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Costs and Time Loss from Pre-Anesthesia Consultations for Canceled Surgeries: A Retrospective Study at Aachen University Hospital in Germany

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Abstract: Background: In Germany, over 16 million pre-anesthesia consultations (PAC) are conducted annually, which is associated with a significant investment of time and high costs. However, some PACs do not lead to surgery, which is inefficient and results in wasted resources. This study evaluates the costs and time loss associated with PACs that did not result in anesthesia-required surgery or diagnostic procedures and identifies the predictors of these cancellations. Methods: A total of 1357 PACs conducted in September 2023 at the University Hospital Aachen were retrospectively analyzed. The study groups included patients whose PACs resulted in anesthesia-required surgery or diagnostic procedures (SURG group) and those whose PACs did not (NoSURG group). The primary outcomes were costs in EUR and the hours lost due to PACs not resulting in anesthesia for patients in the NoSURG group, and the secondary outcomes included the predictors of surgery cancellations, the frequency of missing test results, necessary pre-anesthesia re-consultations due to missing tests, and hospital length of stay for NoSURG patients. Results: In September 2023, 7.3% (99/1357) of PACs did not result in anesthesia-required procedures. ASA scores were higher in the NoSURG group, with almost two-thirds classified as ASA III or higher ($p = 0.001$). The NoSURG group had more planned postoperative IMC stays (16.2% vs. 9.3%; $p = 0.027$) and fewer medical report letters available (50.5% vs. 97.1%; $p < 0.001$). The reasons for surgery cancellation were often undetermined (47.5%). Other reasons included surgeons opting for a conservative approach (19.2%), patient decisions (9.1%), surgery no longer indicated (8.1%), hospital capacity constraints (5.1%), patient transfers (3.0%), and high surgical risk (8.1%). The annual projected cost for the NoSURG group was EUR 29,182, with 888 h of time loss. The median hospital length of stay for the NoSURG group was 5 (2; 15) days. Conclusions: PACs that were carried out but were not followed by anesthesiology services led to substantial costs and time loss. Improving medical report availability and assessing procedure necessity beforehand might help to reduce these expenses and time losses.

Keywords: pre-anesthesia clinic; pre-anesthesia consultation; PAC; preoperative care; surgery cancellation

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1. Introduction

With over 16 million anesthetic procedures conducted annually, excluding diagnostic procedures such as biopsies and imaging diagnostics [1], the extensive scale of necessary pre-anesthesia consultations (PAC) becomes evident, as each anesthesia session requires a prior PAC. In Germany, with 1893 hospitals [2] and thus 1893 PAC clinics, nearly 27,572 anesthesiologists [3] conduct these consultations. This equates to an average of 580 PACs per anesthesiologist per year, or about 2.2 PACs per working day. Based on these numbers, each PAC clinic in Germany handles an average of 23 patients per day. However, the number of PACs depends on the size of the hospital and the number of surgeries performed [4].

At university hospitals in Germany, pre-anesthesia clinics may need to manage up to 130 patients daily [5]. To handle this number of patients, staffing typically includes several medical assistants responsible for scheduling and coordination, a senior physician, and 4–7 residents.

The primary objectives of PACs are to minimize perioperative morbidity and mortality and ensure fast rehabilitation after surgery [6]. Various benefits of PAC have been described. This includes a reduction in preoperative consultations and costs associated with unnecessary testing, a decrease in surgical cancellations due to inadequate preoperative preparation [7], shortened hospital stays [8], and a reduction in mortality [9].

The duration of PACs correlates with the ASA score, number of comorbidities, type of surgery, and patient's current admission category (ambulatory, inpatient, or critical care) [10–12]. A study in Germany on a cohort of over 10,000 patients found that the specific cost of PACs ranges between 4% and 9% in relation to the overall anesthesia costs [13]. Similar specific costs were reported in a study by Lee et al., which found that PACs accounted for approximately 4% of the overall anesthesia costs [14].

Despite these benefits, several challenges remain. Van Klei et al. [9] reported that 6.3% of the 16,219 outpatient PACs resulted in surgery cancellations due to various reasons, including cancellation by anesthesiologists, surgeons, or patients, logistical issues, and insufficient diagnostic workup. Additionally, patients frequently need a second PAC due to outstanding or missing test results that are essential for the evaluation of the pre- and postoperative risks. Another study by Lee et al. [14] reported a cancellation rate of 2.3% in a PAC clinic, with most cancellations initiated by the surgeons. In contrast, Vongchaiudomchoke et al. [15] documented a lower cancellation rate of 0.9%, citing various factors, such as patient-related medical conditions, hospital facility issues, and cancellations made by surgeons, anesthesiologists, or the patients themselves.

With capacity strain becoming increasingly problematic, especially for large academic hospitals [16], many approaches to managing the increased demands on hospital capacity have emerged. One of the often-used strategies relies on allocating staffing more efficiently and encouraging shorter hospital stays to allow for a better patient flow [17]. Staffing shortages are predicted to increase over the next years and remain one of the biggest challenges in streamlining preoperative processes efficiently [18]. To limit the number of anesthesiologists conducting PACs, approaches such as employing teleconsultations [19] or nurse-run PAC clinics [11] have been implemented. However, the impact of these measurements is diminished if surgeries are canceled after the PACs, therefore leading to unnecessary costs and time loss.

Additional PACs result in additional costs for the clinic, as well as a significant loss of time for the anesthesiologist, the surgeon, and the patients. The financial and time burdens of PACs that do not lead to surgery are unknown, and studies focusing on PAC effectiveness are still lacking [20]. Therefore, the aim of this study is to evaluate the costs and time loss for the anesthesia department of PACs that did not lead to surgery (NoSURG

group) and to identify the frequency and predictors of surgery cancellations. Secondary outcome parameters include the overall frequency of missing test results, the frequency of necessary pre-anesthesia re-consultations due to missing test results, a comparison between scheduled and actual surgery dates, and the length of hospital stay (LOS) for patients in the NoSURG group.

2. Materials and Methods

This retrospective study was conducted at the University Hospital Aachen and received approval from the Ethical Committee (approval number: EK24-028, date of approval 29 January 2024). An analysis was conducted on the data collected in the PAC clinic during September 2023. The month of September was chosen because it does not contain any public holidays, allowing for the maximum number of patients to be included.

The documentation of patients presenting to the PAC clinic was managed using the CGM Medico (Release 28.00.11.01 WIPS0090 Ambulanz/Leistungsstelle 32-Bit, CGM Clinical Europe GmbH, Maria Trost 21, 56070 Koblenz, Germany) program. All patient data were pseudonymized.

2.1. Study Groups

This study divided patients into two groups: the SURG and NoSURG groups.

SURG Group: This group consisted of patients who had a PAC and received anesthesia for a planned surgery or procedure (e.g., sedation for an MRI scan).

NoSURG Group: This group included patients who had PACs but ultimately did not undergo the planned surgery or procedure.

For simplicity, we named the groups SURG and NoSURG, even though not all cases involved surgery; some involved other anesthesia-required procedures, like biopsies and diagnostic procedures.

