

December 2024

Volume 77

Number 12



South Dakota
medicine

THE JOURNAL OF THE SOUTH DAKOTA STATE MEDICAL ASSOCIATION

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South Dakota Medicine

(ISSN 0038-3317)

Published 12 times per year with one special issue by the South Dakota State Medical Association.

The SDSMA thanks the University of South Dakota Sanford School of Medicine for its financial contributions toward the production of South Dakota Medicine.

Subscription price: \$50 per year domestic
\$65 per year foreign, \$8.95 for single copy

Periodicals postage paid at Sioux Falls, South Dakota and additional mailing offices.

Postmaster: Send address changes to South Dakota Medicine
2600 W. 49th Street, Suite 100
Sioux Falls, SD 57105

SDSMA Home Page: www.sdsma.org

AMA Home Page: www.ama-assn.org

Printer:
Walsworth
P.O. Box 370
Fulton, Missouri 65251-0370



LIVING WELL AND FULLY LIVING

CALEB BROWN, CFP®, Lead Advisor



This article is for those who are retired or are thinking about retirement. My hope is for you to make the most out of it. You will have more unstructured time on your hands than you did when you were making a career and/or building a family. For some people, that is going to sound like freedom and for others, it might sound like boredom. Regardless of your feelings about that free time, I'll share with you the essential do's and don'ts that could help you enjoy your retirement life to the fullest.

Let's start with the "don'ts". I have only two that I want to focus on. The first should be no surprise: I recommend that you limit your news intake. I can't back this one up with proof, but I'd be willing to bet that the most fearful clients we work with are those who watch too much Fox News, CNN, or "pick your media poison". I understand that we need to be informed, but all the big news will eventually reach you. I promise.

The second "don't" is don't believe that what other people are doing with their finances is what you should be doing with yours. Every person has a different temperament and personality, a different set of unique goals, ambitions, preferences, values, responsibilities, duties, obligations, opportunities, limitations, and financial situations. That is a lot of variables. At Foster Group, we know those factors, and we understand our clients so well that we can give the optimal personal advice for them.

The clients that seem to be enjoying their retirement the most tend to spend their time intentionally. Here are some very practical "do's" for spending your retirement leisure time:

Read: Many of the clients we work with read regularly. This could be reading for pleasure, reading to grow in a subject, or reading to learn something completely new. Reading strengthens your brain, builds vocabulary, and is a healthy alternative to stay informed. If you're not a reader, another option is to listen to thoughtful podcasts.

Exercise: There are many possibilities here, but a common theme is regular exercise. For some, this is biking, running, hiking, strength training, etc.. For others, it's classes or group-based

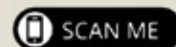
workouts, like Pilates, CrossFit, or Yoga. This helps combat health conditions that creep up as you age, controls your weight, improves mood, boosts energy, and promotes better sleep.

Adventure: I used to call this "experiences", but I once had a client tell me how they always called their getaways "adventures". That just resonated with me. Adventure doesn't have to be travel to Europe. It could be adventuring to your local trail, pub, or theater. It's the idea of getting out of the house and exploring what this wonderful world has to offer.

Hobby involving skill: This is the perfect time to take up a hobby that involves learning a new skill or improving upon a skill you already possess. I've had clients work on home projects, learn guitar, play piano, learn a foreign language, teach, take up quilting, gardening, etc. Is there anything you've wanted to learn how to do but have never had the time to do? Write those down and start to consider what it would take to be relatively good at that skill. You get bonus points if you use that skill to help others by volunteering and giving it away for free.

Consistent Connection: Regularly gathering with people in your community is one of the most essential aspects of a quality retirement. This can be your friends, family, a book club, your place of worship, a gym membership, spending time with vacation buddies, and even having a few meetings each year with your friendly financial advisor. The idea is to have a regular social outlet to look forward to. We have heard repeatedly about the link between a strong social life, a lower risk of depression, and a longer life span.

There are many other activities that might fit into some of those five broad categories, but this should give you a good place to start thinking and planning how to live the one retirement life you get. Do you have questions about optimizing your financial plan for a fulfilling retirement? Reach out today!



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Dr. TikTok: The Viral Social Media App Acting as the Newest Self-Diagnosis Platform

Cole D. Tessendorf, MS IV

“Don’t confuse your Google search with my medical degree” is a phrase that I have seen in several of my attending physicians’ offices and even on one of their favorite mugs. The term “Dr. Google” is used to describe the phenomenon of people seeking medical information and self-diagnosis through online communities rather than consulting a healthcare professional. While older individuals may be the first group to consult Dr. Google, there may be a new web-based “medical professional” for teenagers and young adults.

The social media platform TikTok is an app that allows users to easily create, share, and watch short videos, and it has grown to become an integral part of life for many Americans. As of August 2024, the wildly popular app had over 1.5 billion users worldwide with 41% of the users between ages 16 and 24.¹ While the app was initially popularized for its variety of entertainment videos ranging from dance routines to funny cats, it has now evolved to include videos about home improvement, politics, domestic and global news, and even medical information. Recent studies have shown that young people now even prefer to use social media, particularly TikTok, instead of traditional search engines like Google when looking for answers.²

The COVID-19 pandemic can largely be accredited for the growth of TikTok. With the pandemic forcing both children and adults to be isolated within their homes, many found communities within the app despite being physically apart. People started creating videos that transported others into their daily lives. They shared workout routines and home DIY projects, but also videos about nutrition, vaccines, mental health struggles, and many other health-related topics. Public health organizations took advantage of its surge in popularity toward health topics, and many were successful at integrating topics such as handwashing, masking, and social distancing into eye-catching videos on TikTok.²

While TikTok has been used to enhance medical education, it also can serve as a petri dish for misinformation. While some misinformed TikTok trends are relatively harmless, like when people were putting potatoes in their socks overnight

to “draw out toxins,” others can be dangerous, such as videos that encouraged people to drink borax with their morning coffee to “clean out their bowels.”

I spoke to one of my third-year rotation attendings about “Dr. TikTok”, and she said patients come in almost daily asking questions about symptoms and diagnoses they saw on TikTok or online.

“I find that those social media videos often steer patients in the wrong direction,” the primary care physician said. “At least daily I will have someone who comes to me and says ‘I saw on TikTok that these symptoms might mean I have ADHD or autism or POTS,’ it goes on. One time I even had a patient thoroughly convinced from just one TikTok video that she had Waldenstrom’s macroglobulinemia. I don’t understand it, but I’m glad I can at least provide some answers to them.”

My attending physician is right. On one hand, I am very thankful that many patients continue to bring their worries to a medical professional. While some concerns do have merit, a vast majority can be dispelled after a conversation with the physician. On the other hand, many others may regard these videos as true—which is a scary thought. It might just lead to someone harmlessly putting potatoes in their socks, but could also lead to a parent finding their teenager dead from a borax overdose in their morning coffee.

TikTok uses an algorithm to determine what videos and topics show up in a user’s feed. Interacting with a video by clicking “like,” sending the video to a friend, or following the video creator will ultimately lead to that person seeing more videos on similar topics.³ For example, if I happen to like one funny dog video, I will be seeing dog videos non-stop for the next several days. This individualized algorithm results in dramatically different TikTok video experiences among users. Currently, my dad’s TikTok feed is mostly politics and house DIY tricks while my mom’s is puppies and the newest Taylor Swift and Travis Kelce updates. If teenagers and young adults are truly using TikTok as their main news outlet and source of information, it is concerning that a few “likes” here and there could lead someone down a very concerning or

misinformed path.

A recent study aimed to assess how factual TikTok videos are. After searching “sinusitis” on TikTok with a few keywords, over 221 videos were found that garnered over 300 million views and 1 million shares. However, nearly half of the videos contained non-factual information. And of those inaccurate videos, most were posted by nonmedical influencers despite their portrayal as “educational medical advice.”⁴ For example, there was a trend of people shoving whole cloves of garlic up their noses to relieve congestion. It may not have been coming from a bad place, but shoving garlic cloves up one’s nostrils is most certainly not coming from any medical professional.

The number of people that use “Dr. TikTok” as their primary physician is certainly on the rise. Of the many accounts I follow, a few are run by physicians. Two of my favorites are neurosurgeon Dr. Betsy Grunch, better known as “Lady Spine Doc,” and ophthalmologist Dr. William Flanary, better known as “Dr. Glaucomflecken.” Their videos include a blend of educational content and hilarious skits. On many occasions though, both physicians have used their platforms to address medical misinformation that they have encountered on the app. As medical professionals, we can more easily deduce medical facts from fiction. However, the same cannot be said about my 17-year-old sister or my 80-year-old grandmother. So while I applaud Dr. Grunch and

Dr. Flanary for their efforts in steering the information towards the truth, their responses cannot stop millions of viewers from watching the original misguided videos.

With TikTok evolving from an entertainment platform into a broader hub for politics, news, and healthcare information, the number of people consulting “Dr. TikTok” will undoubtedly continue to impact physicians more and more. As an avid user myself, I do not advocate that every physician should download TikTok and become a viral sensation. I do propose, however, that physicians embrace and learn about this important social media platform. The undeniable influence of the viral app should encourage medical professionals to come prepared for the inevitable referrals from Dr. TikTok and the misinformation that may accompany it.

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SDSMA's Quick Action Brings Important to Fixes to Medical Board Legislation

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

Ask yourself the following question – if your license was ever to come under question, who would you want making that most serious of a decision? It's a decision that could change the course of your career and life. Would you want a dietician to make that decision? How about an emergency medical technician? Obviously, no physician would ever want to be in a position that could result in losing our license, but I assume every one of us would want physicians around that table when the decision is being made. We would want professionals who fully understand the complexities of patient care, for example, in cases involving intricate surgical procedures or the prescribing of medications for patients with multiple co-morbidities. This was nearly lost during the last state legislative session when the South Dakota Department of Health proposed significant changes to the structure of the South Dakota Board of Medical and Osteopathic Examiners (SDBMOE).

Many different professions are regulated by the SDBMOE – these include physicians, physician assistants, occupational therapists, respiratory therapists, athletic trainers, genetic counselors, licensed nutritionists/dietitians, and all emergency medical services which includes emergency medical responders, emergency medical technicians and ambulance drivers. Until this year, the SDBMOE was made up of nine members. Seven of those members were physicians and two were lay persons. This meant that any decision being made about a physician's license was being made by physicians.

The proposal that came out of the Health Department earlier this year significantly increased the size of the SDBMOE and proposed to eliminate physicians from having the majority position on the board. Under the new board structure as initially drafted, members would include representatives from all the different professions – one physician assistant, one emergency medical services personnel, one respiratory care practitioner, one nutritionist or dietician, one athletic trainer, one occupational therapist or occupational therapist assistant, one genetic counselor, and one member of the public. Physicians would have comprised eight of the board's 16 members.

The SDSMA was notified of this restructuring proposal late

in the process, and found out that every other profession licensed by the SDBMOE had been given the opportunity to provide feedback – every profession except physicians. This was met with immediate concern and dismay by the SDSMA Board of Directors and a letter was drafted to Governor Noem and the Health Department immediately to let them know of our deep concern with the proposed changes.

The proposal went forth regardless, and a bill was introduced in a legislative committee. The bill passed out of committee and went to the Senate floor where the SDSMA was able to add an amendment that added one more physician to the SDBMOE, putting the total number of physicians at nine instead of eight. This now means that physicians maintain the majority representation on the board. Also, and perhaps even more important, is the fact that the legislation was further amended to ensure that physician licensure matters are handled exclusively by the physician board members and lay representative – all other members of the board are excused for this part of the meeting.

All South Dakota physicians can be confident that any evaluation of their license will be undertaken by physicians who fully grasp the challenges of medical practice, rather than individuals from other healthcare fields who do not have a full understanding of the complexities of being a physician. This is not to diminish the value of other healthcare professions, but rather to acknowledge the specialized knowledge and experience required to evaluate a physician's work.

The SDBMOE's first meeting under this new structure occurred in September. The SDSMA will be monitoring the effectiveness and responsiveness of the new structure of the board.

This situation highlights the outstanding staff in the SDSMA office who keep their ears to the ground even when the Legislature is not in session. It also highlights the Board of Directors' ability to influence legislation and the importance of building and maintaining relationships with legislators. As we begin another legislative session, please know that your Board of Directors is ready to assert our influence quickly if need be. Thank you for being a member of the SDSMA – we couldn't do what we do without your help!

A Survey of Employed Orthopedic Surgeons Ability to Estimate Operating Room Device Costs

Michaela Derby, MS IV; Edward Floyd, MD; David Sturdevant, MS; Hunter O'Connor, MD; and Nathan Skelley, MD

Abstract

Background: Orthopaedic devices represent a large amount of the overall cost incurred in the operating room. It is unknown if employed sports medicine surgeons are aware of the true prices of these devices. The purpose of this study was to assess sports medicine orthopaedic surgeons' knowledge of implant and device costs, as well of commonly used items in their operating rooms.

Methods: REDCap surveys were distributed to 18 orthopaedic surgeons who perform arthroscopic and sports medicine procedures. All surgeons are employed at a healthcare system spanning four different states. Surgeons estimated the cost of 26 items used in the operating room. A surgeon reported cost within 10% of the actual price was established as having awareness of that item's cost.

Results and conclusions: Response rate was 89% (16/18). Twenty-five percent ($n = 4$) of surgeons were within 10% of the actual cost of only one item (Swivelock 4.75mm). Forty-three percent ($n = 7$) were within 20% of the actual cost of one item (Achilles Allograft). Those who perceived they had the poorest insight into device costs were found to have the greatest difference between estimated and actual cost. Surgeons in our study were not aware of the cost of commonly used items and implants in the operating room. Surgeons with greater insight into this topic can contribute toward a more value-based delivery of care. These findings support engaging employed physicians with initiatives to increase their awareness of the actual cost of the care they deliver, benefiting the whole healthcare system.

Introduction

Over \$199 billion was spent on medical devices in the U.S. in 2019.¹ Orthopaedic devices warrant independent consideration as significant expenditures occur in orthopaedic procedures compared to other specialties.¹ Orthopaedic implants represent 43-50% of total procedural costs for most procedures.² Therefore, relative pricing among implant choices may have a significant impact on the profitability of specific procedures. Similarly, reimbursement rates have also decreased in recent years adding to additional financial challenges for health care systems.

The sub-specialty area of sports medicine is especially susceptible to pricing concerns given many of the procedures are elective and the procedures involve a diverse range of medical devices. Inflation-adjusted Medicare reimbursement rates have dropped to a 20-year low for sports medicine procedures according to a recent report from Pollock et al.³ They found a 23% decrease in compensation for hip-related procedures, a 38% decrease for foot and ankle-related

procedures, and a 31% decrease for knee-related procedures.³

The concept of value-based care is growing in importance throughout the field of orthopaedic sports medicine care.⁴ Driven by legislation over the past 20 years and initiatives from the Centers for Medicare and Medicaid Services (CMS), patient reported outcomes, longitudinal care costs, and incentivization of bundled models of payments have shifted the landscape away from the previous era where more surgeries equaled more revenue.⁵ Similarly, in this same timeframe, a major shift has occurred from independent and private practice models to more orthopaedic surgeons joining employed positions at large health care systems. In this new landscape, there is a critical role for the employed surgeon in improving hospital revenues by mitigation of costs.⁶

While the prices for similarly purposed implants vary significantly between vendors,^{7,8,9,10} physician awareness of these different price points often becomes lost as the increasing drive toward consolidation places many practicing surgeons in healthcare networks where they are separated

from these cost concerns.¹¹ In these settings, isolation of clinical practice from billing and coding increasingly removes the surgeon from knowledge of actual case-by-case expenditures.¹² Additionally, negotiated contracts may change annually at individual sites within networks and confidentiality clauses prevent cost information sharing. An accurate understanding of implant price, along with billable and stocked-item cost on the part of orthopaedic surgeons is important to maximize value in OR material purchases and procedures.

