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SCIENTIFIC ARTICLE

Validity time of normal results of preoperative tests for surgical reintervention and the impact on postoperative outcomes

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Abstract
Background and objective: There are few data defining the period of time in which preoperative tests can be considered valid. The purpose of this study was to determine the likelihood of changes in the results of preoperative tests previously normal in relation to time, and the impact of these changes on postoperative outcomes.
Methods: A total of 970 patients with normal preoperative tests before the first surgery and who required a new intervention were included. The preoperative tests performed for the first procedure were compared with those performed for the second procedure. The following variables were assessed regarding their potential to induce changes in test results: sex, age, surgical risk, previous chemotherapy or radiotherapy, and presence of comorbidities. In-hospital outcomes were analyzed.
Results: The median time between procedures was 27 months (6–84). The probability of change in at least one of the preoperative exams was 1.7% (95% CI: 0.5–2.9), 3.6% (95% CI: 1.8–5.4), and 6.4% (95% CI: 3.9–8.9) during the 12, 24, and 36-month intervals, respectively, for patients aged <50 years and 2.1% (95% CI: 0.7–3.5), 9.2% (95% CI: 5.9–12.5), and 13.4% (95% CI: 9.3–17.5), respectively, for patients ≥50 years of age. Age ($p = 0.009$), surgical risk ($p < 0.001$), chemotherapy ($p = 0.001$), radiotherapy ($p = 0.012$), and comorbidities ($p < 0.001$) were associated with the likelihood of changes in test results. Test changes were not significantly associated with in-hospital adverse outcomes ($p = 0.426$).

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Conclusion: For patients undergoing a second surgical procedure, the probability of change in previously normal preoperative tests is low during the first years after the first surgical intervention, and when changes occurred, they did not adversely affect the in-hospital postoperative outcomes.

PALAVRAS-CHAVE
Período pré-operatório;
Validade;
Cirurgia;
Desfecho pós-operatório;
Testes preoperatórios

Tempo de validade dos exames pré-operatórios normais para uma reintervenção cirúrgica e o impacto nos desfechos pós-operatórios

Resumo
Justificativa e objetivo: Existem poucos dados que delimitam o período de tempo em que os exames pré-operatórios podem ser considerados válidos. O objetivo deste estudo foi determinar a probabilidade de mudanças nos resultados de exames pré-operatórios previamente normais em relação ao tempo e o impacto dessas alterações nos desfechos pós-operatórios.
Métodos: Foram incluídos 970 pacientes com exames pré-operatórios normais antes da primeira cirurgia e que requereram uma nova intervenção. Os exames pré-operatórios feitos para o primeiro procedimento foram comparados com aqueles feitos para o segundo procedimento. As seguintes variáveis foram analisadas em relação ao seu potencial para induzir alterações nos resultados dos exames: sexo, idade, risco cirúrgico, quimioterapia ou radioterapia prévia e presença de comorbidades. Desfechos intra-hospitalares foram analisados.
Resultados: A mediana temporal entre os procedimentos foi de 27 meses (6-84). A probabilidade de alteração em pelo menos um dos exames pré-operatórios foi de 1,7% (IC 95%: 0,5-2,9), 3,6% (IC 95%: 1,8-5,4) e 6,4% (IC 95%: 3,9-8,9) nos intervalos 12, 24 e 36 meses, respectivamente, para pacientes < 50 anos e 2,1% (IC 95%: 0,7-3,5), 9,2% (IC 95%: 5,9-12,5) e 13,4% (IC 95%: 9,3-17,5), respectivamente, para pacientes ≥ 50 anos. Idade ($p = 0,009$), risco cirúrgico ($p < 0,001$), quimioterapia ($p = 0,001$), radioterapia ($p = 0,012$) e presença de comorbidades ($p < 0,001$) estavam associadas com a probabilidade de mudanças nos resultados dos exames. Alterações nos exames não se associaram significativamente a desfechos intra-hospitalares adversos ($p = 0,426$).
Conclusão: Para pacientes submetidos a um segundo procedimento cirúrgico, a probabilidade de alteração nos exames pré-operatórios previamente normais é baixa durante os primeiros anos após a primeira intervenção cirúrgica e quando ocorreram mudanças não afetaram adversamente os desfechos pós-operatórios intra-hospitalares.