A surgical approach refers to any medical intervention that requires the patient to undergo an operation, typically involving general or regional anesthesia. In contrast, "procedures" refer to diagnostic or therapeutic interventions that are either minimally invasive, such as angiography, or non-invasive, such as magnetic resonance imaging (MRI) or computed tomography (CT), and require sedation or general anesthesia.

The term "conservative approach" describes non-surgical and non-interventional treatment strategies, such as pharmacological management, physical therapy, or watchful waiting.

2.2. Inclusion and Exclusion Criteria

This study included all patients who presented to the PAC clinic at the University Hospital Aachen in September 2023. Patients attending a PAC included both outpatients coming from home and inpatients already admitted to the hospital. These consultations were conducted by anesthesiologists working in the PAC clinic. While mobile patients visited the clinic in person, anesthesiologists performed bedside consultations on the wards for those with mobility limitations. We excluded patients who underwent a pre-transplantation evaluation but did not receive a transplant, had scheduled appointments at the PAC clinic that were canceled before the consultation, died prior to surgery, or had missing data for primary or secondary outcome measures.

2.3. Primary and Secondary Outcome

The primary outcomes included (1) the evaluation of costs and time loss for the anesthesia department due to PACs that did not lead to surgery (NoSURG group) and (2) the frequency and predictors of surgery cancellations. Secondary outcome parameters included (1) the overall frequency of missing test results, (2) the frequency of a necessary 2nd PAC due to missing test results, (3) the frequency of another PAC because the last PAC

occurred more than five weeks ago, (4) a comparison between scheduled and actual surgery dates, and (5) the length of stay in the hospital (LOS) for patients in the NoSURG group.

2.4. Cost and Time Calculation PAC

Cost calculations for PAC consultation included individual physicians' wages based on the remuneration table for physicians at German university hospitals [Supplement Table S1] [15]. Additional costs associated with the PAC clinic, such as rent, salaries of the administrative staff, office supplies, and infrastructure costs (e.g., heating and electricity), were not included in the calculation. The times of the PAC consultations were documented by the anesthesiologist who conducted the PAC consultations. The start of PAC consultation is usually defined as the first contact with the patient face-to-face or the beginning of screening the patient's chart. PAC consultations end when documentation is fully completed. At the University Hospital Aachen, it is mandatory for each anesthesiologist to document the duration of the PAC, starting from the beginning of the consultation and ending when all required documentation is fully completed.

During this process, the time required for a PAC was multiplied by the monthly salary of the anesthesiologist in the corresponding pay group.

2.5. Statistical Analysis

Statistical analyses were conducted using GraphPad Prism software (Version 9.3.1, GraphPad Software, San Diego, CA, USA). Values were expressed as mean +/− SD, median (25th quartile; 75th quartile) or number (%). The normal distribution of metric variables was tested using the Shapiro–Wilk test. The Mann–Whitney U test with a two-tailed *p*-value was used to compare the metric variables, and the Kruskal–Wallis test with Dunn's correction was used for multiple comparisons. The chi-squared test was calculated for the comparison of discrete variables if all cells had expected frequencies of $\geq$10. Otherwise, Fisher's exact test was used. Spearman's rank correlation test was used for correlation analysis. A binary logistic regression analysis to analyze potential predictors for cancellation was performed by using SPSS software Version 22 (SPSS Inc., Chicago, IL, USA). The inclusion of parameters for the logistic regression model was based on results from the Mann–Whitney test, chi-squared test, or Fisher's exact test. Parameters with *p*-values of <0.1 were included. A Kaplan–Meier curve was plotted for better visualization of the outstanding procedures after the PACs.

A *p*-value of <0.05 was considered significant (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$).

All patients were always included in all the statistical tests that were performed. If the inclusion of all patients was not possible due to missing data, this information was explicitly added in the description below the table or figure.

3. Results

3.1. Patient Selection Process

Out of the 1610 initially screened patients, several were excluded based on the criteria described above [Figure 1]. Specifically, 155 patients were scheduled for a PAC but did not attend, 6 patients died before surgery, 6 were listed for transplants without consecutive surgery, and 86 were excluded due to missing data regarding the primary and secondary outcomes. Consequently, 1357 patients were included in the final analysis. Of these, 1258 underwent surgery (SURG group), while 99 had their surgeries canceled (NoSURG group) after the PAC.

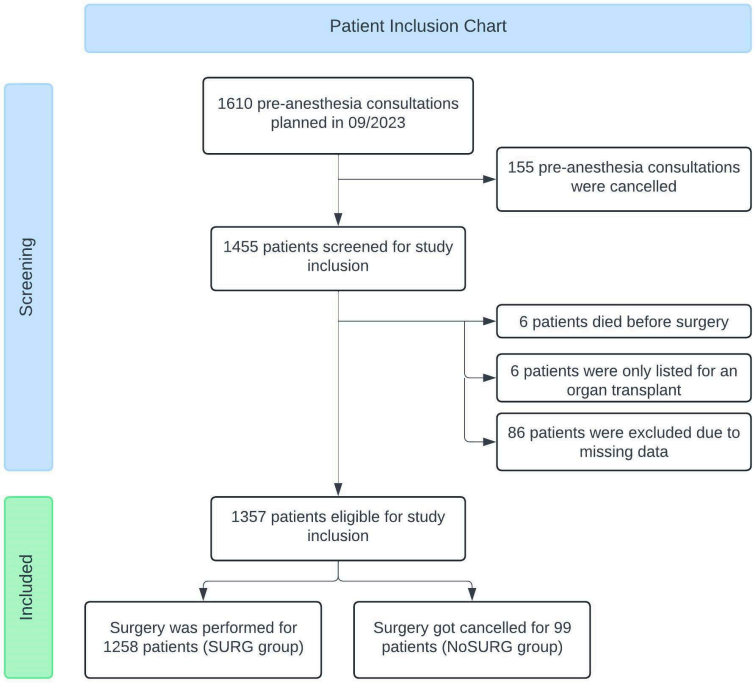

Figure 1. Screening process and patient inclusion and exclusion criteria.

3.2. Baseline Clinical Characteristics of the SURG and NoSURG Group

The ASA scores differed significantly between patients from the SURG group and patients from the NoSURG group. The ASA scores were higher in the NoSURG group. Almost two-thirds of the patients in the NoSURG group were classified as ASA III or higher, in contrast to the SURG group, with only two-fifths of the patients classified as ASA III or higher ($p = 0.001$) [Table 1]. Additionally, the NoSURG group had a significantly higher number of patients with a planned postoperative stay in intermediate care (IMC) compared to the SURG group (16.2% vs. 9.3%; $p = 0.027$). Moreover, the availability of a medical report letter, which includes details of all pre-existing conditions, test results, and current medications, was significantly lower in the NoSURG group (50.5% vs. 97.1%; $p < 0.001$). None of the other baseline characteristics, e.g., age or gender, showed significant differences between the two groups.

