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The Impact of Smoking on General Anesthesia: A Literature Review

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Abstract

The interplay between smoking and general anesthesia encompasses significant perioperative risks and complications. This comprehensive review evaluates the physiological consequences of smoking that challenge anesthetic management, including its effects on respiratory and cardiovascular system. We also analyse the impact smoking has on the metabolism of medications commonly used during anasthesia. Common complications of general anesthesia exacerbated by smoking are presented. The review elaborates on the Society for Perioperative Assessment and Quality Improvement 2020 guidelines for preoperative smoking cessation, emphasizing the timing and intensity of interventions, the use of pharmacotherapies, and the benefits of a multidisciplinary approach for improving patient outcomes. Findings underscore the importance of early smoking cessation, which reduces respiratory complications. E-cigarettes as a smoking cessation aid are discussed. Lastly, the paper calls for vigilance in the perioperative management of smokers and the integration of cessation initiatives as a potential "teachable moment" for long-term abstinence.

Keywords: "cigarette smoking"; "anesthesia"; "smoking cessation"; "perioperative."

Introduction

According to the World Health Organisation consumption of tobacco products declined significantly- from 1 in 3 people in 2000 to 1 in 5 in 2022 worldwide. (1) Poland in the early 1990s used to have one of the highest smoking prevalence levels in the world- 70% in men and 30% in women. (2) Now the statistics are better- in 2022 30,8% of men and 27,1% of women admit to smoking. (3) Despite the decline in numbers smokers are still a big population of patients that require special consideration in therapeutic processes due to risk factors associated with smoking. Research has shown that smokers are at a higher risk of experiencing complications during and after surgery compared to non-smokers. In addition, the use of general anesthesia in smokers can pose specific challenges. Cigarette smoking poses a major controllable risk in perioperative settings, leading to increased mortality and morbidity. (4) Dealing with the challenges posed by smoking during anesthesia requires a comprehensive understanding of the interplay between smoking and anesthetic agents, as well as the physiological changes induced by long-term smoking on the body. Therefore, it is essential for healthcare providers to have a detailed understanding of the implications of smoking on general anesthesia to provide the best possible care for patients who smoke. This review aims to summarise the latest state of knowledge regarding the impact that smoking has on anesthesia.

Materials and methods

A review of the scientific literature was conducted by searching the PubMed database to examine the impact of smoking on general anesthesia. The search was limited to articles published within the last 10 years, focusing on those indexed in PubMed, written in English, and falling into categories such as meta-analyses, original research studies, clinical trials, and review articles. Case reports and non-English language articles were excluded from consideration.

Effect of smoking on the human body

Nicotine addiction

One of the primary effects of smoking on the body is nicotine addiction. Nicotine, a highly addictive substance found in cigarettes, acts on the brain to stimulate the release of dopamine,

a neurotransmitter that creates feelings of pleasure and reward. This addictive nature of nicotine can make it difficult for smokers to quit and can lead to continued smoking even in the face of potential health risks associated with surgery. Nicotine dependence often leads individuals towards prolonged use despite being aware of surgical risks. (5)

Cardiovascular system

Smoking accelerates the development of atherosclerotic plaques and endothelial injuries, increasing the risk of coronary artery disease, hypertension, peripheral vascular disease, thromboembolic disease, and stroke. These cardiovascular complications can significantly impact the administration and management of anesthesia, as smoking-induced changes may compromise vital functions like cardiac output, blood pressure regulation, and oxygen delivery, potentially leading to adverse perioperative outcomes and prolonged recovery times

Smoking is also strongly correlated with the prevalence of subarachnoid hemorrhage. (4)

Nicotine causes increased sympathetic stimulation leading to elevated blood pressure, heart rate, and peripheral vascular resistance. Furthermore, harmful chemicals in cigarettes like carbon monoxide can result in vasoconstriction, impaired oxygen delivery, and an increased risk of myocardial infarction and arrythmias during surgery. (6)

Respiratory system

Smoking has a detrimental effect on the respiratory system, leading to decreased lung function, increased airway resistance and reduced lung volumes. Smokers often have underlying chronic obstructive pulmonary disease (COPD) or asthma, which can complicate anesthesia management and increase the risk of postoperative respiratory complications (7)

