JNS SPINE
J Neurosurg Spine 41:559–562, 2024

Neurosurgical Forum

LETTERS TO THE EDITOR

The spectrum of particulate matter exposure in neurosurgical procedures

TO THE EDITOR: We read with great interest the article by Choi et al.[1] (Choi SJ, Seo D, Ham CH, et al. A quantitative analysis of surgical smoke–derived particulate matter and formaldehyde exposure during spine surgery: a possible occupational hazard. *J Neurosurg Spine*. 2024;40[3]:395-402). The authors have done commendable work in demonstrating the health hazards associated with exposure to various sizes of particulate matter (PM). We would like to highlight certain additional aspects that could be emphasized through their article.

As the authors rightly mentioned, the health hazards are imposed not only on surgeons, but also on the nursing staff, technicians, and anesthesiologists alike. The authors must emphasize the different concentrations of PM across the surgical suite/operating room (OR) during various stages of electrocautery. It is important to identify areas within the room that would have lesser or variable PM exposure, e.g., near the main entrance door, near the room vent, and near the instrument trolley. This would give a larger perspective for implementing safety measures according to the level of exposure, e.g., use of additional N95 masks or face shields embedded in the masks may be used by the nursing team or scrub technicians.

Another important aspect to investigate is the PM concentration generated using diathermy over the bone. In spinal fusion/decompression procedures, a significant use of diathermy is to identify the bone anatomy by dissecting the ligamentous tissue off the bone. It would be interesting to note whether the PM concentrations were different when diathermy was used over soft tissue, muscle, and fat versus bony structures. Although not the primary aim of this paper, another source of PM generation that needs to be discussed is drilling of bone.[2] We know that the hazard of PM exposure is high during use of diathermy. The dust generated during drilling of bone also is believed to transmit infectious diseases and pose a long-term health hazard to OR staff.[3] Any measures to reduce smoke exposure would be effective in reducing exposure to bone dust PM as well.

As the authors rightly noted, techniques to reduce occupational hazards from surgical smoke must be actively implemented. The use of a negative pressure–assisted microenvironment surgical hood was first described when COVID-19 was the driving factor for innovation.[4] This device has been tested across various cranial and spinal neurosurgical procedures with demonstration of significant reduction in PM concentration. However, similar methods need to be implemented in the present-day OR to safeguard the health of our caregivers.

Sanjeev Sreenivasan, MD, MCh
Michael Schulder, MD
NorthShore University Hospital and Long Island Jewish Medical Center, Northwell Health, Manhasset, NY

References

1. Choi SJ, Seo D, Ham CH, Kim JH, Kwon WK. A quantitative analysis of surgical smoke–derived particulate matter and formaldehyde exposure during spine surgery: a possible occupational hazard. *J Neurosurg Spine*. 2024;40(3):395-402.
2. Pluim JME, Jimenez-Bou L, Gerretsen RRR, Loeve AJ. Aerosol production during autopsies: the risk of sawing in bone. *Forensic Sci Int*. 2018;289:260-267.
3. Norris BK, Goodier AP, Eby TL. Assessment of air quality during mastoidectomy. *Otolaryngol Neck Surg*. 2011;144(3): 408-411.
4. Patir R, Sreenivasan SA, Vaishya S. Negative pressure assisted microenvironment surgical hood: a novel cost-effective device to minimize aerosol contamination during neurosurgical procedures in times of COVID-19. *World Neurosurg*. 2021;150:153-160.

Disclosures

The authors report no conflict of interest.

Correspondence

Sanjeev Sreenivasan: sanjeev_ariyan@yahoo.com.

INCLUDE WHEN CITING
Published online June 21, 2024; DOI: 10.3171/2024.5.SPINE24551.

Response

I would like to extend my gratitude to Dr. Sreenivasan and Dr. Schulder for their keen interest in our article, which delved into the potential occupational hazards in the OR associated with surgical smoke–derived PM and formaldehyde (HCOH) during spinal surgery. Their insightful comments on our study are immensely appreciated, as they shed light on the key messages we aimed to deliver through our research.

