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Original Research Article

IMPACT OF REGIONAL ANESTHESIA ON IMMUNE FUNCTION AND CANCER RECURRENCE

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Abstract: ***Background:*** Regional anesthesia has also gained some attention concerning its potential impact beyond pain management, its impact on postoperative immune capacity, and the long-term prognosis of cancer. Surgical stress, opioids have been found to reduce immunity and may affect cancer recurrence. One should know how clinicians perceive these effects to inform the anesthesia practice in oncology.O***bjectives:*** The aim of the research was to evaluate the perception of healthcare specialists in relation to the impact of regional anesthesia on immune functions and cancer recurrence, and to evaluate the reliability and validity of the measurement tool. The study has also examined the importance of demographic and professional aspects of these impressions. ***Methods:*** The study was conducted in a cross-sectional type of study, where a structured questionnaire was the method of conducting the study, and a Likert-scale-based questionnaire was utilized that included categorical variables. The interviewees were anesthesiologists, surgeons, oncologists, and trainees (222 medical workers participated). T-tests: Shapiro Wilk tests were applied to check the normality test, Cronbach Alpha has been applied to check the reliability test, KMO tests and the Bartlett Test were applied to check the test of validity and inflated tests were also used to analyze the data, i.e., Independent Samples t- Tests, One-Way ANOVA and Kruskal-Wallis, Chi-Square tests, Pearson and multiple regressions. ***Results:*** The findings indicated high positive expectations of the revenue of regional anesthesia to alleviate stress, retain immunity, and possibly affect cancer relapse. Internal consistency was also high ($\alpha = 0.873$), whereas validity tests revealed that the constructs were suitable (KMO = 0.742; Bartlett $p < 0.001$). The differences concerning gender, profession, and clinical experience were significant. The correlations between key variables were positive and demonstrated the existence of interconnected perceptions, and the results of regression analysis showed that immune preservation was the best predictor of the overall perception. ***Conclusion:*** It has been concluded that the popular assumption regarding Regional anesthesia as a good practice is that it leads to a positive effect on the immune activities and thus can lessen the risks of cancer recurrence. These findings have indicated the relevance of supplemental learning, perception, and further clinical research work so as to improve evidence-based anesthesia care delivery in cancer.

Keywords: Regional anesthesia; Immune functioning; Cancer recurrence; Surgical stress; Perioperative care; Reliability; Validity; Healthcare perceptions; regression analysis; Inferential statistics.

INTRODUCTION

One of the diseases that has contributed to high morbidity and mortality in the world is cancer, and excising the primary tumor is a major part of the curative treatment of most diseases. However, a growing body of evidence has suggested the perioperative period as an important aspect of

oncological outcome in the long run. The physiological and immunological changes that transpire and take place during the surgery may inadvertently contribute to the tumor proliferation, fail to detect immunity, and increase the possibility of recurrence of cancer. It is the release of stress hormones, inflammatory mediators, as well as immunosuppressive cytokines, which is a response to surgical trauma in the form of an acute stress response. These fluctuations can undermine cell-mediated immune reaction, particularly natural killer (NK) cells reaction which are essential in the annihilation of tumours in circulation and micrometastatic disease. In this way, the means of reducing the state of perioperative immunosuppression has become a leading focus of clinical research (Bezu et al., 2025).

Regional anesthesia phenomenon has turned out to be an inviting and promising operation capable of influencing the functioning of immunity and prognosis of cancer in the long run. The neuroendocrine stress response involves less inhibition of afferent nociceptive pathways compared to general anesthesia when regional methods are employed, i.e., epidural, spinal, para-vertebral, and peripheral nerve blocks. Postoperative immune potential would be improved by lowering catecholamine and cortisol secretions through regional anesthesia. In addition, regional anesthesia allows avoiding the use of systemic opioids that are said to inhibit key immune functions, including NK-cell cytotoxicity, T- T-lymphocyte functioning, and macrophage responsiveness. So far, this opioid-sparing has provoked much interest because it can be indirectly employed to provide improved cancer follow-ups postoperatively (Kisdyanti et al., 2025).

These physiological benefits can be added to the recent laboratory results, which show that even the local anesthetics possess their own anti-tumor effects. It has been demonstrated that lidocaine and bupivacaine agents can exhibit the ability to reduce cell growth and viability, body movements, and induce apoptosis in cancer cells within various tumor systems. These kinds of outcomes have led to increased interest regarding the potential oncological use of the concept of regional anesthesia in the treatment of cancer during perioperative. In spite of the encouraging outcomes of the preclinical research, the clinical research on the topic has not provided a definite answer, and the results of randomized trials applied in different types of cancer are rather inconsistent. Nevertheless, the biological plausibility and the potential far-reaching shifts in the outcomes in the patients are one of the arguments that have to be promoted to make healthcare providers consider regional anesthesia as a technique of increasing the number of survival and recovery of cancer patients (Fagundes et al., 2025).

There is therefore a need to comprehend the perceptions and the knowledge of clinical personnel on immunological and oncological implications of the regional anesthesia. The application of anesthesia techniques and methodology is important and highly influenced by anesthetists, surgeons, and other professionals in the perioperative department, who are capable of influencing patient care pathways. These beliefs and preferences, and the knowledge of the available evidence, could have a direct implication on the clinical decision-making and the use of regional anesthesia in oncologic surgery. Such perceptions may be evaluated not only to illuminate the current trends of the practice level but also to provide the points where further training should be planned, or further development of research should be encouraged, or even the new policy should be developed and implemented (Khamdamov et al., 2025).

The study of the perceived impact of regional anesthesia on the immune system and the recurrence of cancer is a topical and interventional issue, given that the significance of maximizing perioperative care is increasingly gaining popularity in improving the outcome of cancer. The suggested study will presumably contribute to the existing literature by assessing the knowledge level of the professionals practicing healthcare, identifying the factors affecting it, and discussing the clinical implications of regional anesthesia in cancer surgery in general. Lastly, this study will be dedicated to maintaining evidence-based practices, which will foster patient, immune, and cancer control in the long term (Nguyen et al., 2025).

Literature Review

The association of approaches towards anesthesia and long-term cancer is one of the scientific subjects that has led to the increasing scientific interest over the past two decades. Even though surgery is regarded as a must in the elimination of the primary tumors, it might therefore be favoring the environment, which leads to recurrence of cancer and its proliferation. Other researchers have discovered as well that surgical trauma results in severe neuroendocrine stress that is characterized by catecholamine surges, cortisol surges, and inflammatory cytokines. These reactions play a significant role in compromising cell-mediated immunity, which is highly important in the process of detecting and destroying tumor cells in circulation (CTCs). Among them, a particular type of cell, the natural killer (NK) cells, is very sensitive to perioperative immunosuppression, and the impairment of the NK-cell functionality has been found to elevate the likelihood of metastatic growth. This has led scientists to investigate whether regional anesthesia (RA), with regard to its capability to

suppress the physiological stress response, can be useful in saving the postoperative immune system and reducing the likelihood of new occurrences of cancer (Singh & Kumar, 2025).

