is keeping bad time."¹

Science has a Trust problem per credible physician authorities over the past two decades such as: Dr. John Ioannidis in 2005, "...most published research findings are false..."²; Dr. Marcia Angell in 2009, "It is simply no longer possible to believe much of the clinical research that is being published or to rely on the judgement of trusted physicians or authoritative guidelines. I take no pleasure in this conclusion, which I reached slowly and reluctantly..."³; Richard Horton in 2015, "The case against science is straightforward: much of the scientific literature, perhaps half, may simply be untrue...science has taken a turn towards darkness..."⁴; Dr. John Abramson in 2022, "An enormous gap exists between doctor's faith in the scientific evidence they receive from trusted sources and the cold hard fact that much of this so-called scientific evidence has reached them because of its commercial value."⁵; and Dr. Marty Makary in 2023, "Nothing speaks more to the intellectual dishonesty of public health officials than their complete dismissal of the data on natural immunity, making the U.S. an international outlier in this academic dishonesty..."⁶

What then are we to follow? Who then are we to trust? The Clock of Science might as well be running on "...imaginary time..."⁷

Think again.

"Rather than being the main instigators of an accident, operators tend to be the inheritors of system defects...Their part is that of adding the final garnish to a lethal brew, whose ingredients have already been long in the cooking."⁸ So wrote James Reason in his 1990 game-changing book *Human Error*⁸ which launched the Patient Safety Movement (PSM).⁹ Reason was so influential in this paradigmatic shift of Medicine that one safety expert declared, "We're all living in the Age of Reason."¹⁰

The PSM forced Medicine to see that the patient as "Story"¹¹, is the most powerful knowledge¹²⁻¹⁵ in healthcare, requiring right brain/"R-directed"¹¹ thinking to balance dominant left brain/"L-directed thinking"¹¹ "A Whole New Mind"¹¹ reformation became the greatest contribution to Science, for an embarrassing deficit in thinking allowed right brain atrophy – and harm¹²⁻¹⁵ followed.

But within "...the history of Western culture..."¹⁶ the PSM illustrates a far more imbalanced and therefore destructive thinking - spanning centuries. I speak of the attack on Knowledge itself and especially on definitions. Physicians must be informed - for we face a reigning Logic that will deny Reality, allowing right brain atrophy to occur...writ large.

Think again.

"For this reason I turn to William of Occam as the best representative of a change which came over man's conception of reality....It was William of Occam who propounded the fateful doctrine of nominalism, which denies that universals have a real existence...With this change in the affirmation of what is real, the whole orientation of culture takes a turn and we are on the road to modern empiricism"¹² So wrote Richard Weaver in 1948 with his epic book *Ideas Have Consequences*. Weaver warned of a lethal brew affecting "...every concept..."¹⁶. Occam, from the 14th century ("Occam's razor"), rejected what Weaver called "...the reality which is perceived by the intellect and to posit a reality that which is perceived by the senses..."¹⁶ C.S. Lewis in a famous 1943 essay called such a concoction "...poison..."¹⁷

Per Weaver, the denial of universals include "...The shift from the truth of the intellect to the facts of experience... (issued) in a change...over the study of logic...Logic became grammaticized...(and)...the assault upon definition: if words no longer correspond to objective realities, it seems no great wrong to take liberties with words...faith in language...looks for a remedy in the new science of semantics."¹⁶

Think again.

"One cause of misery and vice is always present with us...but at certain periods in history this is greatly increased by... false philosophy...I am not referring to the Power philosophies of the Totalitarian states, but to something that goes deeper and spreads wider and which, indeed, have given these Power philosophies their golden opportunity. I am referring to the poison of subjectivism."¹⁷ So wrote C.S. Lewis one of the most impactful thinkers of the 20th century.

Lewis scholar Jerry Root articulates that "...Lewis does not write against subjectivity, but subjectivism....(or) that form of subjectivity no longer tethered to reality...Subjectivism...seeks to adjust reality to itself..."¹⁸ Per Lewis, Subjectivism is an "...apparently innocent idea {from which} comes the disease that will certainly end our species...that a community can choose it's 'ideology' as men choose their clothes."¹⁷ Subjectivism is captured by Lewis, that "Unless the measuring rod is independent of the things measured, we can do no measuring."¹⁷

Universals in Medicine transcendently provide the rod for measuring things – including Hippocrates' Do No Harm, Aristotle's Scientific Method and W.J. Mayo's Patient Centeredness. Any departure from them through manipulation by language is Subjectivism.

Think again.

"The master heresy is subjectivism. It is the parent of all the others..."¹⁹ So writes Peter Kreeft, the author of *Socratic Logic*, one of the rare texts of traditional Aristotelian (Socratic) logic in print. Per Kreeft, "All the other logic texts, over 500 of them teach symbolic logic..."²⁰.

Kreeft explains the "Two Logics"¹ and the effect of Aristotelian Logic (AL), the logic of everyday conversation, argument and debate – moving to the "new" logic – Symbolic Logic (SL). SL also known as mathematical logic, despite its technical usefulness, has introduced a pernicious consequence, that being "...the fatal assumption that the immediate object of human knowledge is our own ideas."²⁰ SL rules via mere symbols which govern "...every concept..."¹⁶ and so may become the de facto operating system for all thinking. Per Kreeft, "In this logic, we can no longer ask the Socratic question of 'what' something is..."¹

The question for Medicine is whether we are allowing right-brain Epistemological/Metaphysical Realism to atrophy and left-brain Symbolic Logic/Nominalism to enlarge into "...that form of subjectivity no longer tethered to reality."¹⁸ This makes Stephen Hawking's SL central – that "...it is meaningless to ask: which is real, 'real' or 'imaginary' time? It is simply a matter of which is the more useful description."⁷ Hawking and his unnerving pragmatism illustrates that "...the road to modern empiricism..."¹⁶, unmoored from universals may end in the will-to-power. Weaver saw this "...rational basis for modern science, whose systemization of phenomena is...a means to dominion"⁸. No wonder ideas have consequences if Nietzsche wound the clock ahead and gave these, "...Power philosophies their golden opportunity..."¹⁷

Think Again.

Examples of Science as Subjectivism extend to the (re)definition of life. I speak of Dr. Henry (Pete) Travers, who in this Journal advocated a form of Nominalism adding his own "...garnish to a lethal brew, whose ingredients have already been long in the cooking..."⁸ This through language redefining the pre-born human being.

"Viewing the heartbeat as a manifestation of life is a common and general understanding for many; we all have our own reactions to hearing the familiar 'lub-dub' or even to thinking about it. It is these reactions that we often use to relate life to the heartbeat, *but that is not what science reveals*"²¹ So writes Travers in "Talking the Walk: Our Obligation to Speak Out"²¹ – which targeted South Dakota's abortion statute (SD 34-32AA-1) – aka the "heartbeat bill."²¹ Per Travers, "life"²¹ *is the interpretation of a sound* making the definition of life "...no longer tethered to reality..."¹⁸

Is "...lub-dub..."²¹ a mere symbol? Is "...life..."²¹ now merely in the eye of the beholder?

Travers' "...reactions..."²¹ bespeaks the language of Subjectivism – a "Power"¹⁷ philosophy using symbols – which permits an "...assault upon definition."¹⁶ Travers' statement that "...this is not what science reveals..."¹⁷ is not a scientific statement because the Scientific Method is never categorical. Travers' SL demonstrates that supposedly objective Science is vulnerable to be "...the more useful description"⁷. Therefore, Universals may be subjugated to personal hermeneutics *and the pre-born human being as "Story"*^{11,15} *will be left untold*.

To be trusted, the Clock of Science must be reformed – back to the Scientific Method, where "...all the terms must be clear and unambiguous"¹ Science as Subjectivism must be challenged for its willingness to "...adjust reality to itself..."¹⁸

Think again.

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Response

Henry Travers, MD, FACP

In a deeply philosophical communication, Dr. Wendell Hoffman reintroduces physicians to concepts of bias, reality, trust, logic (both Aristotelian and symbolic), universals, subjectivism, realism and even knowledge itself. Many of these have appeared before in Hoffman's masterful reviews of various aspects of medicine today.^{1,3} Hoffman guides physicians through these concepts using quotations from an array of scholars. He begins chronologically with

William of Ockham, a late 13th to early 14th century Franciscan monk who, with Scotus, championed scholasticism and nominalism. An admirer of the reasoning of Aristotle, Ockham noted in the prologue to his *Summa Logicae* that “false arguments and sophistry, as Aristotle teaches, bind the mind”⁴ [my translation]. Nominalism is an idea not easily grasped (the term is not restricted, for example, to simply a rejection of “universals,” a term that itself can mean several different things). Moreover, it fails as a rubric under which Hoffman rejects a statement as “not scientific” without asking whether the assertion that “Science is never categorical” is actually true.

Hoffman poses the question for medicine as whether physicians are acting to diminish epistemological/metaphysical realism in favor of symbolic logic/nominalism with subjectivity divorced from reality. This question, a topic considered by Descartes in the 17th century and by Kant a century later,⁵ is useful only if one perceives the two as either reciprocal or, at least, contradictory. Descartes would have embraced the question; Kant would have seen it differently.

Hoffman’s lengthy preface is meant to support, in the final four paragraphs, perceived negative results stemming from a misinterpretation of an observation in “Talking the Walk.”⁶ One part of that article noted an individual’s perception of the heart’s familiar “lub-dub” can unconsciously elicit a reaction, an idea consonant with the views of psychologist Jonathan Haidt.⁷ We all have those reactions, unique to each of us, as a complex interplay of what we know, believe and feel. Those reactions will influence a person’s understandings and decisions. Their consequences for one’s decisions about the significance of, in this case, the fetal “heartbeat,” in public policy are unguided by as detailed a knowledge as we have of fetal cardiac development. There is in this no “assault upon definition,” no subjugation of universals, no disconnection of the definition of life from reality and no adjustment of reality to fit a subjective view. Instead, it is an observation supporting the contention that the *misuse* of science to promote philosophical viewpoints underpinning public policies should be vigorously opposed.

I agree with Hoffman’s appeal for medicine’s regaining trust. Rather than pursuing that goal through the scientific method and philosophic battles with the devil *subjectivism*, more might be gained from disconnecting medicine, as both a practice and a scientific pursuit, from personal benefit while reconnecting it to charity, service and kindness.

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Response: Definitions and the Unconscious Consequence

Wendell W. Hoffman, MD, FACP, FIDSA

I am grateful for Dr. Travers’ response for he proves the premise of this essay – that Subjectivism is an attack on definitions. For instance, instead of addressing the definitions of Nominalism and Universals proffered by Richard Weaver¹ and Subjectivism by C.S. Lewis² and Peter Kreeft,^{3,4} Travers pivots to his own philosophical counter-definitions (including avoiding definition) by obfuscating Weaver (“...(Nominalism) not easily grasped... (Universals) can mean...different things...”⁵, mocking Lewis/Kreeft (“...the devil *subjectivism*...”⁵) and dismissing me (“...no subjugation of universals...”⁵). No wonder he claims “...misinterpretation...”⁵ for hermeneutical suspicion is his preferred tool in the debate over the “...manifestation of life...”⁶

There is another tool however to consider...the stethoscope.

To wit, Travers evolves his definition with - “unconsciously”⁵ – to modify his original term “reactions.”⁶ Perhaps this is unconscious Gnostic impulse (ancient anti-Realism), avoiding the very real sound at the center of abortion

controversy, one *consciously* heard via fetal heart-to-abdominal wall-to-stethoscope-to-tympanic membrane-to-auditory cortex. No matter, for Travers this “...is not what science reveals...”⁶ I wish I had known this before auscultating hundreds-of-thousands-of-patients over more than four decades. Perhaps having a PhD in Psychology could’ve tuned me to my unconscious state and improved my physical diagnosis.

Therefore, the fundamental question for Dr. Travers is – *What’s making that sound?* Is it a fetal heartbeat or a fetal human being’s heartbeat? Definitions *do* matter, for once the great linguistic exchange of “fetal human being” for “fetus” occurred, the “...science of semantics...,”^{1,7} tuned public debate to Science-as-Subjectivism. The pre-born human being however has been keeping real time for Science (110-160 beats/minute), speaking “...lub-dub...”⁶

Think again my friend.

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Reframing the Narrative

Henry Travers, MD, FACP

I thank Dr. Hoffman for clarifying the premise of his essay. It is a premise with which I generally agree, for I believe there is objective reality, what we can observe, measure and test. I’m not as sure as Hoffman about where “universals” fit into this: as properties of something, e.g. color, they have a reality (many can be observed, measured, and tested). Philosophers, though, ask if universals *exist*, and the utility of that discussion escapes me.

Hoffman’s statement of my “fundamental question” misconstrues my point, and his stethoscopic imagery together with reframing my embryological position into an epistemological one (fetus – human fetus) reinforces my view that he misunderstood what I said or construed it under his own framing.

I argued against recognizing the rhythmic contraction of a vascular *tube* as a “heartbeat;” the tube makes no S1 and S2. Not only is the tube not anatomically a heart, but the word “heartbeat” conjures up in us its common symbolism (heartbeat = life) as well as human feelings the associated “lub-dub” sound engenders. I argued that the law was based on an imagery that did not reflect the embryological reality: neither the chambers nor the valves needed to carry out the heart’s physiologic function or produce the heartbeat’s familiar sounds are formed at the earliest time a “heartbeat” can be detected.

Contrary to Hoffman’s assertion, there was no discussion in my response to his essay, hermeneutical or otherwise, about “life.”



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Mental Health Awareness

Jen Tinguely, MD, MPH
President, South Dakota State Medical Association



As you might have known, May was National Mental Health Awareness Month. This month of increased awareness has been recognized since 1949 and has an aim to bring light to the darkness that many of our patients, our family members, our colleagues and we ourselves face. There is also an aim to work at diminishing the stigma behind mental health disorders. It's been 75 years since this special designation was introduced but I would argue that destigmatization of mental health conditions is still in its infancy.

However, we know that mental health conditions are incredibly prevalent and should not be something that we're uncomfortable talking about both with our patients and with our family members. Data shows that 1 in 6 adults will deal with depression at some point in their lives. And according to the Substance Abuse and Mental Health Services Administration, nearly 16 million Americans are affected by depression every year. Anxiety conditions are seemingly even more prevalent. The 2023 U.S. Census Bureau Household Pulse Survey showed that 32.3% of all adults reported having anxiety symptoms at some point in the past year. The American Psychiatric Association has data showing that at the end of 2022, 37% of Americans rated their mental health as "fair" or "poor."

Of course, you probably don't need this data to know that mental health conditions are running at very high rates in our patient populations...we feel it every day in our clinics. At my clinic in Sioux Falls (Falls Community Health, a federally qualified community health center), depression and anxiety are in our top three diagnoses year over year. I'm a family practice doctor and the majority of my daily visits with patients deal with some type of mental health disorder or substance use disorder (or, more commonly, both of those co-occurring together). But I would bet that our endocrinologists throughout the state have patients whose diabetic control is being challenged by their mental health. Rheumatologists who work with patients who have chronic pain must also acknowledge the interplay between a patient's mental health and the way they experience pain. Our obstetricians see the struggles of new moms dealing with postpartum depression. There is no getting away from it... we are all providing mental health care for our patients in one way or another.

Access to mental health services for our patients is a challenge and the wait times to see a psychiatrist or mental

health counselor are often detrimental to the patient. Your SDSMA's 2024 Advocacy Agenda included improving access to mental health services. Supporting the use of telemedicine is another way that the SDSMA is working to increase access to those specialties that are limited across our state. In the meantime, though, if you see a psychiatrist or other behavioral health provider from your organization, give them a "high five and a thank you" – their work is tireless and the patients are carrying a heavy burden with them into the exam room.