They highlighted several areas that should be subjects for future research that merit attention. Specifically, they mentioned the variability in PM or HCOH levels across different sites within the OR, potentially impacting different OR personnel with varying degrees of risk. We acknowledged this aspect in the discussion section of our article and fully agree with their suggestion that further investigation could inform the implementation of mask-related safety measures in the OR. Additionally, I concur with their observation regarding the significance of varying PM or HCOH levels during diathermy on different tissues, such as subcutaneous fat and muscles. It is well-established that electrocautery on different tissues produces varying levels of surgical smoke,[1] leading to differing levels of PM and HCOH exposure during different stages of spinal surgery. This underscores the importance of future research aimed at enhancing our understanding of surgical smoke–related hazards in spinal surgery. Along similar lines, their insight into the potential PM levels during bone drilling as another distinct OR air condition-related hazard is noted.

I appreciate Dr. Sreenivasan and Dr. Schulder for their positive feedback on our recent research and for offering valuable perspectives on further research directions. Indeed, their remarks highlight the need to progress beyond our current research endeavors aimed at identifying potential hazards in the OR during spinal surgery and toward the development of measures to mitigate existing risks. I trust that our study will serve as an important initial step in this direction.

Woo-Keun Kwon, MD, PhD
Korea University Guro Hospital, Korea University College of Medicine, Seoul, Republic of Korea

References

1. Karjalainen M, Kontunen A, Saari S, et al. The characterization of surgical smoke from various tissues and its implications for occupational safety. *PLoS One*. 2018;13(4):e0195274.

INCLUDE WHEN CITING
Published online June 21, 2024; DOI: 10.3171/2024.5.SPINE24553.

Tranexamic acid in spinal surgery

TO THE EDITOR: We were honored to read the article by Mullin et al.[1] (Mullin JP, Soliman MAR, Smith JS, et al. Analysis of tranexamic acid usage in adult spinal deformity patients with relative contraindications: does it increase the risk of complications? *J Neurosurg Spine*. 2024;40[6]:684-691). In this study, the authors collected data on adult patients who received tranexamic acid (TXA) during spinal deformity correction at 21 medical centers, and evaluated whether the use of TXA in patients undergoing complex spinal deformity correction surgery based on preexisting risk factors for thromboembolism would increase the incidence of thromboembolism, acute myocardial infarction, and stroke complications. We are very grateful for the authors' contribution. However, there are some problems in their paper that need to be further discussed.

First, different routes of administration may affect the effectiveness of TXA. In the study of Yu et al.,[2] the efficacies of oral and intravenous TXA were compared to explore the most effective regimen. The cost of oral drugs is low, and their efficacy is better than that of an intravenous injection. Oral drugs are an alternative to intravenous TXA and may improve the medical cost-effectiveness of the study population. However, in their study Mullin et al. did not mention the impact of different injection methods, which may affect the accuracy of their results.

Second, in their study Zhang et al.[3] showed that intravenous injection of TXA was dose-dependent. Setliff et al.[4] showed that evidence for the use of a standardized dose in spinal surgery was lacking, and Brown et al.[5] showed that before determining the true safety and optimal dose of high-dose TXA, further research is needed. The dose of TXA used by Mullin et al. in their study was not clarified, which may affect the accuracy of the results.

In addition, Mullin et al. did not verify the safety of TXA in spinal reoperations. In their study, Eisinger et al. pointed out that patients using TXA showed worse physiological function and may even have more severe bleeding.[6] If there were no adverse consequences, the safety of TXA would be supported. Therefore, further exploration of the precise mechanism of TXA may help guide its empirical use and allow more targeted applications.

Finally, Mullin et al. also discussed the prophylactic use of TXA. In their study, Alfitian et al. demonstrated that the need for blood transfusion in single-segment fusion surgery is rare, and in high-risk patients undergoing this surgery, the omission of TXA does not affect the need for blood transfusion.[7] Therefore, prophylactic use of TXA is not recommended; instead, alternative blood protection strategies should be used, when necessary.