Introduction

More than 240 million elective surgical procedures are performed annually worldwide.[1,2] The vast majority of institutions routinely perform clinical and laboratory testing prior to surgery to determine the patient's preoperative condition in order to reduce perioperative morbidity and mortality.[3] Thus, a large number of patients undergo preoperative tests, such as electrocardiogram (ECG), chest X-ray, and laboratory testing (complete blood count, blood glucose, urea, creatinine, and coagulation tests).[4,5] However, the efficacy of these tests to identify diseases not detected by anamnesis and/or physical examination and its predictive value for perioperative complication has been questioned.[6–11] Furthermore, there is no reliable information on the time period in which the results of previous preoperative examinations can safely be used in a second surgical intervention. Therefore, laboratory tests are repeated several times leading to a cost increase and delay in a second procedure. Due to insufficient data for evidence-based recommendations, in 2002 the American Society of Anesthesiologists published a guideline,[12] recently updated,[13] stating that the results of preoperative tests performed within six months prior to surgery are acceptable if patient's medical history has not changed.

The aim of this study was to determine the probability of changes in previously normal preoperative tests in relation to time, as well as the impact of these changes on postoperative outcomes in a second intervention.

Method

A retrospective cohort study of 970 patients diagnosed with neoplasia who underwent two surgical procedures under general anesthesia at least six months apart and had preoperative results within the limits of normality in the first surgical procedure. The study was approved by the Research

Ethics Committee of the Brazilian Cancer Control Institute under CAAE number: 06271212.7.0000.0062.

Each patient underwent a complete preoperative testing that included: ECG; chest X-ray; blood count; glycemia, urea, and creatinine; and coagulation tests.

Data were obtained through an electronic search of hospital records. Test results from the first surgery were compared with those from the second intervention. Patients were also divided into two age groups at the time of the second procedure (<50 and ≥50 years). Variables that could impact test results over time were assessed. Variables included age, sex, first intervention surgical risk (American Society of Anesthesiologists Physical Status Classification [ASA PS]), presence of comorbidities, and need for chemotherapy and/or radiotherapy. Cardiovascular, pulmonary, endocrine, renal and nervous system comorbidities were considered important. We consider as a normal laboratory test result any value less than or greater than 5% of the reference limit adopted by the laboratory of our institution (leukocytes 4000–12,000 cm; hemoglobin ≥ 12 for men; ≥10 g.dL^{-1} for women; platelets 140,000–400,000 mcL; PT 70–100%, APTT up to 35 s; fasting blood glucose 60–99 mg.dL^{-1}, urea 15–40 mg.dL^{-1}; creatinine ≤ 1.4 for men; ≤1.2 mg.dL^{-1} for women). Electrocardiographic abnormalities were identified by a single member of the institution's Department of Cardiology and classified as rhythm disturbances, ventricular overload, atrial overload, ventricular repolarization changes, intraventricular block, atrioventricular block, and sinus bradycardia (<50 beats.min^{-1} in the absence of drugs). A member of the Department of Radiology assessed the chest X-rays and classified them as pulmonary opacities, increased cardiac diameter, parenchymal infiltrates, aortic stretching, pulmonary metastasis, and pleural effusion. The intra-hospital outcomes of patients with normal outcomes prior to both surgical interventions were compared with those who had any abnormalities in any of the preoperative exams prior to the second intervention. Surgeries were allocated into three categories according to duration of surgery: short (<2 h), intermediate (between 2 and 4 h), and long (>4 h). The duration of second intervention in patients with normal preoperative exams was compared with the duration of surgery in patients who had some abnormalities in these exams. Any clinical complication that increased the length of hospital stay for the proposed surgical procedure or death was considered intra-hospital adverse outcome.

Table 1 Characteristics and preoperative tests of the studied population ($n = 970$).

Variable	Description
Age in the second procedure (years)	49.9 ± 12.3
Female	884 (91.1%)
ASA physical status in the first procedure	
I	532 (54.8%)
II	400 (41.2%)
III	38 (3.9%)
Chemotherapy before or after first procedure	479 (49.4%)
Radiotherapy before or after first procedure	464 (47.8%)
Number of comorbidities	
0	567 (58.5%)
1	323 (33.3%)
2	71 (7.3%)
3	9 (0.9%)
Change in ECG	48 (4.9%)
Change in chest X-ray	29 (3%)
Change in blood tests	58 (6%)
Change in any test	127 (13.1%)
Interval (months) between procedures (mean ± SD)	33.9 ± 21.5
Interval (months) between procedures (median – min.; max.)	27 (6; 84)
Surgery (2nd intervention)	
Breast	267 (27.5%)
Gynecological	268 (27.6%)
Plastic	110 (11.3%)
Skin tumor	71 (7.3%)
Head and neck	173 (17.8%)
Urological	42 (4.3%)
Abdominal surgery	11 (1.1%)
Chest	20 (2.1%)
Neurosurgery	8 (0.8%)

Values presented as *n* (%), mean ± standard deviation or median (range).