Just as we see the mental health struggles in our patients, we must also acknowledge that many of us are struggling, too. Physician burnout is a phrase we hear frequently now. A study by the AMA showed that 63% of all physicians reported some symptom of burnout by the end of 2021 as compared to 38% in 2020. Now we all know that the COVID pandemic was a dagger in the heart for many physicians (and all healthcare workers for that matter). But we are beyond the pandemic now and physicians are still struggling. There are a multitude of reasons for this and countless agencies and programs are working hard at trying to understand and help. One of those programs is our own Physician Well-Being Program.

The South Dakota Physician Well-Being Program is a high-quality program for physicians, residents and medical students that offers confidential, individualized support services and resources. The SDSMA contracts with an external vendor, Midwest Health Management Services to offer the Physician Well-Being Program. Individualized services may include help with stress and anxiety, depression, substance abuse, grief and loss, career fatigue, financial stressors, work/family balance, personal and family stressors. All these services are confidential and completely independent of the licensing board, state government and employers. There is no insurance billing for these services and funding assistance for the program comes from Avera Health, COPIC, Monument Health, Sanford Health and Wellmark Blue Cross and Blue Shield of South Dakota. If you are curious about the program, contact 605-275-4711. If you are struggling in any way, please reach out for help. It's absolutely okay for the physician to turn into the patient because by taking care of ourselves, we can take better care of our patients. And our patients need us. Our families need us. I am so grateful for the dedicated care you provide to your patients day in and day out. Just remember to take care of yourself, too!



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Antibiotic Stewardship in Chorioamnionitis Exposed Neonates, A Quality Improvement Project

Jacquelyn EM Grev, MD; Mallary Van Tol, MSN, APRN, NNP-BC; Brooke Welker, DNP, APRN, NNP-BC; Bette Schumacher, MS, CPN, CNS, APRN; Lori Mulder, BSN, RNC-NIC; Andrea Dykstra, BSN, RN; and Laurie Richards, MD

Abstract

Background: Rates of neonatal early onset sepsis (EOS) in term infants have recently decreased. The 2018 AAP guidelines for the management of infants at risk for early onset sepsis allows for using a multivariate risk assessment to determine need for empiric antibiotics in infants 35 weeks or greater, including those exposed to chorioamnionitis.

Methods: A quality improvement (QI) project was undertaken to implement use of EOS calculator in chorioamnionitis exposed infants with an aim to safely decrease antibiotic exposure. Multiple Plan-Do-Study-Act (PDSA) cycles occurred to implement the change. Data regarding antibiotics, labs, length of stay and safety metrics were collected.

Results: Implementing the EOS calculator's use in chorioamnionitis exposed neonates decreased antibiotic exposure from 100% to 75%, and decreased average duration of antibiotics from 68 to 40 hours. Implementation decreased prolonged courses of antibiotics, lumbar punctures, length of stay and laboratory tests. No cases of early culture confirmed EOS were missed, and none occurred in this well appearing population.

Conclusions: Quality improvement initiatives to implement evidence-based tools can safely and appropriately decrease antibiotic exposure in neonates.

Background

Rates of neonatal early onset sepsis (EOS) in term infants are lower now than two decades ago, decreasing from 3-4/1,000 to 1/1,000.¹ The number of newborns treated with antibiotics for the evaluation of EOS exceeds the number of newborns with culture confirmed EOS.¹ It is important to recognize and treat ill neonates at high risk for sepsis as morbidity and mortality is high in culture confirmed early onset sepsis. However, it is also important to recognize that empiric antibiotic treatment may result in increased health care utilization, intensive care days, medical costs, painful procedures, increased risk for asthma and childhood obesity, and have a negative impact on the gut microbiome.¹ In December 2018 the American Academy of Pediatrics (AAP) published guidelines for the management of neonates born at 35 weeks and greater with suspected early onset bacterial sepsis to give clinicians guidance on evaluation for EOS in the current era.¹ Three approaches for risk stratification for EOS for neonates were endorsed: categorical risk assessment, multivariate risk assessment and risk assessment based on newborn clinical condition.¹

One common multivariate risk assessment used to calculate an individual neonate's risk for EOS is the Neonatal Early-Onset Sepsis Risk Calculator (<https://neonatalespsiscalculator.kaiserpermanente.org>).² The calculator uses gestational age, duration of rupture of membranes, maternal intrapartum antibiotic administration, maternal GBS status and highest maternal intrapartum temperature to calculate an individualized risk for neonatal infection at the time of birth. It then incorporates the neonate's vital signs and clinical status to further gauge risk for early onset sepsis and makes recommendations about neonatal monitoring and antibiotic administration.

To use the EOS risk calculator, a baseline population risk for EOS must be chosen. The CDC national EOS incidence for term infants is 0.5/1,000, while late preterm infants have a risk of 1/1,000, and infants exposed to chorioamnionitis have a risk of approximately 4/1,000.^{1,3} There is debate in the literature regarding the use of the EOS risk calculator for infants exposed to chorioamnionitis, and how to appropriately gauge baseline infection risk.³⁻⁷ The advantage of the tool is that it incorporates the highest maternal

antepartum temperature and not the subjective clinical diagnosis of chorioamnionitis.⁴ In practice, many centers use 0.5/1,000 incidence for all term infants, regardless of chorioamnionitis diagnosis, as intended by the makers of the tool, since the tool already accounts for maternal temperature elevation.

Chorioamnionitis exposed neonates are at risk for EOS, as evidenced by the increased incidence of EOS quoted above. Locally, clinical chorioamnionitis has been defined as a single intrapartum maternal temperature of 100.4 F plus maternal leukocytosis, purulent cervical drainage, or fetal tachycardia, an intrapartum maternal temperature of 100.4 F on two occasions at least 30 minutes apart, or any intrapartum maternal temperature of 101 F. Traditionally CDC guidelines endorsed empiric antibiotics for this population via categorical risk assessment.

With the AAP's updated recommendations, the Sanford Boekelheide NICU undertook a quality improvement (QI) initiative to reduce empiric antibiotic administration in the chorioamnionitis exposed newborn population with implementation of the EOS risk calculator. This article aims to highlight one local approach of implementing evidenced based antibiotic stewardship in a neonatal population at risk for EOS.

Methods

In 2019, Sanford's Boekelheide's NICU initiated a QI project to safely reduce antibiotic use in well-appearing, inborn, chorioamnionitis exposed infants born at 36 weeks or greater, the population already included in the local chorioamnionitis protocol. The goal was to reduce the number of these infants exposed to antibiotics by 5% within 18 months. To achieve this goal, a multidisciplinary quality improvement team was formed which included neonatologists, neonatal nurse practitioners, neonatal nurses, and a NICU clinical nurse specialist. With the input from NICU and obstetric providers and nurses, the protocol for caring for chorioamnionitis exposed neonates was revised.

Traditionally, newborns were evaluated by categorical risk assessment based upon the 2010 CDC guidelines.⁷ Infants whose mothers were diagnosed with suspected chorioamnionitis had a blood culture drawn at birth and received empiric antibiotics (ampicillin and gentamicin) for a minimum of 48 hours. An evaluation in these infants included CBC with differential at birth, CBC and CRP at 12 hours of life, and CBC with possible CRP at 36 hours of life. With negative blood culture, normal labs and well

appearance, antibiotics were stopped at 48 hours. With abnormal labs and negative blood culture, antibiotics were continued until at least 72 hours of life. If labs continued to be abnormal at 72 hours, antibiotics were continued until 7 days of life to treat for clinical sepsis, with further evaluation of CSF by lumbar puncture.

This QI project revised the chorioamnionitis protocol to implement the use of a multivariate risk assessment, using the Neonatal Early-Onset Sepsis Risk Calculator, to determine an infant's need for antibiotics. Local incidence of EOS had not been calculated, so national incidences were utilized. With a desire to be cautious and conservative, achieve group consensus and buy-in, and to bridge the large cultural shift of withholding antibiotics for some chorioamnionitis exposed infants, a baseline incidence of 4/1,000 risk was chosen for this project.

Further aspects of the revised chorioamnionitis protocol are outlined here. Clinical exam was performed within the first hour of life and all infants had a cord or infant blood culture drawn after birth with a minimum goal volume of 2 ml. Those who were clinically ill upon initial assessment received antibiotics and were excluded from this QI project. Those who were well appearing or transitioning were monitored with enhanced vital signs. This included monitoring heart rate, respiratory rate, temperature and blood pressure frequently over the first 12 hours of life, then every 4 hours throughout the remainder of hospitalization. Continuous pulse oximetry and frequent glucose checks were also used for monitoring. The results of the EOS risk calculator dictated whether to initiate empiric antibiotics (Ampicillin and Gentamicin). If infants developed an equivocal exam or clinical illness per the EOS risk calculator definitions, infants were re-evaluated for antibiotics. Well appearing infants who did not receive antibiotics had no further laboratory studies obtained, and infants could be discharged as early as 48 hours of life with a negative blood culture. Infants who were treated with antibiotics received evaluation with a CBC with differential at 12 and 36 hours of life with recommendations to discontinue antibiotics at 48 hours of life with negative blood culture, reassuring CBCs and continued well appearance. For well appearing infants with concerning CBCs at 48 hours, the protocol endorses two possible options, either continuing antibiotics until at least 72 hours of life with repeat CBC, or discontinuing antibiotics at 48 hours of life and monitoring inpatient for another 12-24 hours. Any infant with a positive blood culture would have a lumbar puncture, and based on the results, be

treated for the appropriate duration with antibiotics.

Prior to implementation, education was provided to all groups surrounding the changes, and Plan-Do-Study-Act (PDSA) cycles ensued to further refine and improve process changes, ensure safety, and monitor improvements. Data was collected regarding antibiotic use, length of stay, CBC and CRP lab draws, readmissions within 7 days, positive blood cultures, meningitis diagnosis, protocol adherence, and potential safety concerns.

Results

The revision to the protocol occurred in April of 2020. Retrospective data was collected to define a baseline prior to initiation. Data was collected from initiation through February 2022. As the Neonatal EOS Calculator and revised protocol was implemented, several PDSA cycles were performed to engage team members, provide education, create streamlined electronic medical record documentation, refine the data collection process, promote compliance and ensure patient safety. These PDSA cycles included education on determining maternal antibiotic category and duration of antibiotics to providers, reminders about GBS bacteriuria in pregnancy, changes to EMR data pulls from maternal to infant records, printing references and reminders of workflow on computer stations, nursing re-education on the protocol and reminders about laboratory timing. Through these PDSA cycles, compliance and adherence to protocols improved.

During this period of time there were 63 inborn infants born to mothers with chorioamnionitis who were not clinically ill at the time of the initial assessment who were included in the project. The median number of well-appearing infants who received antibiotics decreased from 100% to 50%, and then stabilized at 75% over the course of the QI project (Figure 1). The median duration of antibiotics decreased from 68 hours to 40 hours (Figure 2). After initiation of the

QI project, only one infant with a negative blood culture had a lumbar puncture performed and had a seven-day course of antibiotics. All other infants either had no antibiotics or antibiotic courses 72 hours or less in duration.

Process measures: The median number of CBCs per infant decreased from 3.3 to 1.7 and the median number of CRPs decreased from 2.4 to 0 per infant. The average length of stay decreased from a median of 3.9 to 2.9 days per infant.

Balancing measures: Clinical illness is a clinical status defined by the EOS risk calculator as persistent need for CPAP, high flow nasal cannula or mechanical ventilation outside of the delivery room, hemodynamic instability requiring vasoactive drugs, neonatal encephalopathy, or the need for supplemental oxygen for greater than 2 hours outside the delivery room. Six infants developed clinical illness after the initial assessment, three already receiving antibiotics and three not receiving antibiotics. Three infants were started on antibiotics later than the initial assessment due to clinical changes. There were no positive blood cultures on infants not empirically started on antibiotics, nor for any infants in this QI study, no diagnoses of meningitis prior to discharge, no neonatal deaths, and only one readmission within 7 days of discharge in an infant who had received empiric antibiotics.

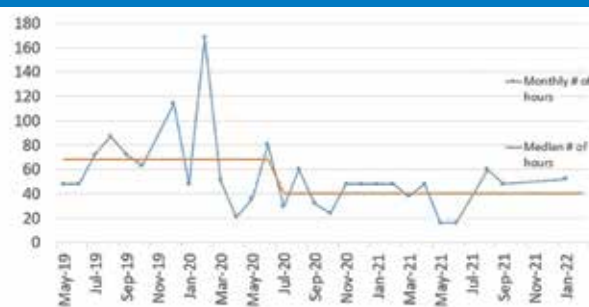
Discussion

This QI project safely decreased antibiotic administration to neonates exposed to chorioamnionitis. Fewer infants received antibiotics and those who did had overall shorter courses, typically for 48 hours. Infants were monitored very closely due to their relatively high risk for infection. Close clinical monitoring and adequate nursing ratios are important aspects of care for neonates at high risk for infection, especially those not on antibiotics, so that changes in clinical status can be detected early and appropriately addressed. Many of the protocol changes involved processes on how to closely monitor infants and reassess for clinical

Figure 1. Run chart % of well appearing infants exposed to chorioamnionitis 36 weeks and above who received antibiotics.



Figure 2. Run chart of average # of hours of antibiotics.



changes that could require initiation of antibiotics.

This project also achieved shorter length of stay, fewer lab draws, IV placements, and lumbar punctures, equating to fewer painful procedures and lower patient care costs, all with an appropriate safety profile. The goal of the project was not to eliminate antibiotic administration, but to judiciously assess individual risk and decrease overall antibiotic exposure within the context of the pre-existing hospital system and culture. While there was an initial marked decrease in infants receiving antibiotics, as seen in Figure 1, this later increased slightly and plateaued. The stabilization of empiric antibiotics around 70% median likely reflects patient variability with small overall number of infants per month, improving recognition of maternal risk factors and infants' clinical status, and using the EOS incidence of 4/1,000. However, as seen in Figure 2, the overall median duration of antibiotics decreased and remained low, reflecting that while some infants still qualified for initiation of antibiotics, they often received shorter courses. Future directions for the QI project could include changing the incidence of EOS used in the calculator to 0.5-1/1,000 to better reflect overall EOS incidence, or more broadly applying the calculator to include all neonates regardless of categorical designation. These implementations would better align with the intended use and design of the calculator and could further decrease the number of infants who receive antibiotics.

The key to a successful QI project, especially one that changes the culture and practice of a hospital unit, is early engagement with all invested team members, open and

frequent communication, and frequent data monitoring and sharing. Quality improvement methodology with frequent PDSA cycles and data collection allowed us to quickly address questions, process issues, and implement process changes to help promote adherence and buy in with the protocol.

Acknowledgements – A special thank you to the Sanford Neonatal Intensive Care Quality Improvement Committee for supporting this project.

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Case Report: Non-ischemic Papillary Muscle Rupture due to MRSA Myocarditis with Concurrent Thromboembolic Myocardial Infarction Secondary to Infective Endocarditis

Andrii Maryniak, MD; Filip Oleszak, MD; Jiannan Huang, MD; David Maziarz, MD; Tomasz Stys, MD, FACC, FSCAI; and Adam Stys, MD, FACC, FASA, FSCAI, FACP

Abstract

Non-ischemic papillary muscle rupture (PMR) is rare. PMR caused by myocarditis in the presence of concurrent infective endocarditis (IE) and myocardial infarction (MI) has not been described. We report a 46-year-old male with recurrent MRSA bacteremia who presented in septic shock and suffered cardiac arrest. Echocardiography revealed acute mitral valve regurgitation resulting from posteromedial PMR. An intra-aortic balloon pump was implanted. Angiography revealed thrombotic occlusion of a small distal left circumflex artery. Emergent mitral valve replacement surgery was performed. MRSA myocarditis and IE were diagnosed by tissue cultures. Coexistence of myocarditis, IE, and MI poses a challenge in determining etiology.