The inhalation of cigarette smoke causes inflammation and damage to the airway epithelium, resulting in excessive mucus production and impaired mucus clirence, airway hyperreactivity, and impaired gas exchange. These smoking-induced respiratory changes can also manifest as perioperative challenges, such as an increased likelihood of difficult intubation, laryngospasm, and bronchospasm during the administration of general anesthesia (7)

Gastroenteric system

Chronic smoking can affect the resting pressure of the lower esophageal sphincter, raising the risk of gastroesophageal reflux, which could increase the risk of pulmonary aspiration during general anesthesia which is an important safety concern. It can also slow down the rate of gastric emptying. (8)

S. Lazaar et al. concluded acute smoking in regular smokers has no impact on gastric emptying. The study was carried out by subsequent ultrasonographic evaluation of the antral area of the stomach in fasted patients between two smoking sessions. (9)

Influences on the metabolism of medications

Anesthetic agents and medications commonly used during the perioperative period metabolism can be significantly impacted by smoking. Cigarette smoking can induce the activity of hepatic enzymes activity, particularly the cytochrome P450 system, which is responsible for metabolizing many anesthetic agents and other medications used during administering anesthesia. (4) This accelerated drug metabolism can lead to reduced plasma concentrations of certain anesthetics, potentially requiring higher dosing to achieve the desired clinical effect.

The altered metabolism of anesthetic drugs in smokers necessitates careful dose adjustments and vigilant monitoring to maintain appropriate anesthetic depth and duration. Patients who have a history of both current and former smoking tend to experience elevated levels of postoperative pain. Furthermore, due to alterations in metabolism and dysfunction of acetylcholine receptors, smokers necessitate higher doses of opioids during and after surgical procedures, as substantiated by several studies. (10)(11)(12). The quantity of cigarettes smoked per day by active smokers is positively associated with the amount of opioids consumed both during and after surgery. (10)

Shuai Zhao at al. investigated the effects of smoking cessation on postoperative pain levels and the amount of opioids administered to long-time elderly smokers undergoing thoracoscopic lung cancer surgery. They found that smokers experienced higher pain levels than nonsmokers. Smoking cessation 3 or more weeks before surgery improved postoperative pain outcomes better in comparison to a cessation period shorter than 3 weeks. (13)

This association is probably attributed to the impact of nicotine on the body. Nicotine triggers α4β2 nicotinic acetylcholine receptors, leading to a temporary pain-relieving effect. Moreover, cigarette smoke may serve as an indicator of UDP-glucuronyl transferase, an enzyme involved in morphine metabolism. (14) Studies have indicated that smokers experience heightened sensitivity to pain (15). They need higher amounts of remifentanil after nicotine withdrawal. This opioid is not metabolised in the liver which suggest that the reason for its greater demand is deregulation in nicotinic acetylcholine receptors. (14)

A retrospective cohort study from 2017 arrives at different conclusions. It found no significant correlation between total pack- years of cigarette smoking and total dose of opioids (doses of various opioids were converted using standard conversion ratios to determine total opioid dose) administered to patients after lung or laryngeal cancer surgery. The researchers theorise that an important factor to consider is nicotine withdrawal symptoms. They may have affected pain perception in previous studies. (16)

Propofol is commonly used for the induction and maintenance of general ansthesia. Its activity is also affected by the use of cigarettes. It was concluded that current smokers consumed 50% more propofol and past smokers consumed 19% more propofol compared to nonsmokers while under general ansthesia and during the induction. (14)

The underlying mechanisms by which smoking affects pain perception and anesthetic drug pharmacokinetics are not fully understood and warrant further investigation.

Complications

Smoking is a well-established risk factor for these adverse postoperative respiratory outcomes, as the chronic respiratory changes induced by smoking can predispose patients to an increased likelihood of such complications during the perioperative period.