Current literature on physician understanding of overall surgical and implant costs is limited, and primarily subspecialty-focused.^{13,14} To have a salutary effect on reining in increasing healthcare costs with diminishing reimbursement, surgeons must have the ability to choose devices with a working knowledge of their cost relative to comparable alternatives. The purpose of this study was to assess employed sports medicine orthopaedic surgeons' knowledge of implants and device costs, of commonly used items in their operating rooms, at a large health care system in the U.S. We included data from across our healthcare system which spans four states and includes data from both rural community-based hospitals and two major trauma centers.

Methods

This study received approval from the governing system Institutional Review Board. Over a three-week period, REDCap surveys (Research Electronic Data Capture) were distributed to eighteen orthopaedic surgeons who regularly perform arthroscopic procedures.¹⁵ Surveys were distributed to surgeons in the four market regions of a community-based health system, including four sites across three U.S. states. Surgeons who voluntarily completed the survey were asked to identify the cost of twenty-six items on an inventory list, comprising both disposable and implantable items (Table 1). Costs were defined as item cost to the health system, defined as the actual cost paid by the hospital and/or ambulatory surgery center (ASC) for each item; examples are demonstrated in Figure 1A (arthroscopy floor mat), Figure 1B (arthroscopic shaver blade) and Figure 2 (Figure 2A: ACL Tightrope; Figure 2B: cortical suspensory fixation button). A surgeon-reported cost within 10% of the actual price was considered as having awareness of that item's true costs. We arbitrarily chose 10% to be a close enough estimate and 20% to be a moderately close estimate to the actual cost. A linear regression was performed to assess the surgeon's ability to estimate the cost of surgical devices while controlling for years of residency, fellowship training, and their primary health campus. Responses were collected and stored using

Table 1. Items surveyed for surgeon cost awareness.

Disposable items	Implantable items
MACI biopsy kit	GraftLink FGL
Curved shaver blade	Arthrex Speedbridge
Suction floor mat	Semi-T allograft
Curved radiofrequency ablation probe	Achilles allograft
Straight shaver blade	ACL tightrope with cortical suspensory fixation button
Tourniquet - 34 inch	PushLock - 2.9 mm
Straight radiofrequency ablation probe	SwiveLock - 4.75 mm
Disposable Trimano	FiberTak - 1.8 mm
Lateral decubitus arm positioner	FiberTape
Small Ioban	Bio-composite interference screw
Flexible cannula	SutureTape - 1.7 mm
Rigid cannula - 7 mm	FiberWire - #2
Clear Incise Drape	FiberLink suture

Figure 1. Examples of non-implantable items surveyed: Surveys were distributed to sports medicine surgeons at our institution to ascertain their knowledge of the cost of both implantable and other medical device costs. (A) Arthroscopy floor mat; (B) arthroscopic shaver blade used for survey cost estimation.

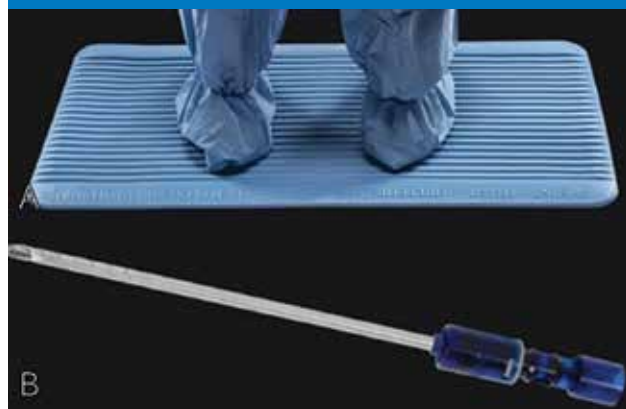
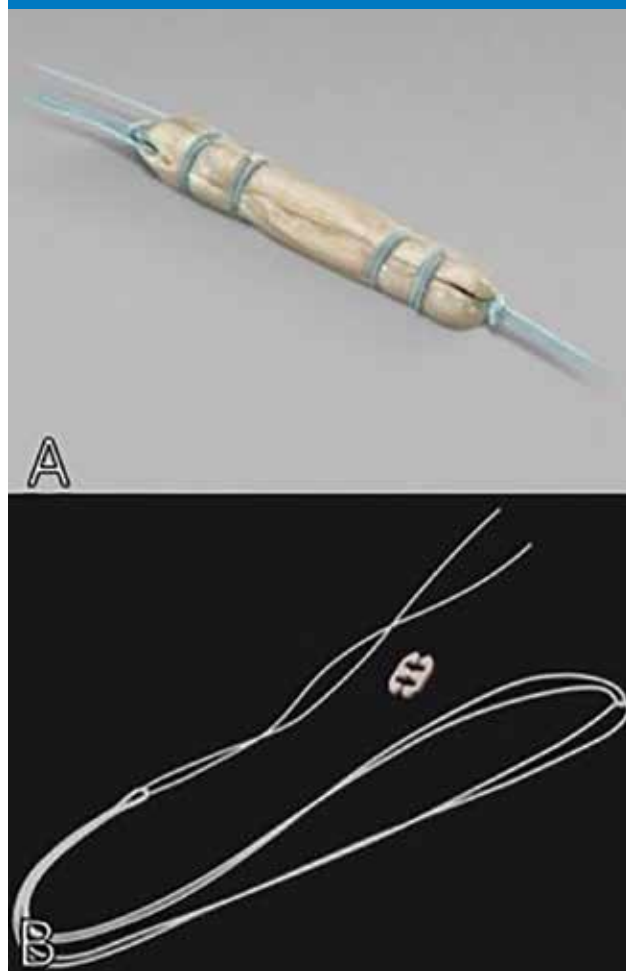


Figure 2. Examples of implantable items surveyed. Surveys were distributed to sports medicine surgeons at our institution to ascertain their knowledge of the cost of both implantable and other medical device costs. These are representations of an ACL Tightrope (A) cortical suspensory fixation button (Arthrex) (B) used for survey cost estimation. Both devices from Arthrex (Naples, FL).



the REDCap platform.

Results

Demographics

The overall survey response rate was 89%. Of the 18 sports medicine surgeons surveyed, 16 responded. Ten of the 16 respondents were fellowship trained.

Accuracy of Device Estimates

For all items on the questionnaire, no surgeon was able to record an estimate within 20% of the actual price of each item for more than three items. Twenty-five percent ($n = 4$) of surgeons did estimate within 10% of the actual cost of one item (SwiveLock 4.75 mm, Arthrex, Naples, FL) (Table 2). Forty-three percent ($n = 7$) were within 20% of the actual cost of one item (Achilles allograft). (Table 2) Items whose prices were most underestimated by surgeons (between \$6,000 and \$14,000 USD) included allograft options (Achilles Allograft, Semitendinosis), suspensory fixation buttons, Arthrex Speedbridge, and the MACI biopsy kit (Vericel, Cambridge, MA).

The largest average percent differences between estimated and actual cost of devices included disposable devices; surgeons underestimated the prices of six pieces of equipment on our questionnaire by more than 100% of the item value. These were mostly disposable items, consisting of “Clear Incise Drape,” “Small Ioban,” (Ioban, 3M, Minneapolis, MN) “Suction Floor Mat,” “Curved shaver blade,” “Tourniquet – 34 inch,” and “Straight shaver blade” (Table 2).

Respondents provided the closest estimates to implantable devices relative to disposable items or instruments (Table 2). When evaluating the total difference in estimated cost compared to the actual cost of the device, the more expensive the item, the higher percent difference between surgeon estimate and the actual price (Table 2). There was no statistical difference between the four main geographic regions surveyed. Fellowship training and years in practice did not significantly affect the accuracy of surgeon estimates.

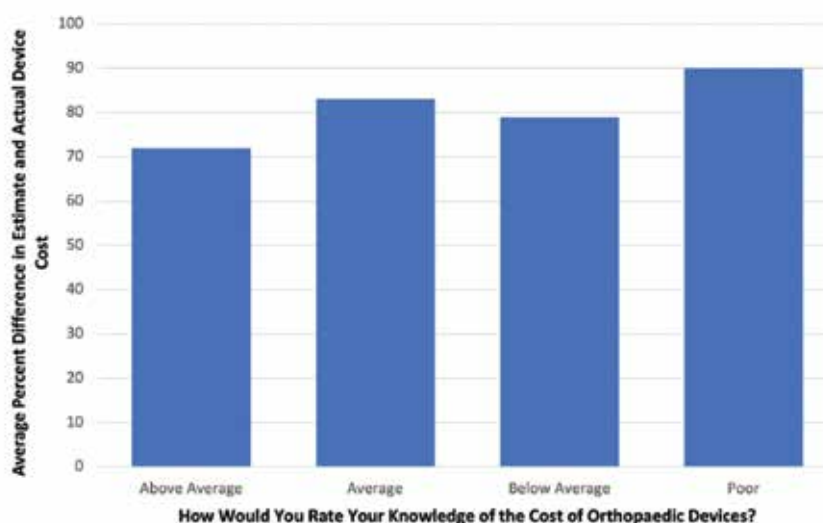
Self-Rated Cost-Awareness

Surgeons were asked to rate their knowledge of the cost of orthopaedic devices. The questionnaire included a self-reported ranking of the individual’s own cost-awareness (Figure 3). Those who perceived they had the poorest insight into device costs were found to have the greatest difference between estimated and actual device cost.

Table 2. Comparison of device actual cost to the surgeons' mean ($\pm$ SD) estimated cost from 16 surgeons, including the mean ($\pm$ SD) percent difference and number of surgeons within 10% and 20% of the actual cost.

Device	Actual cost	Estimated cost	Percent difference	Number within 10%	Number within 20%
Achilles allograft	\$1,688.00	\$1,843.75 (\$943.02)	40.28 (29.52)	1	7
ACL tightrope with cortical suspensory fixation button	\$368.50	\$656.25 (\$552.53)	47.35 (42.06)	2	3
Arthrex Speedbridge	\$1,914.00	\$1,211.88 (\$735.97)	64.72 (52.92)	3	4
Bio-composite interference screw	\$235.00	\$254.69 (\$163.09)	57.04 (36.91)	1	3
Clear Incise Drape	\$2.00	\$54.38 (\$40.33)	174.35 (26.15)	0	0
Curved radiofrequency ablation probe	\$199.00	\$370.94 (\$242.09)	61.87 (39.52)	1	2
Curved shaver blade	\$42.00	\$293.44 (\$200.92)	126.94 (49.33)	0	1
Disposable Trimano	\$104.39	\$243.13 (\$195.57)	76.55 (45.88)	2	3
FiberLink suture	\$85.00	\$141.56 (\$208.79)	62.32 (41.99)	0	4
FiberTak - 1.8 mm	\$484.00	\$419.38 (\$329.05)	51.65 (42)	3	6
FiberTape	\$65.00	\$187.19 (\$235.01)	81.51 (41.7)	0	1
FiberWire - #2	\$22.00	\$127.81 (\$186.68)	92.27 (54.76)	1	2
Flexible cannula	\$32.00	\$106.56 (\$54.55)	93.69 (39.42)	0	0
GraftLink FGL	\$2,295.20	\$1,978.13 (\$1,000.83)	44.95 (39.86)	3	5
Lateral decubitus	\$176.00	\$237.81 (\$203.4)	58.35 (45.94)	0	4
MACI biopsy kit	\$568.00	\$881.25 (\$1207.32)	76.93 (59.12)	1	4
PushLock - 2.9 mm	\$440.00	\$304.38 (\$274.98)	70.77 (49.82)	2	3
Rigid cannula - 7 mm	\$35.20	\$106.88 (\$74.56)	80.9 (44.94)	0	2
Semi-T allograft	\$1,700.00	\$1,275 (\$704.04)	55.68 (34.79)	0	1
Small loban	\$4.37	\$86.56 (\$68.87)	163.03 (42.88)	0	1
Straight radiofrequency ablation probe	\$190.00	\$322.5 (\$191.43)	55.14 (33.73)	1	1
Straight shaver blade	\$42.00	\$242.5 (\$166.46)	115.28 (55.09)	1	2
Suction floor mat	\$31.68	\$257.81 (\$249.73)	127.68 (50.52)	1	1
SutureTape - 1.7 mm	\$50.00	\$146.88 (\$121.67)	73.73 (49.64)	2	3
SwiveLock - 4.75mm	\$440.00	\$390.31 (\$325.07)	58.66 (48.24)	4	4
Tourniquet - 34 inch	\$21.90	\$200.25 (\$238.47)	125.94 (52.09)	0	1

Figure 3. Self-reported knowledge of the cost of orthopaedic devices versus average percent difference in estimate and actual device cost. Respondents who believed they had the poorest insight into device costs were found to have the greatest difference between estimated and actual device cost.



Discussion

Employed sports medicine orthopaedic surgeons across a large health system in the U.S. demonstrated a lack of awareness of the price of commonly used surgical implants and devices utilized in their operating rooms. Our study reinforces the need to develop orthopaedic surgeons' awareness of the relative prices associated with common devices. Other studies have supported decreasing utilization and expenditure with greater physician engagement for cost-informed decision making.^{16,14} To our knowledge, this is the first study that has evaluated orthopaedic implant cost perspectives in a primarily rural healthcare system with employed sports medicine surgeons. This study suggests that there is an opportunity to educate surgeons in these practice settings on device costs.

One key finding of our study was that surgeons who self-reported they better understood pricing did perform better when estimating pricing on our device list. These findings support developing surgeons' knowledge of relative vendor pricing within their healthcare system. This may assist in avoiding unnecessary high-cost utilization decisions in the operating room. For example, a surgeon presented with choosing between multiple similar devices for a surgical application could choose a lower cost item without negatively impacting the quality of patient care they are delivering if they understand the device costs.

Albersheim et al. determined that there is opportunity for surgeons and administrators to become more aware and knowledgeable of surgical devices by investigating surgeons' insight on implant pricing across subspecialties at a single level I trauma hospital.¹⁶ Surgeons were asked to estimate the total cost of different implants on a 10-question survey. The surgeon cohort averaged an underestimation of \$608.06/case for their subspecialty cases and an underestimation of \$33,160.07/case for control cases. The authors concluded that surgeons had a poor ability to estimate trauma operating room and case-specific expenditures.¹⁶ Another report by Ayoub et al. reported on surgeon and resident estimation of the costs of 13 implants related to orthopedic trauma surgery; the authors found an overall average error of \$31,735 for attending physicians when estimating implant costs.¹³

Okike et al. described the "Red-Yellow-Green" implant selection tool to guide surgeons toward more cost-effective implants.¹⁴ The aim of the initiative was to assess the effect of the price-awareness tool on preferred implant usage rates, vendor attitudes toward pricing structure, and hospital implant expenditures. Devices were ranked on a "Red-Yellow-

Green" chart by cost level and classified as either "green" (preferred vendor), "Yellow" (midrange), or "red" (used for patient-specific requirements) based on costs, where "red" items were the most expensive. After the intervention, the authors found that use of "red" implants decreased by 21%, "yellow" decreased by 25%, and "green" increased by 56%. Following the intervention, the authors observed average implant price decreases ranging from 1.1% to 22.4% during subsequent vendor renegotiations. Average cost savings for the specified implants in this experiment was \$216,495 per year at the authors' hospital network. The authors concluded that implant selection tools can decrease hospital implant expenditures and competition among vendors, resulting in overall lower prices.¹⁴

One of the strengths of our study is the high response rate of surgeons from different regions in our healthcare network's footprint across four different U.S. states. Additionally, surgeons represented diverse career points relative to training and years in practice, encompassing a wide range of perspectives and fellowship training. These factors increased the external validity of our findings. Finally, device OR records were utilized to select survey items that the surgeons in our survey used regularly. In this manner, we ensured their familiarity with the selected devices and the applicability of the cost awareness analysis.