Introduction

Papillary muscle rupture (PMR) secondary to bacterial colonization and inflammation has been recognized as an uncommon complication of myocarditis and infective endocarditis (IE).¹⁻⁴ Septic emboli causing ischemic PMR in the setting of IE has been comprehensively described in literature.^{5,6} We present a case of PMR secondary to methicillin-resistant *Staphylococcus aureus* (MRSA) myocarditis, with concurrent IE and incidental MI, whereby pathogen-mediated inflammation and myocyte necrosis rather than myocardial ischemia resulted in PMR.

Case Presentation

A 46-year-old male with insulin-dependent type 2 diabetes, end-stage renal disease requiring hemodialysis, and right-sided below knee amputation, presented to the emergency department reporting one-week of fatigue, intermittent fevers and chills with associated nonspecific back pain and chest pressure. He denied headache, cough, abdominal pain, vomiting, diarrhea, urinary symptoms, or recent travel. The patient was last dialyzed the day prior to arrival. Vital signs were notable for a blood pressure of 71/50 mmHg and heart rate of 122 beats per minute (bpm). Cardiac auscultation was unremarkable with no appreciable murmurs. Examination revealed a clean arteriovenous fistula site and a shallow skin abrasion without abscess on the right popliteal fossa. Lab results were significant for leukocytosis, hyperkalemia,

elevated creatinine and liver enzymes. COVID-19 and influenza screening were negative.

Within the past year, our patient had several hospitalizations for recurrent MRSA infections. This included cellulitis of the left arm and left foot, right sternoclavicular (SC) septic arthritis, sepsis due to bacteremia, and a liver abscess. Notably, a transesophageal echocardiogram (TEE) from three months ago showed no valvular vegetations and his last six blood culture showed no bacterial growth.

While in the emergency department, the patient suddenly became bradycardic, unresponsive and suffered cardiac arrest. The initial rhythm was pulseless electrical activity followed by torsades de pointes and ventricular fibrillation. Cardiopulmonary resuscitation was performed with return of spontaneous circulation (ROSC) after three rounds of defibrillation. The patient was intubated and transferred to the intensive care unit (ICU). After resuscitation blood pressure was 111/72 mmHg and heart rate was 118 bpm.

Workup and Treatment

Post arrest, troponin I was elevated to 10.358 ng/mL (reference range <0.033 ng/mL). Electrocardiography (EKG) after ROSC showed ST-segment elevations in leads II, III, aVF, V5, and V6 (Figure 1). A chest X-ray demonstrated acute pulmonary edema. Echocardiography showed severe acute mitral valve (MV) regurgitation with a flail anterior

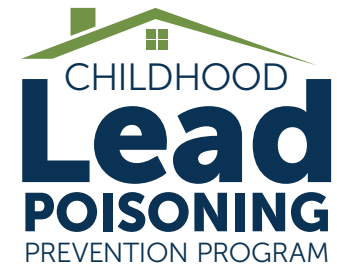
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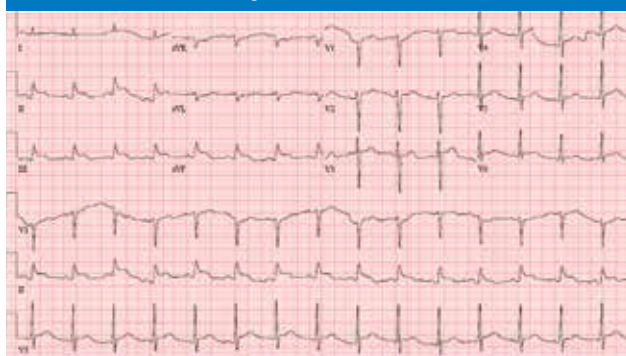


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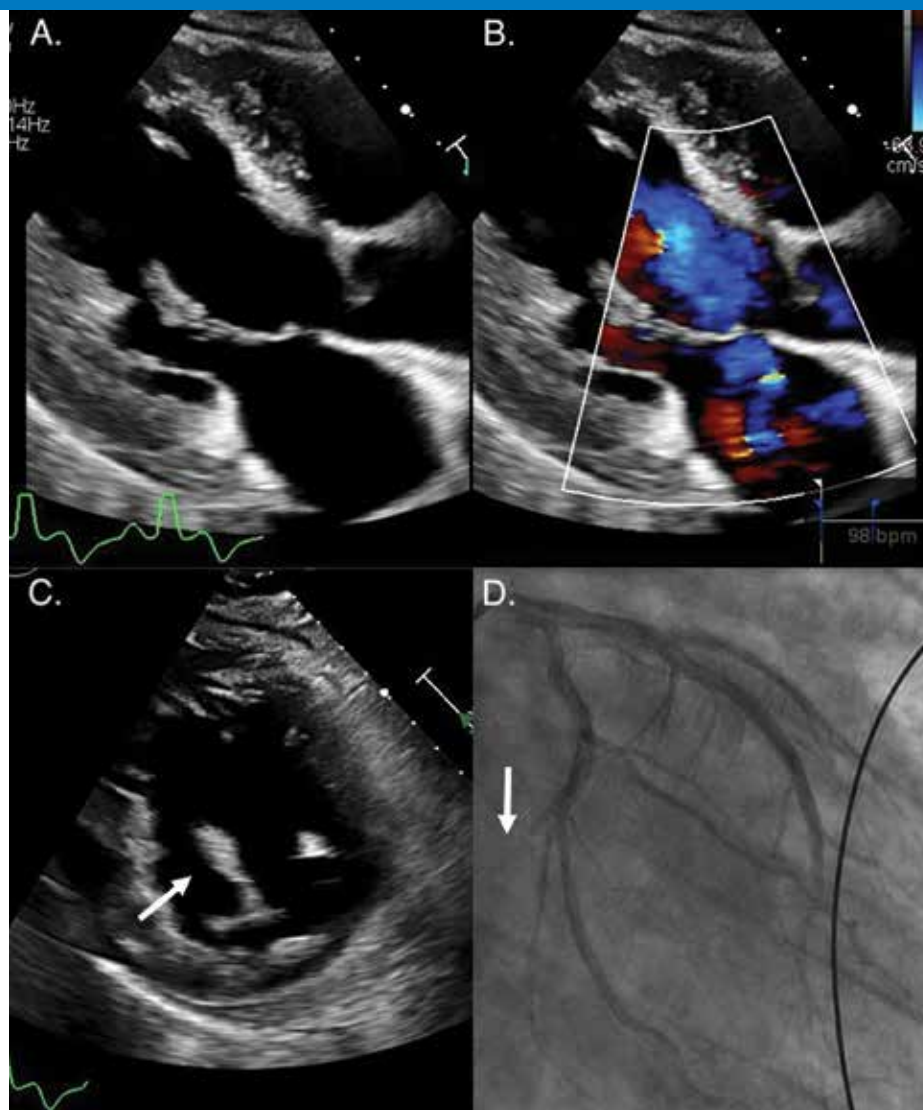
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Figure 1. Post-ROSC EKG showing sinus rhythm with a ventricular rate of 90 bpm, ST-segment elevations with T wave inversions in leads II, III, aVF, borderline ST-segment elevations in leads V5 and V6.



MV leaflet (AMVL) and posteromedial PMR (Figure 2A-D). The left ventricular ejection fraction was 60-65% with hypokinetic inferolateral wall segments and trivial pericardial effusion. Emergent coronary angiography showed right coronary dominance with 100% thrombotic occlusion of a small caliber distal left circumflex artery (LCX) (Figure 2D). The left anterior descending (LAD) and right coronary (RCA) arteries were patent. An intra-aortic balloon pump (IABP) was implanted for cardiogenic shock prior to emergent surgical valve repair. On surgical inspection, the pericardium was thickened with a large pericardial effusion present. A flail AMVL was noted with an attached completely ruptured posteromedial papillary muscle measuring 2.5 x 1.3

Figure 2. 2A) Flail anterior mitral valve leaflet. 2B) Severe mitral regurgitation with bidirectional flow. 2C) Ruptured posteromedial papillary muscle. 2D) RAO caudal view of acute complete thrombotic occlusion of a small caliber distal LCX.



x 1.0 cm. The flail leaflet was excised with preservation of an intact posterior MV leaflet and chordae. A mechanical On-X MV prosthesis was implanted and bipolar right ventricle epicardial pacing wires were placed. The patient was initially treated with vancomycin, to which ceftaroline was added after 1 week of persistently positive cultures for additional MRSA coverage.

Outcome and Follow-up

Pathological examination of the MV specimen showed marked acute inflammation and numerous bacteria. Culture of the excised posteromedial papillary muscle, AMVL, pericardial tissue, and peripheral blood confirmed MRSA growth. The postoperative course was complicated by complete atrioventricular block (AVB), empyema, recurrent SC joint abscess, and left hemothorax. The IABP was removed on postoperative day (POD) 3 and the patient was extubated on POD 5. A leadless permanent pacemaker was implanted for AVB. Surveillance blood cultures last grew MRSA on POD 10. The SC joint abscess and pleural effusions resolved with intravenous antibiotic therapy. The patient recovered well and was discharged after twenty days in the hospital.

Discussion

PMR predominantly occurs after MI, complicating 0.03% of ST elevation MI cases in the reperfusion era.⁷ Non-ischemic causes are rare and include myocarditis, IE, trauma, intramural amyloidosis, chronic mechanical force,⁸ and cases attributed to unknown etiology.⁹ In our patient, coexistence of myocarditis, IE and MI, presented a challenge in determining the underlying etiology of PMR. Establishing causation has critical implications in management because it guides whether to expedite emergent valve surgery as opposed to focusing on cardiac muscle salvage by revascularization. Postoperative histopathology and culture results determined the etiology of PMR in our case was fulminant MRSA bacteremia culminating in myocarditis. Inflammation resulting from overt bacterial colonization induced physical and mechanical strain on the involved papillary muscle leading to complete rupture.

The posteromedial papillary muscle is most commonly involved in cases of PMR due to its single blood supply from the posterior descending artery (most commonly a branch of the RCA, and less commonly the LCX). Voci et al. reported about 75% of MI-related PMR cases involved posteromedial papillary muscle¹⁰ as it often had sole perfusion by the RCA or the third obtuse marginal branch. In contrast, the anterolateral papillary muscle usually has dual-perfusion

by branches of both the LAD and LCX.^{10,11} Although MI was coexistent in our patient, the thrombotic occlusion was found in a non-dominant distal small caliber LCX which generally supplies the anterolateral papillary muscle and alone would be unlikely to cause rupture in the presence of a patent LAD. Thus, coronary angiography supported the notion of non-ischemic etiology of PMR.

EKG is essential in diagnosis and offers high utility in MI localization. In our case, a post-ROSC EKG showed ST elevations in leads II, III, aVF, and V_{5,6}. A similar inferolateral ST elevation pattern was described in previous cases of anterolateral PMR with occlusion in the obtuse marginal artery (OMA) of the LCX.^{6,12,13} Contrastingly, the posteromedial papillary muscle was involved in our case and was likely unaffected by coronary occlusion. It is important to acknowledge that ST elevations are not exclusively caused by myocardial infarction. The mechanism of ST changes on EKG is transmural heterogeneities of sodium and ATP-sensitive potassium channel properties.¹⁴ PMR represents major myocardial necrosis, which vastly alters the electrolyte balance and ATP production within the region of myocardium affected by rupture. When ruptured, damaged cardiomyocytes undergo electrolyte channel heterogeneities that can result in ST-segment elevation.

Overall, we concluded that the catastrophic complication of posteromedial PMR in our patient was caused by direct bacterial colonization and invasion of the myocardium ultimately leading to mechanical strain and necrosis. The occluded coronary artery was likely incidental, non-contributory and may have been the result of septic embolization. Up to 65% of left-sided endocarditis patients develop systemic embolization, including coronary occlusion.¹⁵ Angiography showing mild CAD and patent LAD and RCA making atherosclerotic plaque rupture an unlikely explanation. One question that remains unanswered is the primary source of infection. Our patient had no echocardiographic evidence of IE three months prior to admission. Similarly, examination showed no clinical stigmata of IE and six preceding blood cultures suggested complete clearance of prior bacteremia. Transesophageal echocardiography has a very high sensitivity (92-99%) for clinically occult *S. aureus* left-sided native valve endocarditis.¹⁶ A newly acquired infection through the popliteal skin lesion or an insidious infection of a previous infected loci such as the right SC joint are potential sources. The patient's immunocompromised state predisposed him to severe infection.

Prompt surgical intervention is the cornerstone of PMR

management.^{17,18} In hemodynamically unstable patients, imminent coronary angiography is also prudent. Angiography helps reveal or rule out MI as an underlying etiology of PMR and allows for cardiac muscle salvage by revascularization. In a retrospective study, 70% of PMR patients required mechanical circulatory support before mitral valve surgery¹⁹ to help stabilize hemodynamics. The optimal surgical treatment strategy is determined by papillary muscle viability and the severity of rupture. Mitral valve repair is preferred in carefully selected patients when the results are expected to be durable.¹⁸ However, mitral valve replacement is generally required in the presence of necrotic papillary muscle²⁰ or complete PMR.¹⁷ Our patient had a visibly necrotic large fragment of completely ruptured posteromedial papillary muscle on surgical inspection therefore the decision was made to proceed with implantation of an On-X mechanical MV prosthesis. The prognosis of infective PMR is unknown. Based on post-MI PMR prognostic data, patients with surgical correction of mitral regurgitation have a good prognosis with heart failure-free survival rates similar to those in MI patients without mechanical complication.²¹

Conclusion

In this extremely rare case of PMR caused by bacterial myocarditis with concurrent IE and non-contributory coronary artery occlusion, thorough analysis of the clinical context and appropriate diagnostic testing is imperative in identifying the true culprit. Non-ischemic etiologies, albeit rare, must be considered when the anatomic presentation of acute PMR on echocardiography is incongruent with findings on coronary angiography. Definitive treatment of PMR relies on surgical intervention and preoperative mechanical circulatory support is often necessary. A multidisciplinary approach in the management of this life-threatening mechanical complication is indispensable.

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Subcutaneous and Fascial Abdominal Wall Endometriosis in the Setting of Previous Gynecologic Surgeries: Two Case Reports

Sena Uzunlar, MS IV; Alexander Haitham Turaihi, MD, PhD; Amity Peterson DO, PhD; Andrew Skattum, DO, FACS; and Thavam Thambi-Pillai, MD, MBA, FACS

Abstract

Abdominal wall endometriosis is a rarely reported condition with increasing incidence linked to pelvic surgery, and is also referred to as incisional endometriosis. Here we report two cases of women with previous history of Cesarean section who presented with abdominal wall masses years after surgery. In both cases, CT imaging was used to visualize the masses and surgical exploration and tissue examination revealed the excised masses to be endometriosis of the abdominal wall. Etiology of this ectopic endometrial tissue may be iatrogenic and caused by implantation of endometrial tissue during operative proceedings. This paper aims to highlight the incidence of abdominal wall endometriosis and to discuss differential diagnoses and management.