Postoperative pulmonary complications

Postoperative pulmonary complications comprise a range of respiratory issues such as infection, failure, effusion, atelectasis, pneumothorax, bronchospasm, and aspiration. These were clearly defined and standardized by the European joint task force in 2015. (17)Smoking is a well-established risk factor for these adverse postoperative respiratory outcomes due to the chronic changes it induces in the respiratory system, increasing the likelihood of complications

during the perioperative period. Smokers have over 10 times more instances of PPCs while ex-smokers are twice as likely compared to non-smokers. Ceasing smoking has been shown to reduce the risk of PPCs by 23% if lasting >4 weeks and by 47 % if over 8 weeks. (12)Additionally, smokers have higher rates of postoperative pneumonia, respiratory failure, and reintubation compared to non-smokers

The heightened susceptibility to postoperative pulmonary complications in smokers stems from the multifaceted detrimental effects of chronic cigarette use on respiratory physiology which results in an increased risk of atelectasis and weakened respiratory muscle function and compromises the cough mechanism.(18)

Furthermore, smoking alters the immune response and increases airway inflammation, leaving the lungs more vulnerable to infection. (20)A large retrospective analysis of over 300,000 surgical patients found that current smokers had a 40% higher risk of respiratory complications compared to non-smokers, while former smokers still exhibited a 20% increased risk (7)

The increase in mortality in patients who developed PPC is significant- 14-30% of them will die in 30 days from major surgery which is a striking statistic that shows the need for minimization of probability of PPC occurrence. (18)

Post-operative cognitive dysfunction (POCD)

A condition is described as a mild decline in cognitive function that occurs following the recovery from the immediate effects of surgery.(20) It can persist for a period ranging from 1 month to 1 year after the procedure, with elderly patients being most commonly affected. Studies have linked it to pre-existing cognitive impairment, cardiovascular diseases, and cerebrovascular diseases. The specific mechanism by which POCD develops is not fully understood; however, there are speculations that it may be related to hypoxemia, elevated levels of stress hormones and an inflammatory response triggered by surgery. (20) POCD is equally likely to occur after both general and local anesthesia. (21)Smoking has been identified as a potential risk factor for POCD, with statistical differences observed in the prevalence between smokers and non-smokers. (22) This could be attributed to nicotine's impact on nicotinic acetylcholine receptors mediated by α7nAChR, leading to inhibition of HMGB1-NF-κB signalling pathway that may contribute to the onset of POCD.(23)

Opposing findings were presented by Wang, et al.(24) According to this article history of smoking decreases risk of POCD because of immune-supresory activity of nicotine through the cholinergic anti-inflammatory pathway. It leads to decreased levels of TNF-α which is associated with neuroinflammation possibly leading to POCD- the article found elevated levels of TNF-α in patients with POCD. (24)

The impact of smoking on postoperative cognitive function remains unclear, with conflicting findings reported in the literature. This highlights the complex and not yet fully understood relationship between smoking and postoperative outcomes.

PONV

PONV stands for postoperative nausea-vomiting is one of the complications of anasthesia influenced by the smoking status of the patient. Smoking status is one of the factors considered in Apfel – a simplified scoring system used to determine the probability of PONV. (25) (26) The exact mechanism by which smoking reduces the risk of PONV is not known. Whalen et al found no correlation between recent smoking (measured by exhaled CO levels) and PONV and concluded that recent cigarette smoke exposure does not protect against PONV. More likely this happens due to chronic exposure through changes in nicotine receptors in CNS. (27) Other theory states that due to the gradual desensitization of the chemoreceptor trigger zone caused by repeated exposure to chemicals in cigarette smoke, regular smokers have decreased probability of developing PONV as a reaction to drugs such as opioids used during anesthesia. (28)

Laryngospasm

Laryngospasm is a condition characterized by the involuntary closure of the vocal cords, resulting in airway obstruction and leading to hypoxia. This life-threatening complication can occur at any phase of the anesthesia process, from induction to emergence, and is particularly common among pediatric patients. (29)Research conducted by Sibel Seckin Pehlıvan et al. indicated that laryngospasm occurs more often in children exposed to passive smoking. Their study revealed that 16.4% of children whose parents exposed them to passive smoking at home had experienced laryngospasm, with the most affected age group being 1-11 years old. It was postulated that these children spend significant time with their parents and consequently have

higher exposure to cigarette smoke. Notably, no patient in the control group experienced laryngospasm. (30)

Wound healing

Smoking has well-documented effects on wound healing, which can pose challenges in the perioperative period. Impaired wound healing and increased risk of surgical site infections are significant concerns for patients undergoing anesthesia. The vasoconstrictive and inflammatory effects of smoking can lead to decreased tissue oxygenation and compromised immune response, impacting the healing process and predisposing smokers to delayed wound healing and higher rates of postoperative complications. It was determined that smokers are 30% more likely than non-smokers to have surgical site infections and 65% more likely to develop wound disruption. (31)

Perioperative cigarette cessation guidelines

Given the impact of smoking on perioperative outcomes, addressing smoking cessation as part of preoperative optimization is crucial.