A total of 1357 PACs were conducted in September 2023. Most anesthesiologists who conducted the PACs were specialists (38.24%), in their fifth year of training (26.22%), or in their fourth year of training (15.24%) [Figure 2A]. The mean duration of the PACs differed depending on the ASA score ($p < 0.001$), with the mean duration of PACs increasing with an increasing ASA score. For patients classified as ASA IV, the mean duration of a PAC was 43 min, whereas the mean duration of a PAC for patients classified as ASA I was only 20 min ($p < 0.001$) [Figure 2B]. Anesthesiologists in their first year of residency required significantly less mean time for a PAC (21.5 min $\pm$ 12.8 min) compared to residents in their second year of residency (31.3 min $\pm$ 17.2, $p < 0.001$), anesthesiologists in their third year (25.8 min $\pm$ 11.3, $p < 0.001$), fourth year (29.8 min $\pm$ 17.0, $p < 0.001$), or fifth year of training (26.9 min $\pm$ 14.6, $p < 0.001$), and specialists (25.4 min $\pm$ 9.9, $p < 0.001$). There was no statistically significant difference in the duration of PACs between anesthesiologists in their first year of training and senior consultants nor between anesthesiologists in their second year of training up to their fifth year of training or between any of these and specialists [Figure 2C]. There was no correlation between the ASA status of the patient who received the PAC and the residency year of training of the anesthesiologist who conducted the PAC [Supplement Figure S1], with anesthesiologists in all stages of training seeing a similar mix of patients regarding their ASA status.

Table 1. Baseline characteristics of patients with consultations at the PAC clinic.

Characteristic	All Patients n = 1357	SURG Group n = 1258	NoSURG Group n = 99	*p*-Value
Age, y	55 (32; 69)	56 (31; 69)	51 (36; 71)	0.324
Sex assigned at birth (f/m)	633/724 (46.6%/53.4%)	587/671 (46.7%/53.3%)	46/53 (64.5%/53.5%)	0.970
ASA Score	2 (2; 3)	2 (2; 3)	3 (2; 3)	0.001
ASA I	289 (21.3%)	271 (21.5%)	18 (18.2%)	0.432
ASA II	477 (35.2%)	456 (36.3%)	21 (21.2%)	0.003
ASA III	512 (37.8%)	464 (36.9%)	48 (48.5%)	0.022
ASA IV	76 (5.6%)	64 (5.1%)	12 (12.1%)	0.004
ASA V	3 (<0.1%)	3 (0.2%)	0 (0%)	>0.999
Bedside PAC	158 (11.6%)	146 (11.6%)	12 (12.1%)	0.878
Planned IMC admission post-surgery	133 (9.8%)	117 (9.3%)	16 (16.2%)	0.027
Planned ICU admission post-surgery	214 (15.8%)	193 (15.3%)	21 (21.2%)	0.123
Time between PAC and first scheduled surgery date, d	3 (1; 7)	3 (1; 7)	3 (1; 7)	0.289
Availability of medical report letter at first PAC	1272 (93.7%)	1222 (97.1%)	50 (50.5%)	<0.001
Current PAC is a follow-up consultation	72 (5.3%)	66 (5.3%)	6 (6.1%)	0.633

Results are expressed as median (25th quartile; 75th quartile) or No. (%). PAC = pre-anesthesia consultation; ASA score = American Society of Anesthesiologists physical status classification score; IMC = intermediate care unit; ICU = intensive care unit.

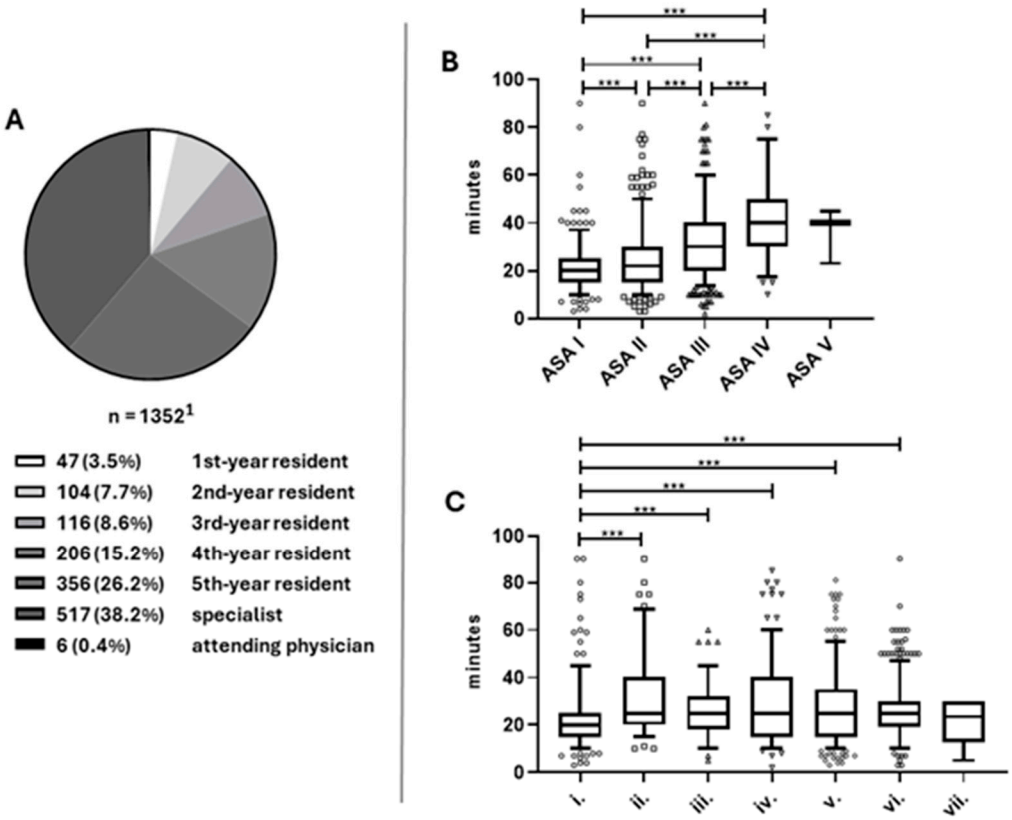

Figure 2. (**A**) Percentage of PACs per residency year of the anesthesiologist conduction the consultation. Results are expressed as No. (%). (**B**) Duration of PACs in relation to the ASA score. Results are expressed as median (95% CI). (**C**) Duration of PACs in relation to the residency year of the anesthesiologist conduction the consultation. Results are expressed as median (95% CI). i. = 1st-year resident ii. = 2nd-year resident; iii. = 3rd-year resident; iv. = 4th-year resident; v. = 5th-year resident; vi. = specialist; vii. = attending physician. [1] The year of residency of the anesthesiologist conducting PAC could not be determined for 5 patients due to incomplete documentation. Different symbols were chosen to represent the data points outside the 95% CI for each category. *** = $p < 0.001$.

Additionally, there was a significant difference between the specialties who requested a PAC regarding the duration and costs of the PAC (both: $p < 0.001$) [Table 2]. Palliative care had both the highest PAC duration and cost, although it needs to be taken into account that only a single patient in palliative care was included. The second highest mean PAC duration and cost were found in internal medicine, with 38.6 ± 15.5 min and 24.0 ± 9.17 EUR/case, respectively. The specialty with both the lowest duration (20.1 ± 8.0 min) as well as cost (12.60 ± 5.13 EUR/case) was ophthalmology, followed by nuclear medicine, with only slightly higher numbers.