Introduction

Endometriosis is clinically defined as the presence of functioning endometrial tissue outside of the uterine cavity.¹ Ectopic endometrial glands result in enclosed bleeding which may produce adhesions or scar tissue; this is one of the main underlying causes of adhesions that is not related to previous surgical procedures.^{2,3} While sometimes asymptomatic, patients with endometriosis most commonly present with dyspareunia, dysmenorrhea, and pelvic pain, and the disease can be further associated with menstrual irregularities and infertility.^{4,5} Furthermore, these adhesions can lead to constrictions surrounding the gastrointestinal tract and result in small or large bowel obstructions.² Malignant transformation of endometriosis, though a rare complication, occurs in <1% of cases and mostly involves endometriosis of the ovaries but it has been reported in other sites such as the sigmoid colon and the rectum.³

Up to 10-15% of women of reproductive age are affected by endometriosis.⁶ Treatment for endometriosis ranges from symptomatic management to treatment with hormone therapy including contraceptives, GnRH agonists and antagonists, progestin therapy, aromatase inhibitors, and conservative surgery.⁷ Minimally invasive techniques such as thermal ablation or percutaneous cryoablation of abdominal wall endometriosis (AWE) may have a role in the

treatment of select patients.⁸ However, hysterectomy and oophorectomy are considered the most effective treatment for endometriosis.⁹

Endometriosis most commonly localizes to the ovaries, ovarian tubes, the broad ligament of the uterus, the rectovaginal septum, pelvic peritoneum, and laparotomy scars. In fewer instances, endometriosis lesions have even been found in the pleural cavity, liver, kidneys, ureters, bowel, lymph nodes, and within the abdominal wall.^{5,6,10} Endometriosis that occurs in a single surgical scar site may be referred to as incisional endometriosis or scar endometriosis. Cesarean section scars are the most common sites of abdominal wall endometriosis (AWE).¹¹ Endometriomas, or well-circumscribed masses of endometrial tissue, arising from incisional implantation can further be categorized as AWE.

AWE describes the presence of endometriosis superficial to the peritoneum, embedded in the subcutaneous fat, fascia, and the muscle layers of the abdominal wall. AWE is rare with an estimated incidence of 0.03-1%, usually seen after Cesarean section and laparoscopic surgery, and is usually described as being adjacent to the surgical scars.¹² The incidence of incisional endometriosis following laparoscopic hysterectomy is 1.08-2% whereas that after Cesarean section is reported to be 0.03-0.4%.¹³ but it is believed that 10-15% of all women in their reproductive age



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will develop endometriosis and 25-35% of all women who are infertile have endometriosis. Incisional endometriosis (IE) The pathogenesis of AWE is likely contrived from direct inoculation of endometrial cells into incisional sites during surgery.¹⁴

Low in prevalence and oftentimes presenting with generally nonspecific symptoms, endometriosis of the abdominal wall is easy to misdiagnose. Differential diagnoses commonly include hernia, tumor, hematoma, lipoma, or a suture granuloma and oftentimes the correct diagnosis is not made until after surgical exploration and pathological examination¹⁴ a frequently misdiagnosed condition. Methods This was a retrospective study of 21 consecutive women with pathologically proven endometriosis of the abdominal wall. Ultrasonographic and Doppler examinations were performed, before surgery, with a high-frequency linear transducer. The clinical data and the results of the sonographic examinations were reviewed and described. Results At ultrasound, all the nodules appeared as discrete solid masses that were less echogenic than the surrounding hyperechoic fat. The nodules had a median diameter of 20 (range, 5–50. In this paper, we present two cases of AWE, both presenting in patients with previous history of Cesarean sections. Both patients presented with an abdominal mass on physical examination that was further visualized on CT. The masses were localized along the previous surgical section scars in both cases, and postoperative histological examination of the surgically removed masses revealed endometrial tissue.

Case Presentations

Case 1

A 43-year-old woman (G3P3) with a past medical history of 3 Cesarean sections (the last of which was in 2008, 15 years before current patient presentation), status post hysterectomy in 2010 (13 years before current patient presentation), and laparoscopic sleeve gastrectomy and hiatal hernia repair in 2021 presented to the plastic surgery clinic for consultation for panniculectomy following weight loss of 27 kg (from 104 kg to 77 kg). Preoperative examination revealed a scar from a previous Pfannenstiel incision and what seemed to be a 2-3 cm infra umbilical hernia. The patient was then referred to general surgery for management. General surgery consultation revealed no hernia on physical examination but noted evidence of a focal nodularity or soft tissue within the inferior anterior abdominal wall. The patient noted discomfort in the lower abdomen with palpation at this time; she was otherwise asymptomatic. CT revealed a focal nodularity of the inferior anterior abdominal wall measuring 31 x 22 mm (Figure 1).

Surgery for subcutaneous suprapubic mass excision was subsequently scheduled. Intraoperative findings revealed a mass involving or arising from the fascial layer. The mass was excised en bloc with fascia cleared circumferentially around the mass. A retrorectus mesh was placed. The excised mass was sent to pathology. Gross pathological findings revealed a 4 x 3.4 x 3 cm tan-white, fibrotic, ill-defined mass with central areas of hemorrhage. A representative section of the mass was submitted for microscopic pathology findings of which revealed endometriosis (Figure 2 A-B).

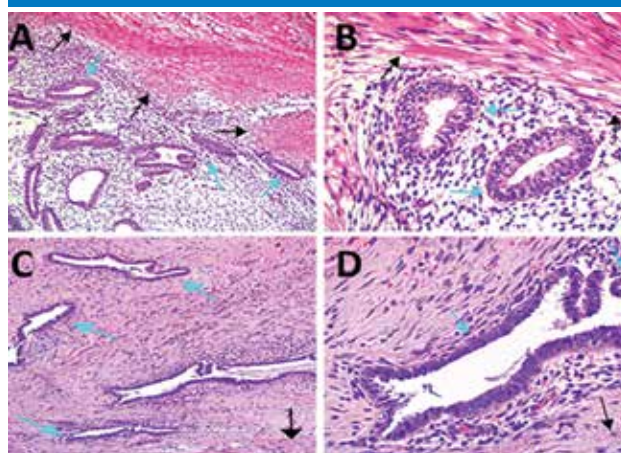
Case 2

A 33-year-old woman with a past medical history of abnormal Pap smear and subsequent cervical biopsy in 2014, and Cesarean section in 2019 presented to a family medicine clinic for symptoms concurrent with UTI. Abdominal physical examination was performed and a mass in the right lower quadrant was identified just superior to the lateral

Figure 1. Abdominal CT shows focal nodularity or soft tissue mass (31 x 22 mm) within the inferior anterior abdominal wall. A) Axial view B) Sagittal view.



Figure 2A-D. Hematoxylin eosin stained sections (A-B, case 1 and C-D, case2). Bland endometrial-type stroma surrounding numerous endometroid-type glands (blue arrows) in close proximity to abdominal wall skeletal muscle (black arrows) (Magnification: A,C: 100x. B,D: 400x).



aspect of a well-healed Pfannenstiel incision scar with no discernable hernia defect. The patient stated that the mass had been there for around 11 months with no inciting events that she could recall. The mass was intermittently painful and worsened with activity. Abdominal CT was obtained for further assessment and revealed an enhancing nodular lesion abutting the rectus musculature measuring 16 x 10 mm along the lateral aspect of the cesarean section scar (Figure 3). Surgery was scheduled for excision of the lower quadrant abdominal mass. Intraoperative findings revealed a 1 x 1.5 cm abdominal wall mass with anterior rectus fascial involvement. The mass appeared cystic with brownish coloration and a small amount of brown fluid was present at the base of the mass. A partial thickness fascial resection was done to completely excise the mass and the specimen was sent to pathology for permanent section. Gross pathological examination revealed a 2 x 1.4 x 1 cm tan-white fibrotic soft tissue with multiple 0.1-0.2cm smooth-lined cysts filled with brown, tenacious material. Microscopic pathological examination revealed the mass to be endometriosis (Figure 3 C-D).

Figure 3. Pelvic CT shows an enhancing nodular 16x10mm lesion in the right lower pelvis abutting the rectus musculature along the lateral aspect of Cesarean section scar. A) Axial view, B) Sagittal view.



Discussion

Endometriosis refers to functional endometrial tissue presenting outside of the uterine cavity. AWE is a rare presentation of endometriosis with a suspected occurrence rate of 0.03-1%.¹ a frequently misdiagnosed condition. **Methods** This was a retrospective study of 21 consecutive women with pathologically proven endometriosis of the abdominal wall. Ultrasonographic and Doppler examinations were performed, before surgery, with a high-frequency linear transducer. The clinical data and the results of the sonographic examinations were reviewed and described. **Results** At ultrasound, all the nodules appeared as discrete solid masses that were less echogenic than the surrounding

hyperechoic fat. The nodules had a median diameter of 20 (range, 5-50) Because of its unusual location, AWE can be difficult to diagnose, especially if the patient is not displaying common symptoms of endometriosis such as menorrhagia or dyspareunia. Clues of endometriosis can be elicited from the patient's past surgical history as previous abdominal wall surgeries (especially Cesarean sections) are a common etiology of extraperitoneal endometriosis.¹¹

Physical examination should focus on determining if fascial defects are present and if the mass feels like it is attached to the anterior fascia. Generally, ultrasound is the initial imaging modality for assessment of abdominal wall masses.¹⁵ However, ultrasound is non-specific and cannot differentiate AWE from other causes of abdominal wall masses.⁸ Additional testing via imaging modalities (CT, ultrasound, and MRI) may be obtained if there is concern for fascial involvement or if the diagnosis is in doubt, though these cannot provide a definitive preoperative diagnosis.¹¹ However, these imaging modalities may help in facilitating surgical excision. Contrast enhanced CT can assist in determining size, location, and involvement of muscle or fascia. MRI is more useful for visualizing smaller lesions and assessing vasculature feeding the site.¹⁶ Oftentimes, presentation of a lump or mass in the abdominal wall is referred to the surgeon as a hernia, and in these cases, CT imaging has usually already been done. In the two cases presented in this paper, endometriosis was not initially suspected due to the subcutaneous and fascial location of the masses. Intraoperative excisional biopsy is the gold standard for making this diagnosis (Figure 3).¹¹ If indicated, fine-needle aspiration cytology is helpful in ruling out malignancy prior to surgery.⁷

Classical symptoms of endometriosis include cyclic or catamenial pain, however, this is not necessarily a universal presentation. Other signs include a mass, lower abdominal pain, and bleeding from superficial lesions. Another difficulty in the diagnosis of AWE arises from the delayed onset of any indicating factors, such as a mass, from the time of the original cesarean section. On average, patients develop symptoms 3.6 years after their initial abdominal surgery¹². However, the timing between operation in clinical presentation has been variable from 3 months to 10 years¹³ but it is believed that 10-15% of all women in their reproductive age will develop endometriosis and 25-35% of all women who are infertile have endometriosis. Incisional endometriosis (IE). In Case 1, the patient did not have onset of symptoms until almost 15 years after her last Cesarean which is a very unusual timing. Case 2 followed the previously stated average a little

more closely, with diagnosis occurring 4 years after last the Cesarean section was performed.

Cesarean section or laparoscopic gynecological surgery such as hysterectomy seems to play a role in the pathogenesis of AWE, and the most well established risk factor for AWE is previous surgery.⁷ During a C-section, endometrial cells may relocate through the incision in the uterus and implant within the abdominal wall. Vascular dissemination of endometrial tissue may explain findings of endometriosis far removed from the abdominal cavity such as lesions found in organs such as the kidney or lungs.¹² Other theories of endometriosis etiologies include retrograde menstruation resulting in endometrial tissue deposits in the peritoneum, metaplasia of peritoneal epithelium into endometrial tissue, and differentiation of Mullerian remnants into endometrial tissue.³ dyspareunia, and low back pain that worsen during menses. Endometriosis occurring shortly after menarche has been frequently reported. Endometriosis has been described in a few cases at the umbilicus, even without prior history of abdominal surgery. It has been described in various atypical sites such as the fallopian tubes, bowel, liver, thorax, and even in the extremities. The most commonly affected areas in decreasing order of frequency in the gastrointestinal tract are the recto-sigmoid colon, appendix, cecum, and distal ileum. The prevalence of appendiceal endometriosis is 2.8%. Malignant transformation is a well-described, although rare (<1% of cases

Any incorporation of endometrial tissue within abdominal musculature requires en bloc resection of the underlying myofascial elements.¹² Gold standard of treatment for AWE is surgical with wide surgical excision requiring at least 1cm margins on all sides of the mass.^{5,13} but it is believed that 10-15% of all women in their reproductive age will develop endometriosis and 25-35% of all women who are infertile have endometriosis. Incisional endometriosis (IE) Preventative strategies for AWE include careful handling of endometrial tissue during cesarean section such as lifting the uterus outside of the pelvic cavity while closing the uterine incision, protective bags for specimens, wound protectors, and using separate needles and performing glove changes for uterine and abdominal wall closure during gynecologic surgeries.

Conclusion

AWE is relatively uncommon and can be difficult to diagnose due to nonspecific or asymptomatic presentation. In evaluation of abdominal masses, especially in patients with prior obstetric history including laparotomy or cesarean

section, AWE should be included in the differential diagnosis. Imaging with CT or MRI may aid in localization, degree of involvement of the abdominal wall, and size which may help with planning with reconstruction of the abdominal wall. Fine-Needle Aspiration Cytology assists in diagnosis of ectopic endometrial tissue and ruling out malignancy. Treatment of AWE requires surgical excision with clear margins.

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Acute Osmotic Central Pontine Demyelination in an Alcoholic Patient With Normal Sodium Levels and a Vitamin B6 Deficiency

Cole D. Tessendorf, MS IV; Jared F. Hueser, MS IV; Brendan Wechsler, MD; and Nessim N. Amin, MD

Abstract

We report a Native American male in his 50s with a complex medical history including alcohol use disorder and seizure disorder who presented with complaints of generalized weakness and multiple falls. The patient was admitted for altered mental status, community acquired pneumonia, sepsis, and bacteremia. On hospital day 23, the patient reported a sudden onset of sensation of food stuck in his upper chest. Brain MRI confirmed osmotic demyelination syndrome (ODS) within the central pons. Further workup revealed this finding was likely due to malnutrition, alcoholism, hypoalbuminemia, and vitamin B6 deficiency. However, the patient presented with normonatremia throughout his entire hospital stay. After acute onset of ODS, the patient was transferred to the ICU where he continued to decline. After 68 days from initial presentation, the patient died in hospice care from myelinolysis complications. This case demonstrates a case of ODS of the central pons in a patient with normonatremia, hypoalbuminemia, and severe vitamin B6 deficiency.

Background

Osmotic demyelination syndrome (ODS), also called central pontine demyelination due to it classically affecting the central pons, is typically associated with chronic hyponatremia. However, some cases have been reported in patients with normonatremia, hypernatremia, malnutrition, or vitamin deficiencies.¹⁻³ In this case report, we present a patient that developed symptoms of ODS on hospital day 23, despite being normonatremic the entire stay. This case highlights that early and proper diagnosis of the syndrome should be based on clinical presentation of acute brainstem dysfunction. Additionally, a history of severe alcohol consumption and malnutrition, even in the presence of normal sodium levels, may increase risk in patients.

Case Report

A Native American male in his 50s with a complex medical history including alcohol use disorder, seizures, and medication noncompliance presented to the emergency department with complaints of full-body weakness, slurred speech, and multiple falls for 3 days. He also reported right-sided flank pain and shortness of breath. On initial examination, the patient had moderate dysarthria but his mental status, cranial nerves, motor, sensory, and coordination were all intact and unremarkable. Head CT was negative for acute intracranial abnormalities and

CT angiography was negative for a pulmonary embolism. Chest X-ray revealed right middle lobe pneumonia. While being treated by medical services for pneumonia, sepsis, and bacteremia, he was found to have persistent difficulty with speech and swallowing that progressed to recurrent aspiration and hospital-acquired pneumonia. A barium swallow study showed penetration events remaining above the vocal folds without ejection from the airway. Neurology was consulted for a suspected neurologic pathology causing his oropharyngeal muscle weakness.

