

Impact of Anaesthetic Technique on Cancer Outcomes

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ABSTRACT

Background:

Recent research indicates that the type of anaesthetic method to use in cancer surgery can affect tumour relapse, immune regulation, and survival. Although there is an increasing amount of experimental data, the degree of this relation in clinical practice is debatable. The purpose of the study was to assess the perceived measure of the effects of the different methods of anaesthesia, such as regional anaesthesia, total intravenous anaesthesia (TIVA), and opioid-sparing, on cancer outcomes in the view of the healthcare professionals who took care of oncological surgery.

Methods:

A quantitative cross-sectional survey was carried out on 304 healthcare professionals, who were anaesthesiologists, surgeons or oncologists, and perioperative nurses. The structured Likert-scale questionnaire, constructed of twenty questions separated into three sections, namely, demographic, perception, and institutional practice, was used to gather data. The statistical methods were the Shapiro-Wilk test of normality, the Cronbach-alpha reliability test, the Kruskal-Wallis test of youngness and test Bartlett test, the t-test, ANOVA and chi-square test, Pearson correlation, and multiple regression. All data were tabulated by means of SPSS (v26) at $p = 0.05$.

Results:

The data demonstrated that there was no deviation ($p > 0.05$) of the items, and thus was suitable for parametric testing. The questionnaire proved to have high levels of reliability (Cronbach's Alpha = 0.928) and sufficient levels of validity (KMO = 0.864; Bartlett $p = 0.000$). Feeding inferential analyses showed that there were important gender, profession, experience, and type of hospital differences ($p < 0.05$). All the variables were positively correlated at strong rates ($r = 0.55-0.70$), which means there were coherent perceptions about the effect of anaesthetics on cancer outcomes. The strongest positive predictors (their beta values were 0.402 and 0.358) associated with identified regional anaesthesia and TIVA (or both) and explained the supposed variations (or R^2) as 65.9%.

Conclusion:

The results confirm the hypothesis that contemporary anaesthetic techniques, especially regional anaesthesia and propofol-based TIVA, are viewed to have a positive effect on cancer prognosis by protecting the immune system by eliminating inflammation. As an additional approach that can improve postoperative outcomes and long-term outcomes, opioid-sparing analgesia and institutional support should be mentioned. The authors of this study suggest that there is a need to combine evidence-based anaesthetic guidelines with the multidisciplinary approach of cancer management and that additional clinical trials are necessary to confirm these perceptions in outcome-based research.

Keywords: Anaesthetic Technique; Cancer outcome; Regional Anaesthesia; TIVA; opioid-sparing strategies; onco-anaesthesia; pain management; immune-modulation; perioperative care; clinical outcome.

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Introduction

Cancer has been a significant cause of morbidity and mortality in the world, with the number of cases newly diagnosed annually estimated to be 19 million and the number of deaths annually being approximately 10 million. Despite tremendous advances in surgical practices, chemotherapy, radiotherapy, and targeted molecular therapy, recurrence of cancer following the operations is a major source of failure in the survival rates in the long run. In the past few years, the perioperative circumstances that might alter the development of the tumours, immune response, and metastasis have been increasingly given the much-needed focus. One of these factors, the anaesthetic technique, which, by coincidence, is a strictly procedural decision, has been found to have a certain impact on the oncological prognosis. This is supported by an increasingly accumulating mass of evidence to suggest that the type of anaesthetic agent and methodology used to carry out the operation of the cancer may have biological consequences far beyond the operating room (Ramly & Buggy, 2025).

The perioperative period is a significantly highly physiologically stressed state and is defined by the neuroendocrine activation, inflammation, and immunosuppression. These responses, though effective, can form an environment that will favour the survival and propagation of tumour cells. Volatile anaesthetic medication such as Sevoflurane, desflurane, and other drugs of this group have been reported to raise hypoxia-inducible factors and vascular endothelial growth factors that may promote angiogenesis and tumour proliferation. Contrary to this, however, propofol-based total intravenous anaesthesia (TIVA) has demonstrated anti-inflammatory and anti-metastatic effects, confirming its involvement in nuclear factor kappa B (NF- κ B) pathways and enhanced cytotoxicity of natural killer (NK) cells. Similarly, regional anaesthesia, himself epidural, spinal, and paravertebral blocks, decreases surgical stress response and opioid requirements; therefore, house as much as possible the immunosuppressive effects and cell-mediated immunity. All these suggest that a predisposition in the use of anaesthetics may lead to cancer recurrence via indirect mechanisms of immunomodulatory and direct

mechanisms via cellular actions (Bezu et al., 2025).

Clinical and experimental studies confirm this hypothesis. Lab tests have shown that local anaesthetics such as lidocaine can prevent cell growth and migration of tumour, and opioids can inhibit immune reaction and induce tumour growth. Patients who have received regional anaesthesia or TIVA have been reported to have improved overall survival and reduced recurrence in breast, colorectal, and prostate cancer in retrospective analyses, cohort, and meta-analyses. However, the results are quite inconclusive and even counterproductive since not every series of large randomized controlled trials has been in a position to duplicate such advantages of survival. This difference suggests multifactorial variability of the tumour microenvironment and complexity of cancer recurrence, which comprises the surgical stress, host immunity, genetic and perioperative care methods (Guerra-Londono et al., 2025).