Table 2. Duration and cost of PACs by case and specialty.

Specialty	All Patients n = 1357	Duration of a PAC [min/case]	Cost of a PAC [EUR/case]
Palliative Care	1 (0.1%)	50.0 ± 0.0	31.70 ± 0.00
Internal Medicine	118 (8.7%)	38.6 ± 15.5	24.00 ± 9.17
Neurology	25 (1.8%)	37.6 ± 18.6	23.00 ± 10.50
Cardiac Surgery	69 (5.1%)	33.1 ± 14.0	19.80 ± 9.15
Trauma Surgery	188 (13.9%)	29.9 ± 17.1	18.10 ± 10.40
Neurosurgery	80 (5.9%)	29.6 ± 15.3	18.50 ± 8.99
Psychiatry	6 (0.4%)	29.2 ± 11.6	17.70 ± 7.05
Thoracic Surgery	36 (2.7%)	28.4 ± 11.8	17.90 ± 7.27
Vascular Surgery	34 (2.5%)	28.4 ± 11.3	18.30 ± 6.52
Pediatrics	84 (6.2%)	26.6 ± 13.0	17.20 ± 8.67
Plastic Surgery	59 (4.4%)	26.3 ± 15.8	16.10 ± 9.31
General Surgery	111 (8.2%)	26.0 ± 12.0	16.50 ± 7.92
Dermatology	6 (0.4%)	24.3 ± 8.1	15.00 ± 4.18
Otorhinolaryngology	111 (8.2%)	23.8 ± 8.7	15.10 ± 6.03
Dentistry and Maxillofacial Surgery	99 (7.3%)	23.6 ± 11.3	15.00 ± 7.47
Urology	81 (6.0%)	22.1 ± 11.5	14.10 ± 7.20
Gynecology	145 (10.7%)	22.0 ± 10.2	13.80 ± 6.51
Nuclear Medicine	3 (0.2%)	21.0 ± 7.9	15.70 ± 6.12
Ophthalmology	101 (7.4%)	20.1 ± 8.0	12.60 ± 5.13
Overall	**1357 (100%)**	**27.1 ± 14.0**	**16.94 ± 8.69**
***p*-Value**		**<0.001**	**<0.001**

Results are expressed as mean ± SD or No. (%). PAC = pre-anesthesia consultation.

The mean duration for all PACs was 27.1 ± 14.0 min, and the mean cost per case was EUR 16.94 ± 8.69. The duration and cost of the PACs for the NoSURG group, depending on the specialty that requested them, are detailed in Supplementary Table S2.

3.3. Primary and Secondary Outcome Parameters

In September 2023, 99 (7.3%) out of 1357 PACs did not result in surgery (NoSURG group) [Figure 3A]. The reasons for cancellation of surgery were diverse, but in the majority of cases (47.5%), it was not possible to determine the underlying reason due to incomplete or unclear documentation by the surgical and anesthesiology departments. Other identified reasons included surgeons opting for a conservative approach (27.3%), patients deciding against the surgery (9.1%), the planned surgery no longer being indicated due to illness progression or spontaneous remission (8.1%), hospital capacity constraints (5.1%), patient transfer back to the referring hospital for further treatment (3.0%), and high surgical risk (8.1%). Some of the reasons, like patients deciding against the surgery or illness progression, are challenging to predict in advance and hard to minimize. However, the main concern is the lack of knowledge about the reasons in almost half of the canceled cases.

In September 2023, the total cost of PACs was EUR 22,813, with a total time commitment of almost 614 h. The cost of PACs without subsequent surgery was EUR 1610 [Figure 3B], with a total time commitment of 48 h [Figure 3C]. Additionally, repeated PACs due to missing test results at the first PAC resulted in additional costs of EUR 822 and an additional time commitment of 26 h.

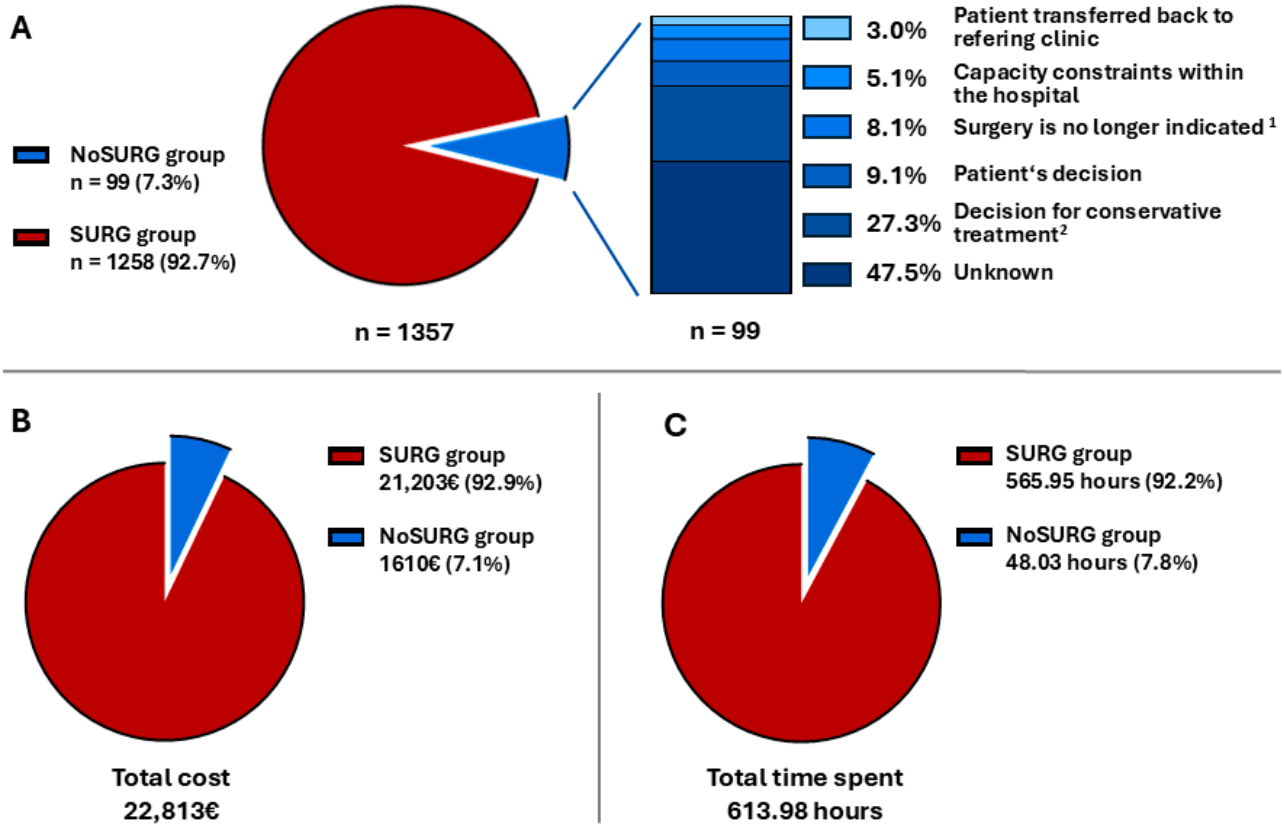

Figure 3. (**A**) Number of PACs in the NoSURG and SURG groups in September 2023 and reasons for surgery cancellations in the NoSURG group. (**B**) Total cost of PACs in the SURG and NoSURG groups in September 2023. (**C**) Duration of PACs in the SURG and NoSURG groups in September 2023. Results are expressed as No. (%). [1] Surgery was no longer indicated due to the progression of the underlying illness or spontaneous remission. [2] A conservative treatment approach was chosen over surgery, as the surgical team deemed it safer for this particular patient.