Our study also provided cost estimates for various surgical items orthopaedic surgeons use beyond just implantable surgical devices. One potential avenue for future investigation into cost-savings may be assessment of the efficacy of surgeon education programs on the total costs of procedures and operating room supply choices of disposable items. There are multiple areas of surgeon decision making in the operating room that add to procedural costs beyond implantable devices.

Limitations of our study include a small sample size and that all surgeons were associated with one healthcare system. In our group, 16 of 18 surgeons responded to the survey which may have affected the accuracy of total expenses in our dataset. Additionally, hospital negotiated prices vary by institution which also impacts the generalizability of our results.

Conclusions

Surgeons in our study group demonstrated a poor understanding of the cost of common sports medicine surgical implements in the OR. There was no difference by region, level of training, or years' experience. Those who felt

they had better knowledge of the prices did perform better on the survey. Surgeons were better at estimating the more expensive implantable items rather than disposable OR room equipment; however, all areas are opportunities for cost education and system improvement. Our findings support engaging employed orthopaedic sports medicine physicians in cost-saving programs and strategies to help improve health system costs.

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Conflict of Interest Disclosure

Nathan Skelley, MD is a consultant to CONMED Corporation on topics unrelated to the presented information in this manuscript.

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Expanding the Genetic Etiology of Multiple Morphological Abnormalities of the Sperm Flagella: A Case Report of Two Novel *DNAH1* Variants

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Abstract

Background: The following case report details the genetic evaluation and treatment of a 30-year-old male with a history of asthenoteratospermia and notable abnormalities of the sperm flagella.

Methods: Genetic evaluation was performed via a multi-gene panel of genes associated with primary ciliary dyskinesia and multiple morphological abnormalities of the sperm flagella (MMAF) prior to the couple's in vitro fertilization (IVF) cycle.

Results: The patient was found to have two novel variants in the *DNAH1* gene (c.6139-1G>A and c.11667_11668insC). The patient's partner screened negative for variants in this gene, lowering reproductive risk for future offspring. The couple underwent an autologous IVF cycle and the patient's sperm was used to successfully fertilize a number of oocytes, however there was poor blastocyst development following fertilization. Subsequently, the couple underwent a second IVF cycle using donor sperm.

Conclusions: The two novel *DNAH1* variants add to the growing body of evidence of the relationship between *DNAH1* and multiple morphological abnormalities of the sperm flagella. *DNAH1* variants and abnormal sperm morphology appear to negatively impact embryo development. Genetic counseling can aid in genetic testing and counseling related to male infertility.

Introduction

Approximately 50% of cases of infertility can be attributed to male factors, which can have a variety of underlying causes such as lifestyle, environmental, anatomical differences, infection, hormone imbalances, or genetic.^{1,3} In approximately 15% of cases of male infertility there is an identifiable genetic etiology.⁴

Semen analysis allows for identification of factors attributing to infertility, such as abnormal volume, low sperm count, abnormally shaped sperm, or low motility.^{1,5} Abnormal sperm motility, or asthenospermia, is diagnosed when less than 40% motility is reported in a semen sample.⁵ Complete asthenospermia, or 0% motility, is reported to be seen at a rate of 1 in 5,000 men and is often related to abnormal sperm morphology.^{4,6}

Abnormal morphology can be attributed to abnormal spermatogenesis. Certain morphological abnormalities such

as globozoospermia, multiple tail abnormalities, headless spermatozoa and fibrous sheath dysplasia can all be suggestive of an underlying genetic cause.¹ Semen analysis may reveal variable morphological abnormalities, or seemingly uniform anomalies which are more likely to result from a genetic cause.^{2,7}

Primary ciliary dyskinesia (PCD) is a well-established genetic condition associated with chronic respiratory tract infections, situs inversus, and male infertility due to asthenospermia.⁷⁻¹⁰ PCD is associated with variants in >40 genes; it is most commonly inherited in an autosomal recessive manner, however, other modes of inheritance, including X-linked and autosomal dominant, have been reported.^{2,10,11}

More recently, multiple morphological abnormalities of the sperm flagella (MMAF) was proposed as a distinct condition describing a sperm-specific phenotype of multiple morphological anomalies of the sperm flagellum, resulting



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in impaired sperm motility and male infertility.^{2,7,12} There is a degree of overlap in genes associated with both PCD and MMAF, including genes such as *CFAP43*, *CFAP44*, *CFAP69* and *DNAH1*. A currently emerging issue is determining whether MMAF is a phenotypic variation of PCD, or a distinct category of defects.^{7,12,13}

The following case study discusses two novel variants identified in *DNAH1* for one male patient known to have abnormal morphology and 0% motility, as well as discuss treatment plan and cycle outcomes. *DNAH1* (Dynein Axonemal Heavy Chain 1) is a gene that contributes to the development of structural components of sperm responsible for motility and is one of the first genes identified to be associated with MMAF.^{12, 13}

The case provides further insight into the overlap and distinction between MMAF and PCD phenotypes, as well as exploration of the outcomes between autologous and donor sperm in vitro fertilization (IVF) cycles.

Case Report

A healthy 30-year-old male and his 30-year-old nulliparous female partner presented for evaluation of primary infertility following initial abnormal semen analysis and unsuccessfully attempting conception for 12 months. Both individuals reported unremarkable personal and family histories. Notably, the male partner reported no history of recurrent sinus or respiratory infections, and no known history of situs abnormalities. The female partner's fertility evaluation was unremarkable.

Initial semen analysis revealed complete asthenospermia as well as oligospermia (Table 1). Repeat semen analysis demonstrated asthenospermia in the presence of borderline

low concentration. Normal sperm morphology was seen in <1% of the sample with several tailless heads and short tails present.

A third semen analysis included hypo-osmotic swelling (HOS) testing to determine sperm viability. A borderline low concentration was once again observed in the presence of 0% motility. HOS results are measured by the percentage of sperm that appear to swell appropriately, with a percentage above 58% being considered normal.³ The patient's result showed 86% appropriate swelling, and therefore the sperm was considered viable.

The couple underwent genetic counseling to review potential genetic etiologies for the observed semen analysis abnormalities. The patient reported an unremarkable personal and family history for hereditary causes of infertility including PCD. The patient underwent testing via a 46 gene Primary Ciliary Dyskinesia/Immotile Cilia Syndrome panel utilizing next generation sequencing and deletion/duplication analysis performed by PreventionGenetics.

Genetic testing identified two novel variants in *DNAH1* (c.6139-1G>A and c.11667_11668insC). The c.6139-1G>A variant affects the final G nucleotide of *DNAH1* intron 38, one of the consensus splice acceptor bases. It is predicted to abolish the canonical splice acceptor site at the junction of intron 38 and exon 39 and result in aberrant splicing. This variant has not been observed in the large population databases indicating this variant is rare.¹⁴ The c.11667_11668insC variant has an insertion of C nucleotide between nucleotides c.11667 and c.11668 and is predicted to result in a frameshift and premature protein termination. This variant is reported in 0.012% of alleles in individuals of African descent in gnomAD.¹⁴ Although neither variant

Table 1. Semen analysis results.

Parameter	Reference range/units	Jul-2020	Aug-2020	Nov-2020
Volume	≥2.0 mL	3.1	4.0	3.4
Concentration	≥20.0 million/mL	12.0 ↓	21.0	29.0
Motility	≥50%	0% ↓	0% ↓	0% ↓
Concentration of motile sperm	Million/mL	0.0	0.0	0.0
Total motile sperm	Million	0.0	0.0	0.0
Morphology	≥4%	N/A	<1% ↓	N/A
Notes		Many short tails and tail-less heads observed		
		HOS Results: 86% viable sperm; many tail-less heads observed		

Results from three semen analyses conducted between July and November 2020. Abnormal results are noted in red. Each analysis included testing for volume, concentration, motility, concentration of motile sperm, and total motile sperm. Morphology was assessed on the second analysis, and HOS testing performed in conjunction with the third semen analysis.

had been previously reported in the literature, other loss of function variants in *DNAH1* have been reported as causative for disease.¹⁵ Both variants are classified as likely pathogenic per ACMG/AMP guidelines.¹⁶ The patient was reportedly heterozygous for each variant and, given his clinical presentation, the variants were assumed to be in trans. However, parents were not available for parental testing to confirm phasing of these variants.

Given expected autosomal recessive inheritance, *DNAH1* gene sequencing and copy number variant analysis was ordered for the patient's partner. Her results were negative, greatly reducing the recurrence risk of symptoms in offspring.

Given the abnormal semen parameters and genetic testing results, the couple elected to proceed with IVF and intracytoplasmic sperm injection (ICSI). During this cycle, 18 oocytes were retrieved, 18 of which were mature (Figure 1). Thirteen oocytes successfully fertilized, 12 of which showed cleavage at Day 3. Ultimately, two embryos developed into blastocysts and were biopsied on Day 6 for elective preimplantation genetic testing for aneuploidy (PGT-A). PGT-A results classified both embryos as mosaic. Of the oocytes retrieved, 72% were successfully fertilized with 15% of embryos developing into blastocysts.

The couple elected for a second IVF cycle using donor sperm due to poor embryo development in the previous cycle. The treatment protocol during the IVF cycle using donor sperm was the same as during their previous cycle. During the second cycle, 17 oocytes were retrieved, 16 of which were mature (Figure 1). Twelve embryos fertilized, five

of which showed cleavage at Day 3. Five embryos developed into blastocysts and were biopsied on Days 5 (two embryos) and 6 (three embryos) for elective PGT-A. PGT-A results classified three embryos as euploid and two as aneuploid. In this cycle there was a similar fertilization rate (75%), but a higher percentage of embryos reached blastocyst stage (42%).

Following their IVF cycles, the couple proceeded with the transfer of a euploid embryo from the IVF cycle utilizing donor sperm which resulted in a singleton pregnancy and live birth.

Discussion

Approximately 7% of men experience infertility, with an estimated 15% of male infertility having an identifiable underlying genetic abnormality.^{4,17} Chromosomal abnormalities are well-established findings in cases of azoospermia and severe oligospermia, while single gene defects associated with male infertility outside of cystic fibrosis remain less defined.¹⁸

Ben Khelifa et al. first defined MMAF as a distinct phenotype in a report of 20 individuals with asthenoteratospermia.¹² MMAF is characterized by the presence of absent, short, bent, and coiled flagella without additional symptoms of PCD.¹² Subsequent case reports have further established the association of *DNAH1* and MMAF, as well as identified additional related genes, including *CFAP43*, *CFAP44*, and *CFAP69*.⁷ A recent review of five studies estimated that variants in *DNAH1* cause 24.6% of MMAF cases.⁷

The axoneme is a well conserved cytoskeletal structure shared

Figure 1. Comparison of IVF cycle outcomes. Summary of outcomes following oocyte aspiration through PGT-A results for autologous IVF cycle and donor sperm IVF cycle.

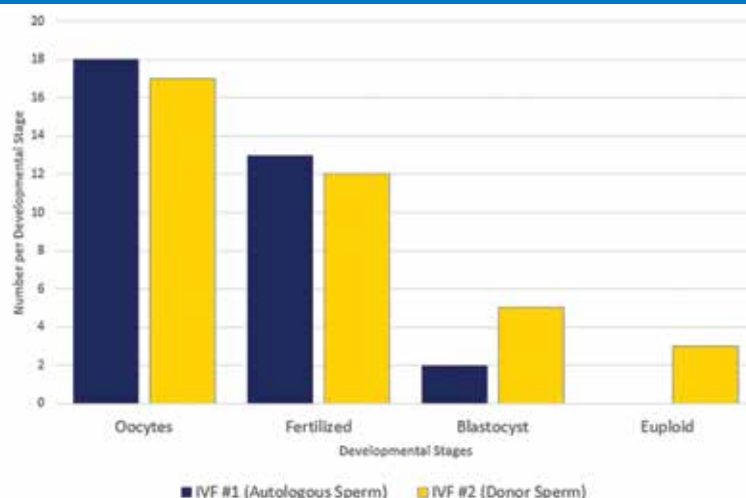
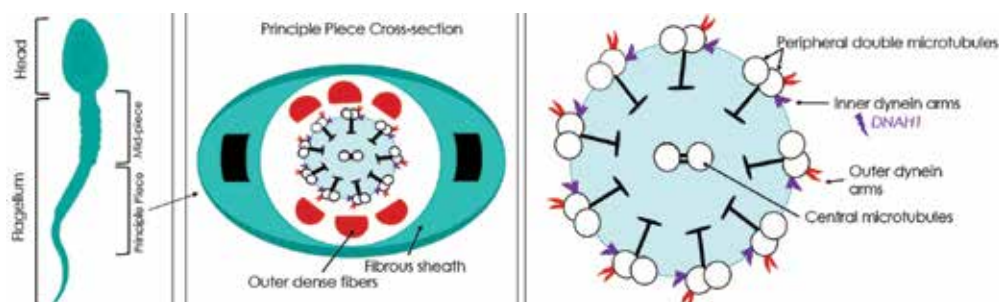


Figure 2. Expression of *DNAH1* in sperm structure. *DNAH1* is expressed in the inner dynein arms of the sperm flagella. Mutations in *DNAH1* lead to disorganization and disruption of flagellar structure. Previously observed anomalies have included absence of microtubules, absence of inner dynein arms, absence of radial spokes, and absence of the mitochondrial sheath.^{12,19,20}



between cilia and flagella.¹⁷ *DNAH1* is expressed in the inner dynein arm (IDA) of the sperm flagellum (Figure 2), which is responsible for propagating waves of the flagellum allowing motility of the sperm.¹⁹ Variants in *DNAH1* have been shown to lead to disorganization of the sperm flagellar structure including absence of microtubules, inner dynein arms, radial spokes, and the mitochondrial sheath.^{12,19,20} Previous studies have shown that although *DNAH1* is expressed in cilia throughout the body as well as sperm flagella, many individuals with *DNAH1* variants have isolated male infertility.^{12,17} This suggests that the expression of the gene may be more critical to flagellar than cilia function.¹²

Historically, treatment for MMAF would include IVF with ICSI. ICSI has been shown to aid in fertilization for patients with MMAF, although the degree of successful fertilization with the utilization of ICSI may still vary based on the particular flagellar defect observed.^{7,21,23} It has been suggested that MMAF may be associated with abnormal sperm-derived centrioles, which can impair embryonic development due to improper mitosis.^{21,22} This is a concern that may not be overcome with the use of ICSI and may benefit from additional studies to understand the underlying issue as well as to identify any possible treatment.