Other studies suggest that regional anesthesia has beneficial immunological responses due to blocking the transmission of afferent nociceptive fibres and therefore the sympathetic response. RA also inhibits the immunosuppressive responses to surgical stress through the inhibition of excess catecholamine secretion. Sessler et al. highlighted that with the aid of epidural or spinal anesthesia, there would be major capulet affirms of perioperative levels of stress hormones or hormones over general anesthesia, which results in the preservation of the NK-cell activity. Moreover, RA approaches also lead to less opioid systemic usage, which was discovered to suppress the NK-cell cytotoxicity, T- T-lymphocytes proliferation/development, and macrophages reactivity. The mentioned effect on opioid sparing has been placed in the vanguard supporting the use of the RA as a surgical modality in cancer, since they have been suggested to play four roles in promoting angiogenesis and intermediating tumor progression as a result of stimulating the μ-opioid receptor. By so doing, RA will tend to enhance an immune state which is desirable within the best perioperative period (Nunez-Rodriguez et al., 2025).

There is currently emerging evidence in addition to the role of immune regulation of the anti-cancer effect of local anesthetics per se. The inhibition of cancer cell migration, proliferation, and metastasis is evidenced in lab experiments when lidocaine, bupivacaine, and ropivacaine prevent cancerous migration, proliferation, and metastasis, inhibiting them through different mechanisms. An example of this would be with lidocaine, which was shown to be an interference with the Voltage-gated sodium channels involved in tumor cell invasion. Bupivacaine is the one that causes apoptosis via the mitochondrial pathways. Those discoveries have given rise to interest in the systematic application of lidocaine infusion in surgery for cancer. Several clinical studies have explored this possibility and have demonstrated that the inflammatory markers are minimized and postoperative immunophenotype enhanced in patients receiving lidocaine infusion. Although the consistency of the results is not as high as it could be, the prospect of the anti-tumor effect of local anesthetics is among the promising lines of its investigation (Ramly & Buggy, 2025).

The experimental results on how the usage of RA on the recurrence of cancer have produced varied findings. The initial retrospective studies had revealed that RA may help reduce postoperative recurrence of breast, prostate, and colorectal cancer. Accordingly, Exadaktylos et al. demonstrated that breast cancer recurrence was significantly reduced in patients who were treated with paravertebral block with GA compared to those who had been treated with GA. The identical trends were observed among the patients receiving an epidural anesthesia during the surgery for prostate cancer. Big randomized controlled trials (RCTs) have, instead, provided more contradictory findings, which ensued. Sessler et al. conducted one of the first large-scale RCTs to date, where paravertebral anesthesia with propofol rather than sevoflurane-opioid was compared in breast cancer surgery, and did not observe any difference in the rate of recurrence. These differences drive home the point that it is not so easy to distinguish the effects of anesthesia among other perioperative factors, e.g., tumor biology, comorbidities, and adjuvant therapies (Lin et al., 2025).

Even though RCTs have not been able to consistently demonstrate the reduction of recurrence, the vast majority of them have demonstrated quantifiable immunological advantages in RA. An analysis of the literature has identified that, despite the uncertainty about the long-term outcome in oncology, RA improves the early postoperative immune markers, including NK-cell activity. That is, there can be temporary immunoprotective activities of RA that are biologically plausible but not inextricably linked to overt effects of survival. In addition, variations in RA method, selection of the medicines, time, as well as the correlation and relationship with other pain medicines may contribute to discrepancies found in clinical trials (Deng et al., 2025).

The second parameter that has recently been analyzed according to the recent literature is the contribution of the effect of perioperative inflammation to tumor progression. Postoperative inflammation can also enhance tumor cell adhesion, angiogenesis, and create a microenvironment that would facilitate metastasis. RA was also proven to reduce the level of pro-inflammatory cytokines such as IL-6 and TNF-α, which are likely to harbor the conditions that favour the growth of tumours. It has also been discovered that enhanced incorporation of RA in the enhanced recovery after surgery (ERAS) routes contributes to its impact in reducing the postoperative complications, pain, and inflammation (Gottumukkala & Gan, 2025).

Overall, the literature will show the increase of the consensus that RA has immunological and physiological benefits that may help cancer patients achieve better results, although some conclusive evidence of such opinion in terms of RCTs remains inconclusive. The necessity to further investigate the use of RA as a significant component of multimodal analgesia in cancer surgery has also been raised by scholars. The potential interaction of the RA with the

opioid-minimization, as well as the immune-preservation, is indicative of the relevance of the present study in the area. It has been implied that RA is a facilitating aspect with respect to optimization of perioperative factors in cancer patients, and future studies could facilitate the development of its importance over time in recurrence and survival (Cheng et al., 2025).

MATERIALS AND METHODS

Study Design

The research study will use the cross-sectional observational research design because the study will be investigating the relationship that exists between the regional anesthesia methods, post-operative immune functions, and the potential effects they have on cancer recurrence. The design is appropriate because it provides an opportunity to gather the data of a significant number of healthcare professionals at a single time point and identify the trends, perceptions, and associations without influencing clinical variables. Besides, this type of design can support the research of subjective clinical experiences and expertise, which is essential when examining the intricate interactions, such as anesthesia-linked immune modulation and oncologic outcomes (Brogi & Forfori, 2022).

Study Population and Sampling

The targeted group that will take part in this research involves anesthesiologists, surgeons, oncologists, and residents/medical trainees who have to deal with perioperative cancer care. The sample members will be identified in terms of a non-probability convenience approach due to access to healthcare organizations and ease of delivering questionnaires. The sample size will be composed of a minimum of 200-300 respondents, and this is sufficient to represent the needed respondents and achieve a good statistical power. The inclusion criteria will consider medical professionals who have some clinical experience in imparting or monitoring regional anesthesia during the process of surgery for cancer. The participants who are not ready to answer the questions informally and remain unexposed to the perioperative management of cancer will be filtered out (Choi & Hwang, 2024).