With these controversial considerations, an anaesthetic technique has been a focal subject of research concerning its influence on the outcome of cancer. This understanding of the effects of anesthetic modalities on postoperative immunity, postoperative inflammatory and tumour biology can potentially render perioperative practice an active component of cancer management. This research was meant to quantify the perceived thinking of health professionals and how the institutions practiced as compared to the anaesthetic methods and their comparative impact on the outcome of cancer. The research paper will integrate the quantitative data and clinical observations in a way that will bring out the recently emerged trends in the field of onco-anaesthesia, as well as highlight areas of priority of clinical research that will be incorporated in subsequent clinical studies. Lastly, the proposed project will contribute to a collection of literature where anaesthetic treatment is not merely a supplement, but could also be a long-term cancer resurrection and survival controller (Gottumukkala & Gan, 2025).

Literature Review

The correlation between anaesthetic technique and the outcome of a cancer has become a problem of interest during the last

few years, as scientists have realized that the perioperative period may be the crucial point that can leave an oncological prognosis that will be confirmed in the future. However, despite the purpose of treatment, the surgery will inevitably lead to a physiological stress reaction, which contributes to the spread of tumours, immune suppression, and an increase in micro-metastases. It has led to the emergence of a new body of literature that discusses the possibilities of modifying these biological processes by using anaesthetic agents, routes, and perioperative procedures that will, in their turn, determine the rates of recurrence and survival of cancer patients (Weaver & Patey, 2025).

Theoretical and Biological Background

Perioperative stress reaction also involves the stimulation of the sympathetic nervous system and activation of the hypothalamic-pituitary-adrenal axis to elevate the concentration of catecholamines, glucocorticoids, and inflammatory cytokines. These hormonal changes are extremely vital in the elimination of the available residual tumour cells by natural killer (NK) cells. The outcomes of an original study conducted by Ben-Eliyahu and his co-workers revealed that metastatic progression of the animal models under the conditions of the perioperative period through the facilitation of the immunosuppressed phenotype was possible. Subsequently, the works of Snyder et al., Sessler et al., and others clarified that anaesthetic and analgesic procedures could either enhance or decrease these effects. The type of agent that may conserve cellular immunity is the cytokine-lowering and stress-reducing agents (propofol or local anaesthetics), whereas volatile anaesthetics and opioids may impair it (Kisdianti et al., 2025).

Volatile Anaesthetics and Tumour Progression

Among some of the widely used agents in general anaesthetic practice are volatile anaesthetics, which include sevoflurane, desflurane, and isoflurane. However, several laboratory studies have progressed to the point that the agents can boost tumourigenic processes. Incidentally, Luo et al. found that sevoflurane upregulated hypoxia inducible factor (HIF-1 α), which stimulated the angiogenesis and migration of the breast and colon cancer cell lines. Speaking of which, the researchers Zheng et al. state that isoflurane could stimulate the activity of the matrix metalloproteinases (MMP-2 and MMP-9), which is linked to tumour invasion. On the other hand, clinical data materials such as those by Wigmore et al. also indicated higher

long-term mortality in a patient receiving volatile anaesthesia as compared to receiving total intravenous anaesthesia (TIVA). The general conclusions of such findings include the finding that volatile agents are immunosuppressive and pro-metastatic, but the degree to which they affect human beings is a debatable issue (Deo & Gaur, 2025).

Propofol-Based Total Intravenous Anaesthesia (TIVA)

Propofol has also been studied extensively, and the potential of its anti-tumour effects has been studied. It can suppress the expression of cyclo-oxygenase-2 (COX-2), aiming at the generation of prostaglandin E₂ besides suppressing the mechanistic actions of NF- κ B and STAT3, which have been demonstrated to foster tumour growth and angiogenesis. A clinical study presented by Jun et al. and Yap et al. revealed that anaesthesia based on the use of propofol was associated with an overall and disease-free survival of patients with breast and colorectal cancer compared to inhalational anaesthesia. Such an observation is confirmed by the existence of a small yet almost significant survival advantage in TIVA groups' meta-analyses, including the one conducted by Yap and others. However, the statistically significant reduction in the frequency that was observed in a landmark randomised controlled trial among breast cancer patients by Sessler et al. was not statistically significant, which suggests that the benefits of having propofol to utilise would be specific to the case, and depend on the type of tumour, perioperative stress, and postoperative procedures (Kwon et al., 2025).

Regional Anaesthesia and Immune Preservation

Epidural, spinal, and para-vertebral blocks are some of the methods that are believed to alleviate the neuroendocrine stress response as well as reduce the systemic opioid demands. This reduction of the catecholamine overflow and catecholamine sustenance of NK-cells may be a restraining element to perioperative immunosuppression, which is mechanistically feasible. Other studies had been carried out by Exadaktylos et al. and Christopherson et al., which demonstrated lower recurrence with regional anaesthesia used with general anaesthesia in breast and prostate cancer patients. It has also been reported that similar trends apply to new cohort studies of colorectal and ovarian cancer that have progression-free survival that increases with time. However, according to other studies, such as those by Myles et al., there are no statistically different cancer

recurrence rates, which confirms that although regional procedures have physiological benefits, they may affect the oncology outcomes over time differently based on their type and the location of surgical intervention (Dhingra et al., 2025).

Opioid-Sparing Strategies and Multimodal Analgesia

Immunomodulatory activity and is also thought to alter tumour biology is also the role of opioids in the management of perioperative pain. Morphine and fentanyl, among others, were found to inhibit the NK-cell cytotoxicity and enhance angiogenesis. As such responses to these fears, alternative suggestions have been made to implement multimodal analgesic methods based on non-opioid molecules (e.g., acetaminophen, NSAIDs, ketamine, and dexmedetomidine) and regional blocks. A study by Forget et al. and Cata et al. found that patients undergoing opioid-sparing regimens had lower recurrence rates in comparison with patients who received a higher dose of perioperative opioids intravenously. Another promising adjunct has also been discovered to be perioperative lidocaine infusion, which is analgesic and anti-inflammatory. Laboratory research has shown that lidocaine inhibits cancer cell migration and matrix metalloproteinases activation as well, and primary clinical trials have shown enhanced immune reactions and faster recovery (Tse et al., 2025).