A lumbar puncture with CSF analysis showed mildly elevated protein 42.9, glucose 57, and WBC 0. A comprehensive CSF panel for *E. coli*, *H. influenzae*, *L. monocytogenes*, *N. meningitidis*, *S. agalactiae*, *S. pneumoniae*, CMV, enterovirus, HSV1, HSV2, HHV6, parechovirus, varicella zoster, and *C. neoformans* was negative, and CSF cultures resulted in no growth. Noncontrast brain MRI showed new hyperintense T2 signal abnormalities in the central pontine area with restricted diffusion but no apparent diffusion coefficient (ADC) to correlate. An additional lumbar puncture was completed and showed no evidence of infection or inflammation, with protein 30, glucose 68, WBC 1. Oligoclonal bands, anti-TPO, ANA, ANCA, gangliocyte antibodies, and an additional comprehensive CSF panel were all negative, ruling out infection or inflammation. At this

point, findings were suggestive of ODS or subacute infarct. Other differential diagnoses during the workup were CNS vasculitis, autoimmune encephalitis, and demyelinating disorders. Repeat MRI imaging was performed (Images 1-3), and this strengthened the diagnosis of ODS.

Sodium level ranged from 135 to 144 throughout his entire admission. Albumin ranged from 2.7-3.7 g/dL during the admission (normal 3.5-5.2 g/dL). Per hospital protocol, the patient was given IV 12.5g albumin 5% solution when below 3.0 g/dL throughout his stay. Vitamin B12 and TSH were within normal limits. Vitamin B6 level came back low at 3mcg/L (normal range of 5-50 mcg/L). Accordingly, 100 mg of vitamin B6 oral supplementation was recommended daily for 3 weeks, followed by a maintenance dose of 35 mg daily. The patient was transferred to the ICU due to altered mental status, respiratory failure, and worsening pneumonia. While in the ICU however, the patient's condition continued to deteriorate where he was eventually discharged to hospice care on day 45.

Outcome and Follow-Up

Due to deteriorating status from complications related to ODS, the patient was discharged to a nearby hospice care facility 45 days after his initial admission. The patient died

after 24 days in hospice care.

Discussion

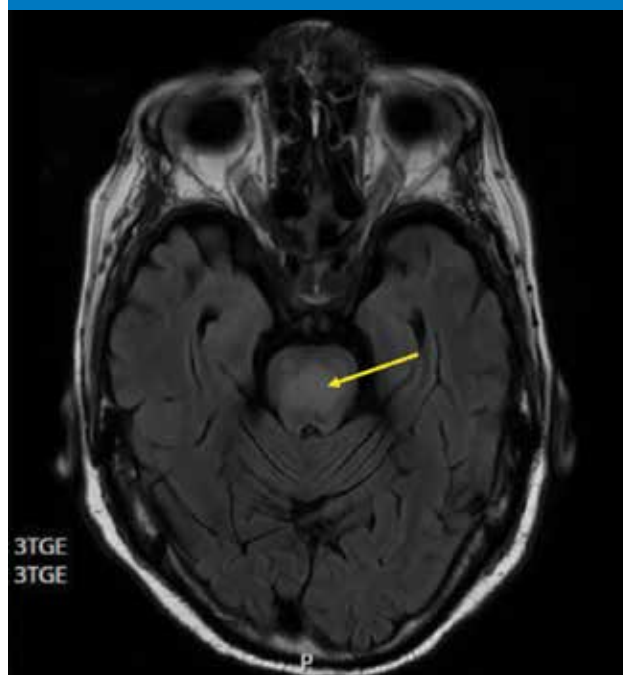
ODS was first defined and described in 1959.⁴ Classically, it is associated as a severe outcome in refeeding syndrome in the setting of chronic hyponatremia. During periods of hyponatremia, low serum tonicity causes water to flow across the blood-brain barrier and increase water content in the brain tissue to cause swelling. In chronic states of hypotonicity, the brain cells adapt by selectively losing organic solutes to allow water movement out of the cells in order to decrease brain swelling.^{2,5} The adaptation allows patients with chronic hyponatremia to appear asymptomatic despite having a serum sodium concentration below 120 mmol/L.⁶

This adaptation of solute loss from brain cells in chronic hyponatremia also creates a potential problem when the serum sodium is therapeutically or spontaneously corrected. The reuptake of solutes in the brain during electrolyte correction occurs more slowly than the loss of solutes, resulting in net water loss from brain tissue. In severe cases, fast correction of the hyponatremic brain can cause rapid water loss from neurons leading to apoptosis and loss of myelin, hence where the term "osmotic demyelination" is drawn from.⁷ As such, the rapid correction of hyponatremia in patients

Figure 1. Axial T2-weighted MRI imaging with Gadolinium contrast-enhancement demonstrating high signal within the pons.



Figure 2. Axial T2-weighted MRI with FLAIR demonstrating high signal within the pons without hemorrhage or mass lesion.



is an important risk factor for the development of ODS.^{7,8} Historically, ODS has also been referred to as central pontine myelinolysis due to susceptibility and high involvement of the central pontine area. The exact mechanism and explanation of the location of demyelinating lesions in the pons or midbrain is not well understood, however studies in rats have shown that demyelination primarily occurs in areas of the brain that are slowest in reaccumulating osmolytes after rapid correction of hyponatremia.⁹

The diagnosis of ODS is often made radiographically, in combination with common presentations which raise suspicion.³ As patients with ODS typically present with encephalopathy, a head CT is often the initial scan obtained, which may demonstrate low attenuation crossing the midline in the lower pons. However, a non-contrast MRI scan is the preferred study to detect ODS. The earliest change can be seen on DWI with restriction in the lower pons, which has been seen within 24 hours of onset of tetraplegia. This same region eventually demonstrates a high T2 signal followed by a low T1 signal.³ The T1 and T2 changes may take up to two weeks to develop and is likened to the appearance of a trident due to predominant involvement of the transverse pontine fibers and relative sparing of the descending corticospinal tracts, known as the Trident Sign, which is not specific for

ODS. Other associations with the Trident Sign include Wilson disease and multiple sclerosis.¹⁰

In a study of 174 cases of pontine myelinolysis, underlying conditions of ODS were investigated. Severe alcohol use was found in 39.4 percent of the cases, rapid correction of low serum sodium levels was present in 21.5 percent and 17.4 percent were after immunosuppressive treatment in patients with liver transplantation.¹ ODS has also been associated in patients with hypokalemia, hyperglycemia, severe burns, diabetes mellitus, pituitary surgery, lithium toxicity, hypophosphatemia, chemotherapy, and chronic renal failure.¹¹⁻¹³ While the patient described in our report did have comorbidities, he was not hyperglycemic, taking lithium for any medical conditions, have kidney failure, or any other described electrolyte abnormality expect for chronic alcoholism.

While ODS is classically associated with chronic hyponatremia, it has also been reported in normonatremic and hypernatremic patients. Staikov et al.¹⁴ reports a young woman with a history of long-term alcohol abuse and malnutrition that presented after a 10-day period of confusion and aggressive behavior. She developed an acute bulbar quadriparetic syndrome with characteristic MRI findings

Figure 3. Axial MRI diffusion-weighted imaging (DWI) with corresponding apparent diffusion coefficient (ADC) map demonstrating high signal involving the pons on DWI without a corresponding decreased signal on the ADC map.



typical for ODS, all while having normal sodium levels. The authors proposed reasons for ODS such as vitamin B1 deficiency and direct toxic effects of acetaldehyde.^{14,15} There are additional reports of normonatremic ODS occurring in patients with persistent hyperglycemia and with severe burns.¹⁵ Another study reports a ODS patient with severe alcohol use disorder with minimal hyponatremia of 133 mg/dL and hypoalbuminemia. They suggest that hypoalbuminemia is a common factor in chronic alcoholics which could lead to a hypo-osmolar state, making them more susceptible to ODS.¹⁶ Our patient also initially presented with low albumin in the setting of chronic alcoholism, making hypoalbuminemia another plausible factor in creating a hypo-osmolar state. Droogan et al.¹⁷ describes a patient with normonatremia, history of chronic alcohol use, and clinical features of ODS, specifically acute confusion, seizures, and flaccid quadriplegia. Throughout the patient's 14 days of admission, the patient's serum sodium concentration was measured daily or every second day and gradually rose from 139 mmol/L to 153 mmol/L, similar to our described patient.¹⁷

We report a unique case where a chronic alcoholic patient suffered from ODS due to refeeding syndrome. Despite normonatremic levels and adequate sodium and electrolyte monitoring, he had acute onset of oropharyngeal muscle weakness due to ODS. The diagnosis of ODS in the central pons was confirmed with MRI imaging. His only identified deficiencies found were a low Vitamin B6 level and hypoalbuminemia. Despite aggressive hospital intervention, the patient did not recover and died from ODS-related complications. This case highlights that early and proper diagnosis of ODS should be based on clinical presentation of acute brainstem dysfunction. Additionally, a history of severe alcohol consumption and malnutrition, even in the presence of normonatremic levels, may increase risk of ODS in patients.

Conclusion

Despite adequate sodium and electrolyte monitoring and normonatremic levels, our patient developed ODS confirmed with brain imaging. A history of severe alcohol disorder, malnutrition, and vitamin deficiencies, even in the presence of normonatremic levels, may increase risk of ODS in patients. Early and proper diagnosis of ODS should be suspected based on clinical presentation of acute brain stem dysfunction, regardless of normal electrolytes.

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Anesthetic Considerations for Carbon Dioxide Emboli in Patients with Obesity – A Case Report

Andrew L. Guymon, MS IV; Donald P. Keating III, MS IV; Andrew M. Reuter, MS IV; David Fromm, MD; and Brendan Feehan, MD

Abstract

Gas embolization is a rare but potentially deadly complication of any laparoscopic surgery. There has only been one other report of gas emboli in patients undergoing bariatric surgery. We present a case of gas embolization in a young female patient undergoing Roux-en-Y gastric bypass. Onset of gas embolus was identified by a dramatic drop in End Tidal Carbon Dioxide (ETCO₂) followed by drops in blood pressure, heart rate, and oxygen saturation over the following 15 minutes before the patient was stabilized and transferred to the ICU. The surgery was completed three days later without incident, and extensive hepatomegaly was identified. A discussion on pre-operative evaluation, special considerations, and acute management of gas embolization in patients with obesity ensues. We highlight the emerging Jain's point for insufflation, the potential for ultrasound-guided Verres needle insertion, and the paucity of literature evaluating the risk, incidence, and outcomes of gas embolization in patients with obesity.

Introduction

As the American obesity epidemic grows, robotic-assisted bariatric surgery has become increasingly more common, tripling in incidence between 2015 and 2020¹ and demonstrating improved safety and performance.² It has established itself as the gold-standard for sustained and treatment refractory weight loss³ with few life-threatening perioperative risks. However, we report the second documented occurrence of venous gas emboli during bariatric surgery and the first during robotic-assisted Roux-en-Y gastric bypass. We found only one other report of gas emboli during bariatric surgery through a PubMed and Medline search as of June 17, 2023. Although both arterial and venous gas emboli can occur during laparoscopic surgery, arterial gas emboli is classically associated with decompression sickness while numerous reports have identified venous gas emboli during laparoscopy.⁴

A meta-analysis reviewing 489,335 closed laparoscopic surgeries reported a symptomatic gas emboli incidence to 0.001%, but a devastating 28% mortality rate remains.⁵ It is understood that carbon dioxide (CO₂) microemboli commonly occur during laparoscopy, however, a confident incidence of asymptomatic gas emboli remains unknown.⁶ A serious CO₂ embolus occurs during laparoscopic surgery when damaged vasculature or solid organs allow insufflated CO₂ to travel to the right atrium and obstruct the right

ventricular outflow tract. This error usually occurs during or shortly after insufflation of carbon dioxide into the body cavity.⁷ Altered hemodynamics ensue, including right ventricular failure due to airlock of entrapped emboli, vasoconstriction of pulmonary arteries, and diminished filling of the left heart. The clinical manifestations of venous air embolism are primarily a result of insults to the cardiovascular, respiratory, and neurologic systems. Bradyarrhythmias or tachyarrhythmias often occur, as well as dyspnea or tachypnea due to acute hypoxemia or pulmonary edema.⁴ Neurologic manifestations may occur either as a result of cerebral hypoperfusion or a patent foramen ovale allowing paradoxical cerebral embolism. Sudden onset hypotension and decrease in ETCO₂ are also signs that should prompt consideration of CO₂ emboli.⁴

Careful surgical techniques including correct position of the Veress needle with a feedback test such as the hanging drop test, hissing sound test, manometer test, and, as used in this patient, the saline drop test as well as a low insufflation pressure (<10 mmHg) are used to ensure the Veress needle is not in a vessel.^{7,8} The critical care management of obese patients has been well described, but the acute management of and considerations for CO₂ emboli in obese patients remain unclear.

Case Report

A 42-year-old woman with past medical history significant

for class III severe obesity, gastroesophageal reflux disease (GERD), a small type I hiatal hernia, polycystic ovarian syndrome (PCOS), gout, and obstructive sleep apnea (OSA) was admitted for elective robotic-assisted Roux-en-Y gastric bypass. She had tried diet and exercise modifications along with semaglutide for weight loss without success. She had undergone previous surgeries for both ovarian cyst removal (2003) and attempted hysterectomy (2012) but could not complete the hysterectomy due to respiratory distress resulting from Trendelenburg positioning.

Preoperatively, her height and weight were measured at 61 inches and 291 lbs (BMI: 55.0), respectively. Blood pressure, heart rate, and temperature were 150/97 mmHg, 71 bpm, and 36.7°C. Her oxygen saturation was 96% on room air, lungs were clear, she had no history of respiratory or cardiovascular disease, and she could perform four metabolic equivalents (METs) during daily activity. Sequential compression devices were applied, and two peripheral IVs placed. She was pre-medicated with acetaminophen 1,000 mg, diphenhydramine 25 mg, ondansetron 4 mg, clindamycin 900 mg, and heparin 7,500 units before the first incision.

In the operating room, the patient was placed supine on the table, and non-invasive blood pressure (NIBP), ECG, SpO₂ %, depth of neuromuscular blockade (via train of four), ET CO₂, and temperature were continuously monitored. Anesthesia was induced with 50 mcg fentanyl, 100 mg lidocaine, 150 mg propofol, 20 mg ketamine and 50 mg rocuronium. The airway was secured, and anesthesia preserved with sevoflurane titration. Ventilation occurred at a tidal volume of 498 – 560 ml, rate of 13-17 breaths per minute, and PEEP of 12 cm H₂O.

Pneumoperitoneum was established 24 minutes after

anesthetic induction via insertion of a Veress needle within Palmer's point (located in the left upper quadrant, 3 cm below the costal margin, and in the midclavicular line). Correct placement was confirmed with a successful saline drop test, insufflation was started at low flow, and low insufflation pressure was observed (<9 mmHg). After adequate pneumoperitoneum was established, a small stab incision was placed in the midline for an 8 mm port. At this point, end-tidal CO₂ plummeted from 30 to 9 mmHg, and heart rate dropped from 66 to 44 bpm in less than three minutes. Conversations between anesthesia and the surgery team about CO₂ embolization began at the onset of decreasing ET CO₂. At the same time, SpO₂ and BP began their descent to 64% and 83/41 mmHg (Table 1).