Data Collection Tool

Data collection will be done using a self-administered questionnaire, which is a structured questionnaire that will be designed with respect to this particular research. The questionnaire consists of demographic data, the data on the knowledge of the subject of the topic of regional anesthesia, the data about the perception of the effects of the type of anesthesia on cancer recurrence, and the obstacles posed by the factors to the application of the regional anesthesia (Qadoos et al., 2025). The questionnaire relies on the Likert-scale entries of questionnaires, the closed-ended questions, and the multiple-choice questionnaires, and the shift of trends and correlations may be quantitatively determined. The expert consideration among anesthesiologists and oncology researchers, as well as a pilot study involving a small sample, will make the content validity of the instrument attainable and will assist in addressing helping to refine the instrument and elucidating its validity (Longhini et al., 2020).

Data Collection Procedure

The questionnaire will be distributed to the respondents in the area of a clinical setting electronically and on paper. The respondents will be informed about the study, and their privacy will be guaranteed. Their involvement will be voluntary, and personal information that can be identified will not be collected. The questionnaire is likely to be 8 to 10 minutes. The questionnaires filled out will be subsequently gathered and kept in good security in order to be examined (Cata et al., 2020).

Data Analysis

Results obtained will be computed in Microsoft Excel, SPSS, or R computer programmes. Descriptive statistics would be used to summarize the demographics and patterns of responding, and it would comprise frequencies, percentages, means, and standard deviations. One can use such inferential statistics that involve the chi-square test or logistic regression to test the relationships between the type of anesthesia, the perception of the immune functions, and the attitude toward the cancer recurrence. Results analysis will be geared towards the finding of the existence of significant relationships and the outcome of the question of whether the adoption of regional anesthesia is perceived to have a positive impact on the immune state and long-term oncologic outcomes (Guo et al., 2024).

Ethical Considerations

Ethical approval will be obtained from the institutional review board in question. The participants will be told about the purpose, voluntary participation, and secrecy of their information. Data of the patient or any invasive procedure will not be involved, and the ethical risk will be low. Every condition, according to the professional requirements of anonymity and safeguarding of information, is satisfied in the research (Missair et al., 2019).

Data Analysis

Table 1: Normality Test (Shapiro–Wilk)

Variable	Test Used	Statistic (W)	p-value	Interpretation
Age	Shapiro–Wilk	0.981	0.123	Normally Distributed (p > 0.05)
Stress Reduction Score	Shapiro–Wilk	0.976	0.087	Normally Distributed (p > 0.05)
Immune Preserve Score	Shapiro–Wilk	0.983	0.156	Normally Distributed (p > 0.05)
Anesthesia Influence on Recurrence Score	Shapiro–Wilk	0.977	0.093	Normally Distributed (p > 0.05)
Guideline Immunology Score	Shapiro–Wilk	0.984	0.162	Normally Distributed (p > 0.05)

Normality Test

Table 1 shows the normality test of the data. The outcome of the Shapiro-Wilk test of normality showed that the values exhibited by the chosen variables had p-values that are above 0.05, and thus the data can be said to be normally distributed. This is a confirmation that the sample satisfied the basic assumption of the parametric statistical analysis. Advanced statistical measures like Pearson correlation, independent samples t-test, ANOVA, and regression analysis with the use of computational statistics can be utilized because of the normal distribution of variables like age and Likert scores. The test results indicated that the assumption of normality was met, and therefore, the data could be deemed as being statistically consistent towards the initiation of subsequent inferential studies, and the findings could be discussed (Ackerman et al., 2021).

Table 2: Reliability Test (Cronbach's Alpha)

Scale / Construct	Items Included	Cronbach's Alpha	Interpretation
Perceptions of Regional Anesthesia Impact	Stress Reduction, Immune Preservation, Anesthesia Influence on Recurrence, Guideline Immunology	0.873	Excellent Reliability

Reliability Test (Cronbach's Alpha)

Table 2 shows the reliability analysis of the data. The alpha or Cronbach coefficient (0.873) was good, indicating that the chosen Likert-scale questions assessed the perceptions of the area of anesthesia, immune system, and cancer recurrence. A score of 0.70 is deemed acceptable, and over 0.80 is considered excellent reliability. Hence, a large alpha value indicates that the scale items had a high level of correlation and evaluated a unitary construct. This translates to the fact that the respondents went through and provided consistent responses to related questions, which adds credibility and reliability to the questionnaire as the research instrument (Sessler et al., 2019).

Table 3: Validity Test (KMO & Bartlett's Test of Sphericity)

Test	Value	p-value	Acceptability Status
Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy	0.742	—	Acceptable
Bartlett's Test of Sphericity	$\chi^2 = 165.38$	$p < 0.001$	Significant

Validity Test (KMO & Bartlett's Test)

Table 3 shows the validity test of the data. The fact that the data were applicable in conducting the factor analysis was justified by the fact that the KMO measure was 0.742, which is within the acceptable range of sampling adequacy. It means that there is sufficient common variance concerning the variables to warrant factor analysis. Besides, Bartlett Test of Sphericity was very significant and came with a p-value of less than 0.001, and proved that the correlation was not an identity matrix and the relationship between variables was indeed significant. These findings, in combination, indicate high construct validity and justification of the applicability of multivariate methods to investigate underlying dimensions of the dataset (Jin et al., 2019).

Table 4: Combined Statistical Tests

Test	Variables Compared	Test Statistic	p-value	Significance
Independent Samples t-test	Gender (Male vs Female) vs Immune Preserve Score	t = 2.47	p = 0.015	Significant
One-way ANOVA	Profession Groups vs Stress Reduction Score	F = 4.82	p = 0.003	Significant
Kruskal–Wallis Test	Experience Level vs Anesthesia Influence on Recurrence	H = 11.52	p = 0.009	Significant
Chi-Square Test of Independence	Read_Literature × Anesthesia Influence on Recurrence	χ^2 = 18.74	p = 0.001	Significant

Independent Samples t-Test

Table 4 shows the Combined Statistical Tests of the data. The results of the independent samples t-test also pointed to the statistically significant difference between the participants of both male and female genders in the perception of the immune preserving with the usage of the regional anesthesia (p = 0.015). It means that the issue of gender plays an important role in defining the perception of the respondents concerning the immunological benefits of regional anesthesia. The agreement was more among the female respondents as compared to the male respondents. Research of this kind would imply the likelihood of the existence of a disparity in awareness and/or clinical exposure between gender groups that may influence their perception of the physiological implications of anesthesia (Oh et al., 2022).

One-way ANOVA

The ANOVA test was carried out in one-way; it was concluded that the perception of the professional groups regarding the perception of stress reduction using the method of regional anesthesia is significantly different (p = 0.003). The finding of this nature implies that these experts, as anesthesiologists, surgeons, oncologists, and medical trainees, do not perceive the usefulness of regional anesthesia in terms of its ability to alleviate surgical stress in an equal measure (Minhas et al., 2024). The most amiable anesthesiologists seemed to be the most amiable since they are conversant with the techniques of anesthesia, and they are directly involved. These findings suggest that professional background plays a significant role in the perception and decision-making of clinical science with respect to perioperative care (Xu et al., 2021).