The overall cost of PACs of patients in the NoSURG group, along with repeated PACs due to missing test results, led to a total cost of EUR 2432 in September. By projecting these numbers to a year, the total cost for the NoSURG group amounts to EUR 29,182, with a total time commitment of 888 h.

A follow-up visit in the PAC clinic was significantly more frequently necessary for patients in the NoSURG group compared to patients in the SURG group (12.1% vs. 2.8%, $p < 0.001$) [Table 3]. However, there was no difference between the two groups regarding necessary follow-up visits due to PACs that had taken place more than 5 weeks prior (at the University Hospital Aachen, PACs occurring more than 5 weeks prior require patients to attend a second PAC). In the NoSURG group, there was a significantly higher rate of missing test results (42.2% vs. 30.5%, $p = 0.013$). Specifically, TTE/TEE results were absent significantly more often in this group (7.1% vs. 2.1%, $p = 0.008$), and preoperative consults, other than those from cardiology, were missing more often in the NoSURG group (3.0% vs. 0.7%, $p = 0.051$), although this result was only borderline significant.

If surgery was performed, the actual date matched the anticipated date in 51.1% of cases. In over 30% of cases, there was a discrepancy of more than three days between the planned and actual surgery dates [Figure 4]. The NoSURG group had a median hospital length of stay (LOS) of 5 (2; 15) days.

Table 3. Secondary outcome parameters.

	All Patients n = 1357	SURG Group n = 1258	NoSURG Group n = 99	*p*-Value
2nd PAC is necessary; diagnostic workup is missing	47 (3.5%)	35 (2.8%)	12 (12.1%)	<0.001
2nd PAC is necessary; older than 5 weeks [1]	12 (0.9%)	11 (0.8%)	1 (0.1%)	0.599
Preoperative test results are missing (total)	425 (31.3%)	383 (30.5%)	42 (42.2%)	0.013
Missing test results:				
Preoperative lab test results	309 (22.8%)	286 (22.7%)	23 (23.2%)	0.910
Preoperative ECG	98 (7.2%)	91 (7.2%)	7 (7.1%)	>0.999
Preoperative TTE/TEE	33 (2.4%)	26 (2.1%)	7 (7.1%)	0.008
Other preoperative imaging	14 (1.0%)	11 (0.9%)	3 (3.0%)	0.076
Preoperative report of cardiology consultation	22 (1.6%)	20 (1.6%)	2 (2.0%)	0.674
Other preoperative consults [2]	12 (0.9%)	9 (0.7%)	3 (3.0%)	0.051

Results are expressed No. (%). ECG = electrocardiogram; TTE = transthoracic echo; TEE = transesophageal echo; PAC = pre-anesthesia consultation. [1] Follow-up PAC is required at the University Hospital Aachen if the last PAC occurred more than 5 weeks prior. [2] Other PACs include consultations by otorhinolaryngology, nephrology, pulmonology, internal medicine, hematological oncology, and maxillofacial surgery.

A binary logistic regression analysis was conducted to identify predictive variables for patients in the NoSURG group. The logistic regression model was highly statistically significant ($\chi^2(26) = 246.239$; $p < 0.001$), explained 41.0% (Nagelkerke R^2) of the variance in surgery cancellations, and correctly classified 94.3% of cases. Variables were included based on their univariate *p* values (see section statistical analysis) and included medical discipline, ASA score, missing test results, the necessity of a follow-up visit, planned postoperative stay in the IMC, and the presence of a preoperative medical report listing the patient's diagnoses.

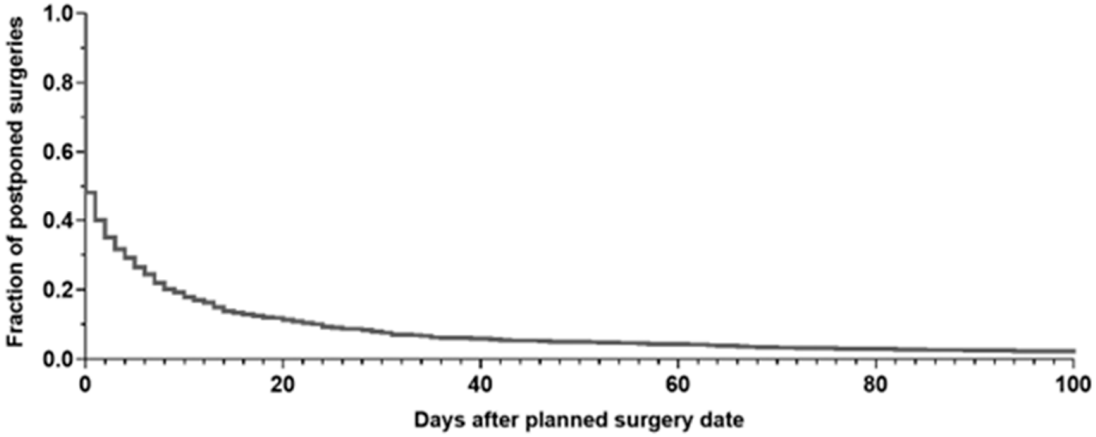

Figure 4. Difference between planned date of surgery and actual date of surgery in days. Results are expressed as fraction of postponed surgery. More than 2/3 of procedures were performed within 72 h after the actual planned time point. Over 90% of all planned surgeries were performed within 24 days of the initially scheduled date.

The binary logistic regression analysis showed that the likelihood of surgery being canceled depends on the medical department ($p = 0.022$) [Table 4]. Specifically, the probability of surgery cancellation increases by 85.1% for neurology (OR: 0.149, 95% CI: 0.023–0.960); 80.1% for gynecology (OR: 0.199, 95% CI: 0.045–0.886); and 79.1% for internal medicine (OR: 0.209, 95% CI: 0.046–0.951). There was no significant association between an in- or decrease in the likelihood of surgery and any other departments. The strongest predictor, with an almost fivefold risk increase for surgery cancellation, included the necessity of a follow-up PAC (OR: 4.8, 95% CI: 1.9–12.2; $p = 0.001$), followed by a 98.5% risk increase if a medical report letter was missing (OR: 0.015, 95% CI: 0.007–0.030; $p < 0.001$).

Table 4. Predictors of surgery cancellation using binary logistic regression.

Characteristic	OR (95% CI)	*p*-Value
Discipline [1]		0.022
Gynecology	0.199 (0.045 to 0.886)	0.034
Internal Medicine	0.209 (0.046 to 0.951)	0.043
Neurology	0.149 (0.023 to 0.960)	0.045
Follow-up visit in PAC clinic is necessary [2]	4.8 (1.9 to 12.2)	0.001
Medical report letter is not available	0.015 (0.007 to 0.030)	<0.001

PAC = pre-anesthesia consultation. [1] Discipline that requested a PAC [2] due to missing test results.