In response, the pneumoperitoneum was rapidly evacuated, the port removed, and the patient placed in the left decubitus Trendelenburg position. Supportive measures were started. Fraction of inspired O₂ was increased to 100%. Two failed arterial lines were attempted on the radial arteries before successful placement in the right femoral artery. 0.1 mg of epinephrine was administered four times, 0.1 mg atropine was administered twice, and 276 mcg norepinephrine total was administered over the following 20 minutes. Vital signs returned to baseline 16 minutes after the initial drop in ET CO₂. The patient remained intubated and was transported to the ICU in serious but stable condition. On arrival to the ICU, chest X-ray revealed increased pulmonary markings without infiltrate. Transthoracic echocardiogram performed in the ICU showed no residual gas emboli but showed mild tricuspid regurgitation and left ventricular hypertrophy with preserved ejection fraction (72%). Four hours after the onset of gas embolization, arterial blood gas revealed a low pH of 7.30 and an elevated pCO₂ and pO₂ of 47.3 and 232.0 mmHg, respectively. Two hours later, at normal and stable

Table 1. The time course of critical events and vital signs.

Time after intubation (minutes)	ETCO ₂ (mmHg)	NIBP (mmHg)	Heart rate (bpm)	SpO ₂ (%)
00:00 – intubation	31	147/93	77	80
00:24 – VNI	32	-	53	92
00:25	30	97/37	55	92
00:26	14	-	66	91
00:27	9*	-	60	91
00:28	12	83/41*	52	87
00:29	12	-	44*	74
00:37	24	115/66	57	64*
00:43	37	111/96	66	100
00:51 – arterial line successfully placed	41	194/100	78	100

* Indicates minimum values

VNI – Verres needle insertion

vitals, the patient was extubated without incident and had no residual neurocognitive deficits. She was discharged two days later and opted to repeat Roux-en-Y gastric bypass the next day.

Roux-en-Y gastric bypass was completed without incident, although insufflation utilized a 5 mm trocar port in the right upper quadrant of the abdomen. During laparoscopy, it was noted that she had extensive hepatomegaly that prevented repair of her small hiatal hernia and also prevented easy visualization of potential liver trauma. ETCO₂, HR, BP, RR, and SpO₂ remained acceptable throughout the surgery, and the patient's hospital course was typical for the procedure. She was discharged home after two days without complications. At the one-week post-operative follow-up, she presented with expected nausea and mild abdominal pain but no concerning signs or symptoms.

Discussion

The prevalence of obesity in the United States has increased from 30.5% in 2000 to 41.9% in 2017.⁹ Obesity is associated with a 30% greater chance of difficult intubation,¹⁰ increased work of breathing, higher respiratory demand, impaired cardiac contractility,¹¹ and ventilation-perfusion mismatch.¹² ¹³ The stress of a venous air embolism tests the cardiovascular system of all patients, but the compounded cardiovascular and pulmonary restrictions of obesity make hemodynamic compromise during gas embolization especially concerning.

Risk of air embolization is mitigated through careful Veress needle insertion (VNI) and maintenance of low initial insufflation gas flow and pressures. VNI is a safer alternative to the direct trocar insertion (DTI) technique.¹⁴ This is particularly valuable in patients with obesity where the increased force applied perpendicular to the abdomen may lead to more iatrogenic injuries during DTI.¹⁵ Veress needle liver puncture is suspected to be one of the leading causes of gas emboli.¹⁶ The large size of the liver makes it an easy target, while the structured parenchyma prevents vascular collapse when damaged and allows for gas uptake. Obesity frequently causes hepatomegaly that can extend laterally to Palmer's point, as seen in our patient. Unsurprisingly, VNI at Palmer's point is relatively contraindicated in patients with hepatomegaly.¹⁷ Thus, we suggest that blind VNI at Palmer's Point in patients with severe hepatomegaly may be associated with increased risk of gas emboli. Alternatively, Jain's point lies to the left side of the abdomen at the L4 level, 10–13 cm lateral to the umbilicus, and is indicated for patients with hepatomegaly.¹⁷ Further, VNI under ultrasound guidance has been used in individuals with increased abdominal

adipose to avoid puncturing large vasculature or solid organs.^{18,19} Correct VNI is verified through several tests, such as the hanging drop test, hissing sound test, manometer test, and, as used in this patient, the saline drop test.^{7,8}

In this case, CO₂ emboli likely occurred during Verres needle insufflation as ETCO₂ began its descent two minutes after VNI and heart rate nadired five minutes after VNI. It is unclear if this was due to penetration of a solid organ or vasculature as no clear evidence of vascular or liver trauma was present during repeat surgery two days later. During insufflation, providers should confirm low (<10 mm Hg) initial pressures to ensure intraperitoneal placement rather than vascular or solid organ insertion.⁷ This is challenging because increased abdominal adipose elevates intraperitoneal pressures, although it may be mediated by low gas flow. Alternatively, intravenous infusion of a hyperosmotic colloid solution can increase central venous pressure to a level that permanently exceeds intraperitoneal pressure.⁷ This reduces the accumulation of carbon dioxide embolism but at the expense of increased hemorrhage.⁷ Unfortunately, no laparoscopic method eliminates the risk of gas emboli as evidenced by our case where attentive VNI, verification, and observation of low peritoneal pressures and flow still resulted in a life-threatening gas embolus. Although Roux-en-Y laparotomy could definitively prevent repeat gas emboli in the subsequent surgery, there is no evidence that previous gas emboli is a risk factor for repeat emboli. Further, overall complication rate and recovery time remain substantially lower with laparoscopic bariatric surgery.²⁰

Once a severe gas embolus is suspected, the anesthetic team's goals include removing intraperitoneal and intravascular CO₂, preventing additional gas infiltration into the abdominal cavity, and maintaining hemodynamic parameters.

Acute CO₂ emboli is recognized first by a dramatic drop in ETCO₂, as seen in our patient.²¹ Management begins by discontinuing insufflation and placing the patient in a head-down left lateral decubitus position to trap the emboli on the lateral wall of the right atrium preventing ascent of more gas to the right ventricular outflow tract.⁴ Although discontinuing insufflation may contribute to increased hemorrhage from injured vasculature, the immediate goal during gas emboli management is to prevent further air embolization. If significant hemorrhage were to ensue, laparotomy to achieve hemostasis may be necessitated. Most recommend head-down left lateral decubitus positioning, however we emphasize the increased work of breathing during head down positioning that can be particularly

challenging in patients with obesity.^{4, 22} Fortunately, our patient was able to tolerate head down positioning during emergent air emboli management in this report, although she was unable to tolerate steep Trendelenburg positioning during a previous hysterectomy.

Nitric oxide should be discontinued, as it may accumulate in the emboli and draw gas emboli into the pulmonary vasculature. The patient should also be placed on 100% oxygen to encourage wash out of the emboli and help correct hypoxemia. Similarly, hyperbaric oxygen and positive end-expiratory pressure therapy may be beneficial as they provide a high diffusion gradient for the dissolution of bubbles.^{16, 22} If needed, flooding the surgical field with normal saline submerges the venous access and prevents further gas embolization.²³

Medications used in a suspected venous air embolism are generally supportive measures to maintain hemodynamic stability. Norepinephrine maintains ventricular function without causing further constriction of the pulmonary vasculature.²⁴ Prostaglandin analogs and phosphodiesterase inhibitors may also be useful in reducing pulmonary vasculature pressure.^{24, 25} Milrinone and dobutamine are tested options to improve contractility and manage afterload.²⁴ Venous air emboli also pose a risk of cardiac arrest secondary to acute dysrhythmias. In this scenario, providers should follow the Advanced Cardiac Life Support Protocol.²⁴

Although peripheral IV and arterial access are required for drug administration and blood pressure monitoring, establishing these lines is more difficult with increased adiposity, as evidenced by two failed arterial lines in this report.¹¹ Likewise, placement of a central venous catheter or a pulmonary artery catheter allows for aspiration of up to 50% of entrained air trapped in the chambers of the right heart, but emergency placement in a patient with increased adiposity is challenging.^{11, 25} Further, the acute nature of a gas emboli and ensuing rapid decline or improvement provides little time for central line placement.

Unproven techniques for emboli detection and management include transesophageal echocardiography (TEE) and external cardiac compressions. Unfortunately, TEE is invasive and generally considered non-specific as it leads to routine detection of clinically insignificant gas emboli.²⁶ External cardiac compression may cause the breakup of locked air and its transport into the pulmonary circulation.^{23, 27}

Conclusion

Venous gas emboli are a rare but serious complication of laparoscopic surgery. We report the second case of gas emboli during bariatric surgery. It is suspected that gas emboli are more dangerous in patients with obesity because of the deleterious effects of obesity on the cardiovascular system. Certain factors such as location of VNI, ultrasound guidance, potential for hepatomegaly, Trendelenburg positioning, airway management, and emergency line access should be considered when preparing for laparoscopic surgery in a patient with obesity. No protocol can eliminate venous gas emboli but careful preparation and prompt response by the anesthetic and surgical teams can reduce morbidity. Importantly, no studies have looked for an association between obesity, gas emboli, and patient outcomes leading to a paucity of data surrounding the topic. To best serve our patients, we emphasize the need for more exploration.

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Scoping Out Arthroscopy: A Concise Review of the Development and Other Important Principles in Orthopaedic Arthroscopy

Cole D. Tessendorf, MS IV; and Nathan W. Skelley, MD

Introduction

Surgical arthroscopy is a well-established treatment and diagnostic option for joint pathologies utilizing a minimally invasive approach. Compared to open surgical procedures, in many scenarios arthroscopy can offer greater comfort, shorter duration of hospital stays, less recovery risks, and improved patient satisfaction scores while maintaining long-term results.¹⁻³ Since its introduction in the early 1900s, arthroscopy has become increasingly relevant to various subspecialties within orthopaedic surgery. With an estimated 1.77 million arthroscopic procedures occurring annually in the U.S., knowledge of how arthroscopy functions is essential in regards to surgical efficacy, care plan understanding, technique, and patient safety.¹ Along with reviewing the early development of arthroscopy, this article aims to discuss fundamental concepts like fiber optic visualization, insufflation methods, fluid management, and techniques related to the evolving field of arthroscopy.

Early Development of Endoscopes and Arthroscopes

The ability for physicians to look into body cavities had always been limited by the ability to introduce light into the cavity. The earliest known instrument designed specifically to look into closed, or “lightless,” body cavities was presented by Philipp Bozzini in 1806.⁴ His invention called the *lichtleiter*, or light conductor, was the first to be able to conduct light into body cavities for direct visualization. Because light bulbs were not yet invented, the *lichtleiter* utilized an apparatus with several concave mirrors and a wax candle. When lit, the candle’s light would be directed into an area of interest like the ear, vagina, or bladder. The operator would then peer through a lens to visualize the illuminated anatomy.^{4,5} Bozzini’s device created an uproar of both enthusiasm and praise, but also extreme criticism. Many called the invention impracticable, not very useful, and even dangerous.⁴ Over the next century, other inventors developed other versions by experimenting with sources of light. One prototype even used the combustion of gasoline and turpentine as the light source to visualize the bladder. Then in 1879, the invention of the light bulb by Thomas Edison would further revolutionize

the field of endoscopy. Just a few years later in 1886 the first cystoscope, utilizing an incandescent bulb for illumination, was developed by Leiter and Nitze in Germany.⁴⁻⁶

Towards the end of the 1800s and early 1900s, endoscopes continued to develop and grow in popularity. However, it was not until 1918 in Tokyo that a modified cystoscope was described as being able to examine knees. Kenji Takagi, a Japanese orthopaedic surgeon, believed that early visualization of the knee joint to diagnose tuberculosis might lead to better treatment and prevention of long-term complications. In 1931, Takagi presented the first practical arthroscope, which was 3.5 mm in diameter. By 1938, he was on his 12th design with varying sizes of trocar diameters, with and without lenses, and with different light sources. Takagi is regarded as the first developer of modern arthroscopy.^{4,5}

The Role of Fiber Optics and Snell’s Law in the Development of Arthroscopes

When he first introduced his device, Bozzini reported that the *lichtleiter* device relied on two main requirements: 1) the ability to direct sufficient light onto the area of interest, and 2) to bring the reflected light back to the examiner’s eyes to visualize it.⁵ Edison’s light bulb certainly expanded the possibilities of light illumination, but it was not until the creation of fiber optics in the 1950s that “more complex” arthroscopic surgery was possible.^{5,7}

When light is transmitted from a material with a high index of refraction to a material with a low index of refraction, the light will enter the second material and be reflected from the interface between the two materials back into the first material.^{8,9} In short, light changes speed when passing over the boundary between two different materials. This change in speed causes light to bend, called refraction.¹⁰ The angle of refraction can be calculated as light travels from one material to the next using Snell’s law, see Figure 1. Fiber optics relies on Snell’s principle of an inner core with high refractive index surrounded by an outer cladding with lower refractive index.^{7,11,12} Due to the difference in refractive indexes, the refracted light rays will completely propagate within the inner

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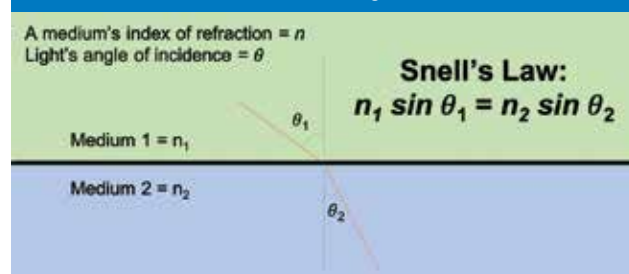
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Figure 1. Snell's Law. When light enters a new medium with a different index of refraction (n), the light's angle of incidence (θ) will also change.



core while not entering the outer cladding. Bundles of fibers surrounded by a material with lower respective refractive indices than the core can then ultimately be used to transmit images without direct visualization.^{8,9,12}

After reading one of the first studies describing fiber optics in the 1950s, Basil Hirschowitz of the University of Michigan visited the authors in Britain and discussed the application of its principles to endoscopy. Over the next several years, Hirschowitz and his associates at Michigan developed numerous prototypes to develop a device similar to modern endoscopes in appearance.^{13,14} However, it was Masaki Watanabe, a student of Takagi, that produced the first arthroscope that utilized fiber optics in the 1960s. Fiber optic arthroscopy would soon become extremely popular and accepted as the standard for orthopaedic surgeons worldwide.^{5,7,14}

Modern Arthroscopy

The ideal arthroscopic medium provides visual clarity, sterility, nonconductivity (ie, allowing for the use of electrosurgical instrumentation), and low cost. Varying gaseous and liquid media have been used with varying successes and indications. In this section, we describe the various mediums within which arthroscopy is performed.