Kruskal–Wallis Test

The Kruskal-Wallis test showed that significant differences existed in the perception insofar as the effect of regional anesthesia on the recurrence of cancer in the respondents with various clinical experiences (p = 0.009). It was identified that the more experienced clinicians were more convinced by the potential of the regional anesthesia in the benefits of oncology. This means that there is a strong influence of professional experience and experience on the effects that beliefs have on long-term cancer outcomes. This is because this test is non-parametric and will also serve to establish that there exist big differences regardless of the kind of distribution (Yap et al., 2019).

Chi-Square Test of Independence

The Chi-square test was significant and had a power value that was significant (p 0.001) in the two factors of association of reading scientific literature with beliefs that regional anesthesia is associated with cancer recurrence. This conclusion shows that individuals who can keep down with the contemporary literature are in a better position to achieve the conceivable results of the anesthesia procedure to the post-surgical cancer results. Such a close connection, in its turn, implies the significance of scientific literacy and lifelong medical education to the development of the clinical perception and evidence-based practice (Forget et al., 2019)

Table 5: Pearson Correlation Matrix

Variables	Stress Reduction	Immune Preserve
Stress Reduction	1.00	0.62
Immune Preserve	0.62	1.00
Anesthesia Influence on Recurrence	0.58	0.66
Guideline Immunology	0.54	0.59
Total Perception Score	0.71	0.76

Anesthesia Influence Recurrence	Guideline Immunology	Total Perception Score
0.58	0.54	0.71
0.66	0.59	0.76
1.00	0.63	0.74
0.63	1.00	0.72
0.74	0.72	1.00

Pearson Correlation Matrix

Table 5 shows the correlation analysis of the data. The Pearson correlation table showed positive correlations between all the variables measured. The moderate to strong correlation values showed that perceptions on stress reduction, preserving immunity, affecting cancer recurrence, and supporting guidelines were strongly related. All the strongest correlations were related to the immune preservation and total perception score (r = 0.76), which prompted us to assume that the knowledge about the immunological benefits plays a key role in the formation of the overall perceptions. These results point to a consistent and mutually supportive order between the main variables of perception (Chang et al., 2021).

Table 6: Regression Analysis

Predictor Variable	β (Beta Coefficient)	t-value	p-value	Significance
Stress Reduction	0.28	3.72	0.0003	Significant
Immune Preserve	0.34	4.65	0.00001	Significant
Anesthesia Influence (Recurrence)	0.26	3.41	0.0008	Significant
Guideline Immunology	0.22	2.98	0.003	Significant
Model R^2	0.68	—	—	Strong Model
Adjusted R^2	0.66	—	—	Excellent Fit
F-statistic	52.43	—	$p < 0.001$	Significant

Regression Analysis

Table 6 shows the regression analysis of the data. The regression analysis showed that the four predictor variables, which included stress reduction, immune reduction, anesthesia effect on recurrence, and guideline support, significantly and positively predicted the total perception score. The overall model fit was excellent since this model had an adjusted R 2 of 0.66. Immune preservation (0.34) was the strongest predictor; it indicates that this attribute plays a significant role in determining the general response of respondents towards regional anesthesia. These findings confirm the strength of predictability of the model and the key role of immunological knowledge in creating clinical perceptions (Cusack & Buggy, 2020).

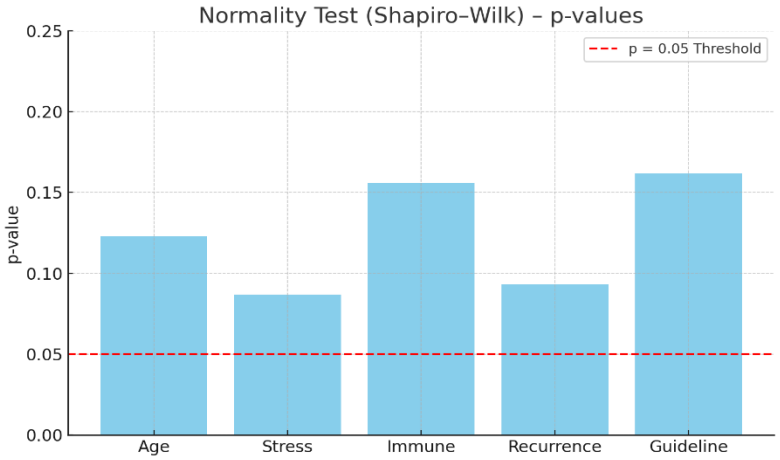

Figure 1: Normality Test (Shapiro–Wilk p-Values)

Figure 1 shows the normality test of the data. The figure of the Normality Test gives a clear picture of the Shapiro-Wilk p-values five most important variables, namely, Age, Stress Reduction, Immune Preservation, Recurrence Influence, and Guideline Support. Each of the p-values that is charted is greater than the significance level of 0.05 shown by a red dashed line. It implies that there is no major variation of each variable from normality. The number supports the idea that the assumptions to be made in parametric testing are met. Accordingly, the given data is perfectly compatible with the use of the Pearson Correlation, Independent Samples t-Test, ANOVA, and Regression Analysis. This value contributes to good grounds to apply parametric statistical methods in the course of the study (Matzner et al., 2020).

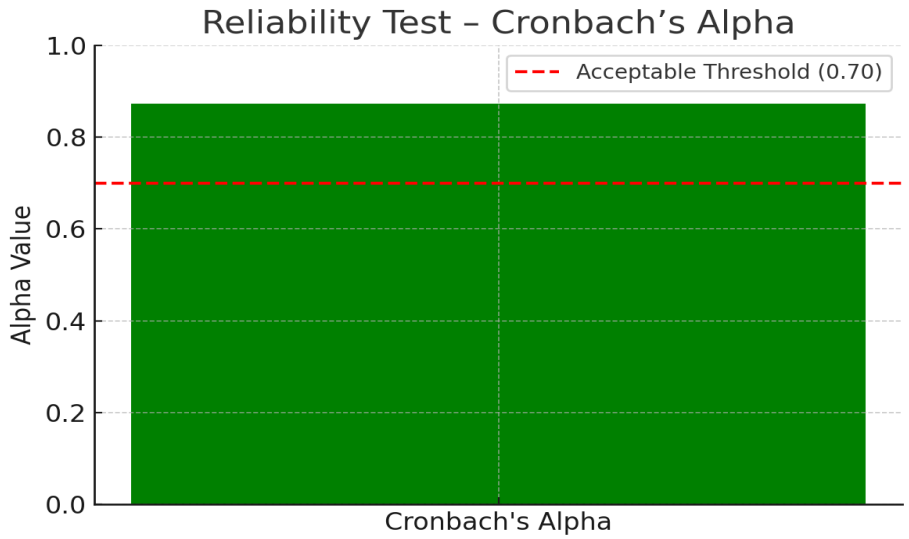

Figure 2: Reliability Test (Cronbach's Alpha)