4. Discussion

In September 2023, 1357 PACs were conducted, with 99 (7.3%) not resulting in surgery (NoSURG group). The NoSURG group had significantly higher ASA scores compared to the SURG group. Additionally, 16% of patients from the NoSURG group were planned for IMC stays, compared to 9% in the SURG group, and medical report letters were more frequently missing in the NoSURG group. The reasons for surgery cancellation in the NoSURG group were often undetermined (47.5%) or due to opting for conservative procedures (27.3%). The strongest predictors for surgery cancellation included the need for a follow-up PAC and the absence of a medical report letter. Patients in the NoSURG group had a median hospital length of stay of 5 (2; 15) days. When projected over a year, the total cost for PACs in the NoSURG group, including repeated visits due to missing test results, is estimated at EUR 29,000, with a time loss of 888 h.

In a single month, 99 PACs (7.3%) were ultimately unnecessary because the patients did not undergo surgery, and in 4.3% of cases (n = 59), a second PAC was necessary. The extrapolated costs for one year were EUR 29,184. Although this reflects unnecessary expenses, the amount appears manageable.

However, it is essential to consider that the actual costs are likely higher. At university hospitals, PACs are billed to health insurance companies [21]. For example, at the University Hospital Aachen, the costs per outpatient case are EUR 28.85 and EUR 37.65 per inpatient consultation, leading to total annual costs of EUR 56,812. It should be noted that the costs associated with the PAC clinic, such as rent, salaries for administrative staff, office supplies, and infrastructure costs (e.g., heating, electricity), were not included in our calculation. The costs for PACs are considerably higher in other countries; for instance, Lee et al. [14] reported costs of USD 109 per patient per PAC. Furthermore, specific costs can vary greatly by country. In Germany, the total personnel costs for an anesthesiologist working at a University Hospital range between EUR 63,700 and EUR 111,627 per year, depending on the level of training and the duration of experience within that specific training level [22,23]. In contrast, anesthesiologists' salaries in the USA are much higher (USD 426,047 per year) [24], significantly exceeding the costs calculated in this study.

Additionally, further costs arise from unnecessary length of stay (LOS) in the hospital, which were not included in this study. More importantly, there is the very important issue of time loss. Our study found 576 h per year lost due to PACs with patients who ultimately did not undergo surgery and 312 h per year due to necessary second PACs. This results in 888 h or 111 full workdays per year (assuming an 8 h workday). It is important to note that the time for a second PAC is not automatically much shorter, as patients are usually seen by a different anesthesiologist who must essentially start the consultation process anew to ensure the information is correctly gathered and the consultation is properly documented.

Moreover, the total time loss also includes the time loss for the patient, who must return to the surgeon for further diagnostics before scheduling another PAC appointment. This results in further time losses for all parties involved: the anesthesiologist, the surgeon, and the patient.

Given the current shortage of physicians in Germany [25], the time loss of 888 h represents a significant loss in working time. The shortage of anesthesiologists [26] further exacerbates this issue, potentially increasing the workload. This is particularly concerning given the high and rising number of operations and diagnostic procedures requiring anesthesia [2]. When comparing our results with those of other studies, significant differences need to be considered. Van Klei et al. [9] found that out of 16,219 PACs from 1997 to 1999, 1027 surgeries were canceled (6.3%). After introducing an outpatient preoperative evaluation (OPE), the cancellation rate could be significantly reduced to 4.6%. However, the LOS in the hospital changed only slightly: from 8.8 days before OPE to 8.1 days after OPE. It is worth noting that this study excluded cardiac surgery, obstetric and pediatric patients, and same-day surgery patients. Mendes et al. [27], on the other hand, noted a significant reduction in the average hospital stay from 6.2 days to 5.0 days over four years after the introduction of an outpatient PAC clinic. Kamal et al. [28] reported a significant decrease in LOS in both the High Dependency Unit (HDU) and Intensive Care Unit (ICU) after the introduction of a PAC clinic.

Further, Mendes et al. [27] observed a significant reduction in overall surgery cancellation rates from 39.3% in the first year to 15.9% in the fourth year after the introduction of an outpatient PAC clinic. Farasatkish et al. [29] found a reduction in the cancellation rate on the day of cardiothoracic surgery from 16.8% to 13.3%. Lee et al. [14], however, found that the day-of-surgery cancellation rates were similar whether patients received a prior PAC (2.3%) or not (3.4%) ($p = 0.75$).

Further, Kamal et al. [28] reported a significant reduction in mortality rates (from 6.1% to 1.2%) following the introduction of a mandatory PAC.

In this context, it is important to recognize the role of the PAC in determining whether a surgical approach carries too much risk, especially for patients with multiple comorbidities, and whether a conservative approach would be a safer option for the patient.

When the pre-anesthesia consultation leads to the decision to pursue a conservative approach instead of surgery, this may incur additional consultation costs but is ultimately more beneficial for the patient by avoiding the heightened risks associated with surgery. Thus, transitioning from a surgical to a conservative approach should not be viewed negatively, as these consultations are vital for ensuring patient safety and minimizing unnecessary surgical procedures, which, in turn, may reduce healthcare costs.

However, this raises the question of why a conservative approach was not considered earlier by the surgical team, especially when it presents a viable option. It is particularly relevant considering that the surgical team is generally aware of a patient's comorbidities and the associated surgical risks before referring them for a PAC. Importantly, in this study, there were no recorded cases in which a conservative approach was chosen because the anesthesiologists deemed the surgical risks too high. This suggests that the decision to opt for conservative treatment may not be directly driven by the PAC but rather reflects broader clinical judgment on the part of the surgical team. To better understand the factors influencing the shift from surgical to conservative management, a prospective study investigating the determinants behind this decision could provide valuable insights.

At the same time, it is important to address the lack of clear documentation regarding the reasons for surgery cancellations. This observation raises concerns about the underlying factors contributing to incomplete documentation and highlights the need for improvement in this area. The implementation of pre-PAC checklists for surgeons that emphasize the pitfalls of delayed or incomplete PACs (e.g., missing medical records) might be a valuable tool to generate awareness and might reduce unnecessary delays or cancellations in advance. Future prospective studies are essential to further investigate these issues and gather more

comprehensive data on the reasons for surgery cancellations, potentially through follow-up interviews with the surgical team.

It is worth considering whether anesthesiologists are necessary for all PACs. Van Klei et al., as well as Arun et al. [11,30], suggested that nurses could conduct PACs with nearly the same accuracy as anesthesiologists. Morau [19] and Wienhold et al. [31] explored the possibility of tele-PACs, showing them to be feasible and yielding high satisfaction rates. However, tele-PACs remain a concern, particularly for ASA 3 and ASA 4 patients, since tele-PACs have only been conducted with ASA 1 and 2 patients so far.