Gas Insufflation

Medical-grade carbon dioxide (CO₂) has been safely used for decades by general surgeons in the peritoneal space during endoscopic procedures. It is highly soluble in blood and effectively exhaled through the lungs.¹⁵ The use of CO₂ for knee arthroscopy began in the 1980s.¹⁵ Employing a gas medium for joint distension like CO₂ allows for a dry operating environment, which may be necessary in procedures such as placement of cartilage matrix into an osteochondral defect.¹⁶

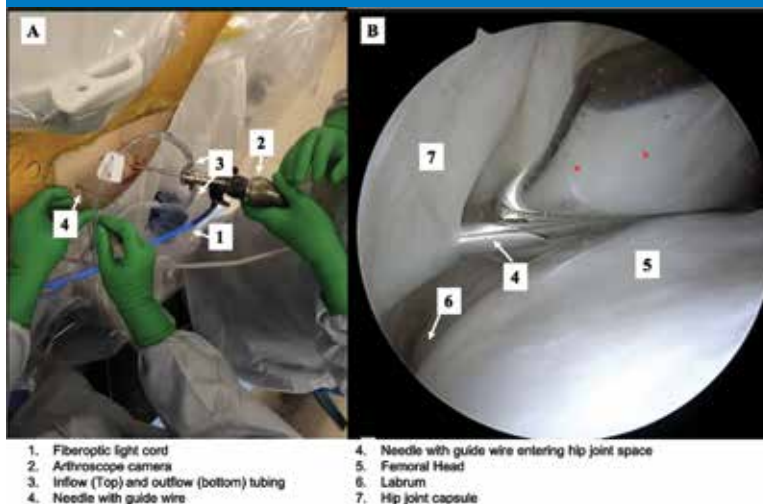
While this is one example of a procedural indication, this can be broadly applied to other surgical techniques using grafts or biomaterial that would benefit from a dry field without the mechanical effects of a saline solution.^{15,16}

A report by Riddell et al.¹⁷ described the use of CO₂ in over 3,000 knee arthroscopies without a complication, and another reported that gas insufflation can be performed safely and provide an alternative environment for treating osteochondral defects requiring a dry field in the knee.^{17,18} Overall, carbon dioxide insufflation for knee arthroscopy provides an effective means of visualization and maintaining a dry environment with a relatively safe profile.¹⁶ While gas insufflation may be safe and effective for specific procedures, the preferred medium for the vast majority of arthroscopic procedures is liquid.

Gravity-Controlled Fluid Management

Normal saline-based pumping systems are also utilized for arthroscopic surgery, and these systems have evolved over the years to provide improved intraoperative visualization. Gravity flow systems were the first system to be described and utilized. In gravity flow systems, irrigation liquid is hung on a nearby IV pole and gravity acts as the primary force determining the inflow pressure.¹⁹ The saline bag is then strategically raised or lowered to change inflow pressure. For example, if a bag of saline would be hung approximately 6

Figure 2. Right hip arthroscopic procedure to treat a hip impingement and labral tear. Image A demonstrates the fiberoptic light cord (1), camera (2) with accompanying grey camera cord for the digital image, and inflow and outflow tubing (3) all attached to the arthroscope. The arthroscope has been inserted into the joint into a location where the needle instrument (4) can be visualized in Image B. A flexible wire is passed through the needle to maintain access to the joint. The needle allowed for air to enter the joint space during placement. Note the air bubble indicated with the red-colored asterisks on Image B trapped under the hip joint capsule (7). The femoral head (5) and labrum (6) are well visualized with this arthroscopic view.



feet above the operative site, the pressure in the joint could be around 120 mm Hg. When fluid begins flowing, the intra-articular pressure would decrease due to the fluid's velocity and friction against the tubing. Thus, in a typical intra-articular environment with modest outflow, the pressure in the joint will drop to an ideal intra-articular pressure, usually between 30 to 60 mm Hg.^{19,20}

The advantages of gravity-controlled fluid management include a simple setup and a lower cost.⁶ However, the disadvantages include lower intra-articular pressures, dependence on the adjustment of fluid bag height, potential occupational injury to staff managing bags, and an inverse correlation between inflow and joint volume. In procedures where high intra-articular pressures are required, gravity-dependent systems may not be appropriate.^{2,20}

Dynamic and Automated Fluid Irrigation Systems

In contrast to gravity-controlled systems, development of fluid irrigation systems in the early 2000s now feature a dynamic system in which the inflow can automatically adjust to and balance the pressure against a changing outflow.² If the surgeon is only taking diagnostic pictures, consistent pressure with gravity dependent management may be sufficient.¹⁵ However, automated dynamic fluid systems are optimal in most scenarios that may have limb repositioning, insertion of tools, suction-linked tools like shavers, among other factors that may affect intra-articular pressure in arthroscopy.²¹ The goal of dynamic arthroscopic pumps is maintaining appropriate fluid pressure for insufflation of the joint space while adapting to the various factors that may affect intra-articular pressure.^{2,6,22} Figures 3-5 show images of a standard dynamic flow irrigation system used in joint arthroscopy.

The advantages of automated systems over gravity irrigation include a more consistent flow, a greater degree of joint distention, decreased need for tourniquet use, a tamponade effect on bleeding, decreased operative time, as well as reduced turbidity to increase visualization in joint spaces.^{2,21,23} Several studies have demonstrated that important disturbances such as bleeding,

Figure 3. Right hip arthroscopic procedure to treat a hip impingement and labral tear. This is the same case as in Figure 2, just a few moments later during the procedure. Note, a new instrument has been inserted into the joint space, called a Switching Stick (4) and the air bubble has since been suctioned out on Image D. Notice that the joint space has been replaced with arthroscopic fluid distending the joint capsule (6) like a balloon via the dynamic pump of the arthroscope.

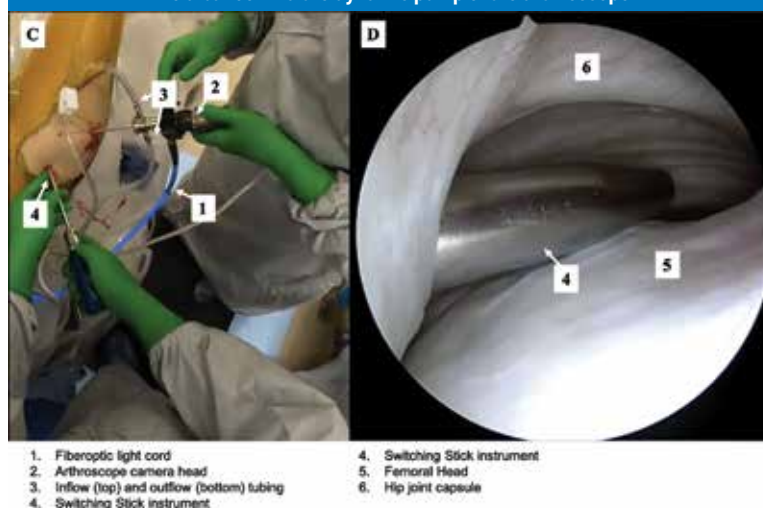


Figure 4. Left knee arthroscopic procedure to repair a bucket handle meniscus tear. The arthroscopic camera (2) has been inserted on the lateral knee portal in order to visualize the needle instrument entering the medial knee portal (1). Note that the blue light cord (3) and gray camera cord (4) both travel back to a the power source and camera box (5) on the surgical tower. The current dynamic pump pressure (6) is shown, as well as the live high definition screen the surgeon uses to performed the procedure (7). The dynamic fluid pump (6) controls the arthroscopic fluid rate into the joint via the inflow tubing. The outflow tubing is connected to a suction machine (12). Arthroscopic fluid is delivered from the hanging bags (8), into the pump system (6), and then through the inflow tubing into the scope sheath placed within the joint. The inset image demonstrates the arthroscopic image obtained of the intra-articular knee anatomy. The medial condyle (11), anterior cruciate ligament (10), and bucket handle meniscus (9) are well visualized. The arthroscopic surgical approach allows the surgical team to obtain this high definition image and access to the knee joint space through a minimally invasive ~6 mm incision in the knee.

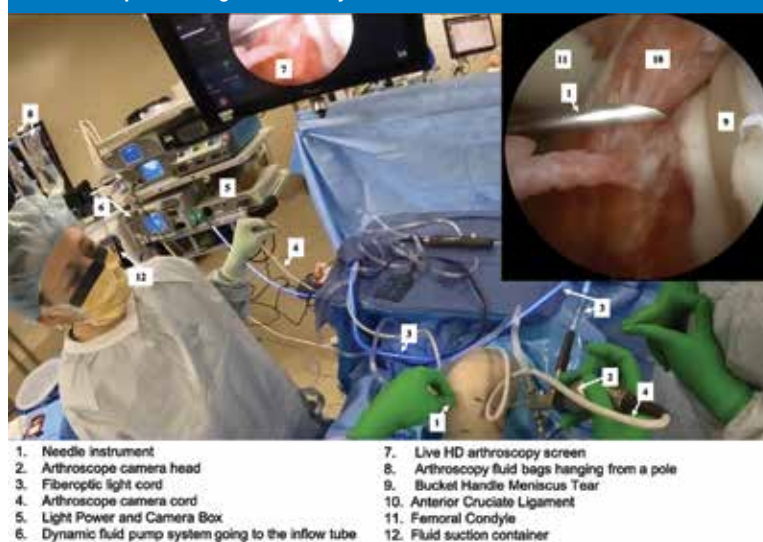
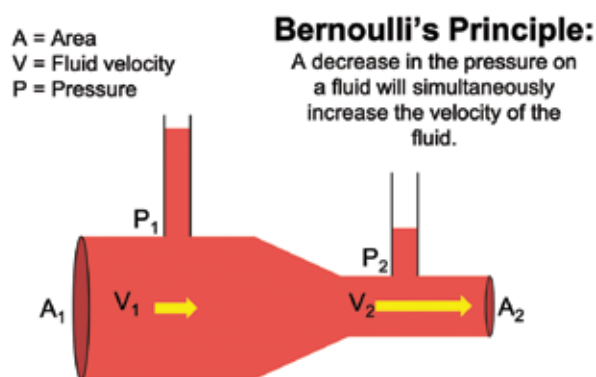


Figure 5. Bernoulli principle. The principle, also called the Bernoulli effect, is simply explained as an increase in fluid velocity will simultaneously be associated with a decrease in pressure. However, in the case of excessive outflow, as in the case of an open arthroscopic portal, a negative pressure gradient develops perpendicular to the high-velocity outflow fluid stream. The negative pressure can draw blood from exposed vessels into the high-velocity stream toward the source of outflow, leading to blood that can obscure the arthroscopic field if this fluid and blood are not appropriately vented from the joint space.



air bubbles, and loose fibrous tissue are not affected by automated pumps.^{23–26} Disadvantages include the need for additional equipment with increased cost and maintenance, a learning curve for the surgical team, and increased risk of extra-articular fluid dissection and associated complications like compartment syndrome.²¹ Overall, automated pumps are effective in keeping joint spaces open with good visualization, along with the additional benefit of fluid pressure control.^{22,27,28} Ultimately, they help to maintain a consistent pressure in the joint, something that can be a struggle to accomplish with IV bags and gravity.

Principles of Arthroscopic Fluid Dynamics

Surgeon awareness of arthroscopic pump function is an important principle in surgical efficiency and safety. The fluid dynamics of arthroscopy is largely underappreciated, as intra-articular pressure must satisfy the balance between safety, visualization, cost, and procedural ease.²¹

A consistent intraarticular pressure (if kept above mean arterial pressure) serves as a tamponade against intraoperative bleeding in the joint. During the procedure, the hydrostatic pressure exerted by the irrigation fluid tamponades the capillary bed within the articular tissues which in turn allows for visual clarity. Thus, maintaining field visualization relies upon limiting bleeding by balancing the patient's blood pressure and the arthroscopic pump pressure, as well as controlling turbulence.²

Conversely, turbulence promotes bleeding according to the Bernoulli principle, in which flowing fluid may create a negative pressure gradient that pulls blood from exposed vessels.²⁹ This effect can be appreciated while working in the subacromial space of the shoulder where non-cannulated portals allow fluid to flow from a high-pressure system (inside the shoulder) to a low-pressure system (outside the shoulder), causing bleeding by virtue of the Bernoulli principle. In this example, it is important for surgeons to resist the temptation to immediately increase the pump pressure as this will only increase the flow velocity and pressure gradient to encourage further bleeding.^{29,30} See Figure 5 for a visual representation of the Bernoulli principle.

In most automated pump systems, inflow and outflow are directed through distinct lumens that allow regulation in regards to clarity, turbulence, and other factors.^{21,30} Controlled bursts of high flow are acceptable and often necessary to help clear excessive debris, but as a standard, low flow is desirable because it maintains a clear field of view while keeping turbulence and fluid extravasation into surrounding soft tissues at a minimum.²

Complications and Considerations

Arthroscopy is largely considered to be safer than open procedures with fewer complications, but it is not benign and patients should be aware of risks.³¹ Postoperatively, the most common minor complications are swelling, ecchymoses, and operative-site pain. The time to full recovery for routine arthroscopy procedures is typically no longer than 5 weeks.^{32,33} Overall, the absolute risk of complications associated with knee arthroscopy remains low between 1 to 5%, with superficial infections and blood clots being the most common major complications.^{32–35} Table 1 lists a general uncomplicated postoperative course, as well as the

Table 1.	
Uncomplicated postoperative course*	
	Pain, swelling, drainage, and ecchymoses at the operative site and portals
	Based on anesthesia type, nausea, vomiting, or headache are possible
	Reduced weight bearing, may need crutches for ambulation for lower extremity surgeries or sling for upper extremity surgeries
Postoperative complications requiring further action	
	Skin or joint infections
	Deep vein thrombosis, thrombophlebitis
	Persistent or excessive swelling
	Hemarthrosis
	Pulmonary embolism
	Neurologic abnormalities (numbness, tingling, etc.)

*Postoperative courses will vary based on procedure and patient comorbidities. Patients should consult their orthopaedic surgeon for their expected postoperative course.

rare, yet sometimes life-threatening, complications that may occur.

While arthroscopy may be a diagnostic and treatment option for many pathologies, it is not recommended for all joint diseases. Arthroscopy performed in the operating room is not advised in patients who cannot tolerate anesthesia, those with extremely distorted anatomy, and in severely infected joints where the purulence or pathology extend beyond the joint space.³⁶⁻³⁸ Current guidelines also do not recommend arthroscopic surgery for the treatment of osteoarthritis. Numerous studies have shown that arthroscopy provides minimal differences in pain, joint function, and quality of life compared to nonoperative medical and exercise programs.^{33,39-41} The definitive surgical management for osteoarthritis is total joint replacement surgery.⁴¹

Therefore, it is important to understand the underlying disease pathology and limitations of arthroscopy is assessing surgical options. Past studies have shown that patients are generally over-optimistic about the effects of all surgical treatments.⁴²⁻⁴⁴ As such, physicians should discuss expected outcomes, risks, and benefits through a shared decision-making process, and patients should be properly educated on expected improvement in pain, function, and quality of life.

Needle Arthroscopy: A New Option for Joint Diagnostics

Currently, the most commonly used arthroscopes utilized in the orthopaedic operating room range from 3.0 to 5.0 mm in diameter.³ As technology has continued to improve, the size of the arthroscopes have grown smaller and smaller. Within the last few years, small-bore needle arthroscopy with scope diameters of a mere 1.0 to 2.0 mm have risen in popularity.^{45,46}

Needle arthroscopy is provided as an in-office procedure. In the case of a knee examination, three standard portal sites are identified: a medial infrapatellar, lateral infrapatellar, and superolateral region.³¹ After applying local anesthetic to the portal sites, the physician may insert the hand-held optical needle allowing access to the patient's joint. In contrast to fluid irrigation, there is no continuous irrigation through the joint.³³

Office-based needle arthroscopy provides healthcare providers with real-time visualization of patient anatomy and instant access to injury assessment. Studies have reported statistical equivalence in respect to sensitivity and specificity for arthroscopy in detecting joint pathology compared to MRI.⁴⁵⁻⁴⁸ For example, DeClouette et al.⁴⁸ found that in detecting certain pathologies, needle arthroscopy was found

to have sensitivities and specificities of 0.93 (0.81-1.00) and 1.00 (1.00-1.00) for rotator cuff tears, 1.00 (1.00-1.00) and 1.00 (1.00-1.00) labral tears, and 0.80 (0.45-1.00) and 1.00 (1.00-1.00) for meniscal tears, respectively. The study concluded that in-office needle arthroscopy is an accurate tool for diagnosing various shoulder and knee pathologies.⁴⁸ Another study found that needle arthroscopy is considered superior in diagnosis compared with MRI for meniscal tears, chondral defects, and other non-ligamentous pathology.⁴⁷

Needle arthroscopy also has its limitations. Fluid is not continuously irrigated through the joint, which may impact visualization in patients with significant hemarthrosis, sclerosis, or synovitis, possibly decreasing the diagnostic accuracy.^{46,47} By forgoing an MRI, evaluation of the subchondral bone is also not possible, which may have ramifications if a subchondral insufficiency fracture or avascular necrosis are suspected.^{45,46} Additionally, while anesthetic is used and it is not considered overly painful, some patients may not tolerate being awake for the procedure.⁴⁶ Overall, needle arthroscopy has been described as a cost-effective, alternative diagnostic tool that may either replace, augment, or enhance the diagnostic abilities of MRI and standard arthroscopes.³¹⁻³³ In the future, continued advances in technology and new innovations in this surgical space will allow for higher resolution images, improved access to joints, and even more minimally invasive approaches.