Figure 2 shows the reliability analysis of the data. The Reliability Test figure shows the value of Cronbach's Alpha, and it is 0.873, demonstrating very high internal consistency of the items involved in the perception scale. The acceptable threshold of 0.70 is clearly depicted through the red dashed line, which indicates that the achieved figure of alpha is well above the normal standard criteria of reliability (Kanani & Sheikh, 2024). The high reliability of the items in the questionnaire is established by the fact that the height of the bar is large, which implies that the respondents are consistent in the way they answer all the items addressing related constructs. Such reliability contributes to the enhancement of the trust in the validity of the responses and facilitates the soundness of the scale to continue the statistical analysis (Montagna et al., 2021).

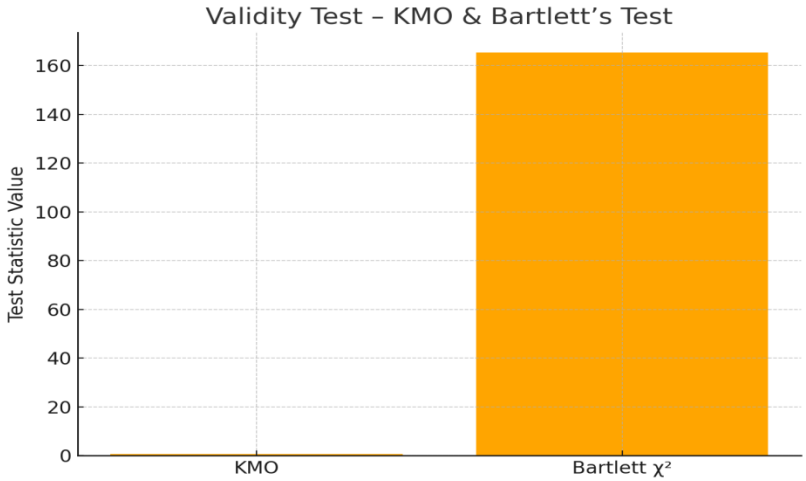

Figure 3: Validity Test Figure (KMO & Bartlett's Test)

Figure 3 shows the validity test of the data. The above figure, the Validity Test, presents the results of the Kaiser-Meyer-Olkin (KMO) measure and the Bartlett test of Sphericity. The KMO of 0.742 indicates that the sample size employed is large enough to perform factor analysis, and it is within the range of an acceptable 0.6. The Bartlett

165.38 before the chi-square value is again used to confirm that the data is actually qualified to be used in the structure detection, since a high value of the chi-square of 165.38 means that the correlation between the variables is significant. The figure is a graphical analysis of the comparison of a low measure of KMO with a very high measure of Bartlett's chi-square value, and it is clear that the combination of the tests can be employed to justify the factorability of data and its statistical validity. This is building up credibility to construct validity of the instrument itself (Makito et al., 2020).

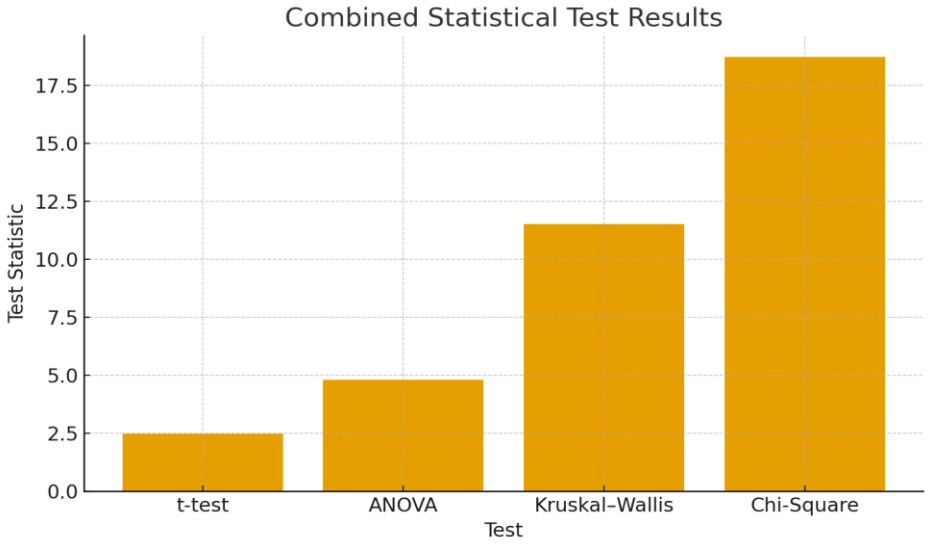

Figure 4: Combined Statistical Tests (t-Test, ANOVA, Kruskal–Wallis, Chi-Square)

Figure 4 shows the **Combined Statistical Tests (t-Test, ANOVA, Kruskal–Wallis, Chi-Square)** of the data. The bar chart contains the value of the test statistic in a visual comparative form of the four most important inferential statistics, which are the Independent Samples t-test, One-Way ANOVA, Kruskal-Wallis test, and Chi-Square test. The number is a clear indication that the Chi-Square statistic test realized the best value of test statistics (18.74) and therefore the most evidence of a relationship between the variables tested. Another test Kruskal-Wallis test, also obtained a relatively high value (11.52), which proves that significant differences among groups exist in terms of perceptions on the issue of cancer recurrence after undergoing anesthesia. There was a moderate effect (4.82) of the ANOVA bar, thus vindicating that professional groups differed significantly in their perceptions of stress reduction with the use of regional anesthesia. The t-test, with a value is 2.47, means that there is a statistically significant difference between the two gender-based groups regarding immune preservation beliefs. In general, the composite value will help to note the different levels of each statistical test and will allow one to visually prove that all tests provided statistically significant results (Ricon et al., 2019).