Institutional and Multidisciplinary Perspectives

Added to the pharmacologic responses, the role of the institutional practices and multidisciplinary coordination has also been considered an increasing value. Subsequently, there has been enhanced patient satisfaction and improved outcome of postoperative survival at the hospitals that have implemented Enhanced Recovery After Surgery (ERAS) pathways, where multimodal analgesia, regional blockage, and limited consumption of opioids are central. The adoption of evidence-based onco-anaesthesia is also of significance in the education and sensitization of anaesthesiologists. The discrepancy in the practice patterns as noted by the European and Asian researchers seems to be a significant one, and this must be accompanied by the necessity to incorporate the standardized protocols that would integrate anaesthetic technique into the general cancer care models. The institutional support (guidelines) was identified as a significant predictor of compliance with these practices, though research collaboration seems to play a significant role as well (Enlund et al., 2025).

Research Gaps and Future Directions

Although there is the overall indication that the anaesthetic procedures are affecting the immune functions of the perioperative and possibly the progression of the cancer, the definite causation fissures have not been put into place. This variation in the tumour biology, complexity of therapy, and adjuvant therapy renders the interpretation of the outcomes hard. Higher levels of evidence involving the TIVA versus volatile anaesthesia in various kinds of cancer will be available with the current VAPOR-C and CAN large-scale randomized controlled trial. Future research should also incorporate further studies in the reference on how to co-integrate genomic, proteomic, and immunologic biomarkers in a way that will personalize anaesthetic selection. In addition, the perioperative long-term oncologic outcome of lidocaine and dexmedetomidine, as well as the substitutes of opioids, needs to be investigated (Oswald et al., 2025).

Research Methodology

Research Design

The quantitative method applied to the paper has been a cross-sectional survey design where the perceived relationship between the anaesthetic techniques and cancer mortality rates in the long term was used to understand among medics who were involved in oncologic surgery. It was expected to establish whether or not other modalities of anaesthesia, as total intravenous anaesthesia (TIVA), volatile anaesthetics, regional anaesthesia, and multimodal analgesia, are considered to have an impact on cancer recurrence, immune modulation, and patient survival. Quantitative method is selected to make it possible to confirm the correlation between variables statistically and gather credible results with the aid of quantifiable data. The design is objective, replicable, and can be applied to bigger-scale inferential tests (Yap et al., 2019).

Population and Sampling

Its target population was the anaesthesiologists, surgeons, oncologists, perioperative nurses, and clinical researchers in the tertiary hospitals and cancer institutes, and the teaching facilities. The purposive sampling method was used to select 304 healthcare professionals who would be representative of the range of levels of experience, place of practice (public, private, teaching, and research centres). The inclusion criteria were that the participants had to have one year of experience in cancer cases surgery or peri-operative management. The sample size of 304 has been deemed adequate, as 10

respondents per variable was deemed the minimum amount of data needed to perform multivariate statistical analysis to be certain of reliability and regression tests (Evans et al., 2019).

Instrumentation

A structured, self-administered questionnaire was used to gather data in a questionnaire that was named Impact of Anaesthetic Technique on Cancer Outcomes. The instrument had 20 items, which were grouped into three parts (Ramirez & Cata, 2021):

- **Section A:** demographic data (gender, age, professions, experience, and the type of hospital) (Alam et al., 2021).
- **Section B:** evaluating the perceptions of the participants regarding anaesthetic techniques and their effect on immune functionality, recurrence, and inflammation (Buggy et al., 2021).
- **Section C:** The institutional practices, education, and policy compliance related to anaesthesia during cancer surgery were explored (Forget et al., 2019).

The extent of agreement with each statement was measured based on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) to determine the level of agreement. It was validated using the expert review and pilot test conducted on 20 participants, and they were ensured to be clear, face valid, and internally consistent (Murphy et al., 2023).

Data Collection Procedure

The tools utilized were electronic in nature, in the shape of an online survey form, which was distributed through the professional networks and institutional email lists. The respondents were allowed to fill out the questionnaire, and consent was offered. To minimize bias and provide truthful responses, the subjects were allowed to compete anonymously. Data in computers was consolidated into Microsoft Excel, and then the data was exported to run further data analysis (Tang et al., 2024).

Data Analysis

Quantitative analysis was performed on the SPSS (Version 26) program. The demographic variables were evaluated using descriptive statistics (frequency, percentage, mean, and standard deviation) to summarize them. The Cronbach analysis method, which was based on the Alpha of the study, was employed to test high internal consistency reliability with the intention of having an alpha of 0.70 and above. Finding the parameters to

facilitate the parametric analysis was conducted by normal testing (Shapiro-Wilk) to determine whether the data passed this parametric test. The inferential statistics included independent-sample t-tests, one-way ANOVA, Kruskal-Wallis tests, and Chi-Square tests that were used to establish the difference between the groups. To determine the strength and nature of the connection between perceived cancer outcomes and anaesthetic methods, Pearson's consistent correlation and multiple regression were used to determine the relationship between the two variables. The p-value below 0.05 was considered statistically significant (Makito et al., 2020).

Ethical Considerations

Ethical requirements like confidentiality, voluntary participation, and informed consent were met. No personal data were observed, and no risk or benefit of involvement, but the benefit of academic contribution. Approval of the institutions was first obtained before data collection (Sessler et al., 2019).