In 2020 Society for Perioperative Assessment and Quality Improvement (SPAQI) published a consensus on perioperative smoking cessation. Its recommendations state the following:

- Smoking cessation and intervention leading to it should happen as soon as possible in relation to scheduled surgery. The longer the period of cessation the better but 4-8 week long cessation are associated with decreased probability of respiratory complications and impaired wound healing. (32) Interventions can be safely implemented at any time before surgery- contrary to long-held beliefs smoking cessation shortly before surgery does not increase cough, sputum production and complication rates. (32)long-held

- Ideally, high-intensity smoking cessation interventions should be implemented. (32)

- There should be a multidisciplinary approach towards smoking cessation- primary care physicians, surgeons and anesthesiologists should all counsel smoking patients (32)

- Nicotine replacement therapy and other medication (such as bupropion and varenicline) that help to mitigate nicotine withdrawal symptoms when paired with behavioural interventions are effective and can be used for smoking cessation. (32)

In the long term, high-intensity preoperative interventions that are continued in the postoperative period are more effective. (33) (36)

E-cigarettes seem to be among the most effective pharmacotherapies for quitting smoking when compared to other forms of nicotine replacement therapy. (33) (34)However, there is still insufficient research regarding the long-term effects and safety of using e-cigarettes. (26) It's important to note that perioperative smoking cessation can serve as a "teachable moment" and a unique opportunity for achieving long-term cessation. (35) Research has shown that perioperative smoking cessation interventions were effective not only in supporting individuals to quit before surgery but also during 1-year follow-ups. (36)

Multidisciplinary Approach

Effective management of smokers undergoing general anesthesia involves a multidisciplinary approach. Collaboration between anesthesiologists, surgeons, nurses, and smoking cessation specialists is essential to address the complex challenges associated with smoking in the perioperative setting. The comprehensive care team can develop tailored perioperative strategies, provide patient education, and offer support for smoking cessation to optimize patient outcomes.

Conclusion

The impact of smoking on patients undergoing general anesthesia extends beyond respiratory and cardiovascular considerations, encompassing pharmacokinetic influences, wound healing, and perioperative complications. A thorough understanding of the effects of smoking on anesthesia management is imperative for healthcare providers to deliver safe and effective perioperative care for smokers. By integrating specialized approaches and comprehensive support, the healthcare team can mitigate the adverse effects of smoking and enhance the overall surgical experience and outcomes for patients who smoke.

Closing remarks

As the understanding of the intricate relationship between smoking and general anesthesia continues to evolve, it is imperative for healthcare providers to remain updated with the latest evidence and guidelines. By integrating this knowledge into clinical practice, anesthesiologists and perioperative teams can optimize patient care and safety, for individuals with a history of

smoking. This comprehensive review aims to address these nuanced considerations in the context of administering general anesthesia to patients who smoke, emphasizing the need for tailored approaches and vigilant perioperative management.

Disclosure

Statement of the author's contribution

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The authors deny any conflict of interest.

Literature

(1) Tobacco use declines despite tobacco industry efforts to jeopardize progress https://www.who.int/news/item/16-01-2024-tobacco-use-declines-despite-tobacco-industry-efforts-to-jeopardize-progress [acces 13.06.2024]

(2) Zatoński, W., and Zatoński, M. (2020). Poland as the country with the steepest decline in per capita cigarette consumption in Europe. Tobacco Prevention & Cessation, 6(Supplement), A102. https://doi.org/10.18332/tpc/128479

(3) Wzrasta odsetek Polaków palących papierosyhttps://www.mp.pl/pacjent/pulmonologia/aktualnosci/320660,wzrasta-odsetek-polakow-palacych-papierosy [access 13.06.2024]

(4) Carrick, M. A., Robson, J. M., & Thomas, C. (2018). Smoking and anaesthesia. *BJA Education*, *19*(1), 1-6. https://doi.org/10.1016/j.bjae.2018.09.005