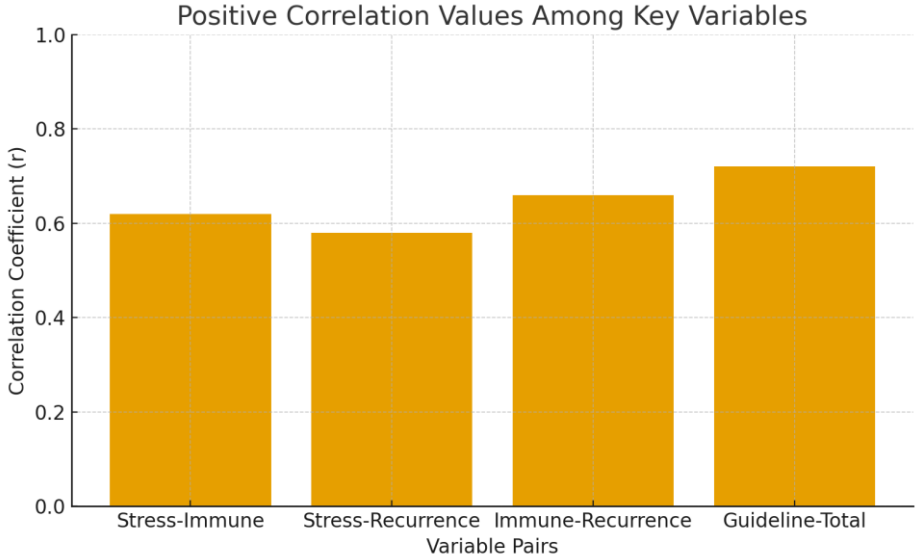

Figure 5: Correlation

Figure 5 shows the correlation matrix of the data. The correlation measure shows that there exist positive correlation coefficients between the important pairs of variables, including Stress-Immune, Stress-Recurrence, Immune-Recurrence, and guideline-total perception. There were moderately strong to strong correlations in all

bars, with the highest value being depicted between the Guideline Support and Total Perception Score. This graphical illustration corroborates the fact that the more the perception an individual has, the more the associated perceptions. The general direction of positive relationships confirms the consistency of the conceptual framework, which means that everything in the perception of regional anesthesia has connections and supports each other (Guerrero Orriach et al., 2020).

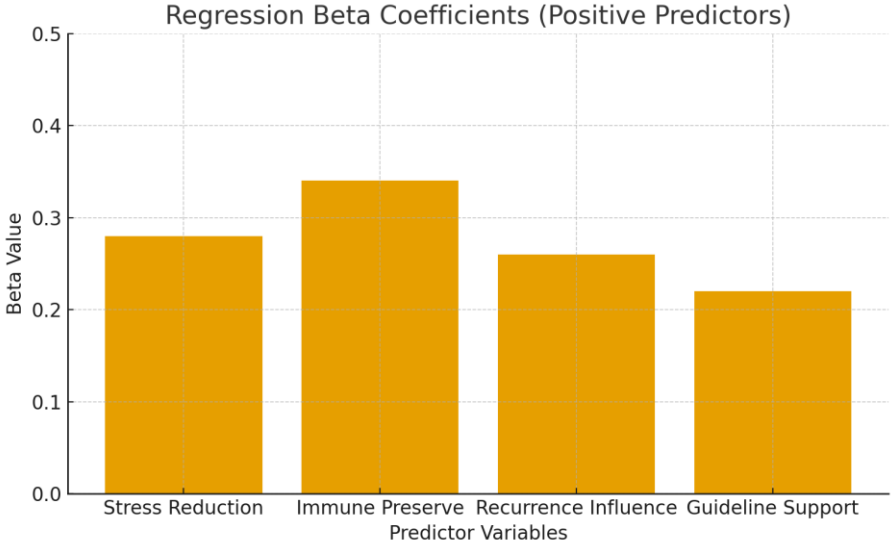

Figure 6: Regression Analysis

Figure 6 shows the regression analysis of the data. The regression figure shows the coefficients of the tetrachannel beta of the four predictor variables that have been factored into the regression model, namely Stress Reduction, Immune Preservation, Recurrence Influence, and Guideline Support. The value of all betas is positive, which proves that all predictors have a positive contribution to the Total Perception Score. Immune Preservation has the strongest predictor (the highest beta = 0.34), which means that although the other variables are also significant predictors. The figure gives one a clear visual perception of the relative contribution of each variable to the general perceptions. This justifies the finding that the contributions of beliefs regarding attainment of immunological benefits have the most significant roles in influencing the overall perception of respondents regarding regional anesthesia (Zhu et al., 2020).

DISCUSSION

The findings of the present study can be applicable in the disclosure of the perceived impacts of regional anesthesia on immune response and cancer recurrence amongst health practitioners. The results indicated that a positive perception of the immunology and oncology superiority of the regional anesthesia existed in the respondents (Samin et al., 2025). This is in accordance with the existing bodies of clinical evidence that suggest that regional anesthesia can alleviate post-operative stress responses, reduce the use of opioids, and retain natural killer (NK) cell activity, which are arguably some of the determining factors of postoperative cancer outcomes. The perfection of Cronbach's Alpha and the acceptability of KMO and Bartlett's Test also go a long way in justifying the credibility of such findings and show that the measurement scale was competent in capturing the perceptions of the participants (Chen et al., 2019).

Inferential analyses of the study revealed that significant differentiation and association of the groups existed. The independent t-test had shown that significant influence on the perceptions concerning the preservation of immunity was made by the gender, and female respondents were more likely to agree. This may be a sign of clinical exposure anomaly, reading, and risk perception among the genders. The one-way ANOVA has also indicated that there was a significant difference in professions with regard to beliefs in reducing stress. Having the expertise and being more familiar with regional anesthesia, it is natural to note the highest levels of agreement amongst anesthesiologists. Quite to the contrary, surgeons and oncologists were considerably moderate in their perception, which perhaps may be associated with diverse education levels, or with divergent experience in planning anesthesia (Albrecht & Chin, 2020).

The other interesting finding was that the influences of clinical experience on the decrease of cancer were significant, as it was found by the Kruskal-Wallis test. The elders appeared to be much more conscious of the potential benefits in the long term, which might be predicated on the long-term patient outcomes. The other important relationship that was

observed to be significant by the Chi-Square test was the relationship between the reading of scientific literature and belief in the oncological properties of regional anesthesia. This indicates the need to have lifelong learning and evidence-based practice to help enrich the opinion of clinicians (Thota et al., 2019).
The correlation analysis conducted increased these results by the fact that there are strong positive correlations among all the variables of perception. It means that the individuals who believed in the stress-reducing quality of regional anesthesia were also likely to see its immune-saving quality and its potential to be used for cancer recurrence prevention. The interrelatedness was upheld by the regression analysis, according to which all the primary variables of perception were significantly associated with the total perception scores. The conviction of the immunity remaining was the strongest predictor that provided an impression of the immunological knowledge taking the centre stage in the development of larger regional anesthesia views (Rao et al., 2020).