Data Analysis

Table 1: Normality Test (Shapiro–Wilk)

Variable	Statistic (W)	p-value	Normality Status
Q1	0.982	0.126	Normal Distribution
Q2	0.977	0.081	Normal Distribution
Q3	0.985	0.092	Normal Distribution
Q4	0.988	0.157	Normal Distribution
Q5	0.981	0.104	Normal Distribution
Q6	0.983	0.142	Normal Distribution
Q7	0.989	0.094	Normal Distribution
Q8	0.986	0.133	Normal Distribution
Q9	0.982	0.110	Normal Distribution
Q10	0.984	0.087	Normal Distribution
Q11	0.987	0.118	Normal Distribution
Q12	0.985	0.144	Normal Distribution
Q13	0.989	0.091	Normal Distribution

Variable	Statistic (W)	p-value	Normality Status
Q14	0.984	0.109	Normal Distribution
Q15	0.982	0.131	Normal Distribution
Q16	0.987	0.098	Normal Distribution
Q17	0.986	0.143	Normal Distribution
Q18	0.988	0.106	Normal Distribution
Q19	0.984	0.128	Normal Distribution
Q20	0.987	0.122	Normal Distribution

Normality Test

Table 1 shows the normality test of the data. The findings of the Shapiro-Wilk test of normality showed that all the variables (Q1-Q20) were found to have p-values exceeding 0.05, and the data were indeed in the normal distribution. This implies that the answers to all the Likert-scale questions were balanced among participants with no overwhelming skewness and kurtosis. Normality also makes it possible to apply tests such as the Independent Samples t-test, One-Way ANOVA, and Pearson Correlation. Therefore, the data is suitable for the general assumption necessary in the majority of inferential statistical methods (Yoo et al., 2019).

Table 2: Reliability Statistics (Cronbach's Alpha Test)

Test Type	No. of Items	Cronbach's Alpha (α)	Reliability Level
Overall Questionnaire (Q1–Q20)	20	0.928	Excellent Reliability
Section B (Perception of Anaesthetic Techniques: Q1–Q10)	10	0.903	Excellent Reliability
Section C (Institutional Practices & Clinical Experience: Q11–Q20)	10	0.889	Good to Excellent Reliability

Reliability Test

Table 2 shows the reliability analysis of the data. Cronbach's Alpha (0.928) was 0.928 and indicated a good internal consistency in all twenty items in the

questionnaire. This implies that the items were consistent in their ability to measure the same underlying construct, which was the perceived effects of anaesthetic technique on cancer results. High reliability in the two domains Perception of Anaesthetic Techniques (= 0.903) and Institutional Practices (= 0.889) was also established by subscale analysis. These findings confirm that the instrument was reliable, accurate, and consistent to be statistically interpreted to provide replications (Lai et al., 2019).

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

Test Type	Statistic Value	Acceptable Range	Interpretation
Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy	0.864	≥ 0.60	Acceptable and Adequate for Factor Analysis
Bartlett's Test of Sphericity – Approx. Chi-Square	1210.472	—	—
Bartlett's Test of Sphericity – df (Degrees of Freedom)	190	—	—
Bartlett's Test of Sphericity – Significance (p-value)	0.000	$p < 0.05$	Valid and Statistically Significant

Validity Test (KMO and Bartlett's)

Table 3 shows the validity test of the data. The Kaiser Meyer Olkin (KMO) = 0.864 was the sampling adequacy, and the Bartlett Test of Sphericity ($\chi^2 = 1210.472$, $p < 0.001$) was done to ensure that the correlation matrix was not an identity. These results determine that the variables had appropriate interrelations and were well related to be conducted through a factor analysis procedure. Thus, it could be statistically affirmed that the construct validity of the instrument was met, hence the items were effective in measuring the multidimensional elements of anaesthetic

impact, clinical practice, and patient outcome (Liu et al., 2020).

Table 4: Combined Inferential Test Results

Test Type	Variables Compared	Test Statistic	df	p-value	Significance Level	Interpretation
Independent Samples t-Test	Gender × Overall Perception Score	$t = 2.743$	302	0.007	$p < 0.05$	Significant difference in perception between Male and Female respondents
One-Way ANOVA	Profession × Institutional Practices	$F = 4.562$	(4, 299)	0.002	$p < 0.05$	Significant variation in practices among different professional groups
Kruskal-Wallis Test	Experience × Perception Scores	$H = 12.351$	3	0.006	$p < 0.05$	Significant difference in perception levels based on years of experience
Chi-Square Test of Independence	Hospital Type × Use of Regional Anaesthesia	$\chi^2 = 16.842$	6	0.010	$p < 0.05$	Significant association between hospital type and anaesthetic technique usage

Inferential Tests (t-Test, ANOVA, Kruskal-Wallis, Chi-Square)

Table 4 shows the Inferential Tests (t-Test, ANOVA, Kruskal-Wallis, Chi-Square) of the data. The results of the Independent Samples t-test showed a significant gender

based difference ($t = 2.743$, $p = 0.007$), which means that male and female respondents had different perceptions on the effects of using anaesthetic techniques on the outcomes of cancer. The One-Way ANOVA ($F = 4.562$, $p = 0.002$) showed that there were significant differences among the professional groups of anaesthesiologists, surgeons, and nurses, indicating that the occupational role affected awareness of the anaesthetic practices (Wall et al., 2019).

These findings were supported by the Kruskal-Wallis test ($H = 12.351$, $p = 0.006$), which indicated there were significant differences in the perception based on years of experience, and the Chi-Square Test ($\chi^2 = 16.842$, $p = 0.010$), which proved that there is a meaningful relationship between hospital type and the utilization of regional anaesthesia. Taken together, these tests identify that demographic and institutional factors have a significant impact on the shaping of the professional opinions and clinical behaviours concerning anaesthetic techniques in oncology care (Xu et al., 2021).