Future research is needed to explore the genetic etiology of MMAF for better recognition of affected patients. Whole-exome sequencing (WES) has been utilized in previous studies to identify potential MMAF causative genes and may be instrumental in further exploring the genetic basis of male infertility.²⁴ Continued efforts to identify and understand the impact of genetic variants associated with male infertility may lead to improved understanding and management. Genetic counselors can assist reproductive endocrinologists in identifying underlying genetic etiologies of male infertility and informing patients and practitioners about additional

health concerns and recurrence risk.³

This case reports two novel *DNAH1* variants reported in a male patient identified to have asthenoteratospermia. The outcomes of two IVF cycles utilizing the same treatment protocol, one with autologous sperm and one with donor sperm, were compared. The impact of *DNAH1* variants on the patient's phenotype as well as IVF cycle outcomes are considered in relation to previously reported literature. The reported case adds additional supporting evidence to previous literature that suggests a relationship between *DNAH1* and a sperm specific phenotype, such as described by MMAF, as well as a suggested correlation between abnormal sperm morphology and poor embryo development.^{2,12,21,22}

Two of the authors are employed by PreventionGenetics, part of Exact Sciences, the lab where the reported variants were identified.

An abstract of the manuscript was presented as an e-poster at the 2023 ASRM Scientific Congress & Expo in Anaheim, California.

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Improving Access to Palliative Care through Education and Training

Amanda Kay Sedlacek DO, MSA; Michelle Gierach, EdD, RN, CNE; Michele Snyders, MSW, CSW-PIP, APHSW-C; and Sarah Mollman, PhD, RN, CHPN, CNE

Abstract

The population is aging, especially in rural areas where people experience higher rates of mortality and chronic illness as well as greater distances to care, including specialty care. Since there is a lack of access to specialty palliative care, all clinicians must be trained to provide the fundamentals of palliative care to improve quality of life and limit suffering. Numerous options are available for clinicians to be trained in palliative care. A long-standing palliative care training option in South Dakota is the Interdisciplinary Palliative Care (IPC) Seminar which trains students from multiple disciplines in the foundation of palliative care. It has demonstrated significant student learning outcomes for 22 years. The IPC Seminar transitioned to virtual delivery in 2020 allowing additional students to participate across the state. It is currently hosted within the University of South Dakota Interprofessional Health Education Center which fostered additional disciplines to participate. As the need for palliative care grows in our state, so too, does the need for palliative care education whether it is acquired through national organizations or local education providers.

Improving Access to Palliative Care through Education and Training

The U.S. population is aging; however, the rural population is aging faster,¹ experiencing higher rates of death and chronic illness and greater distances to healthcare, especially specialty care.² This includes specialty palliative care services³ which is true in South Dakota where these specialty teams are only available in Rapid City, Spearfish, Sioux Falls, and Yankton.⁴ Therefore, it is imperative that all clinicians be trained in the fundamentals of palliative care, known as primary palliative care, which consists of symptom management and goals of care conversations.^{5,6} Providing palliative care locally improves quality of life and decreases suffering⁷ and is an essential component of care in the rural and frontier areas of South Dakota.

Two barriers to providing palliative care to rural patients and families include: 1) lack of trained palliative care providers and 2) inadequate palliative care training for clinicians.⁸ In South Dakota, there are only 36 healthcare professionals who are nationally certified hospice and palliative care: 10 advanced practice nurses, 23 registered nurses, 1 licensed nurse, and 2 social workers.⁹ There are 12 practicing hospice and palliative care board certified physicians.¹⁰ Access to palliative care can be improved not only by increasing the number of palliative care specialists, but also by “identifying and training local palliative care champions”¹¹ and “integrating palliative care

into primary care practice as a standard of care and focusing on providing primary palliative care education and services to local community members.”¹¹

Palliative Care Education and Training

Training and education are available from many different institutions and organizations including course work, conferences, or webinars. Generally, one will have to pay for specialty palliative care training either through tuition charges from institutions such as the University of Southern California Shiley Hanes Institute for Palliative Care or membership fees for organizations like the Center to Advance Palliative Care (CAPC). Primary palliative care training can also include costs, but there are often free, basic training events. Table 1 includes a partial list of national and local resources available for healthcare professionals in search of palliative care education. More resources are available on the SDAHOP palliative care website.

Interdisciplinary Palliative Care (IPC) Seminar

The state of South Dakota has been a leader in providing opportunities for palliative care education for many years. In 1999, the Sanford School of Medicine initiated a gathering of professionals and organizations who cared about improving end-of-life care for citizens within South Dakota.¹² Out of that gathering a 503c known as LifeCircle South Dakota

Table 1. Palliative care training options.

National		
Organization	Type of training	Costs
Center to Advance Palliative Care (CAPC)	Live and on-demand webinars, courses, tools, role-plays	Annual organizational membership* Some courses are open access and free
Vital Talk	Self-paced online courses intended to improve communication skills	Depending on course. Quick guides are free.
National Hospice and Palliative Care Organization	Live, on-demand webinars	Annual organizational membership* Some are open access and free
Fast Facts	Printable, concise, practical, peer-reviewed, evidence-based summaries on key palliative care topics	Free membership and access to Fast Facts- some publications have a cost
MJHS Institute for Innovation in Palliative Care	On-demand courses and webinars along with live webinars	Most courses and webinars are free- some have a minimal charge
Educating Social Workers in Palliative and End of life Care (ESPEC)	Three part virtual training program offered through National Association of Social Workers (NASW)	Course fees- reduced for NASW members
End of Life Nursing Education Consortium (ELNEC)	International, national, regional, local, online courses	Course fees
Spiritual Care Association	Self-guided courses	Course fees- reduced for members
Hospice & Palliative Nurses Foundation	Diversity in Health Care - End of Life Considerations For Individuals of Varying Faiths	Free access
Local		
Organization	Type of training	Costs
LifeCircle SD	Quarterly professional education live webinars and on-demand recordings	Free - live registration available through SDAH0 education calendar and on demand recording available on the LifeCircle webpage.
South Dakota Association of Healthcare Organizations (SDAHO)	On-Demand Palliative Care Education Series: Core Concepts for Primary Palliative Care	Free
SDAHO	Miscellaneous live and on-demand recordings	Free to SDAH0 members*
ELNEC	Train the Trainer Model - local professional can be trained to bring the training to local professionals.	Course fees

*Check with your organization to see if you are members.

was founded with three workgroups which focused on public policy, community education, and academics. Through partnerships across public and private academic organizations and hospital systems, the academic workgroup of LifeCircle began the first Interdisciplinary Palliative Care (IPC) Seminar in 2002.¹³ The academic workgroup involved faculty from multiple disciplines that provided leadership in the development and delivery of the IPC Seminar in a face-to-face format in Rapid City, Sioux Falls, and Yankton. Faculty from medicine, nursing, social work, chaplaincy, and pharmacy created an innovative model to engage students in collaborative learning involving case studies, small and large group discussions as well as interdisciplinary home visits to palliative care/hospice patients.¹³ During the face-to-face patient encounters, students of different disciplines had an opportunity to engage in meaningful discussions with patients regarding their diagnoses and goals of care.

Over time the curriculum and rotation schedule adjusted to accommodate the needs of the disciplines involved as faculty worked diligently to adhere to the principles of interprofessional education. The seminar included a virtual component when the Frontier and Rural Medicine (FARM) program was initiated at the University of South Dakota (USD) School of Medicine to allow the FARM students to engage in the large and small group discussions with the face-to-face cohort, while seeing patients in their rural setting. Additionally, some sites added students from additional professions to include respiratory therapy, nurse practitioners, physician assistants and clinical psychology. Over the course of the IPC Seminar, there were informal and formal evaluations conducted to measure student outcomes and learning. No matter when the research was conducted, there were always significant results found that confirmed the value and importance of an interprofessional approach to educating students about the concepts of palliative care.¹³⁻¹⁵

In the face of the pandemic, the academic workgroup was unsure if it could continue to offer the IPC seminar. However, with the availability of online meeting platforms, the academic workgroup believed it could transition to an online format and provide opportunities for student groups to continue to meet with their patients through virtual platforms. In the fall of 2020, the IPC seminar evolved to virtual delivery as many of the academic institutions and patient care sites continued to have restrictions on visitors and group meetings. This transition provided an opportunity to standardize the seminar across the three sites and open the seminar to more students and disciplines. Interdisciplinary student groups continued to perform patient encounters; however, staff or family members had to coordinate the virtual encounters. Due to coordination challenges, patient encounters transitioned to a virtual simulation in 2023. Formal training was provided to all simulation patients and facilitators which improved the patient encounters as students experienced consistent

patient and family scenarios. In addition, virtual delivery allowed for national palliative care experts to teach sessions, such as pharmacology and spirituality.

Based on the student evaluations of the 2023 IPC seminar, it remains a meaningful interprofessional learning experience for palliative care.

- 95% felt that providing care as an interdisciplinary team improves whole person care.
- 92% felt that safety improves when collaborating and they learn more about specialties while collaborating.
- 90% felt that the other members have an important role and teamwork skills are as important as individual competency.
- 86% felt it helped them learn about how culture and spirituality affect patient care.

Student comments:

These types of questions and conversation that is required is much different than our typical clinical exposure. Practicing and discussing helped improve my understanding of my strengths/weakness in this area.

The virtual simulation encounters were valuable and the reflection time with professionals following the session was the most impactful part. Those discussions allowed me to reflect on what I feel comfortable with and where there is room for growth.

I think a lot of the information as helpful because palliative care is not something we encounter often at this point in our medical training. It was great to learn about how the different factors are involved in Palliative care. I thought it was a good introduction to palliative care and now I feel like I am more prepared to encounter it in the hospital.

The seminar presented so much valuable information. In fact, I have directly used pieces of information from each lecture over the last couple of weeks. I have witnessed and been part of the care of many different end of life patients. I have a greater understanding of end of life and all the intricacies involved with the patient, family, and system. Also, the pharmacology and spiritual care lectures have helped open my mind and curiosity to many different parts of end-of-life care.

Currently, the IPC Seminar is hosted by USD's Interprofessional Health Education Center fostering additional disciplines to participate: occupational therapy, physical therapy, and dental hygiene. It consists of two hours of didactics centered on an introduction of palliative

care and hospice principles, including leading goals of care conversations. Following the didactics, students join interdisciplinary groups of four to participate in a 30-minute virtual, palliative care simulation. A key component of the simulation is debriefing as a group to reflect on the experience. USD health science students who participate in IPC Seminar received credit for interdisciplinary activities which is reflected when they graduate.

As the IPC Seminar evolves, our goal continues to be training interdisciplinary students in the fundamentals of palliative care principles and goals of care conversations so they can incorporate them into their practice, no matter the setting. Many of the students practice in South Dakota, including rural areas; henceforth, the value and interest in creating a program that not only impacts upcoming clinicians but also patients and families.

Conclusion

Palliative and hospice care access and education have been the passion of many South Dakota healthcare professionals since 2002. Through the collaboration of our higher education centers and healthcare professionals, hundreds of students and professionals can receive palliative care education through various mechanisms. As our population ages, palliative care education will be critical to improve access to palliative care.

Acknowledgements – We extend our heartfelt appreciation to Judith Batchelor, PhD; LuAnn Eidsness, MD; and Susan Schrader, PhD for their invaluable leadership as chairs of the LifeCircle SD Advisory Board during the inception of the IPC Seminar. Over the years, numerous faculty members have dedicated their expertise to the LifeCircle Academic Workgroup, shepherding the IPC curriculum throughout South Dakota. We are deeply grateful to all faculty participants for their commitment to providing an interdisciplinary approach to palliative care education, thereby equipping students with essential skills in primary palliative care.

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Tularemia in a Psoriasis Patient on Biologic Therapy After Relocation to Western South Dakota

Alek Keegan, MS IV; Luke Fritsch, MS III; and James Engelbrecht, MD, MACR

Abstract

Background: *Francisella tularensis* is an aerobic, gram negative coccobacillus bacterium that causes tularemia. *F. tularensis* spreads primarily through ticks, biting flies, droplet inhalation, contaminated mud or water, or infected animal bites, and it can survive in animal carcasses with the most common mode of transmission occurring via inoculation into the skin and inhalation/ingestion. Individuals on biologics or immunosuppressive medications are at an increased risk for infections such as tularemia, particularly when moving geographically to regions where it is endemic.

Case Description: We describe a case of tularemia presenting in a South Dakota resident. The patient, who was on long term adalimumab, presented with persistent fever, chills, fatigue, night sweats and anorexia for 6 days. The patient had recently moved from eastern South Dakota to western South Dakota onto a farm that is mostly pasture land. Chest imaging showed bilateral nodular densities, and lymph node biopsy was diagnostic for *F. tularensis*. A diagnosis of tularemia was made based on her biopsy results and exposure to rabbit carcasses while mowing grass on her ranch. She was started on antibiotic therapy, and her symptoms and imaging improved. She followed up with internal medicine and infectious disease clinic, and her symptoms resolved and imaging cleared with transition to ciprofloxacin in the outpatient setting; additionally, she continues to do well with no evidence of recurrence of active infection.

Conclusions: It is important that clinicians recognize the geographical dimension in infectious disease risk for immunosuppressed individuals. The patient's experience with tularemia following her relocation from eastern to western South Dakota highlights how geographic transitions can introduce new infectious exposures and risks. For patients on immunosuppressive therapies, healthcare providers must consider potential infections endemic to the new region and adopt proactive management strategies. Early recognition, targeted therapy, and adjustments in immunosuppression are critical in managing such cases effectively. This case illustrates the importance of detailed travel histories, patient education, and coordination between specialists to ensure comprehensive care and optimal outcomes for immunocompromised patients in new environments.

Introduction

Francisella tularensis is an aerobic, gram negative coccobacillus that causes the zoonotic disease tularemia.¹ The disease typically peaks in the late spring and summer, and is commonly transmitted by ticks, biting flies, droplet inhalation, contaminated mud or water, or infected animal bites.² The organisms can survive in extreme heat, cold, and in animal carcasses, with the most common mode of transmission occurring via inoculation into the skin and inhalation/ingestion. Those at increased risk for the disease include farmers, landscapers, laboratory workers, hunters or trappers, and meat handlers.^{2,3} *Francisella tularensis* is a highly infectious agent, with as few as 10-25 organisms capable of

causing infections in humans.¹ Tularemia, however, is an uncommon disease with roughly 250 cases being reported to the CDC each year and is most common in South Dakota, Colorado, Wyoming, Nebraska, Missouri, Kansas, and Arkansas.³ In South Dakota specifically, the majority of cases of tularemia are reported on the western side of the state (Figure 1).⁵

Diagnosis is dependent on a detailed patient history, including travel history, any recent game/groundwater ingestion, tick bites, or handling of carcasses.⁶ Initial titer > 1:160 or a four-fold rise between initial and convalescent serology, is most commonly used to confirm a diagnosis of tularemia, although diagnosis may be difficult to confirm with serologic



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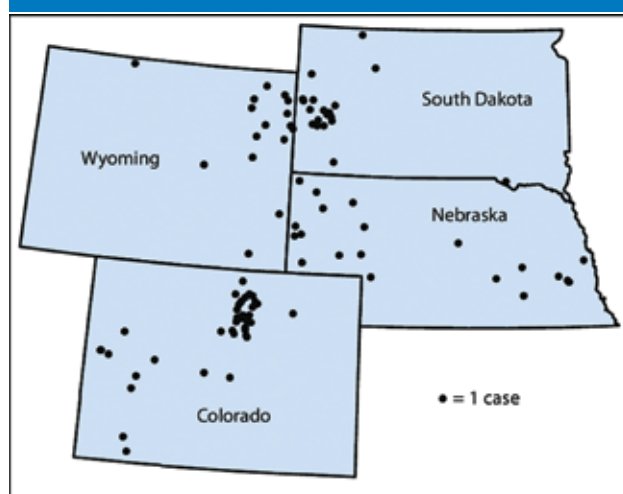
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Figure 1. Geographic distribution of reported tularemia cases in Colorado, Nebraska, South Dakota, and Wyoming, January-September, 2015.