The duration of a PAC depends on the ASA score, as shown in previous studies [12]. Compere et al. [10] reported shorter PAC times (11.2 $\pm$ 8 min), but these PACs primarily involved ASA I and II patients. In contrast, at our university clinic, PAC times were longer, mainly due to bedside consultations, resulting in an average PAC clinic visit time of 27.1 $\pm$ 14.0 min.

Further, the first-year residents in this study took as long to complete PACs as experienced senior attendings. This was not because first-year residents conducted PACs with patients who had higher ASA scores, as our analyses demonstrated [Supplement Figure S1]. However, as residents advance in their training, the duration of PACs increases significantly, possibly due to more thorough assessments over time.

Higher ASA scores were significantly associated with surgery cancellation. This is reasonable, as patients with higher ASA scores are often more complex regarding morbidity and outcome. All the reasons given for cancellations are of particular importance to those patients.

To optimize processes and reduce costs and time loss, surgeons should ensure that all patient findings are available before scheduling a PAC. As missing test results and the absence of a preoperative medical report were identified as key predictors of surgery cancellations, addressing these issues is crucial. One potential solution is to implement a PAC checklist prior to scheduling the PAC appointment. This checklist would ensure that all necessary documents, such as a comprehensive medical report detailing pre-existing conditions and medications, are available in advance. Shifting the responsibility for obtaining these documents to the surgical department could streamline the process, improving both time and cost efficiency by reducing the need for a second PAC.

Limitations

This study has several limitations. First, in 47.5% of cases, the reason for the surgery cancellation could not be determined, making it challenging to identify effective strategies for reducing the cancellation rate. This lack of knowledge implies that there is not enough awareness of the resulting problems. Further prospective studies that include, e.g., follow-up interviews with the surgical team on the topic of surgery cancellations might provide further insights into this issue.

Secondly, while we analyzed patients originally scheduled for surgery in September/October 2023, our follow-up data regarding the subsequent surgeries being performed were limited to 31 May 2024; therefore, it is possible that some patients in the NoSURG group may have received surgery after this date. However, this likelihood is low given the initial planned surgery dates in September/October 2023 and the fact that no subsequent surgeries were performed by 31 May 2024.

Third, our analysis was limited to one month; a longer study period with more patients would increase the impact of this study. Our intention was to analyze a month without any holidays to take any holiday or pre-holiday effects on the number of overall scheduled surgeries into account. However, a longer analysis period and a multicenter design might further improve the reliability of the data. Another possible aspect for more comprehensive

future studies could be evaluating the impact of surgery cancellations and delays on parameters such as patient anxiety and satisfaction, as well as including data on their effect on patient outcomes.

Fourth, the PAC times were recorded by the anesthesiologists conducting the consultations, potentially leading to inaccuracies in estimating the duration of PAC. Future prospective studies could include standardized time monitoring to provide more objective durations for the PAC and allow for a distinction between the time needed for the consultation itself and, e.g., documentation.

Finally, it is important to acknowledge that many of the references cited in this work are based on studies conducted several years ago, and therefore, they may not fully show the current state of research and practical application in hospitals. As emphasized by Kristoffersen et al. [20] in their systematic review, the current body of literature on this topic is sparse and marked by significant heterogeneity. There is a clear need for additional high-quality prospective studies to address this gap in the research.

5. Conclusions

This study conducted in the University Hospital Aachen in September 2023 highlights the significant costs and time loss due to PACs that do not lead to anesthesia-required surgeries or procedures. To optimize the conditions for a need-based PAC, the medical department responsible for requesting PACs should ensure that all relevant patient information is available before making the referral, as missing information is more often associated with both surgery cancellation and follow-up visits. This includes having a comprehensive medical report that details all significant pre-existing conditions and medications, thus avoiding the need for a second PAC.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/anesthres2010002/s1: Table S1: Remuneration table according to German TV-Ärzte as of September 2023; Figure S1: Correlation analysis between residency year of the anesthesiologist conducting the PAC and ASA score of the patient revealed no correlation (Spearman's rho: r = 0.018; p = 0.499); Table S2: Duration and cost of PAC in the NoSURG group by specialty.