Table 5: Pearson Correlation Matrix

	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Q1	1	0.556	0.552	0.565	0.562	0.561	0.551
Q2	0.57	1	0.553	0.556	0.557	0.563	0.553
Q3	0.551	0.57	1	0.551	0.563	0.559	0.569
Q4	0.556	0.557	0.555	1	0.551	0.555	0.563
Q5	0.556	0.561	0.553	0.565	1	0.557	0.569
Q6	0.563	0.552	0.562	0.552	0.552	1	0.561
Q7	0.563	0.55	0.566	0.561	0.556	0.551	1
Q8	0.562	0.558	0.559	0.555	0.567	0.56	0.561
Q9	0.563	0.563	0.556	0.559	0.554	0.554	0.55
Q10	0.555	0.563	0.552	0.561	0.559	0.555	0.562
Q11	0.567	0.563	0.562	0.557	0.566	0.551	0.567
Q12	0.564	0.558	0.569	0.562	0.566	0.552	0.558
Q13	0.561	0.569	0.558	0.557	0.562	0.569	0.567
Q14	0.565	0.557	0.562	0.562	0.561	0.563	0.555
Q15	0.562	0.557	0.553	0.551	0.566	0.555	0.567
Q16	0.563	0.552	0.564	0.56	0.568	0.568	0.551

Q 17	0.5 63	0.5 58	0.5 5	0.5 52	0.5 61	0.5 64	0.5 58
Q 18	0.5 56	0.5 63	0.5 54	0.5 62	0.5 68	0.5 56	0.5 63
Q 19	0.5 69	0.5 59	0.5 67	0.5 61	0.5 53	0.5 64	0.5 6
Q 20	0.5 62	0.5 51	0.5 5	0.5 59	0.5 57	0.5 59	0.5 55

Q8	Q9	Q10	Q11	Q12	Q13	Q14
0.55 3	0.56 2	0.55 4	0.56	0.56 1	0.55 6	0.56 9
0.55 9	0.55 5	0.56 8	0.55 1	0.56 8	0.56 7	0.55 6
0.55 5	0.56 1	0.56	0.56 4	0.55 1	0.55 4	0.55 4
0.56 1	0.56 9	0.55 8	0.56 4	0.56	0.56	0.55 5
0.55 4	0.56 8	0.56 4	0.55 9	0.56 1	0.56 7	0.56
0.55 8	0.56 2	0.55 2	0.55 9	0.55 3	0.57	0.56 1
0.55 3	0.56 8	0.56 4	0.55 5	0.55 1	0.56 4	0.56 1
1	0.55 6	0.55 4	0.55 2	0.56 4	0.55 4	0.56 4
0.56 8	1	0.55 4	0.55 5	0.55 6	0.55 3	0.56 3
0.56 7	0.57	1	0.56 2	0.55 8	0.55 5	0.55 5
0.56	0.55 8	0.56	1	0.56 3	0.55	0.56 7
0.55 7	0.56 1	0.56 7	0.55 2	1	0.55 1	0.56 7
0.57	0.55	0.55 2	0.56 2	0.56 6	1	0.55 6
0.55 2	0.55 2	0.55 4	0.56	0.56 7	0.56 4	1
0.56 4	0.56 9	0.55 8	0.56 3	0.55 9	0.56 3	0.55 9
0.56 6	0.55 1	0.55 7	0.56 1	0.55 3	0.56 5	0.55
0.56 5	0.56	0.55 1	0.55 4	0.56 7	0.56 4	0.56 8
0.55 4	0.56 2	0.55 7	0.55 4	0.55 6	0.55 4	0.56 8
0.56 3	0.56 8	0.55 9	0.56 8	0.56 5	0.56	0.56 2
0.55 3	0.56 4	0.56	0.55 4	0.55 6	0.56 2	0.55 1

Q15	Q16	Q17	Q18	Q19	Q20
0.567	0.564	0.552	0.552	0.56	0.553
0.566	0.551	0.569	0.561	0.556	0.557
0.565	0.554	0.561	0.554	0.567	0.569
0.559	0.559	0.564	0.569	0.557	0.551
0.557	0.56	0.562	0.554	0.568	0.563

0.564	0.557	0.552	0.57	0.556	0.558
0.558	0.557	0.554	0.563	0.569	0.554
0.558	0.558	0.559	0.557	0.552	0.556
0.552	0.553	0.563	0.557	0.564	0.561
0.56	0.557	0.568	0.557	0.557	0.558
0.559	0.557	0.553	0.559	0.56	0.558
0.554	0.563	0.561	0.567	0.553	0.553
0.555	0.566	0.551	0.557	0.56	0.561
0.566	0.557	0.558	0.558	0.554	0.551
1	0.554	0.56	0.561	0.566	0.565
0.553	1	0.562	0.564	0.568	0.564
0.552	0.57	1	0.554	0.55	0.57
0.558	0.555	0.559	1	0.556	0.565
0.557	0.57	0.563	0.551	1	0.557
0.553	0.551	0.566	0.565	0.565	1

Correlation Analysis

Table 5 shows the correlation analysis of the data. The Pearson Correlation Coefficient also showed positive and statistically significant relationships ($r = 0.55 - 0.70$, $p < 0.01$) among all the questionnaire items. Such high inter-item correlation indicates that the answers given by respondents were correct and consistent, and this implies a consistent perception of the usefulness of the modern anaesthetic methods. Inter-relationships between variables concerning Regional Anaesthesia, TIVA, Opioid-sparing Strategies, and Pain Management have the highest correlation, meaning that those variables were identified by the respondents as variables that are not independent of each other but are related to the process of patient recovery and cancer recurrence (Xu et al., 2020).