Source: Map of local health departments in Nebraska from Nebraska Department of Health and Human Services (available at <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6447a4.htm>)

testing.¹ Among all forms of tularemia, fever, headache, and malaise are common.⁶ However, early testing may be negative, as antibodies may not have been formed yet. *F. tularensis* can also be cultured from blood, spinal fluid, lymphatic tissue and swabs of ulcer tissue for definitive diagnosis of tularemia.¹ There have been no randomized controlled trials to define optimal antibiotic therapy for tularemia, but current recommendations suggest IV gentamicin for seven to 14 days depending on disease severity.^{7,8} Ulceroglandular and glandular tularemia are the most common syndromes, in which regional lymphadenopathy occurs near the region of inoculation, with or without ulcers, respectively.¹ Other presentations include: oropharyngeal disease, gastrointestinal disease, respiratory disease, and typhoid tularemia, a febrile illness without any early signs or symptoms.¹

Individuals on biologics or immunosuppressive medications are at an increased risk for infections due to the suppression of their immune system, which impairs their ability to mount effective responses against pathogens.⁹ Biologics, commonly used for conditions such as psoriasis, rheumatoid arthritis, and inflammatory bowel disease, often target specific components of the immune system, such as tumor necrosis factor (TNF), interleukins, or T-cells, thereby reducing inflammation but also compromising immune defenses.⁹ This heightened susceptibility includes not only common infections but also opportunistic infections and those that are typically controlled by a robust immune system. Endemic infections such as tularemia, especially when they move to areas where these pathogens are more prevalent.¹⁰ This case report describes tularemia in a patient on chronic biologic

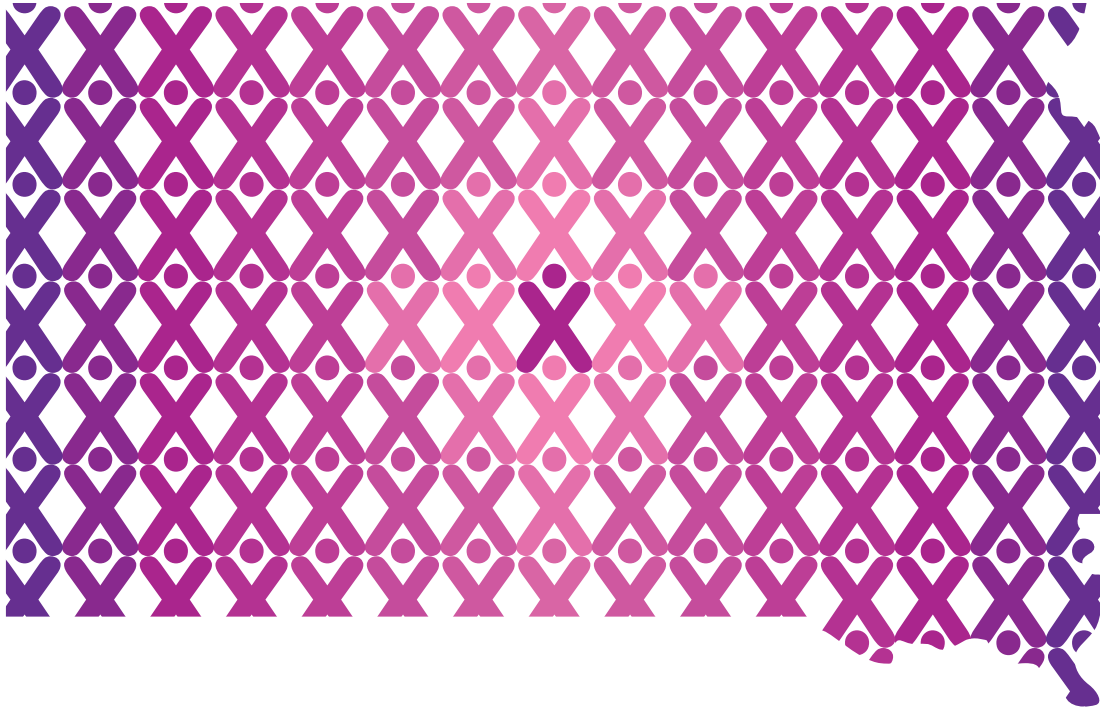
therapy for severe psoriasis who moved from eastern to western South Dakota onto a ranch with different potential exposures, which exemplifies the intersection of biologic therapy and geographic relocation leading to infection risk.

Case Description

A 51-year-old female on adalimumab therapy for psoriasis for 7 years presented to the hospital with persistent fever, chills, fatigue, night sweats and anorexia for 6 days. She injects 40 mg adalimumab subcutaneously every 14 days, and had onset of symptoms one day after her most recent injection. She presented to urgent care 3 days after a persistent fever (up to 104.4 F), and was given amoxicillin for unclear diagnosis. After 2 days of no improvement, she was seen by her primary care provider. Respiratory pathogen panel was negative, and she was given cefuroxime. On the 6th day of illness, she started to have a dry cough and a fever of 104, and presented to the emergency department. She denied hemoptysis, shortness of breath, vomiting, nausea, neck stiffness, unexplained weight loss, and other systemic symptoms. She was treated empirically with ceftriaxone and azithromycin upon admission and throughout her stay. Adalimumab was temporarily discontinued. The patient had recently moved from eastern to western South Dakota onto a farm that is mostly pasture land. She never smoked, and had no recent travel history. The patient reported mowing the lawn often and that there were many rabbits on the property.

Physical exam was unremarkable and showed a tired appearing, anicteric middle aged female with no lymphadenopathy, and normal HEENT, skin, cardiovascular, respiratory, abdominal, and extremity exams. Complete blood count (CBC) was unremarkable, and comprehensive metabolic panel (CMP) indicated elevated liver enzymes (aspartate transaminase 106, alanine transaminase 121, alkaline phosphatase 197) and creatinine 0.79 (unchanged from baseline). C-reactive protein and erythrocyte sedimentation rate were elevated at 152.6 and 24, respectively. The patient had negative Quantiferon Gold, HIV, and viral hepatitis panel. Coccidioidomycosis, blastomycosis, and histoplasmosis tests were negative. Blood cultures showed no growth throughout her stay. Admission chest x-ray showed small bilateral nodular opacities (Figure 2). CT chest, abdomen, and pelvis revealed bilateral nodular densities involving both upper and lower lobes along with mediastinal and hilar adenopathy and ground glass opacities in the left upper lobe, and mild hepatomegaly (Figure 3). Bronchoscopy was performed, which was normal. A lymph node biopsy was performed due to concern for potential metastatic disease or atypical infection, and *Francisella*

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Figure 2. 2-view chest X-ray 6/11/19. Findings: Ill-defined small nodular densities noted in the lungs bilaterally with mild hyperinflation of the lungs. No focal consolidation.



Figure 3. CT chest 6/11/19. Lungs: There are bilateral ill-defined nodular densities involving both the upper and lower lung zones. Largest one measuring about 1.4 cm and the left upper lobe laterally. No focal consolidation. Some surrounding groundglass opacities especially in the left upper lobe.



Figure 4. 2-view chest X-ray 7/1/19. Findings: Lungs appear to be clear. No definite infiltrate or effusion.



tularensis was grown. A diagnosis of tularemia was made based on the biopsy results, rabbit exposure while mowing the lawn, and her clinical presentation. Symptoms and imaging improved after continuation of ceftriaxone, azithromycin, and discontinuation of adalimumab. A chest X-ray at discharge revealed clearing of the lung opacities, and she was discharged on cefuroxime (Figure 4). She was seen soon after in infectious disease clinic and switched to ciprofloxacin for 2 weeks and completed therapy with resolution of symptoms, clearing of chest X-ray, and had no recurrence. Patient was set up with appropriate internal medicine and infectious disease follow up, and monitored for resolution of symptoms and confirmed cure with imaging.

Conclusion

This case highlights the importance of recognizing and considering the geographical dimension in infectious disease risk, especially for immunosuppressed individuals undergoing significant geographic transitions. *F. tularensis*, endemic in certain regions such as western South Dakota, poses a unique threat to those lacking immune protection.^{3,4} The patient's clinical response to targeted therapy and adjustments in immunosuppression emphasize the significance of early recognition and management.

When individuals move to different regions, they encounter new environmental exposures, wildlife, and vectors that may harbor pathogens not prevalent in their previous locations. Western South Dakota, with its diverse ecology including rural and ranch environments, presents distinct risks compared to urban or less rural areas of eastern South Dakota. *F. tularensis* is endemic in certain areas of the United States, including western South Dakota, Wyoming, Nebraska, and Colorado (Figure 1).^{4,5}

In the past couple of decades there has been a surge in both biologic and nonbiologic drugs that modulate both the innate and adaptive immune system to manage many autoimmune inflammatory diseases.¹¹ With that immunosuppression has come an increased risk of both common and unusual infections which can also have more severe presentations in immunocompetent individuals.⁹ This patient's chronic use of adalimumab, a monoclonal anti-tumor-necrosis-factor antibody, for severe psoriasis places her in an immuno-compromised category. In immunocompromised individuals, tularemia can present with atypical and more severe symptoms, and there is an increased risk of complications.^{9,12} Recognizing tularemia in such patients is crucial because the disease can progress rapidly, and its clinical presentation might overlap with other

infections common in immunocompromised hosts.¹² Early identification, obtaining detailed travel/relocation history, and appropriate management are essential to prevent severe outcomes.

The presented case illustrates the intersection of geographic relocation, immunocompromised status, and the emergence of new infectious risks. Tularemia, while relatively rare, poses significant threats to patients on biologic therapies due to their altered immune responses

Acknowledgements – the authors thank Dr. James Keegan for his care of the patient and his expert input in this manuscript.

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Do We Need a Fluid Bolus? The Necessary Refinement of Pediatric Propofol Sedation – a Quality Improvement Project

Andrew L. Guymon, MS IV; Madigan M. Moore, MS IV; Laura E. Nelson, MS IV; and Mir Ali, MD

Abstract

Background: Propofol is commonly used for pediatric MRIs to minimize patient movement. At our institution, intensivists typically administer a prophylactic 20 ml/kg saline bolus to maintain blood pressure (BP) during propofol sedation. This quality improvement project assessed whether a 10 ml/kg and a completely eliminated saline bolus are as effective as the standard 20 ml/kg bolus in completing pediatric propofol sedation and maintaining Mean Arterial Pressure (MAP).

Methods: We reviewed pediatric propofol sedations over an 18 month period in which pediatric intensivists administered the standard 20 ml/kg saline bolus, a reduced 10 ml/kg bolus, and no saline bolus. Successful sedation meant completing the MRI without complications.

Results: 172 patients aged 19 months to 16 years were assessed. The percentage of successful sedations with a 20 ml/kg bolus, 10 ml/kg bolus, and no saline bolus was 92%, 100%, and 91%, respectively. There was a statistically significant higher average MAP in the 0 ml/kg group than in the 10 and 20 ml/kg cohorts ($p = 0.002$). No patients required an additional bolus to maintain blood pressure.

Conclusions: The preservation of hemodynamic stability without a saline bolus supports the literature that the saline bolus can be safely reduced during pediatric propofol sedation for MRI.

Introduction

Propofol offers a safe and effective means of sedation for pediatric patients in a variety of procedures.¹ It offers a quick onset of action and can be discontinued rapidly.² Because of its safety and efficacy, propofol is commonly used in pediatric MRI procedures, since the patient needs to remain still for an extended period.³ The standard propofol drip dosing used for pediatric MRI sedation at the local Children's Hospital was recently reduced to 2 mg/kg bolus followed by a 175 - 199 mcg/kg/min drip following a previous quality improvement project. This reduction in propofol dosing was performed by a separate team aiming to reduce medication costs and adverse effects while still maintaining a high successful sedation rate.⁴

Adverse effects of propofol include decreased cardiac output and decreased blood pressure.⁵ In current practice at our institution, every patient receives a prophylactic saline bolus during deep propofol sedation. However, existing evidence suggests that using a pre-sedation fluid bolus does not decrease the incidence of propofol-induced hypotension in pediatric patients and may not be necessary.^{6,7} Families are charged

for saline administered, increasing the financial burden on patients and the healthcare system. The effectiveness of this practice must be investigated. This retrospective quality improvement project aimed to review the effectiveness of pediatric propofol sedation with a reduced or eliminated saline bolus.

Methods

Institutional review board approval was obtained for this quality improvement study in 2022 accepting the work as non-human research according to the Protocol Template for Record Review (HRP-503a). We retrospectively reviewed baseline blood pressure measured on the day of sedation before the sedation began, average intra-sedation MAP, complications during sedations, and aborted sedations of all pediatric patients who underwent propofol sedation from May 2022 to November 2023. During this time, pediatric intensivists had previously and independently reduced saline bolus dosage from 20 ml/kg to 0 ml/kg as part of a quality improvement initiative.

Sedation success, defined by a sedation completed with

no complications, without being aborted, and without signs of hemodynamic instability, was determined from the sedating physician's notes. The secondary aim was to compare MAP parameters during propofol sedation at different saline doses.

Participants

Participants included all pediatric patients who underwent propofol sedation for MRI at the local Children's Hospital, with a few exceptions:

1. Because intranasal dexmedetomidine is used to sedate all patients less than 18 months old, patients ranged from 19 months to 16 years of age.
2. Patients with a contraindication to the sedation method or those who had previously experienced an adverse reaction to propofol sedation were excluded from the study.
3. Patients who could undergo MRI without sedation were excluded from the study.

In total, 172 pediatric patients, male and female, who received propofol sedation between May 2022 and November 2023 were included in this study.

Procedure

This study was roughly grouped into three eras. During the first era (May-November 2022), most patients received a 20 mL/kg saline bolus. During the second era (November 2022-May 2023) most patients received a 10 mL/kg bolus. During the third era (May-November 2023) most patients received no saline bolus. Continuous vital sign monitoring occurred during sedation, with intensivists ready to abort or administer extra saline in case of unexpected blood pressure drops. In this case, the sedation would be termed complicated and aborted. Anonymous data collection was performed manually with all values reviewed on initial collection and again for unexpected values on data analysis. Researchers used a secured and piloted RedCap software to store information securely. Any records with missing data were omitted from the study.

Results

Data was collected over 18 months, from May 20, 2022, through October 20, 2023. The data collected contained no patient-identifying information. 172 patients aged 19 months to 16 years old participated in the study. In total, 64 patients received a 20 mL/kg bolus, 53 patients received

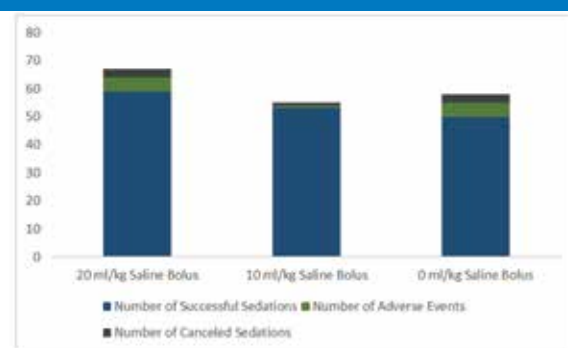
Table 1. Complications.

Description of complication	20 ml/kg Saline bolus	10 ml/kg Saline bolus	0 ml/kg Saline bolus
Airway obstruction due to secretions, laryngospasm, or positioning	5	0	5
Hypotension, hypovolemia, or poor perfusion	0	0	0
Patient required vasopressors or extra saline bolus	0	0	0

Table 2. Percent successful sedations.