Finally, we again appreciate the authors for their research and hope that our interpretations and observations will help the readers of this valuable journal.

Cheng Li, MD
Zhikang Tian, MD
School of Clinical Medicine, Jining Medical University, Jining, Shandong, China

Chunyang Meng, PhD
Affiliated Hospital of Jining Medical University, Jining, Shandong, China

References

1. Mullin JP, Soliman MAR, Smith JS, et al. Analysis of tranexamic acid usage in adult spinal deformity patients with relative contraindications: does it increase the risk of complications? *J Neurosurg Spine*. 2024;40(6):684-691.
2. Yu CC, Fidai M, Washington T, Bartol S, Graziano G. Oral is as effective as intravenous tranexamic acid at reducing blood loss in thoracolumbar spinal fusions: a prospective randomized trial. *Spine (Phila Pa 1976)*. 2022;47(2):91-98.
3. Zhang D, Wu X, Kong Q, et al. Prospective randomized controlled trial on the effectiveness of low-dose and high-dose intravenous tranexamic acid in reducing perioperative blood loss in single-level minimally invasive transforaminal

lumbar interbody fusion. Article in Chinese. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi*. 2022;36(4):439-445.
4. Setliff J, Dalton J, Sadhwani S, et al. Examining the safety profile of a standard dose tranexamic acid regimen in spine surgery. *Neurosurg Focus*. 2023;55(4):E16.
5. Brown NJ, Pennington Z, Himstead AS, et al. Safety and efficacy of high-dose tranexamic acid in spine surgery: a retrospective single-institution series. *World Neurosurg*. 2023; 177:e18-e25.
6. Eisinger EC, Forsythe L, Joergensen S, et al. Thromboembolic complications following perioperative tranexamic acid administration. *J Surg Res*. 2024;293:676-684.
7. Alfitian J, Scheyerer MJ, Rohde A, Schick V, Kammerer T, Schier R. Omission of tranexamic acid does not increase the amount of perioperative blood transfusions in patients undergoing one-level spinal fusion surgery: a retrospective propensity score-matched noninferiority study. *Arch Orthop Trauma Surg*. 2023;143(6):2943-2950.

Disclosures

The authors report no conflict of interest.

Correspondence

Chunyang Meng: mengchunyang1600@mail.jnmc.edu.cn.

INCLUDE WHEN CITING
Published online July 5, 2024; DOI: 10.3171/2024.4.SPINE24414.

Response

We thank Dr. Li and his colleagues for their insightful comments on our publication.

Dr. Li et al. had concerns that there are various routes of TXA administration, and this might have impacted our study results. However, we wish to clarify that our paper explicitly stated that all patients received intraoperative intravenous TXA administration. The majority of patients were administered a loading dose of 50 mg/kg followed by a maintenance dose of 5 mg/kg/hr. Furthermore, there was no significant difference in TXA dosage between high-risk and low-risk patients ($p = 0.88$), as outlined in our study results.

Additionally, the authors questioned the efficacy of TXA in causing severe bleeding and its effects on physiological functions. This aspect fell beyond the scope of our study, as both high-risk and low-risk patient groups received TXA during surgery. Level I evidence supports the effectiveness of TXA in reducing blood loss in adult spinal deformity surgery patients, as demonstrated by randomized controlled trials conducted by Peters et al.[1] and Carabini et al.,[2] along with a meta-analysis by Zhang et al.,[3] which highlighted significant reductions in blood loss and transfusions in multilevel spine surgery utilizing TXA. Regarding thromboembolic complications, our study found no significant difference between high-risk and low-risk patients.

We agree with Li et al. that prophylactic TXA may not be necessary in single-level fusion procedures. However, it is essential to note that our study cohort was composed of adult spinal deformity surgery patients undergoing at least seven-level fusions. These surgeries typically entail an average estimated blood loss of 3 L,[4] warranting the use of TXA as per the aforementioned level I evidence.[1–3]

Our article represents the first study to investigate the safety of intraoperative intravenous TXA use in high-risk patients during adult spinal deformity surgery.[1] We anticipate further research in the near future to either corroborate our findings or contribute additional insights to the existing literature.