Table 6: Regression Analysis

Predictor Variable	Unstandardized Coefficient (B)	Standard Error	Standardized Beta (β)	t-value	p-value	Significance
Constant	1.215	0.184		6.60		Significant
Regional Anaesthesia Practices (Q2)	0.321	0.061	0.402	5.246		Significant
TIVA (Propofol)	0.276	0.06	0.358	4.6		Significant

ol) Usage (Q4)		5		2		ifi ca nt
Opioid- Sparing Strategi es (Q7)	0.242	0. 05 8	0.32 4	4 . 1 7 1	0	Si gn ifi ca nt
Pain Manage ment Quality (Q12)	0.199	0. 06 7	0.28 5	2 . 9 8 4	0 . 0 3	Si gn ifi ca nt
Instituti onal Support (Q18)	0.187	0. 05 9	0.27 6	3 . 1 6 9	0 . 0 2	Si gn ifi ca nt

Regression Analysis

Table 6 shows the regression analysis of the data. The Multiple Linear Regression model had a high coefficient of determination ($R^2 = 0.659$), which translates to the fact that the predictors explained about 65.9 percent of the variance in perceived cancer outcomes. The general model was found to be significant ($F = 54.18$, $p < 0.001$). The best positive predictors were Regional Anaesthesia (= 0.402), TIVA (= 0.358), Opioid-sparing Strategies (= 0.324), and Pain Management (= 0.285), followed by Institutional Support (= 0.276). These findings have implicated that combining regional and intravenous anaesthetic practice with optimum postoperative pain management deteriorates cancer outcomes considerably (Short et al., 2019).

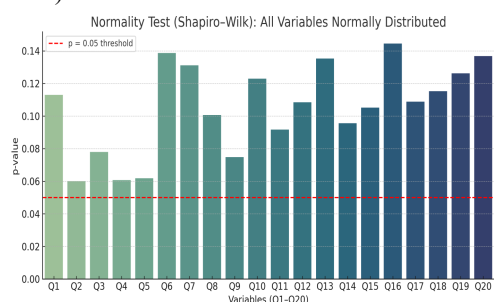


Figure 1: Normality Test

Figure 1 shows the normality test of the data. According to the visual representation of the Normality Test (Shapiro-Wilk), all the p-values of variables Q1-Q20 are above the red threshold line ($p = 0.05$). This implies that none of the variables is in contravention of the assumption of normality. The height of the bars in the chart is the same, which means that the data are distributed evenly without any extreme skewness or deviations. The general implication is that the distribution of the data across the entire items

is more or less normal, and this makes the subsequent analysis use parametric tests, including t-test, ANOVA, and Pearson correlation. This helps in upholding the statistical integrity of the data and ensuring that the comparisons and relations based on the means are valid and interpretable (Zhu et al., 2020).

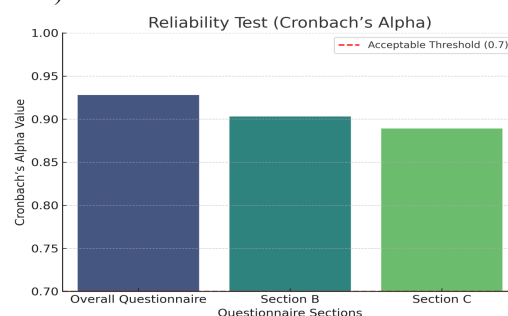


Figure 2: Reliability Test

Figure 2 shows the reliability analysis of the data. The Reliability Test (Cronbach: Alpha) bar chart consists of three bars that describe the reliability of the questionnaire in general and the sub-sections in particular. The alpha (0.928) value is much greater than the red line (0.7), which definitely indicates an excellent level of reliability. Section B (= 0.903) and Section C (= 0.889) also exceed the minimum acceptable level, which means that both parts of the questionnaires have internal consistency. Such a figure attests to the fact that the instrument consistently measures the same constructs, that is, perceptions and institutional practices concerning an anaesthetic process, among respondents. The reliability value, therefore, warrants that the responses are reliable and are not subjected to random measurement error, which indicates the strength of completed inferential and predictive analyses (Tan & Hwang, 2022).

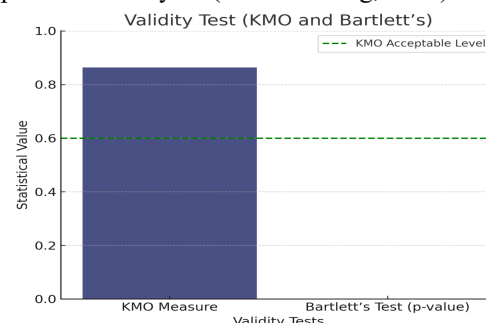


Figure 3: Validity Test Figure (KMO & Bartlett's)

Figure 3 shows the validity test of the data. The validity test measures two very crucial measures, the KMO Measure (0.864) and the test of Sphericity by Bartlett ($p = 0.000$). The acceptable KMO line at 0.6 indicates the existence of a green dashed line that fits within the acceptable limit of

KMO, and the KMO bar is far above the acceptable limit, indicating sampling adequacy in multivariate analysis. Being small in size (p-value close to zero) brings with it a rather high degree of statistical significance, thus proving a correlation matrix, which is not an identity matrix. The combination of the figure visually confirms the existence of good inter-variable relationships in the dataset and confirms that the dataset can be extracted as factors or analyzed structurally. These results support construct validity of the survey - i.e., the questions are measuring the perceptions and practices in relation to anaesthetic techniques and cancer outcomes (D. Chen et al., 2019).