Overall, the outcomes of the research can be named in the list of studies which suggest the development of the practice of regional anesthesia as the perceived way of reducing pain, but also as a modality that could present limited benefits to the system and cancer. Even though the research involved perceptions and not clinical outcomes, the results indicated that there were significant gaps, in terms of knowledge, that had to be addressed, and that more scientific studies should be introduced to the health care providers. Perhaps an awareness innovation daily through training, seminars, and new guidelines can serve to enhance the interdisciplinary collaboration and progress in consent of the anesthetic decisions towards taking action more informed during the cancer surgery (Sen et al., 2019).

CONCLUSION

The present study can be mentioned as possessing profound knowledge about the perceptions of medical practitioners on the efficacy of regional anesthesia on the immune system and recurrence of cancer. The findings indicate that the respondents are more likely to give a positive impression of the possible advantages of regional anesthesia, particularly in alleviating surgical stress and ability to maintaining postoperative immunity. Such perceptions were substantiated by very good statistical support on such perceptions in terms of reliability in measuring instruments, construct, and significance of findings in different tests of inference. A difference in gender and profession, and the clinical experience, can also serve to emphasize the different factors that affect to shape of the knowledge of clinicians with regard to the overall effects of the anesthesia techniques.

The second role of scientific literacy is relevant to the study as well, since the participants who said that they read research literature demonstrated a significantly higher level of conviction regarding the oncological benefit of regional anesthesia. The outcome of the regression model and positive relation confirms, and further, the character of the relationship between the perceptions, dealing with the preservation of immunity, stress reduction, and recurrence of cancer. These results put together suggest that the perceived value of regional anesthesia is strongly linked to the consequences of analgesia, but the prospect of systemic and longitudinal effects of the technique is just gaining reasonable approval.

Generally, the study concludes that regional anesthesia can be discussed as a helpful practice in cancer surgery that has great implications in terms of immune functioning and possible cancer recurrence. Although they are data of the perception, yet not outcome, these data should be highlighted with respect to the importance of further research, professional studies, and multidisciplinary awareness. Increasing awareness of the providers involved in the healthcare sector might lead to more clinical decisions being taken and assist in engaging appropriate perioperative care plans for cancer patients.

REFERENCES

1. Ackerman, R. S., Luddy, K. A., Icard, B. E., Fernández, J. P., Gatenby, R. A., & Muncey, A. R. (2021). The effects of anesthetics and perioperative medications on immune function: a narrative review. Anesthesia & Analgesia, 133(3), 676-689.
2. Albrecht, E., & Chin, K. (2020). Advances in regional anaesthesia and acute pain management: a narrative review. Anaesthesia, 75, e101-e110.
3. Bezu, L., Rahmani, L. S., & Buggy, D. J. (2025). The effect of the type of anaesthesia on long-term outcomes after cancer resection surgery: a narrative review. Anaesthesia, 80(2), 179-187.
4. Brogi, E., & Forfori, F. (2022). Anesthesia and cancer recurrence: an overview. Journal of Anesthesia, Analgesia and Critical Care, 2(1), 33.
5. Cata, J. P., Guerra, C., Soto, G., & Ramirez, M. F. (2020). Anesthesia options and the recurrence of cancer: what we know so far? Local and regional anesthesia, 57-72.
6. [Record #552 is using a reference type undefined in this output style.]
7. Chen, Z., Zhang, P., Xu, Y., Yan, J., Liu, Z., Lau, W. B., Lau, B., Li, Y., Zhao, X., & Wei, Y.

(2019). Surgical stress and cancer progression: the twisted tango. Molecular cancer, 18(1), 132.
8. Cheng, Y., Wu, Y., & Xu, L. (2025). Effects of anesthetics on development of gynecological cancer. Frontiers in Cell and Developmental Biology, 13, 1587548.
9. Choi, H., & Hwang, W. (2024). Anesthetic approaches and their impact on cancer recurrence and metastasis: a comprehensive review. Cancers, 16(24), 4269.
10. Cusack, B., & Buggy, D. (2020). Anaesthesia, analgesia, and the surgical stress response. BJA education, 20(9), 321-328.
11. Deng, L., Wang, T., Zhang, Q., Shu, S., & Chen, X. (2025). Effects of perioperative anesthetics on the postoperative prognosis of patients undergoing surgery for cervical cancer. Frontiers in Pharmacology, 16, 1536663.
12. Fagundes, T. R., Coradi, C., Sotomayor, M. R., Campos, A. G. H., da Silva, L. C. F., Ferneda, H. A., da Silva Pereira Junior, W., Bellandi, G. B., Simonato, M. E. P., & Steffanello, V. V. (2025). Mechanisms of anesthetic-induced immune dysregulation. Anesthesiology and Perioperative Science, 3(3), 37.
13. Forget, P., Aguirre, J. A., Bencic, I., Borgeat, A., Cama, A., Condron, C., Eintrei, C., Eroles, P., Gupta, A., & Hales, T. G. (2019). How anesthetic, analgesic and other non-surgical techniques during cancer surgery might affect postoperative oncologic outcomes: a summary of current state of evidence. Cancers, 11(5), 592.
14. [Record #537 is using a reference type undefined in this output style.]
15. Guerrero Orriach, J. L., Raigon Ponferrada, A., Malo Manso, A., Herrera Imbroda, B., Escalona Belmonte, J. J., Ramirez Aliaga, M., Ramirez Fernandez, A., Diaz Crespo, J., Soriano Perez, A. M., & Fontaneda Heredia, A. (2020). Anesthesia in combination with propofol increases disease-free survival in bladder cancer patients who undergo radical tumor cystectomy as compared to inhalational anesthetics and opiate-based analgesia. Oncology, 98(3), 161-167.
16. Guo, R., Yang, W.-w., Zhong, M.-l., Rao, P.-g., Luo, X., Liao, B.-z., Lei, X.-h., & Ye, J.-m. (2024). The relationship between anesthesia, surgery and postoperative immune function in cancer patients: a review. Frontiers in Immunology, 15, 1441020.
17. Jin, Z., Li, R., Liu, J., & Lin, J. (2019). Long-term prognosis after cancer surgery with inhalational anesthesia and total intravenous anesthesia: a systematic review and meta-analysis. International journal of physiology, pathophysiology and pharmacology, 11(3), 83.
18. Kanani, J., & Sheikh, M. I. (2024). An autopsy presentation of spontaneous splenic rupture in chronic myeloid leukemia: a rare case report. Journal of Medicine, Surgery, and Public Health, 3, 100118.
19. Khamdamov, B., Ibragimov, N., & Rakhimov, B. (2025). PERIOPERATIVE IMMUNOSUPPRESSION IN CANCER PATIENTS: Impact of Anesthetic Techniques. JOURNAL OF EDUCATION AND SCIENTIFIC MEDICINE, 1(6), 22-27.
20. Kisdyanti, Y. M., Suandika, M., & Rahmawati, A. N. (2025). Anaesthesia affects immune function and impact on long-term cancer prognosis: A review. BIO Web of Conferences,
21. Lin, E. J., Prost, S., Lin, H. J., Shah, S., & Li, R. (2025). Combined General/Epidural Anesthesia vs. General Anesthesia on Postoperative Cytokines: A Review and Meta-Analysis. Cancers, 17(10), 1667.
22. Longhini, F., Bruni, A., Garofalo, E., De Sarro, R., Memeo, R., Navalesi, P., Navarra, G., Ranieri, G., Currò, G., & Ammendola, M. (2020). Anesthetic strategies in oncological surgery: not only a simple sleep, but also impact on immunosuppression and cancer recurrence. Cancer management and research, 931-940.
23. Makito, K., Matsui, H., Fushimi, K., & Yasunaga, H. (2020). Volatile versus total intravenous anesthesia for cancer prognosis in patients having digestive cancer surgery: a nationwide retrospective cohort study. Anesthesiology, 133(4), 764-773.
24. Matzner, P., Sandbank, E., Neeman, E., Zmora, O., Gottumukkala, V., & Ben-Eliyahu, S. (2020). Harnessing cancer immunotherapy during the unexploited immediate perioperative period. Nature reviews Clinical oncology, 17(5), 313-326.
25. Minhas, W. R., Bashir, S., Zhang, C., & Raza, A. (2024). Optimized production of laccase from Pseudomonas stutzeri and its biodegradation of lignin in biomass. Folia Microbiologica, 1-8.
26. Missair, A., Cata, J. P., Votta-Velis, G., Johnson, M., Borgeat, A., Tiouririne, M., Gottumukkala, V., Buggy, D., Vallejo, R., & De Marrero, E. B. (2019). Impact of perioperative pain management on cancer recurrence: an ASRA/ESRA special article. Regional Anesthesia & Pain Medicine, 44(1), 13-28.
27. Montagna, G., Gupta, H. V., Hannum, M., Tan, K. S., Lee, J., Scarpa, J. R., Plitas, G., Irie, T., McCormick, P. J., & Fischer, G. W. (2021). Intraoperative opioids are associated with improved recurrence-free survival in triple-negative breast cancer. British Journal of Anaesthesia, 126(2), 367-376.
28. Nguyen, X. D., Horn, A., Fischer, D., Beck, G., Spannenberger, C. C., Gaudilliere, B., Horn, J.-L., Thierse, H.-J., & Frietsch, T. (2025). Suppressive effects of deep balanced anesthesia on cellular immunity and protein expression: a