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References

1. Die 20 Häufigsten Operationen Insgesamt (5-Operationen- und Prozedurenschlüssel 5)—Statistisches Bundesamt. [The 20 Most Common Surgeries Overall (5-Operation and Procedure Codes 5)—Federal Statistical Office]. Available online: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Krankenhaeuser/Tabellen/drg-operationen-insgesamt.html#fussnote-3-119748 (accessed on 1 June 2024).
2. Grunddaten der Krankenhäuser—Statistisches Bundesamt. [Basic Hospital Data—Federal Statistical Office]. Available online: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Krankenhaeuser/Publikationen/_publikationen-innen-grunddaten-krankenhaus.html (accessed on 1 June 2024).
3. Ärztestatistik zum 31. Dezember 2023 Bundesgebiet Gesamt. [Physician Statistics as of December 31, 2023, for the Entire Federal Territory]. Bundesärztekammer. Available online: https://www.bundesaerztekammer.de/fileadmin/user_upload/BAEK/Ueber_uns/Statistik/AErztestatistik_2023_18.04.2024.pdf (accessed on 1 June 2024).
4. Aust, H.; Veltum, B.; Wächtershäuser, T.; Wulf, H.; Eberhart, L. Premedication visits in departments of anesthesiology in Hessen. Compilation of organizational and performance portfolios. *Anaesthesist* **2014**, *63*, 105–113. [CrossRef]
5. Organization of the Pre-Medication Outpatient Clinic. The Anesthesia/Patient Blood Management Consultation: A Model. *Anasthesiol. Intensivmed. Notfallmedizin Schmerzther.* **2016**, *51*, 274–279.
6. Zambouri, A. Preoperative evaluation and preparation for anesthesia and surgery. *Hippokratia* **2007**, *11*, 13–21. [PubMed]
7. Ferschi, M.B.; Tung, A.; Sweitzer, B.J.; Huo, D.; Glick, D.B. Preoperative clinic visits reduce operating room cancellations and delays. *Anesthesiology* **2005**, *103*, 855–859. [CrossRef] [PubMed]
8. Blitz, J.D.; Kendale, S.M.; Jain, S.K.; Cuff, G.E.; Kim, J.T.; Rosenberg, A.D. Preoperative evaluation clinic visit is associated with decreased risk of in-hospital postoperative mortality. *Anesthesiology* **2016**, *125*, 280–294. [CrossRef]
9. van Klei, W.A.; Moons, K.G.; Rutten, C.L.; Schuurhuis, A.; Knape, J.T.; Kalkman, C.J.; Grobbee, D.E. The effect of outpatient preoperative evaluation of hospital inpatients on cancellation of surgery and length of hospital stay. *Anesth. Analg.* **2002**, *94*, 644–649. [CrossRef] [PubMed]
10. Compère, V.; Froemer, B.; Clavier, T.; Selim, J.; Burey, J.; Dureuil, B.; Gillibert, A.; Besnier, E. Evaluation of the Duration of Preanesthesia Consultation: Prospective and Multicenter Study. *Anesth. Analg.* **2022**, *134*, 496–504. [CrossRef]
11. Van Klei, W.A.; Hennis, P.J.; Moen, J.; Kalkman, C.J.; Moons KG, M. The accuracy of trained nurses in pre-operative health assessment: Results of the OPEN study. *Anaesthesia* **2004**, *59*, 971–978. [CrossRef]
12. Arun, N.; Al-Jaham, K.M.A.; Alhebail, S.A.; Hassan, M.J.A.; Bakhit, R.H.; Paulose, J.; Marcus, M.A.; Ramachandran, B.; Lance, M.D. Nurse-run preanaesthesia assessment clinics: An initiative towards improving the quality of perioperative care at the ambulatory care centre. *BMJ Open Qual.* **2021**, *10*, e001066. [CrossRef]
13. Schuster, M.; Standl, T.; Wagner, J.A.; Berger, J.; Reimann, H.; Am Esch, J.S. Effect of different cost drivers on cost per anesthesia minute in different anesthesia subspecialties. *Anesthesiology* **2004**, *101*, 1435–1443. [CrossRef]
14. Lee, A.; Chui, P.T.; Chiu, C.H.; Gin, T.; Ho, A.M. The cost-effectiveness of an outpatient anesthesia consultation clinic before surgery: A matched Hong Kong cohort study. *Perioper. Med.* **2012**, *1*, 3. [CrossRef] [PubMed]
15. Vongchaiudomchoke, W.; Wongcharoen, P.; Wongyingsinn, M. The impact of a preanesthesia assessment clinic on scheduled elective case cancelations at a Thai university hospital. *Medicine* **2023**, *102*, e34823. [CrossRef] [PubMed]
16. Eriksson, C.O.; Stoner, R.C.; Eden, K.B.; Newgard, C.D.; Guise, J.M. The Association Between Hospital Capacity Strain and Inpatient Outcomes in Highly Developed Countries: A Systematic Review. *J. Gen. Inter. Med.* **2017**, *32*, 686–696. [CrossRef] [PubMed]
17. Arogyaswamy, S.; Vukovic, N.; Keniston, A.; Apgar, S.; Bowden, K.; Kantor, M.A.; Diaz, M.; McBeth, L.; Burden, M. The Impact of Hospital Capacity Strain: A Qualitative Analysis of Experience and Solutions at 13 Academic Medical Centers. *J. Gen. Inter. Med.* **2022**, *37*, 1463–1474. [CrossRef]
18. Winter, V.; Schreyögg, J.; Thiel, A. Hospital staff shortages: Environmental and organizational determinants and implications for patient satisfaction. *Health Policy* **2020**, *124*, 380–388. [CrossRef] [PubMed]
19. Morau, E.; Chevallier, T.; Serrand, C.; Perin, M.; Gricourt, Y.; Cuvillon, P. Teleconsultation compared with face-to-face consultation in the context of pre-anesthesia evaluation: TELANESTH, a randomized controlled single-blind non-inferiority study. *J. Clin. Anesth.* **2024**, *92*, 111318. [CrossRef]
20. Kristoffersen, E.W.; Opsal, A.; Tveit, T.O.; Berg, R.C.; Fossum, M. Effectiveness of pre-anaesthetic assessment clinic: A systematic review of randomised and non-randomised prospective controlled studies. *BMJ Open* **2022**, *12*, e054206. [CrossRef] [PubMed]
21. Institut für das Entgeltsystem im Krankenhaus (InEK) GmbH. *Kalkulation von Behandlungskosten: Handbuch zur Anwendung in Krankenhäusern*; Kohlhammer: Stuttgart, Germany, 2016.

22. Tarifvertrag für Ärztinnen und Ärzte an Universitätskliniken (TV-Ärzte), vom 30. Oktober 2006 in der Fassung des Änderungstarifvertrages Nr. 8 vom 25. August 2022, Zwischen der Tarifgemeinschaft Deutscher Länder, Vertreten Durch den Vorsitzenden des Vorstandes, Einerseits und dem Marburger Bund,—Bundesverband-, Vertreten Durch die 1. Vorsitzende und den 2. Vorsitzenden, Andererseits.—Google Search. [The Collective Agreement for Doctors at University Hospitals (TV-Ärzte), Dated October 30, 2006, as Amended by Amendment Agreement No. 8 on August 25, 2022, Between the Tarifgemeinschaft deutscher Länder, Represented by the Chairman of the Board, and the Marburger Bund, Represented by the 1st and 2nd Chairpersons]. Available online: https://www.marburger-bund.de/sites/default/files/tarifvertraege/2022-11/TV-%C3%84rzte%20i.d.F.%208.%C3%84nderungsTV_final.pdf (accessed on 1 June 2024).
23. Entgelttabellen TV-Ärzte TdL 2024. [Remuneration Tables for Public Sector Physicians (TV-Ärzte) TdL 2024]. Available online: https://www.oeffentlichen-dienst.de/entgelttabelle/tv-aerzte-tdl.html (accessed on 1 June 2024).
24. Eltorai, A.S.; Fuentes, C.; Durand, W.M.; Daniels, A.H.; Ali, S. Financial Implications of Physician Specialty Choice. *Rhode Isl. Med. J.* **2018**, *101*, 50–55.
25. Zi aktualisiert Bedarfsprojektion für Medizinstudienplätze—Monitor Versorgungsforschung. [Zi Updates Demand Projection for Medical School Places—Monitor Health Services Research]. Available online: https://www.monitor-versorgungsforschung.de/news/zi-aktualisiert-bedarfsprojektion-fuer-medizinstudienplaetze/?cookie-state-change=1718480047545 (accessed on 1 June 2024).
26. Simoneaux, R. Are We Facing an Anesthesiologist Shortage? *ASA Monit.* **2022**, *86*, 1–5. [CrossRef]
27. Mendes, F.F.; Mathias, L.A.d.S.T.; Duval Neto, G.F.; Birck, A.R. Impact of preoperative outpatient evaluation clinic on performance indicators. *Rev. Bras Anestesiol.* **2005**, *55*, 175–187.
28. Kamal, T.; Conway, R.M.; Littlejohn, I.; Ricketts, D. The role of a multidisciplinary pre-assessment clinic in reducing mortality after complex orthopaedic surgery. *Ann. R. Coll. Surg. Eng.* **2011**, *93*, 149–151. [CrossRef] [PubMed]
29. Farasatkish, R.; Aghdaii, N.; Azarfarin, R.; Yazdanian, F. Can preoperative anesthesia consultation clinic help to reduce operating room cancellation rate of cardiac surgery on the day of surgery? *Middle East J. Anaesthesiol.* **2009**, *20*, 93–96.
30. Dexter, F.; Witkowski, T.A.; Epstein, R.H. Forecasting preanesthesia clinic appointment duration from the electronic medical record medication list. *Anesth. Analg.* **2012**, *114*, 670–673. [CrossRef] [PubMed]
31. Wienhold, J.; Mösch, L.; Rossaint, R.; Kemper, I.; Derwall, M.; Czaplik, M.; Follmann, A. Teleconsultation for preoperative evaluation during the coronavirus disease 2019 pandemic: A technical and medical feasibility study. *Eur. J. Anaesthesiol.* **2021**, *38*, 1284–1292. [CrossRef]