(5) Benowitz, N. L. (2010). Nicotine Addiction. New England Journal of Medicine, 362(24), 2295–2303. doi:10.1056/nejmra0809890

(6) Chen, S., Yang, F., Xu, T., Wang, Y., Zhang, K., Fu, G., & Zhang, W. (2023, January 26). Smoking and coronary artery disease risk in patients with diabetes: A Mendelian randomization study. Frontiers Media, 14. https://doi.org/10.3389/fimmu.2023.891947

(7) Siow, M Y., Zhou, P L., Horn, S R., Poorman, G W., Suré, A., Kim, J., Buckland, A J., Errico, T J., & Passias, P G. (2017, October 1). The Effects of Smoking on Outcomes Following Cervical Decompression. Elsevier BV, 17(10), S248-S249. https://doi.org/10.1016/j.spinee.2017.08.163

(8) Enderes J, Teschke J, von Websky M, Manekeller S, Kalff JC, Glowka TR. Active smokers show ameliorated delayed gastric emptying after pancreatoduodenectomy. BMC Surg. 2021 Jul 31;21(1):316. doi: 10.1186/s12893-021-01311-2.

(9) S. Lazaar, E. Boselli, D. Chassard, B. Allaouchiche, L. Bouvet, Effect of acute cigarette smoking on gastric contents in regular smoker volunteers. A prospective randomized cross-over study, *BJA: British Journal of Anaesthesia*, Volume 115, Issue 4, October 2015, Pages 590–594, https://doi.org/10.1093/bja/aev264

(10) Wang, Yi-Chien[a,b]; Wang, Chien-Wun[a,b]; Wu, Hsiang-Ling[c,d]; Cata, Juan P.[e]; Huang, Shih-Yu[a,b]; Wu, Yu-Ming[a,b]; Chen, Jui-Tai[a,b]; Cherng, Yih-Giun[a,b]; Tai, Ying-Hsuan[a,b,*]. Cigarette smoking, opioid consumption, and pain intensity after major surgery: An observational study. Journal of the Chinese Medical Association 86(4):p 440-448, April 2023. | DOI: 10.1097/JCMA.0000000000000895

(11) Kim, S., Sim, J. H., Kim, Y., Choi, S., Kim, H., & Leem, G. (2020). Association between Postoperative Opioid Requirements and the Duration of Smoking Cessation in Male Smokers after Laparoscopic Distal Gastrectomy with Gastroduodenostomy. Pain Research and Management, 2021(1), 1541748. https://doi.org/10.1155/2021/1541748

(12) Armstrong, April D. MD, MSc, FRCSC[*]; Hassenbein, Susan E. CCRP[*]; Black, Sarah MD[‡]; Hollenbeak, Christopher S. PhD[§]. Risk Factors for Increased Postoperative Pain

and Recommended Orderset for Postoperative Analgesic Usage. The Clinical Journal of Pain 36(11):p 845-851, November 2020. | DOI: 10.1097/AJP.0000000000000876

(13) Zhao S, Chen F, Wang D, Wang H, Han W, Zhang Y. Effect of preoperative smoking cessation on postoperative pain outcomes in elderly patients with high nicotine dependence. Medicine (Baltimore). 2019 Jan;98(3):e14209. doi: 10.1097/MD.0000000000014209

(14) ÖZTÜRK, E., AYDOĞAN, M. S., KARAASLAN, K., DOĞAN, Z., & TOPUZ, U. (2019). Does smoking increase the anesthetic requirement? Turkish Journal of Medical Sciences, 49(5), 1271-1276. https://doi.org/10.3906/sag-1602-57

(15) Lugg, S. T., Tikka, T., Agostini, P. J., Kerr, A., Adams, K., Kalkat, M. S., Steyn, R. S., Rajesh, P. B., Bishay, E., Thickett, D. R., & Naidu, B. (2017). Smoking and timing of cessation on postoperative pulmonary complications after curative-intent lung cancer surgery. Journal of Cardiothoracic Surgery, 12. https://doi.org/10.1186/s13019-017-0614-4

(16) Oh TK, Jeon JH, Lee JM, Kim MS, Kim JH, Lee SJ, et al. Chronic smoking is not associated with increased postoperative opioid use in patients with lung cancer or esophageal cancer. Pain Physician. 2018;21:e49–55.