Saline bolus dose (ml/kg)	20 ml/kg Saline bolus	10 ml/kg Saline bolus	0 ml/kg Saline bolus	Total
Number of successful sedations	59	53	50	162
Number of adverse events	5	0	5	10
Number of canceled sedations	3	0	3	6
Percent successful sedations	92%	100%	91%	94%

Figure 1. Visual representation of percent successful sedations.



a 10 mL/kg bolus, and 55 patients received no saline bolus. An inclusive list of the complications and reasons for aborted sedation is given in Table 1. Of note, none of the complications or aborted sedations occurred due to low blood pressure or hemodynamic instability, and no patients required a rescue bolus or vasopressors to maintain blood pressure. When a saline bolus of 0 mL/kg, 10 mL/kg, and 20 mL/kg was administered, the sedation success rate was 91%, 100%, and 92%, respectively (Table 2 and Figure 1).

MAP was assessed throughout sedation. As expected, all groups demonstrated a moderate drop in blood pressure. There was no difference in baseline blood pressures or total propofol received between groups ($p = 0.061$ Figure 2 and $p = 0.177$ Figure 5, respectively). There was no significant difference in average age between groups ($p = 0.591$). The average intra-sedation MAP for patients receiving 20, 10, and 0 mL/kg boluses was 56.6, 57.2, and 61.0 mmHg (Figure 3), respectively. Patients receiving a 0 mL/kg bolus demonstrated a significantly higher MAP as compared to patients receiving a 10 and 20 mL/kg bolus ($p = 0.002$). The patients receiving

a 10 mL/kg saline bolus demonstrated the greatest decrease in MAP from baseline ($p = 0.024$).

Conclusions

This QI project investigated if saline bolus dosage could be effectively decreased during propofol sedation in pediatric MRI procedures. A previous study in adults determined that pre-sedation crystalloid fluids prior to propofol and fentanyl sedation did not affect the drop in blood pressure.⁸ Our study's results parallel these findings. Of 172 pediatric patients, 94% of all sedations were completed successfully (Table 2). The aborted procedures were caused by airway obstruction due to secretions, laryngospasm, or positioning (Table 1). This supports the conclusion that a decreased saline bolus dose had little impact on the successful completion of pediatric propofol sedation during MRI.

Our secondary aim addressed how MAP values are influenced by a reduced or eliminated saline bolus. The relationship between saline bolus and MAP is unclear. The

average MAP for patients who received 20 mL/kg, 10 mL/kg, and 0 mL/kg was 56.6 mmHg, 57.2 mmHg, and 61.0 mmHg, respectively (Figure 3). There was no difference in MAP values at baseline (Figure 2, $p = 0.061$). Although the increase in MAP from patients who received 20 mL/kg and 10 mL/kg to patients who received 0 mL/kg was statistically significant ($p = 0.002$), it was not clinically significant, as evidenced by only a slight increase of 4.4 and 3.8 mmHg, respectively. Additionally, the group that saw the largest decrease in MAP from baseline during sedation was the 10 mL/kg group. Our results support the already prevalent idea that administration of varying doses of saline boluses are not directly related to preservation or reduction in blood pressure and thus may not be essential for to maintain blood pressure during pediatric propofol sedation.^{7,8}

There was no significant difference in total propofol administered per kilogram between groups (Figure 5, $p = 0.177$). Moreover, there was no correlation between propofol dose administered and magnitude of decrease in blood pressure

Figure 2. Baseline MAP.

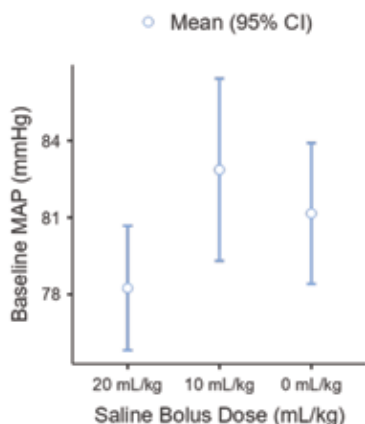
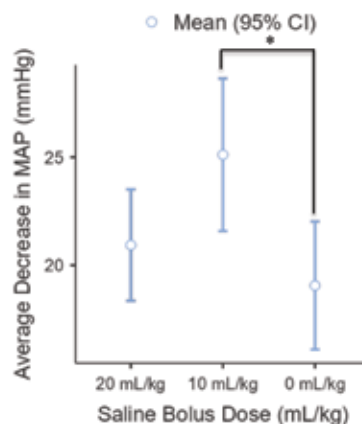
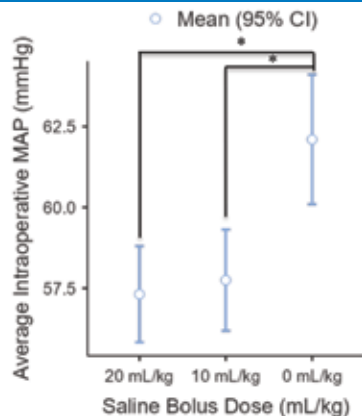


Figure 4. Change in MAP from baseline MAP to intra-sedation MAP.



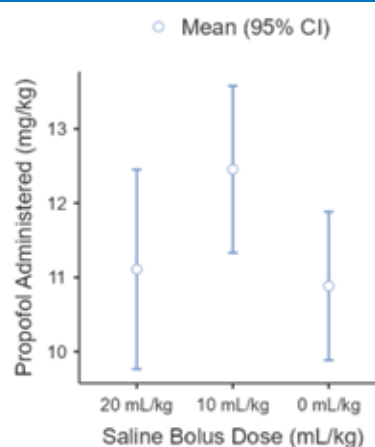
*Indicates p value < 0.05

Figure 3. Average intra-sedation MAP.



*Indicates p value < 0.05

Figure 5. Propofol administration.



(Pearson's correlation coefficient, r , for 20, 10, and 0 mL/kg boluses = 0.033, 0.010, and 0.021, respectively).

Importantly, no groups experienced clinically hypotensive adverse events requiring administration of vasopressors or extra saline (Table 1). This is especially important when interpreting the 0 mL/kg saline bolus group data. These findings suggest that the saline bolus can be eliminated from propofol sedation during pediatric MRI procedures.

It is reasonable to consider new protocols that do not include a saline bolus during pediatric propofol sedation. Based on the percentage of successfully completed MRI procedures, stability of average MAP across each era, and no adverse outcomes related to hypotension, we propose that the saline bolus in pediatric propofol sedation can be reduced during MRI procedures.

Limitations

The small sample size of this study limits the generalizability of the findings to other populations. The pediatric patients in the study underwent MRIs for various reasons; their specific medical diagnoses were not accessed and are thus not accounted for in the results. Finally, although there was no significant difference in average age, pediatric patients across a broad range of ages and comorbidities may represent multiple populations and may have introduced varying blood pressure responses to propofol.

Future Work

Future studies could expand the population size and may also include studying the relationship between propofol and saline in other pediatric procedures, like endoscopies or biopsies.¹ A 2010 study determined that pre-operative

fluid fasting does not affect MAP in adult patients when propofol is infused rapidly.⁸ Future work could provide an in-depth analysis of the financial burden of crystalloid fluids such as normal saline on the patient and healthcare system as a whole.

Authors AG, MM and LN are supported by the National Institutes of Health Department of Health and Human Services (5T35HD088383-05).

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Children's Nebraska Pediatric Surgery

Content submitted by Children's Nebraska

Improving Outcomes and Experiences for Pectus Patients with Innovation, Compassionate Care

Children's Nebraska's pediatric surgeons understand the profound impact of expert, compassionate care for children and their families. As the largest and most experienced pediatric surgical team in the region, it offers unmatched comprehensive care across the full spectrum of surgical interventions – including special expertise in moderate to severe cases of chest wall deformities such as pectus excavatum and pectus carinatum.

“For a long time, we called pectus a cosmetic procedure, but recent studies show it can improve heart and lung function as well,” says Children's pediatric surgeon Robert Cusick, M.D. “I love taking care of these patients because often the physical appearance can hurt their self-confidence at a key point in adolescence. These procedures can have drastic changes on their self-esteem.”

Located in Children's state-of-the-art Hubbard Center for Children, which opened in 2021, the surgical team provides an exceptional, family-centered experience. The world-class surgical suites are equipped to offer minimally invasive surgical interventions, advanced robot-assisted technologies and techniques that promote faster recovery and healing, less pain, lower rates of infection and fewer complications. Each surgery is led by a multidisciplinary pediatric team with specialized pain management techniques, including cryotherapy and cryoablation.



Adil Shah, MBBS, Patrick Thomas, M.D., Robert Cusick, M.D., Kathy Schall, M.D., Melissa Suh, M.D.

“About 18 months ago, we started adding cryoablation to our pectus procedures,” explains Dr. Cusick. “This technique freezes four nerves, providing numbness for 3-6 months after surgery. It has been a game changer.”

With a combined 100 years of experience, the Pediatric Surgery team is committed

to keeping each child safe and comfortable throughout their entire surgical journey, from clinic consultation to the operating room and recovery. Children's also offers surgical treatments for various medical conditions with expertise in bariatrics, colorectal issues, hernias, oncology, thyroid conditions and more.

“There is no greater privilege than caring for a sick child,” says Dr. Cusick. “Education and research allow us to improve children's health into the future, but nothing matters more to our team than caring for and healing our patients today. Patients and their families deserve the best in surgical skills, compassion and a trusting relationship.”

The Pediatric Surgery division at Children's continues to grow and innovate to meet the needs of children and families. Abdalla Zarroug, M.D., Robert Cusick, M.D., Megan Fuller, M.D., Kathy Schall, M.D., Adil Shah, MBBS, Melissa Suh, M.D., and Patrick Thomas, M.D., collaborate and embrace innovation, utilizing the latest techniques and technologies to deliver optimal care for pediatric patients.



Scan the QR code to learn more about Children's pectus surgery team.

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Advanced Cardiac Imaging Modalities: A Brief Review for the Primary Care Physician

Muhammad Hasan, MD; Ninad Nadkarni MD; and Naveen Rajpurohit, MD

Abstract

Advanced cardiac imaging modalities have revolutionized the field of cardiovascular medicine, offering invaluable tools for both diagnosis and the management of a wide spectrum of cardiovascular diseases. These imaging methods, including echocardiography, cardiac computed tomography (CT), computed tomography angiography (CTA), cardiac magnetic resonance imaging (MRI), nuclear imaging, and fluoroscopy, offer various approaches to evaluate both the structure and function of the heart. This article provides an overview of imaging modalities for primary care physicians, highlighting their types, advantages, limitations and clinical uses.

Introduction

Cardiac imaging modalities have emerged as integral components within cardiovascular medicine. This article provides an overview of various imaging technique, encompassing types, advantages, limitations and clinical uses (Table 1 provides a concise overview of different advanced cardiac imaging techniques, along with their respective strengths and limitations.)

Echocardiography

Echocardiography (echo), a cornerstone of cardiac imaging, uses ultrasound waves produced by a transducer to visualize different heart structures throughout the cardiac cycle.

Types

Depending upon where the transducer is placed, images can be obtained via transthoracic echocardiography (TTE), where

Table 1. Summary of advantages and disadvantages of cardiac imaging modalities.

Imaging modality	Echocardiography	Cardiac MRI	Nuclear imaging	Cardiac CT	Fluoroscopy
Advantages	- Low cost - Real time images - Widely available - Time efficient - No exposure to radiation	- High resolution - High sensitivity and specificity - No radiation exposure	- Provides both functional information - Can be combined with CT to produce hybrid images	- Rapid - High diagnostic performance - High spatial resolution	- Real time images - High diagnostic accuracy
Disadvantages	- Low sensitivity and specificity compared to MRI, CT and nuclear - TEE requires sedation - Operator variable	- Limited availability - Implantable devices may preclude its use - -contrast may limit use in renal failure	- Exposure to radiation - Limited anatomical detail - Time consuming - Expensive - Limited availability	- Exposure to ionizing radiation - Contrast may cause AKI or allergic reaction - Limited use in patients with arrhythmias	- Exposure to ionizing radiation - Use of contrast can cause AKI or allergic reaction - Limited soft tissue distinction

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the transducer is placed on the chest, or via transesophageal echocardiography (TEE), where a transducer probe is inserted in the esophagus. Lastly, Intracardiac echocardiography (ICE) is where the probe is inserted intravenously into the heart and provides real-time images of smaller structures within the heart (Figure 1).¹

Advantages

Echocardiography, an ultrasound-based imaging modality, has a significant advantage over X-ray and contrast-based modalities by being safer. It is quick and readily available, making it one of the primary imaging modes for various emergent cardiac and non-cardiac abnormalities, for example, TTE for assessment of cardiac tamponade in patients with pericardial effusion and right ventricular strain evaluation in patients with pulmonary embolism.

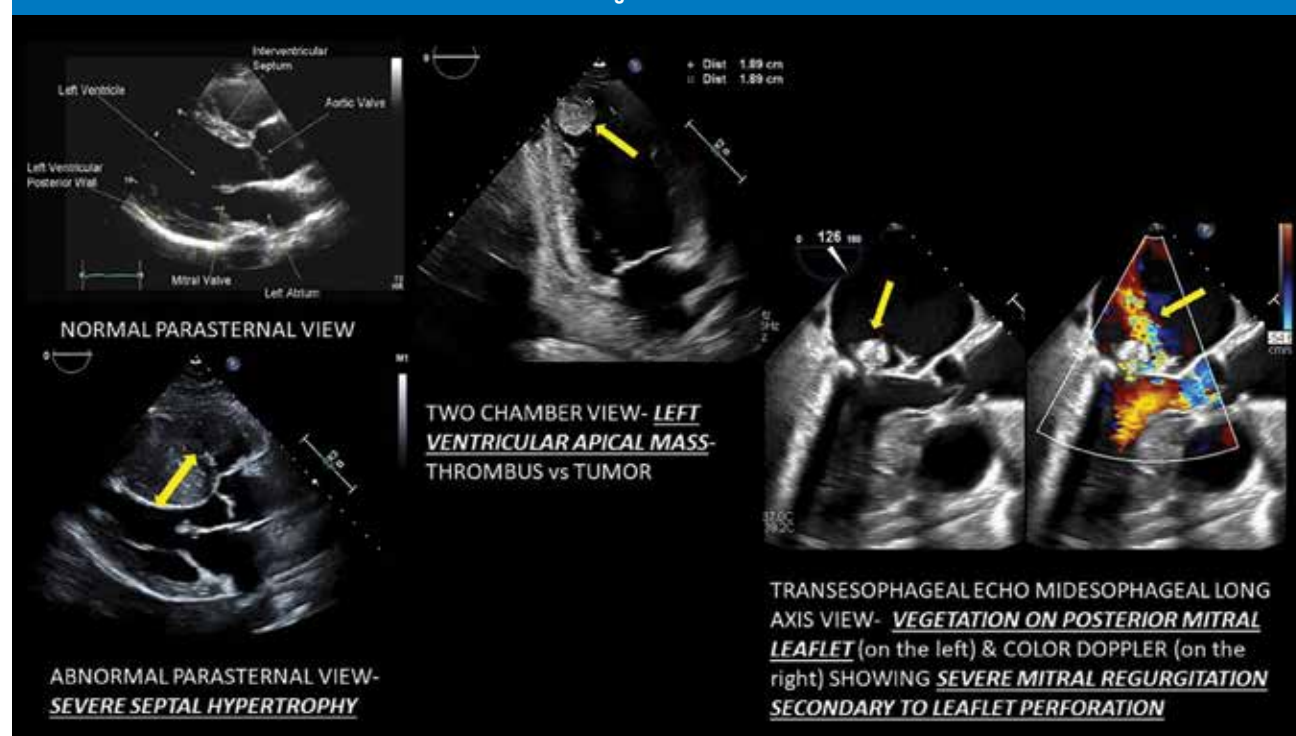
Understanding the inherent image resolution, cost, patient factors, and the cardiac structures to be evaluated play an essential role in choosing an echocardiographic technique or combining them. For example, TEE allows higher resolution without the hindrance of a patient's chest wall or lung tissue, which is a drawback for TTE but is more invasive, requires sedation and specialized training to perform, and is associated with a small risk of life-threatening complications like esophageal rupture. Given the probe being near the

left-sided and posterior structures of the heart, TEE has its advantages in viewing any pathology in the mitral valve, left atrial appendage, and ascending aorta over TTE. Lastly, intracardiac echocardiography (ICE) provides higher-resolution images than TEE. Hence, it plays a vital role in safely performing procedures that require trans-septal puncture; for example, the implantation of the Left Atrial Appendage Occlusion device (WATCHMAN LAO, Amulet etc), implantation of Mitral Clip, and ablation for atrial fibrillation.²

Clinical Uses

The ease of use and safety make echocardiography a first-line imaging avenue in various cardiac and non-cardiac conditions.³ Apart from being used in emergencies, as mentioned above, echocardiography is also first-line imaging in outpatient and inpatient settings for patients with signs and symptoms suspected of being of cardiac origin, i.e., syncope, murmur, palpitations, chest pain, and shortness of breath. It is not only involved in terms of diagnosis but also prognostication of various cardiac diseases like myocardial infarction, heart failure, congenital heart diseases, infective endocarditis, and valvular heart disease. In the evaluation of non-cardiac diseases such as stroke, an echocardiogram is included in the work-up. Echocardiogram with bubble

Figure 1. Echo.