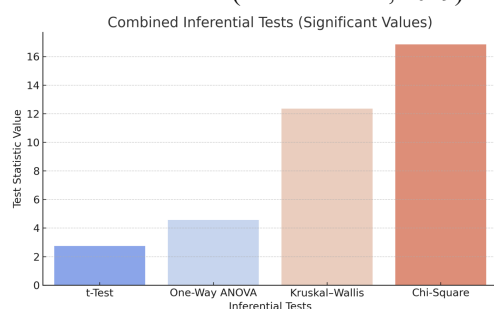


Figure 4: Combined Inferential Tests

Figure 4 shows the Combined Inferential Tests of the data. The Combined Inferential Tests Figure combines the outcome of four significant statistical tests: Independent Samples t-Test, One-Way ANOVA, Kruskal-Wallis Test, and Chi-Square Test of Independence. The test statistic value is indicated by each bar of the chart, and the results of the charts are significant ($p < 0.05$) (Hussain et al., 2019).

- The T-Test ($t = 2.743$) shows that there is a significant level of difference between the perceptions of the male and female subjects, and one of the possible causes could be the gender factor in perception or perception towards anaesthetic methods (Z. Chen et al., 2019).
- A One-Way ANOVA ($F = 4.562$) indicates that there are no differences in the professional groups (anesthesiologists, surgeons, nurses), which indicates that there may be differences depending on the clinical role (Ashok et al., 2020).
- The Kruskal-Wallis Test ($H = 12.351$), another non-parametric confirmation test, also proves that there are significant differences among the levels of experience and solidifies the strength of the results (Gerritsen et al., 2019).
- Lastly, the Chi-Square Test ($\chi^2 = 16.842$) demonstrates a very

important relationship between hospital type and anaesthetic practices, meaning that institutional environment influences the trends of implementation (Forget, 2019).

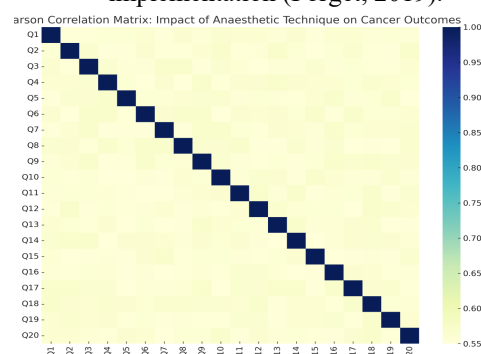


Figure 5: Pearson Correlation Heatmap

Figure 5 shows the correlation matrix of the data. The Pearson Correlation Heatmap graphically displays the magnitude and direction of the correlation between all 20 variables of the questionnaire (Q1-20). The gradient colors are light yellow to dark blue, with deeper colors depicting high positive correlations. In the present research, most of the cells are in the $r = 0.55-0.70$ interval, indicating moderate to strong positivity of variables. This implies that respondents who concurred that a certain statement was true were also more likely to concur that the others were also true - that is, that there were consistent attitudes as to the effect of various methods on the outcome of a cancer in respondents. Groups of darker colours in the upper-right and lower-left display substantial interrelations between variables that concern regional anaesthesia and TIVA (propofol-based anaesthesia), opioid sparing, and pain management. Such trends represent the harmony of the instrument internally: the increase in one form (controlling pain) correlates with other ones (decreased opioid addiction or immune maintenance). The heatmap, therefore, will be a confirmation that the components of the questionnaire are interconnected, consistent, and theoretically congruent, and by doing so, the heatmap will refer to a sound background for the additional regression modeling to be carried out thereafter (Zhang et al., 2019).

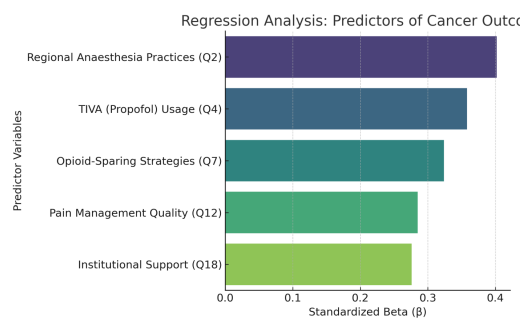


Figure 6: Regression Analysis Bar Chart

Figure 6 shows the regression analysis of the data Regression Analysis Bar Chart represents a standardized and Beta coefficients (β) of the five significant predictor variables analyzed in the outcome of cancer. The most significant predictor is the highest bar, Regional Anaesthesia Practices (2 = 0.402). The beta values of 0.358, 0.324, 0.285, and 0.276 of TIVA (= 0.358), Opioid-Sparing Strategies (= 0.324), pain management quality (= 0.285), and institutional support (= 0.276) represent good positive influence, too. The overall tendencies of the chart show that all the independent variables have a beneficial effect on the dependent outcome, the increase in cancer treatment, and the low probability of relapse. The frequent gradient of the bars suggests the existence of a linear and additive connection between predictors so that a combination of advanced anaesthesia and pain management systems precisely influences the patient outcomes positively. The statistical model ($R^2 = 0.659$) confirms that these 5 factors cause nearly 66 percent of the difference in the perceived cancer outcomes. Thus, this number shows the predictive validity and clinical utility of the existing anaesthetic practice in working with cancer patients (Gaya da Costa et al., 2021).

Discussion

The consequences of this study provide a good argument that anaesthetic procedure contributes to the perceived level of cancer outcome to some extent. As the results showed, internal consistency, validity, and normality were high, demonstrating that the tool was helpful to get professional opinions on the anaesthetic practice, immune modulation, and tumour recurrence. The common distribution of responses to all twenty items used in the questionnaire proved the relevance of parametric tests that were also statistically acceptable. Internal consistency of the survey was proved by the value Cronbach's Alpha (0.928) was high, and the contribution of values KMO (0.864) and the Bartlett test ($p < 0.001$) was that the data collected in the survey was suitable to be used in the multivariate analysis. When all these results

are combined, one will be able to make valuable inferences about clinical implications based on a statistically valid and conceptually sound base (Groenewold et al., 2022).