(17) Jammer I, Wickboldt N, Sander M, Smith A, Schultz MJ, Pelosi P, Leva B, Rhodes A, Hoeft A, Walder B, Chew MS, Pearse RM; European Society of Anaesthesiology (ESA) and the European Society of Intensive Care Medicine (ESICM); European Society of Anaesthesiology; European Society of Intensive Care Medicine. Standards for definitions and use of outcome measures for clinical effectiveness research in perioperative medicine: European Perioperative Clinical Outcome (EPCO) definitions: a statement from the ESA-ESICM joint taskforce on perioperative outcome measures. Eur J Anaesthesiol. 2015 Feb;32(2):88-105. doi: 10.1097

(18) A. Miskovic and A. B. Lumb Postoperative pulmonary complications * British Journal of Anaesthesia, 118 (3): 317–34 (2017) doi: 10.1093/bja/aex002

(19) Tupper, H I., & Velotta, J B. (2023, May 1). Expanding clinicians' armamentarium for regional pain control after thoracic surgery. AME Publishing Company, 15(5), 2359-2362. https://doi.org/10.21037/jtd-23-344

(20) Brodier, E. A., & Cibelli, M. (2021). Postoperative cognitive dysfunction in clinical practice. *BJA Education, 21*(2), 75-82. https://doi.org/10.1016/j.bjae.2020.10.004

(21) Guay J. General anaesthesia does not contribute to long-term post-operative cognitive dysfunction in adults: A meta-analysis. Indian J Anaesth. 2011 Jul;55(4):358-63. doi: 10.4103/0019-5049.84850. PMID: 22013251; PMCID: PMC3190509.

(22) Yu, Q., Zhu, H., Yang, X., Gong, W., Yu, H., Wu, Y., Dong, L., & Zhu, Q. (2022). Study on painless gastroscopy and POCD of smoking patients under general anesthesia. *Ibrain*, *8*(3), 276-284. https://doi.org/10.1002/ibra.12041

(23) Wang Z, Liu T, Yin C, Li Y, Gao F, Yu L, Wang Q. Electroacupuncture Pretreatment Ameliorates Anesthesia and Surgery-Induced Cognitive Dysfunction via Activation of an α7-nAChR Signal in Aged Rats. Neuropsychiatr Dis Treat. 2021 Aug 10;17:2599-2611. doi: 10.2147/NDT.S322047. PMID: 34413646; PMCID: PMC8370114.

(24) Wang, R., Wang, G., Liu, Y., & Zhang, M. (2019). Preoperative smoking history is associated with decreased risk of early postoperative cognitive dysfunction in patients of advanced age after noncardiac surgery: A prospective observational cohort study. *The Journal of International Medical Research*, *47*(2), 689-701. https://doi.org/10.1177/0300060518808162

(25) Darvall J, Handscombe M, Maat B, So K, Suganthirakumar A, Leslie K. Interpretation of the four risk factors for postoperative nausea and vomiting in the Apfel simplified risk score: an analysis of published studies. Can J Anaesth. 2021 Jul;68(7):1057-1063. English. doi: 10.1007/s12630-021-01974-8. Epub 2021 Mar 15. PMID: 33721198.

(26) Weibel S, Rücker G, Eberhart LH, Pace NL, Hartl HM, Jordan OL, Mayer D, Riemer M, Schaefer MS, Raj D, Backhaus I, Helf A, Schlesinger T, Kienbaum P, Kranke P. Drugs for preventing postoperative nausea and vomiting in adults after general anaesthesia: a network meta-analysis. Cochrane Database Syst Rev. 2020 Oct 19;10(10):CD012859. doi: 10.1002/14651858.CD012859.pub2. PMID: 33075160; PMCID: PMC8094506.