In Summary

Physicians and surgeons in practice today may not realize the relative short history of modern arthroscopy visualization and fluid management systems. Understanding the basic principles of fiber optic visualization, insufflation methods, fluid pump design and function, and other techniques related to the evolving field of arthroscopy will aid in the utilization of current practice and future developments in orthopaedic surgery. Knowledge of this system will also help in counseling patients, assisting referring physicians, and meeting expectations for various orthopaedic treatments.

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Please note: Due to limited space, we are unable to list all references. You may contact South Dakota Medicine at ereiss@sdsma.org for a complete listing.

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A Hope for Life

Casey Risinger, MD; Luke Merrill, MD; David Jensen, MD; and Susan M. Anderson, MD, FAAFP

The Frontier and Rural Medicine (FARM) program, an initiative at the University of South Dakota Sanford School of Medicine, presents a unique opportunity for medical students seeking to immerse themselves in the realm of full-spectrum rural medicine to do just that. This program invites medical students to apply during Pillar 1 (or their first year of medical school) to participate in their second year of medical school, extending into their third year. This 10-month program selects up to 13 students to participate at sites in Spearfish, Winner, Pierre, Mobridge, Parkston, Milbank, Chamberlain and Vermillion. While on rotation, students are exposed to the intricacies of rural healthcare, encompassing family medicine, internal medicine, pediatrics, OB/GYN, neurology, psychiatry, surgery, and many subspecialties. Throughout FARM, students can engage in their respective communities in various ways.

As part of the FARM program, students are asked to complete a community project with the goal of connecting with community members at their sites. Students plan and execute a project of their choosing and orally present their project via zoom to USD SSOM faculty, staff, and students at the end of Pillar 2. There is funding to support any expenses related to the community projects provided by the South Dakota Foundation for Medical Care. Our project, conducted in Milbank and Spearfish, focused on suicide awareness in middle and high-school-aged students. However, the students at the Spearfish FARM sites were unable to conduct the project within Spearfish due to another graduate school having established a suicidal awareness curriculum each year within the 6-12th grades in Spearfish. The students then reached out to nearby communities about their interest and completed the project at Lead-Deadwood High School.

Suicide is the second leading cause of death among individuals between the ages of 10 to 24.¹ More adolescent-aged individuals and young adults are lost to suicide annually than heart disease, cancer, infectious disease, and stroke combined.² In 2019, nearly 20% of youth admitted to seriously considering suicide within the past 12 months.³ Almost 10% admitted to attempting suicide.³

Hope for Life is a project that aims to spread awareness on

the topic of suicide tailored to middle and high-school-aged students. The goals of the program are to increase awareness of suicide in rural South Dakota adolescents and to help students recognize the signs of suicidality. The program features a comprehensive five-part lesson series that delves into suicide risk factors, identifying the signs and symptoms of depression, and techniques for aiding individuals in crisis. Notably, the course fosters active student engagement through meaningful conversations with peers in a safe environment for dialogue around the topic of suicide. Each part of the course is designed to be flexibly taught. The lessons can be prepared in five typical one-hour school periods or taught together in roughly five hours.

This curriculum was adapted from Jason Foundation, Inc (JFI), an educational organization dedicated to the awareness and prevention of youth suicide by Dr Filip Radev, USD SSOM CO22. JFI's lesson plans are used by South Dakota as yearly required teacher's Youth Suicide Awareness and Prevention Training. "A Hope for Life" is adapted from the JFI's "A Promise for Tomorrow" teacher curriculum setup up to be taught to pre-college youth.

At Milbank and Lead-Deadwood High Schools, one part of the course was taught weekly to a health science careers class consisting of six students in Milbank and 45 students in Lead-Deadwood, and each class period lasted one hour. The first part of the series focused on suicide facts and statistics. The lesson was formatted in a fun, stress-free multiple-choice test, quizzing the class as a whole on their knowledge of this topic. The second part of the series showed a 40-minute video of high school students going through their typical day. Students were asked to watch the skit and discuss what was shown. The third part was a presentation focused on identifying the signs and symptoms of depression, suicidal ideation, and active suicidality. During the fourth part, the students were asked to rewatch the video skit and re-identify signs of depression, risk factors, and suicidal ideation. Part five included a discussion on what to do if one is in a situation where someone may be actively suicidal. There was also time during this lesson to share student's own thoughts on the topic of suicide.

High school students in rural South Dakota had the opportunity to gain knowledge of suicide statistics and the ability to recognize when a peer may be a danger to themselves. Many students were also able to identify and list an adult they would be comfortable talking to if they were concerned about the safety of another student. Suicide is never easy or fun to talk about, but students were able to address and learn about this topic in a non-judgmental and interactive way with the goal of protecting their fellow classmates.

Medical students were able to engage with the local community, establishing relationships and trust with school faculty. Developing this foundation is crucial to opening the door for future opportunities for medical students to engage with South Dakota youth with the intention of informing

and educating them on public health issues specific to this population.

Acknowledgments: Filip Radev, M.D., Resident Physician, Psychiatry, Southern Illinois University School of Medicine; Milbank High School; Lead-Deadwood High School.

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2024 SDSMA Annual Leadership Conference

At the 2024 SDSMA Annual Leadership Conference on May 31 at the Holiday Inn Rapid City Downtown, attendees heard from experts on the topic of Native American healthcare. Highlights included:

- The American Medical Association (AMA) president, Bruce Scott, MD, opened the conference and provided information and insights about the federal and state legislative arenas and the value of physicians being advocates for their profession.
- Sarah Shewbrooks, MPH, from the Great Plains Tribal Leaders' Health Board, presented on the ways the organization is addressing syphilis with a multiagency response. The Syphilis Surge Response initiative was launched in February 2024 and includes teams from the Great Plains Tribal Epidemiology Center, the CDC, Oglala Sioux Tribe, Rosebud Sioux Tribe, and the Cheyenne River Sioux Tribe.
- Kristin Cina of the Walking Forward Program talked about what the program is doing to address cancer disparities among American Indians in western South Dakota. For example, American Indians have the highest lung cancer mortality rate in the U.S. The cancer disparity research program provides screening and health care access. Additionally, it holds community education, cancer screenings and clinical trials, smoking cessation programs and lung cancer screenings.
- South Dakota Secretary of Health Melissa Magstadt provided a department update including information on syphilis and measles in South Dakota.
- With the help of a grant from a health journalism organization, Bart Pfankuch of South Dakota News Watch is working to research inequities in care and to understand the outcomes endured by residents, particularly Native Americans, as they deal with the challenges of inadequate access to care. Pfankuch presented this research, through

which he aims to better inform the public and policymakers about the disproportionate number of cases of health concerns, mental health issues and substance use disorder in Native Americans, and potential ways to fix them.

- Tim Ridgway, MD, Dean, presented a USD SSOM update including curriculum, students, and its service and research initiatives.
- Shannon Emry, MD was the SDSMA PAC lunch speaker. She spoke about the organization she founded in Sioux Falls, Midwest Street Medicine. The program provides care for individuals experiencing homelessness in Sioux Falls, addressing people's medical, behavioral, addiction and social needs. The organization has had more than 1,000 interactions with people struggling with homelessness since the organization's founding in 2023.
- A panel discussion moderated by Jen Tinguely, MD, MPH, with panelists Dr. Emry, Bart Pfankuch, and Kristin Cina explored the topic of improving access to health care for South Dakota patients.
- Board of Directors elections – Board members for the 2024-25 year are: President – **Jennifer J. Tinguely, MD, MPH**; President-Elect – **Keith A. Hansen, MD**; Vice President – **Benjamin D. Meyerink, MD**; Secretary-Treasurer – **Lisa B. Brown, MD**; At-large Director – **Deepak M. Goyal, MD, MBA**; At-large Director – **Laura J. Hoefert, MD**; At-large Director – **Megan M. Smith, MD**; Policy Council Chair – **Mandi Greenway Bietz, MD**; Immediate Past President – **Denise S. Hanisch, MD**; AMA Delegate – **Mary S. Carpenter, MD**; AMA Alternate Delegate – **Robert L. Allison, MD**; and AMA Alternate Delegate (presidential appointment) – **Robert J. Summerer, DO**. Dr. Tinguely became the organization's 143rd president during an inauguration ceremony at the annual banquet. Outgoing president Dr. Hanisch presented the presidential medallion to Dr. Tinguely during the swearing-in ceremony.



Congratulations to the 2024 SDSMA Award Recipients!

The South Dakota State Medical Association presented its 2024 awards at the annual banquet held in conjunction with the 2024 Annual Leadership Conference. Congratulations to the following recipients:

The SDSMA's Distinguished Service Award recognizes a physician or lay person who has been of outstanding service to the medical profession in South Dakota. This year the Distinguished Service Award recipient is **Dean Krogman**, the SDSMA's chief lobbyist. 2024 was Dean's 40th legislative session in Pierre.



past president of the SDSMA in recognition of their many years of work and dedication to the SDSMA.

Susan M. Anderson, MD, is the recipient of the Special Presidential Award. This award is chosen by the SDSMA president to recognize the recipient's contributions to the medical profession. The award was given posthumously and was accepted by Matt Anderson.

The Outstanding Young Physician Award was presented to **Ashlea Semmens, MD** of Rapid City. This award is given to a young physician under 40 or within the first eight years of professional practice after residency and fellowship training. This physician is recognized for outstanding achievements, dedication and service to the community and the SDSMA at the local, state, or national levels.



The Friend of Medicine Award recipient is **Sen. Tim Reed** of Brookings, who represents District 7 in the South Dakota Senate. This award is given in recognition of contributions serving as an effective advocate for health care and the medical profession.

The SDSMA's Community Service Award is presented each year to a physician who separates himself or herself through outstanding work in the area of community affairs. This year the award was given to the **Prairie Docs** – Brookings physicians **Andrew Ellsworth, MD; Kelly Evans-Hullinger, MD; Debra Johnston, MD; and Jill Kruse, DO**. **Joanie Holm, RN** accepted the award on the Prairie Docs' behalf.



The COPIC Humanitarian Award honors a physician for volunteer medical services and contributions to their community. **Shannon Emry, MD** of Sioux Falls, founder of Midwest Street Medicine, is the recipient of this year's award. The award recognizes individuals who unassumingly volunteer outside the spectrum of their day-to-day lives. The recipient of the award designates a \$10,000 donation from COPIC to be provided to a health care-related 501(c)(3) organization in South Dakota. Midwest Street Medicine is the donation recipient.

Bart Pfankuch, content director of South Dakota News Watch, is the recipient of the SDSMA's Richard P. Holm, MD Media Award. The Media Award recognizes those who have helped promote the medical field and medical issues in the media.



The Young at Heart Award is presented to a physician who has inspired young physicians as a mentor, role model and leader. This year's recipient is **Dan Heinemann, MD** of Sioux Falls.



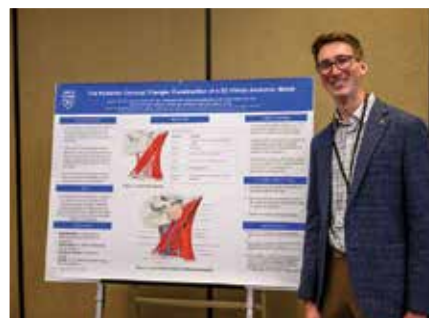
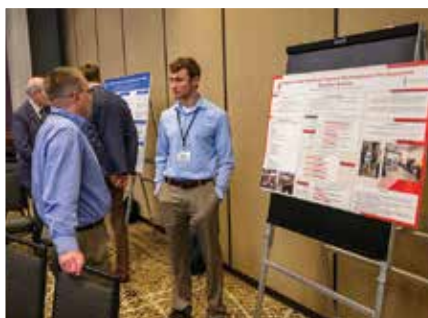
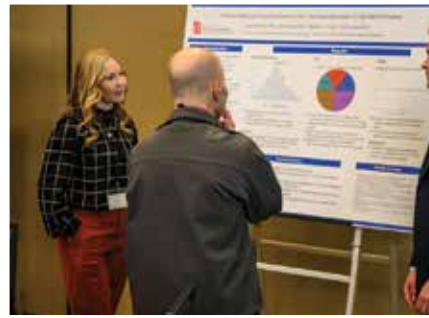
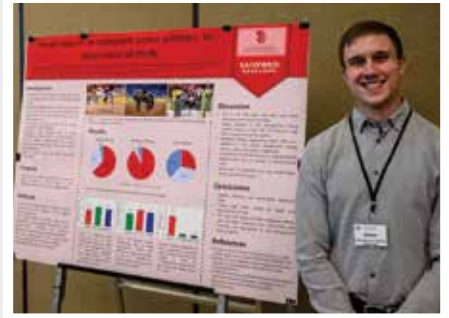
50-Year Awards

Eleven physicians were recognized with the SDSMA's 50-Year Award for medical practice in South Dakota. Physicians who received this award were: **Kenneth P. Aspaas, MD; Gail M. Benson, MD; Alfred E. Hartmann, MD; Robert C. Hohm, MD; Thomas C. Johnson, MD; Si Gaph Lee, MD; Patrick M. McGuigan, MD; Peter K. Rodman, MD;**

Gonzalo M. Sanchez, MD; Ronold R. Tesch, MD; and Daryl R. Wierda, MD. These physicians have been practicing medicine for a half-century and have contributed greatly to the medical profession.

USD SSOM Poster Session

During the Annual Leadership Conference, USD SSOM students participated in a poster session highlighting their work. The SDSMA began the poster session three years ago with an aim to help students and recent graduates improve their CVs and applications for residency programs, an increasingly competitive process. Sydney Payne, MS IV, presented her winning project, "AMA and SDSMA Membership After Graduation," to the SDSMA Policy Council.



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Board News is a monthly feature sponsored by the South Dakota Board of Medical and Osteopathic Examiners. For more information, contact the Board at SDBMOE@state.sd.us or write to SDBMOE, 101 N. Main Avenue, Suite 301, Sioux Falls, SD 57104.

Help Shape the Future of Medicine in South Dakota

The South Dakota State Medical Association Foundation, the philanthropic arm of the South Dakota State Medical Association, is a tax-exempt 501(C)(3) non-profit corporation, was established to assist and support medical research, medical teaching and medical education at the Sanford School of Medicine.

On average, medical students graduate with \$130,000 in

debt. Contributions to the South Dakota State Medical Association Foundation provide financial assistance to students at the Sanford School of Medicine and are all designated for scholarships, grants and low-interest loans for students.

Any amount can be donated at any time throughout the year. If you have questions or want more information, please call 605.336.1965.

Send Your Contributions Today To:

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COPIC is proud to be the endorsed carrier of the South Dakota State Medical Association. SDSMA members may be eligible for a 10% premium discount.

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