A close-up, slightly blurred photograph of a woman with short brown hair and glasses, smiling warmly. The image is tinted with a dark purple/blue color, serving as the background for the text.

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study aims to assess the potential presence of patent foramen ovale (PFO), shunts, thrombi within the heart chambers, and vegetation on the valves. Amongst asymptomatic individuals, an echocardiogram is used to evaluate ejection fraction in patients started on chemotherapy with cardiotoxic medications and as a screening test for diseases like hypertrophic cardiomyopathy, aortic aneurysm, and bicuspid aortic valve in individuals with genetic predisposition.

Cardiac MRI

Cardiac MRI (CMR) uses the same principal as other MR techniques with the addition of ECG gating to suspend cardiac motion. The primary origin of the MR signal used to generate images is either from water or fat within the patient's tissue; specifically it is from the hydrogen nuclei (consisting of a single proton) contained within free water or lipid molecules. MRI uses a powerful magnetic field that charges the protons. A radiofrequency pulse is then used to make the protons spin out of equilibrium. These hydrogen protons return to baseline when radiofrequency is stopped, releasing energy as they do so. This energy varies with different tissues and is used to differentiate between structures.⁴

Types

CMR uses various pulse sequences (software programs that drive the scanner) to obtain information regarding the cardiac function and morphology, large vessel anatomy,

vessel flow, myocardial edema, iron quantification, cardiac masses and pericardium etc. Gadolinium based contrast agents can be used for 3D-MR angiography and for assessing myocardial perfusion. Tissue characterization is one of the unique properties of CMR, for example, late gadolinium enhancement (LGE) for assessment of myocardial injury, scar and fibrosis, etc. Fat suppression sequences can help differentiate fatty tissue with myocardial tissue.

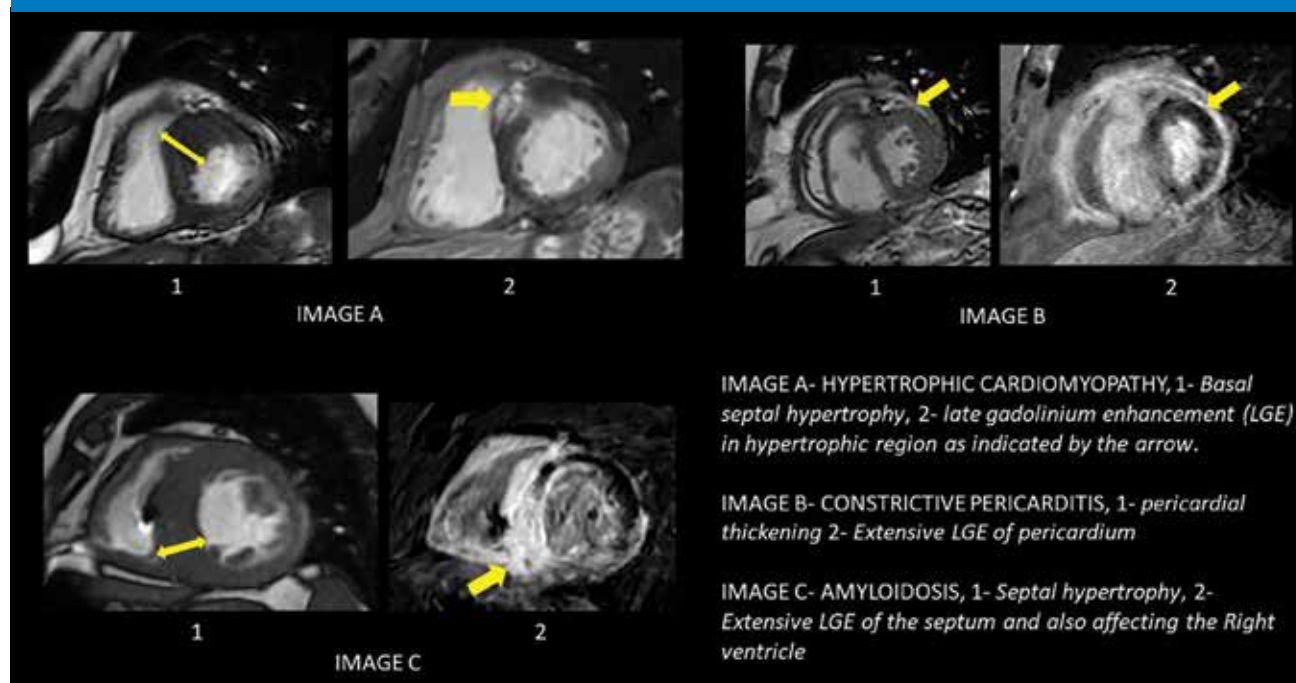
Advantages

CMR provides accurate and reproducible quantitation of cardiac volumes and function without any ionizing radiation. CMR has a relatively high spatial and temporal resolution when compared to other cardiac imaging modalities. Tissue characterization by CMR has obviated the need for tissue biopsy for many cardiac conditions. LGE imaging provides diagnostic and prognostic information in many disease states.

Disadvantages

Image quality may be compromised due to cardiac arrhythmias or inability to hold the breath during the scan (done to reduce motion artifacts). Claustrophobia and severe obesity (inability to fit in the scanner) may limit access for some patients. Gadolinium based contrast agents are contraindicated in patients on hemodialysis and for patients with eGFR<30 ml/min. Due to cost and lack of staff training, CMR may not be available at all healthcare facilities. MRI

Figure 2. Cardiac MRI.



is contraindicated in patients with implantable pacemaker or defibrillator, unless they are MRI compatible, due to the risk of device malfunction, heating of leads or displacement of the device due to the magnetic field.

Clinical Uses

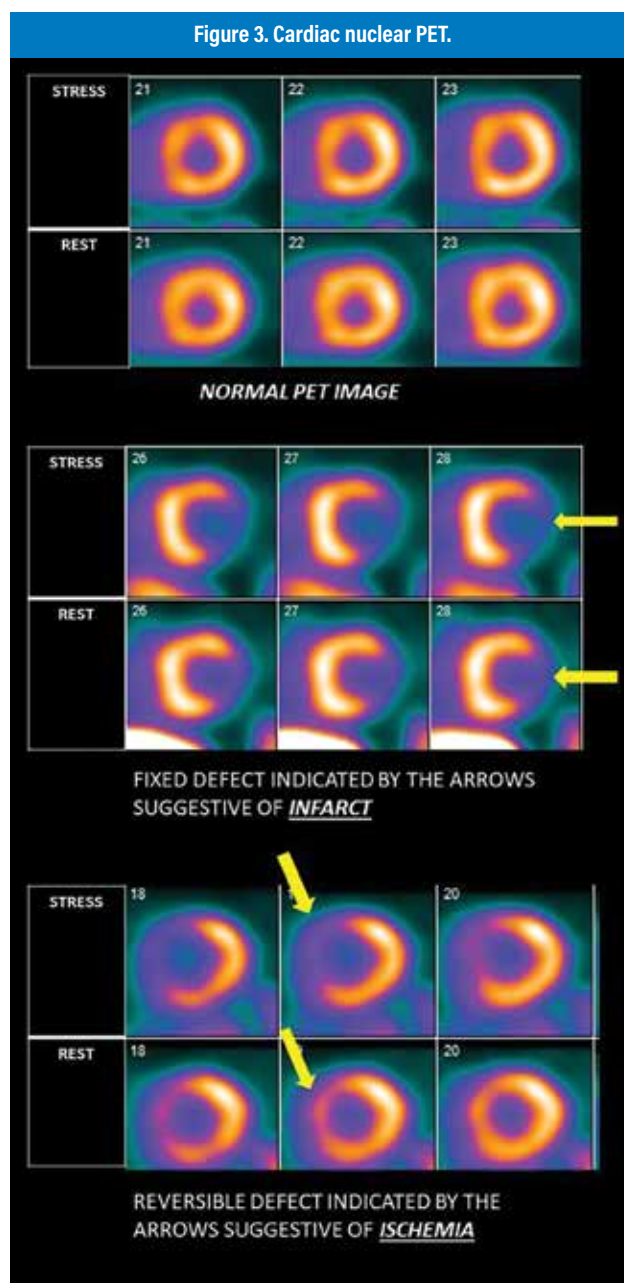
Due to superior image quality, reproducibility and tissue characterization, CMR has established itself as a useful tool for the diagnosis and prognosis of various cardiac conditions. Cardiac MRI is the gold standard for the assessment of regional and global systolic function, myocardial infarction and congenital heart diseases. CMR provides invaluable diagnostic and prognostic information in various cardiomyopathies including, but not limited to, hypertrophic cardiomyopathy (HCM), dilated cardiomyopathies, infiltrative cardiomyopathies including amyloidosis and sarcoidosis (Figure 2). CMR can be used to quantify myocardial iron load in patients with suspected hemochromatosis. CMR can be used to assess myocardial perfusion, ischemia (stress CMR), quantify myocardial infarction and assess for viability. CMR is the preferred imaging modality for the diagnosis of inflammatory cardiac condition, for example, acute myocarditis. Cardiac MR is increasingly becoming the preferred modality for the diagnosis of pericardial diseases including pericardial cysts, acute/chronic pericarditis and for constrictive pericarditis. CMR is also used for assessment of cardiac masses/tumors and more sensitive than echocardiogram for the assessment of cardiac thrombi.⁵

Cardiac Nuclear Imaging

The primary principle of nuclear imaging is detecting the radioactivity of the radioactive isotope injected into the patient's bloodstream and distributed in the body tissues. Depending on the study, the tissue of interest is visualized with the help of a camera, and relying on the radioactivity, the characteristics of the tissue can be determined. These radioisotopes include but are not limited to technetium-99m (Tc-99m), fluorine (F-18), and rubidium (Rb-82).

Types

Cardiac nuclear imaging techniques broadly include single photon emission computed tomography (SPECT) and positron emission tomography (PET) (Figure 3). In SPECT, injected radioisotopes decay and emit gamma rays (high-energy photons), which the gamma-ray camera detects. The Gamma-ray camera rotates around the patient and captures images from various angles. In PET, injected radioisotopes emit positrons (particles similar to electrons but positively



charged), which travel a few millimeters in the tissue and interact with the electrons, leading to the annihilation of both, which releases two high-energy photons that are detected by an electronic camera and images are acquired. After acquiring images in both studies, they undergo processing through specialized software to generate 2D and 3D images highlighting regions of interest.⁶

Advantages

Nuclear imaging has wide applications in cardiology and is used to see differences in myocardial perfusion, metabolism,

myocardial blood flow, and ventricular function. Hence, it helps with risk stratification and provides valuable information to predict adverse cardiac events in different cardiac diseases. It's also flexible, producing hybrid images after combining with other imaging modalities (such as CT).

Disadvantages

One of the most significant disadvantages of cardiac nuclear imaging is radiation exposure. Compared to other cardiac imaging modalities, it may have limited anatomical detail. It is also time-consuming and expensive.⁶ Apart from the above disadvantages, nuclear imaging, especially SPECT, has inherent problems with attenuation and scatter, compromising the image quality and, thereby, the diagnosis. On the other hand, PET is worse with these problems but has standardized attenuation correction, improving its image quality.

Clinical Uses

Nuclear imaging is one of the most common non-invasive techniques used to detect coronary artery disease by identifying areas of perfusion defects (ischemia reversible defect and infarction fixed defect) (Figure 3). Based on different protocols, rest and stress images (after the stressor is injected or after exercise) are obtained and compared to detect perfusion defects. PET has an added advantage over

SPECT in measuring myocardial blood flow and having an accurate stress ejection fraction, providing valuable information regarding the patient's coronary artery disease and prognosis.⁷ Other uses for coronary artery disease include determining if cardiac tissue is viable or scarred and helping assess the benefit of revascularization. Apart from coronary artery disease, nuclear imaging has been pivotal in evaluating other systemic diseases that affect the heart, notable sarcoidosis (fluorodeoxyglucose PET scan) and transthyretin (TTR) amyloidosis (technetium-99m pyrophosphate scintigraphy scan).

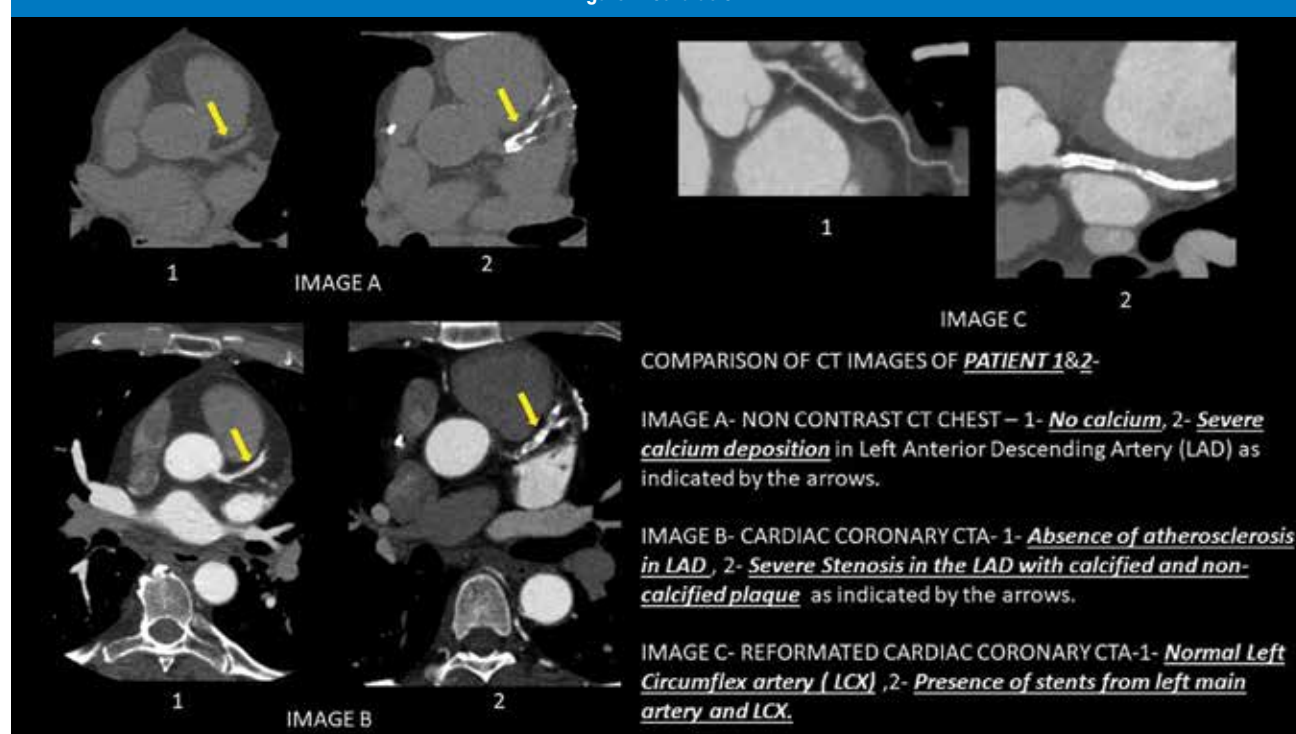
Cardiac CT and CT Angiography

Cardiac CT is a non-invasive imaging technique that uses X-rays to create detailed images of the heart and its blood vessels. The X-ray is projected on the chest, and the detectors collect the X-rays to build a data set, which is reconstructed by specialized software to produce 2D and 3D images. The study may be performed either with contrast, called CT angiography (CTA) or without contrast, depending on the indication (Figure 4).