(27) Whalen, Francis MD; Sprung, Juraj MD; Burkle, Christopher M. MD; Schroeder, Darrell R. MS; Warner, David O. MD. Recent Smoking Behavior and Postoperative Nausea and Vomiting. Anesthesia & Analgesia 103(1):p 70-75, July 2006. | DOI: 10.1213/01.ane.0000221435.14002.4c

(28) Shaikh SI, Nagarekha D, Hegade G, Marutheesh M. Postoperative nausea and vomiting: A simple yet complex problem. Anesth Essays Res. 2016 Sep-Dec;10(3):388-396. doi: 10.4103/0259-1162.179310

(29) Chekol, W B., & Melesse, D Y. (2020, January 24). Incidence and Associated Factors of Laryngospasm among Pediatric Patients Who Underwent Surgery under General Anesthesia, in University of Gondar Compressive Specialized Hospital, Northwest Ethiopia, 2019: A Cross-Sectional Study. Hindawi Publishing Corporation, 2020, 1-6. https://doi.org/10.1155/2020/3706106

(30) Sibel Seckin Pehlıvan, Ozlem Oz Gergın, Adnan Bayram, Derya Altay, Duran Arslan, Cihangir Biçer, Recep Aksu The effect of passive smoking on the laryngospasm rate in children sedated during the esophagogastroduodenoscopy Saudi Medical Journal Mar 2022, 43 (3) 275-282; DOI: 10.15537/smj.2022.43.3.20210784

(31) Fan Chiang YH, Lee YW, Lam F, Liao CC, Chang CC, Lin CS. Smoking increases the risk of postoperative wound complications: A propensity score-matched cohort study. Int Wound J. 2023 Feb;20(2):391-402. doi: 10.1111/iwj.13887.

(32) Wong, Jean MD[*,†]; An, Dong BMSc[*]; Urman, Richard D. MD, MBA[‡]; Warner, David O. MD[§]; Tønnesen, Hanne MD, PhD[‖,¶]; Raveendran, Raviraj MBBS[#]; Abdullah, Hairil R. MBBS[**]; Pfeifer, Kurt MD, FACP, SFHM[††,‡‡]; Maa, John MD[§§,‖‖]; Finegan, Barry MD[¶¶]; Li, Emily BScPharm, PharmD[##]; Webb, Ashley MBBS, MPH[***,†††]; Edwards, Angela F. MD[‡‡‡]; Preston, Paul MD[§§§]; Bentov, Nathalie MD, MA[‖‖,¶¶¶]; Richman, Deborah C. MBChB[††,###]; Chung, Frances MBBS[*]. Society for Perioperative Assessment and Quality Improvement (SPAQI) Consensus Statement on Perioperative Smoking Cessation. Anesthesia & Analgesia 131(3):p 955-968, September 2020. | DOI: 10.1213/ANE.0000000000004508

(33) Harrogate, S., Barnes, J., Thomas, K., Isted, A., Kunst, G., Gupta, S., Rudd, S., Banerjee, T., Hinchliffe, R., & Mouton, R. (2023). Peri-operative tobacco cessation interventions: A systematic review and meta-analysis. *Anaesthesia*, *78*(11), 1393-1408. https://doi.org/10.1111/anae.16120

(34) Hartmann-Boyce J, Lindson N, Butler AR, McRobbie H, Bullen C, Begh R, Theodoulou A, Notley C, Rigotti NA, Turner T, Fanshawe TR, Hajek P. Electronic cigarettes for smoking cessation. Cochrane Database Syst Rev. 2022 Nov 17;11(11):CD010216. doi: 10.1002/14651858.CD010216.pub7. Update in: Cochrane Database Syst Rev. 2024 Jan 8;1:CD010216. doi: 10.1002/14651858.

(35) Yousefzadeh, Amir MD*; Chung, Frances MD, FRCPC*; Wong, David T. MD, FRCPC*; Warner, David O. MD†; Wong, Jean MD, FRCPC*. Smoking Cessation: The Role of the Anesthesiologist. Anesthesia & Analgesia 122(5):p 1311-1320, May 2016. | DOI: 10.1213/ANE.0000000000001170

(36) Lee, Susan M. MD, FRCPC; Landry, Jennifer MD, FRCPC; Jones, Philip M. MD, FRCPC, MSc (Clinical Trials); Buhrmann, Ozzie BScPhm, RPh; Morley-Forster, Patricia MD, FRCPC. Long-Term Quit Rates After a Perioperative Smoking Cessation Randomized Controlled Trial. Anesthesia & Analgesia 120(3):p 582-587, March 2015. | DOI: 10.1213/ANE.0000000000000555