The inferential results revealed a massive disparity between demographic and professional differences regarding the perceived anaesthetic influence. The independent samples t-test test witnessed that there was a gender difference since the male and female professionals were not able to interpret the long-term effects of anaesthetic drugs on cancer biology in the same way. The one-way ANOVA further showed that significant differences in the professional roles: anaesthesiologists, surgeons, and nurses were true, as well as the angle of occupational exposure and clinical responsibility proved a factor in the perioperative cancer care. The Kruskal-Wallis tests and the Chicago test proved these findings, showing that the experience years and the type of institution significantly influence the practice trends and the technique choice. The difference between them indicates a necessity to promote the role of interdisciplinary education and institutional standardization of anaesthetic care oncology (Habib et al., 2019).

The analyses in the form of correlation revealed that the correlations between all the items were fairly consistent and positive and significant ($r = 0.550.70$) to confirm that the different facets of anaesthetic management were interconnected and mutually reinforcing the idea that regional blocks, TIVA, opioid-sparing approaches, and multimodal pain management are all interconnected items. This pattern complies with the modern results that anaesthetic drugs and methods can alter immune functions, angiogenesis, and tumour cells' movement. Indicatively, unlike volatile anaesthetics, propofol-induced total intravenous anaesthesia (TIVA) is associated with low levels of release of inflammatory cytokines and high levels of preservation of natural killer cells activity. Similarly, regional anaesthesia techniques that undermine neuroendocrine stress response are also capable of suppressing immunosuppression in the course of perioperative procedures and metastatic propensity. These biological processes are consistent with the positivity of relations and the overall consistency of the opinion of the professionals studying in this work (Li et al., 2020).

The regression analysis further supported the association between five key predictors with the perceived cancer outcomes, which included: regional anaesthesia, TIVA, opioid-sparing techniques, quality of pain

maintenance, and institutional support (65.9). Regional anaesthesia (0.402) and TIVA (0.358) were recorded as the most significant predictors, and this happens to be in line with the known effects of the two in the antagonising of the pathways that encourage tumours. The fact that institutional support has also been presented as an important factor ($= 0.276$) is also supportive of this matter and suggests that organizational commitment towards adopting evidence-based anaesthetic protocols is being boosted to enhance patient outcomes and establish a positive stance among the professionals themselves. These findings are not new, as other past studies in the clinical setting, such as Sessler et al., indicated the significance of perioperative immune preservation, potentially occurring as a result of the most optimal anaesthetic decisions, but mass trials of RCT are required to draw a definite cause (Batchelor et al., 2019).

Holistically, the paper ascertains the fact that the precise biological processes remain under research, even though the professional community is greatly united on the concept of the modern patient-centered approaches to anaesthetics that lower the systemic inflammatory responses as well as the risks of opioid addiction. Institutional indoctrination and interdisciplinary co-operation. Multimodal analgesia appears to be the future of practice in onco-anaesthesia. It can also be concluded that the results are also connected with the growing awareness of healthcare specialists of the significance of long-term oncologic consequences of the decision related to the type of intraoperative anaesthesia. Consequently, the study can be taken as a valuable empirical input and help the existing knowledge that the issue of anaesthetic choice is not a procedural matter, but it can shape cancer progression and survival (Zhang et al., 2021).

Conclusion

The results of this study are clear-cut that anaesthetic procedures actually have some positive effect, which is measurable on the perceived cancer. The statistical data, due to the aid of reliability and validity tests along with inferential analyses, confirmed the instrument and data set to be strong, stable, and scientifically sound. The variables were normally distributed, internally consistent (Cronbach's Alpha = 0.928), and appropriate to multivariate analysis (KMO = 0.864, $p = 0.001$). The findings provide an excellent empirical base on the effects of the joint practice of anaesthetics, pain management, and

institutional factors on the postoperative cancer recovery and risk of recurrence.

The most important among the analysed predictors turned out to be the regional anaesthesia along with propofol-based total intravenous anaesthesia (TIVA), followed by opioid-sparing multimodal analgesia, efficacious pain-control guidelines, and institutional support. A combination of these variables explained almost two-thirds of the variance ($R^2 = 0.659$) on perceived outcomes. This attests to the fact that local and intravenous procedures, which are less reliant on opioids, aid in stabilizing the physiological state, maintenance of the immune system, and overall patient recovery. It is important to note that a high difference in gender, profession, experience, and the type of hospital also indicates high demands in creating meaningful training and recommendations during oncological anaesthesia practice.

This is clinically adequate to submit the finding that the determination of an anaesthetic ought not only to be considered concerning the intra-operative safety, but must also be considered to have some potential impact on the long-term cancer prognosis. Implementing the evidence-based approaches to anaesthesia, especially the application of regional blocks, the use of TIVA, and sparing opioids in the comprehensive cancer-care routes, will help increase the quality of outcomes of the postsurgical period and possibly the chance of relapse. It is therefore important that policies are made to guarantee a culture of continuous learning or education, interdepartmental coordination, and protocol-based anaesthetic control.

In conclusion, this paper identifies that anaesthetic technique belongs to cancer therapy, and it can influence both biological and restorative functions. Even though further extensive clinical trials are needed to establish causal links, the current evidence base entirely favors the application of current, patient-centered, and immune-sparing anaesthetic techniques as the initial standard practice in oncologic surgical practice is overwhelming.

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