Types

Cardiac CT study protocols encompass not only the evaluation of coronary arteries but also the evaluation of myocardium, pericardium, cardiac valves, chambers, veins,

Figure 4. Cardiac CT.



and arteries. Most of these protocols use iodinated contrast of varying amounts and alter the X-ray beam's timing relative to the bolus of contrast and the beam's location on the chest to obtain clear images of the cardiac structure of interest. Apart from the above, the images are gated to the cardiac cycle (with the help of an electrocardiogram) so that they are obtained when the heart has minimal to no motion. Non-contrast cardiac CT is primarily used for the evaluation of coronary artery calcium.

Advantages

Cardiac CT's most significant advantage over other non-invasive imaging modalities is its ability to provide rapid, high-quality images with great anatomical details by visualizing the heart and the nearby extra-cardiac structures. Cardiac coronary CT can be combined with other stress nuclear imaging modalities like SPECT to provide more anatomical information to help further risk stratify patients for ischemia.

Disadvantages

One of the major drawbacks of cardiac CT is exposure to ionizing radiation. The contrast used in cardiac CT has the potential to cause an allergic reaction or acute kidney injury. Patient factors like obesity, arrhythmias, and motion can affect the image quality, causing artifacts and, at the same time, increasing the contrast and radiation dose, compromising the study's safety. Even though cardiac coronary CT provides excellent image quality in most patients, it has limited utility in patients with prior coronary artery stents and severe renal impairment.

Clinical Uses

Given its unique characteristics, cardiac CTA has a wide range of clinical applications. Cardiac coronary CTA is the only clinical tool to assess the patency of native coronary arteries and bypass grafts and identify areas of stenosis, plaque buildup, and calcifications non-invasively.⁸ Within the scope of evaluating the coronaries- evaluation for anomalous

origin, course, and termination of coronary arteries can be assessed non-invasively by a CT. As mentioned above, coronary artery calcium is primarily estimated with a non-contrast chest CT. It has become an integral part of risk stratification for the primary prevention of atherosclerotic disease by differentiating patients who would or would not benefit from the initiation of aggressive pharmacological prevention strategies, i.e, aspirin and statins (Table 2). Further studies are ongoing regarding expanding the use of coronary artery calcium.

Outside of coronary arteries, cardiac CTA has become an essential modality in planning and evaluating the need for any surgical or percutaneous procedures involving cardiac structures like in- valvular heart disease (including but not limited to trans catheter aortic valve implantations (TAVI) for aortic stenosis, mitral clip for mitral regurgitation, prosthetic/ native valve endocarditis requiring valve replacement), congenital heart disease (including but not limited to closure devices/patch/surgeries for atrial septal defect, ventricular septal defects, and other complex congenital diseases), miscellaneous (including but not limited to visualizing pulmonary veins for atrial fibrillation ablation).

Fluoroscopy

Fluoroscopy employs X-ray technology to acquire dynamic real-time images. This method involves the administration of a contrast medium enriched with iodine, which is introduced into the patient's vascular system. Consequently, this contrast agent enhances the visibility of blood vessels in relation to the neighboring tissues.⁹

Advantages

It can provide real time moving images making it ideal for minimally invasive interventions like cardiac catheterization.

Disadvantages

Fluoroscopy has the potential for exposure of ionizing radiation. Contrast medium injected into the bloodstream

Table 2. Relationship between the Agatston score and the severity of coronary artery disease.

Agatston score	Degree of coronary artery disease	Description
0	No coronary artery disease	No calcified plaque detected, low risk
1-99	Mild disease	Some calcification present, mild to moderate risk
100-399	Moderate	Significant calcification, moderate to high risk
≥400	Severe	

can risk allergic reactions and kidney damage. It uses X-rays which has limited ability to distinguish between soft tissues.¹⁰

Clinical Uses

Fluoroscopy is a vital tool used in diagnostic cardiac catheterizations and for percutaneous coronary interventions (PCI) in the catheterization laboratory. Procedures performed for structural heart diseases such as TAVI, mitral clips, WATCHMAN LAO devices, ASD/PFO occlusions are performed under fluoroscopy, often in combination with other imaging modalities. It can be used to visualize mechanical heart valves in cases of suspected obstruction. In the electrophysiology laboratory fluoroscopy is used to guide device implantations (permanent pacemaker, implantable defibrillators) and ablation procedures for various arrhythmias.

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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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In Memoriam 2024

Honoring physician members of the SDSMA who passed away in 2024.



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This list contains 2024 contributions as of November 22, 2024.

Member News

Visit www.sdsma.org for the latest news and information.

Volunteers Needed! Doctor of the Day Program

Consider signing up to volunteers as a Doctor of the Day! The SDSMA is looking for volunteers for the association's Doctor of the Day Program at the State Capitol during the 2025 legislative session.

This volunteer opportunity involves one day at the State Capitol in Pierre by providing basic medical assistance to elected representatives and staff as needed. South Dakota's 2025 legislative session opens January 14, 2025.

Sign up to volunteer at sdsma.org.

Doctors of the Day have the unique opportunity to interact with legislators and get a first-hand look at the legislative process and how it affects the practice of medicine. Your presence at the Capitol shows legislators not only your expertise, but also your concern for the health of South Dakotans.



It is critical that volunteer physicians are serving each day of session. Every year we receive requests from PAs and NPs who wish to participate in the program.

Questions? Contact Justin Ohleen at 605.336.1965 or johleen@sdsma.org.



District 7 Medical Society Holds Advocacy Workshop and Legislative Mixer

The District 7 Medical Society hosted an advocacy workshop for physicians the evening of November 20 at Chef Dominique's in downtown Sioux Falls, followed by a legislative mixer.

The workshop, led by Dan Heinemann, MD and SDSMA Director of Advocacy & Policy Justin Ohleen, was designed to equip physicians with the skills to be strong advocates in medicine. The mixer was an opportunity for physicians to meet Sioux Falls-area legislators and District 7 leadership.

Don't Let This Be Your Last Issue!

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Visit sdsma.org to renew today! See a full member benefits listing at sdsma.org. Questions? Email membership@sdsma.org.



Copic Tips: Top Patient Safety Concerns of 2024

ECRI, a leading authority in patient safety, has released its annual report highlighting the top patient safety concerns for 2024. Of the 10 concerns cited, eight involve technologies utilizing forms of artificial intelligence, highlighting AI's rising prominence in the patient safety and medical liability arenas. Copic's summary below aims to provide insights into the identified concerns to mitigate risk and enhance patient safety.



Cybersecurity vulnerabilities in medical devices – Medical devices are increasingly connected to networks, posing cybersecurity risks. Device vulnerabilities can lead to data breaches, patient privacy violations, and potential harm if the devices are compromised. Healthcare facilities must implement comprehensive cybersecurity measures to protect patient data and ensure the safe operation of medical devices.

Alarm, alert, and notification fatigue – The proliferation of alarms, alerts, and notifications in healthcare settings can lead to desensitization among healthcare providers, resulting in missed or delayed responses to critical events. Healthcare organizations should prioritize strategies to reduce unnecessary alarms, customize alerts to individual patient needs, and provide appropriate training to staff to mitigate alarm fatigue.

Injection safety risks with closed-loop medication administration systems – Closed-loop medication administration systems aim to enhance patient safety by automating medication delivery processes; however, errors in programming, configuration, or interoperability issues can introduce risks such as medication errors or delays in treatment. Healthcare facilities should conduct frequent assessments of closed-loop systems, implement safety protocols, and provide adequate training to staff to prevent adverse events.

Missed or delayed diagnosis with point-of-care testing – Point-of-care testing offers rapid diagnostic results, enabling timely interventions. However, reliance on these tests without confirmatory laboratory testing or clinical judgment can lead to missed or delayed diagnoses. To avoid diagnostic errors, point-of-care testing should be used as a complement to traditional diagnostic approaches and results interpreted within the context of the clinical presentation.

Risks associated with wearable health technologies – Wearable health technologies have gained popularity for monitoring various health parameters and promoting wellness. Concerns exist regarding the accuracy, reliability, and privacy of data generated by these devices. Healthcare professionals should educate patients about the limitations of wearable health technologies, encourage critical evaluation of device performance, and integrate data from wearables into clinical decision-making cautiously.

Medication errors related to electronic health record usability – Electronic health records are critical tools in modern healthcare delivery but can contribute to medication errors if they lack user-friendly interfaces or fail to support safe prescribing practices. Healthcare organizations

should prioritize EHR optimization, involve frontline users in system design and customization, and provide ongoing training to healthcare providers to mitigate medication errors associated with EHR usability issues.

Risks associated with remote patient monitoring – Remote patient monitoring enables continuous monitoring of patients outside traditional healthcare settings, offering opportunities for early detection of deteriorating conditions and timely interventions. Challenges include data security breaches, technical malfunctions, and inadequate response protocols, which can compromise patient safety. Healthcare providers should implement cybersecurity measures, ensure interoperability of monitoring devices with existing systems, and establish clear protocols for remote monitoring to maximize its benefits while minimizing risks.

Failure to rescue deteriorating patients – Early recognition and rescue of clinical deterioration is critical in preventing adverse outcomes. Communication failures, inadequate staffing, and gaps in clinical monitoring all contribute to delays. Healthcare organizations should prioritize training in rapid response and escalation protocols, foster a culture of open communication and collaboration among multidisciplinary teams, and invest in technologies that facilitate real-time patient monitoring to improve outcomes.

Unintended retention of foreign objects during surgery – Surgical procedures continue to pose inherent risks of unintended retention of foreign objects (URFOs) despite several adopted risk mitigation strategies. Healthcare teams must adhere to standardized protocols for surgical counts, implement technologies such as radiofrequency identification (RFID) tracking systems, and enhance communication and teamwork to prevent URFOs and improve patient safety.

Inadequate reprocessing of endoscopes and surgical instruments – Improper reprocessing of endoscopes and surgical instruments can result in the transmission of infections. Healthcare facilities must adhere to stringent reprocessing guidelines, ensure proper cleaning, disinfection, and sterilization processes, and invest in technologies that facilitate effective instrument reprocessing to minimize the risk of healthcare-associated infections.

Information in this article is for general educational purposes and is not intended to establish practice guidelines or provide legal advice.



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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.

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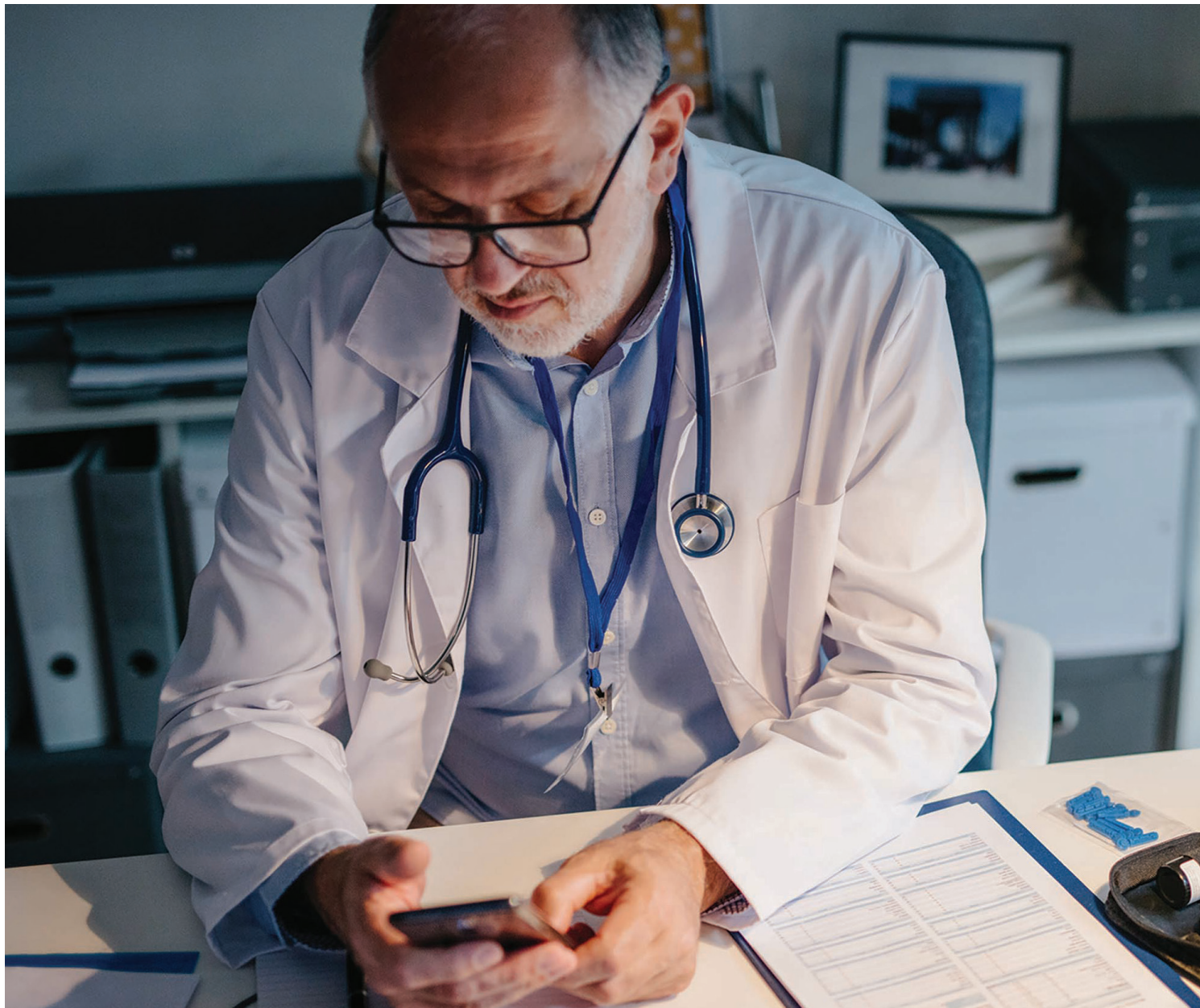
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