Jeffrey P. Mullin, MD, MBA[1,2]
Mohamed A. R. Soliman, MD, PhD[1–3]
Esteban Quiceno, MD[1,2]
Justin S. Smith, MD, PhD[4]
Michael P. Kelly, MD[5]
Thomas J. Buell, MD[6]
Bassel Diebo, MD[7]
Justin K. Scheer, MD[8]
Breton Line, BSME[9]
Virginie Lafage, PhD[10]
Renaud Lafage, MS[10]
Eric Klineberg, MD[11]
Han Jo Kim, MD[12]
Peter G. Passias, MD[13]
Jeffrey L. Gum, MD[14]
Khaled Kebaish, MD[15]
Robert K. Eastlack, MD[16]
Alan H. Daniels, MD[7]
Alex Soroceanu, MD[17]
Gregory Mundis Jr., MD[16]
Richard Hostin, MD[18]
Themistocles S. Protopsaltis, MD[13]
D. Kojo Hamilton, MD[6]
Munish C. Gupta, MD, MBA[19]
Stephen J. Lewis, MD[20]
Frank J. Schwab, MD[10]
Lawrence G. Lenke, MD[21]
Christopher I. Shaffrey, MD[22]
Shay Bess, MD[9]
Christopher P. Ames, MD[8]
Douglas Burton, MD[23]
On behalf of the International Spine Study Group
[1]Jacobs School of Medicine and Biomedical Sciences at University of Buffalo, NY
[2]Buffalo General Medical Center, Kaleida Health, Buffalo, NY
[3]Faculty of Medicine, Cairo University, Cairo, Egypt
[4]University of Virginia, Charlottesville, VA
[5]Rady Children's Hospital, San Diego, CA
[6]University of Pittsburgh, PA
[7]Brown University, Providence, RI
[8]University of California, San Francisco, CA
[9]Presbyterian St. Luke's Medical Center, Denver, CO
[10]Lennox Hill Hospital, New York, NY
[11]University of Texas Health Houston, TX
[12]Hospital for Special Surgery, New York, NY
[13]NYU Hospital for Joint Diseases, New York, NY
[14]Leatherman Spine Center, Louisville, KY
[15]Johns Hopkins University, Baltimore, MD
[16]Scripps Clinic, San Diego, CA
[17]University of Calgary, AB, Canada

[18]Baylor Scoliosis Center, Plano, TX
[19]Washington University, St. Louis, MO
[20]University of Toronto and Toronto Western Hospital, Toronto, ON, Canada
[21]Columbia University Medical Center, New York, NY
[22]Duke University, Durham, NC
[23]University of Kansas Medical Center, Kansas City, KS

References

1. Peters A, Verma K, Slobodyanyuk K, et al. Antifibrinolytics reduce blood loss in adult spinal deformity surgery: a prospective, randomized controlled trial. *Spine (Phila Pa 1976)*. 2015;40(8):E443-E449.
2. Carabini LM, Moreland NC, Vealey RJ, et al. A randomized controlled trial of low-dose tranexamic acid versus placebo to reduce red blood cell transfusion during complex multilevel spine fusion surgery. *World Neurosurg*. 2018;110:e572-e579.
3. Zhang Y, Liu H, He F, Chen A, Yang H, Pi B. Does tranexamic acid improve bleeding, transfusion, and hemoglobin level in patients undergoing multilevel spine surgery? A systematic review and meta-analysis. *World Neurosurg*. 2019;127:289-301.
4. Neuman BJ, Ailon T, Scheer JK, et al. Development and validation of a novel adult spinal deformity surgical invasiveness score: analysis of 464 patients. *Neurosurgery*. 2018;82(6):847-853.

INCLUDE WHEN CITING
Published online July 5, 2024; DOI: 10.3171/2024.5.SPINE24447.