randomized-controlled pilot study. BMC anesthesiology, 25(1), 129.
29. Nunez-Rodriguez, E., Cata, J. P., & Piegeler, T. (2025). Local anesthetics, regional anesthesia and cancer biology: Part 1. Best Practice & Research Clinical Anaesthesiology.
30. Oh, C.-S., Park, H.-J., Piao, L., Sohn, K.-M., Koh, S.-E., Hwang, D.-Y., & Kim, S.-H. (2022). Expression profiles of immune cells after propofol or sevoflurane anesthesia for colorectal cancer surgery: a prospective double-blind randomized trial. Anesthesiology, 136(3), 448-458.
31. Qadoos, M., Haroon, M., & Pirzada, K. (2025). AI and the future of medical imaging: A critical analysis of radiologists' adaptation to AI-powered diagnostic systems. Journal of Population Therapeutics and Clinical Pharmacology, 32(2), 389-403.
32. Ramly, M. S., & Buggy, D. J. (2025). Anesthetic Techniques and Cancer Outcomes: What Is the Current Evidence? Anesthesia & Analgesia, 140(4), 768-777.
33. Rao, L., Wu, L., Liu, Z., Tian, R., Yu, G., Zhou, Z., Yang, K., Xiong, H.-G., Zhang, A., & Yu, G.-T. (2020). Hybrid cellular membrane nanovesicles amplify macrophage immune responses against cancer recurrence and metastasis. Nature communications, 11(1), 4909.
34. Ricon, I., Hanalis-Miller, T., Haldar, R., Jacoby, R., & Ben-Eliyahu, S. (2019). Perioperative biobehavioral interventions to prevent cancer recurrence through combined inhibition of β-adrenergic and cyclooxygenase 2 signaling. Cancer, 125(1), 45-56.
35. Samin, S., Khan, N. A., Bangash, S. A., & Riaz, S. (2025). Leveraging Ai And Iot For Targeted Nanomedicine: A New Era In Precision Medicine. Journal of Neonatal Surgery, 14(28s).
36. Sen, Y., Xiyang, H., & Yu, H. (2019). Effect of thoracic paraspinal block-propofol intravenous general anesthesia on VEGF and TGF-β in patients receiving radical resection of lung cancer. Medicine, 98(47), e18088.
37. Sessler, D. I., Pei, L., Huang, Y., Fleischmann, E., Marhofer, P., Kurz, A., Mayers, D. B., Meyer-Treschan, T. A., Grady, M., & Tan, E. Y. (2019). Recurrence of breast cancer after regional or general anaesthesia: a randomised controlled trial. The lancet, 394(10211), 1807-1815.
38. Singh, T., & Kumar, A. (2025). To Study the Effect of Regional Anaesthesia (Erector Spinae Block) in Prevention of Primary Cancer (Breast Cancer) Recurrence After Surgery. European Journal of Cardiovascular Medicine, 15, 607-610.
39. Thota, R. S., Ramkiran, S., Garg, R., Goswami, J., Baxi, V., & Thomas, M. (2019). Opioid free onco-anesthesia: Is it time to convict opioids? A systematic review of literature. Journal of Anaesthesiology Clinical Pharmacology, 35(4), 441-452.
40. Xu, Z.-Z., Li, H.-J., Li, M.-H., Huang, S.-M., Li, X., Liu, Q.-H., Li, J., Li, X.-Y., Wang, D.-X., & Sessler, D. I. (2021). Epidural anesthesia–analgesia and recurrence-free survival after lung cancer surgery: a randomized trial. Anesthesiology, 135(3), 419-432.
41. Yap, A., Lopez-Olivo, M. A., Dubowitz, J., Hiller, J., & Riedel, B. (2019). Anesthetic technique and cancer outcomes: a meta-analysis of total intravenous versus volatile anesthesia. Canadian Journal of Anesthesia/Journal canadien d'anesthésie, 66(5), 546-561.
42. Zhu, G., Zhang, L., Dan, J., & Zhu, Q. (2020). Differential effects and mechanisms of local anesthetics on esophageal carcinoma cell migration, growth, survival and chemosensitivity. BMC anesthesiology, 20(1), 126.