Statistical analysis

Descriptive data are presented as mean ± standard deviation for continuous variables or absolute and relative frequency for categorical variables; time between procedures is presented as median, minimum and maximum. Kaplan–Meier function and log-rank tests were used to assess probability of change in at least one preoperative test and in each individual test and to compare the rates of changes in these tests between the variables of interest. Cox proportional hazards models were used to evaluate the joint association of all variables of interest with any and each change in preoperative tests. The postoperative outcome and surgical time association with changes in any test and in each individual test was estimated using Fisher and likelihood ratio tests. A p-value < 0.05 was considered significant for all analyzes. Analyzes were performed using the SPSS program for Windows version 20.0 (IBM, Armonk, New York, USA).

Results

Overall, 970 patients were retrospectively analyzed. Mean age was 49.9 ± 12.3 years and 91.1% of patients were female. Of the sample, 843 patients (86.9%) remained with all preoperative tests without any change during the time-interval between surgical procedures. The median time between procedures was 27 months (range: 6–84). The basic aspects regarding patients and preoperative tests are shown in Table 1.

Considering the total sample, the estimated probability of at least one change occurring in at least one of the preoperative tests was 1.9% (95% CI: 0.9–2.9); 6% (4.2–7.8); 9.4% (7–11.8); 15.4% (12.1–18.7); 22.4% (18.1–26.7); 34.5% (27.6–41.4), and 62.4% (46.7–78.1) at 12, 24, 36, 48, 60, 72, and 84 months, respectively (Table 2). Among the assessed variables, age ($p = 0.009$); ASA PS ($p < 0.001$); presence of at least one comorbidity ($p < 0.001$); chemotherapy ($p = 0.001$), and radiotherapy ($p = 0.012$) were associated with the estimated probability of any change occurring in one of the previously normal tests (Table 2 and Fig. 1).

The probability that a patient under 50 years of age ($n = 537$) having any change in at least one of the preoperative tests was 1.7%, 3.6%, and 20.2% at 12, 24, and 60 months, respectively. In those above 50 years of age, the probability of change in test results was 2.1%, 9.2%, and 25% in the same time-interval (Table 2). In an isolated analysis, age appeared as a significant risk factor for change in test results, but when analyzed in conjunction with other variables this significance disappeared ($p = 0.335$).

Among ASA I patients ($n = 532$) at the first intervention time, the estimated probability of change occurring in at least one of the preoperative tests was 2%, 5%, and 18.7% at 12, 24, and 60 months, respectively. Among ASA II patients ($n = 400$), this probability was 1.4%, 5.4%, and 22.1% at 12, 24, and 60 months, respectively. In ASA III patients ($n = 38$), changes can be expected in 5.5%, 22%, and 57% in the same period (Table 2). In joint analysis, this ASA III group has little over twice the risk of changes in preoperative tests compared with patients classified as ASA I (PR = 2.23; 95% CI: 1.16–4.29; $p = 0.016$) (Table 3).

The probability of change in at least one of the tests between the first and second procedures was 88% higher for patients who had some comorbidity compared to those without any comorbidities (PR = 1.91; 95% CI: 1.25–2.93; $p = 0.00003$) (Table 3). However, at 60 months, approximately 70% of patients with comorbidities and 85% of those without comorbidities had normal tests at the time of the second procedure (Table 2 and Fig. 1).

For patients undergoing chemotherapy before or after the first surgery, the probability of changes in preoperative tests was 2.2%, 8.4%, and 27.6% at 12, 24, and 60 months, respectively (Table 2). These patients were 1.76 times more likely to present some change in at least one of the preoperative tests compared to patients who were not exposed to chemotherapy (PR = 1.76; 95% CI: 1.23–2.52; $p = 0.0000$) (Table 3).

Assessed individually, radiotherapy was associated with the emergence of abnormalities in preoperative tests, but when these patients were assessed considering all variables, this influence disappeared (PR = 1.40; 95% CI: 0.94–2.07; $p = 0.098$) (Table 3).

Abnormalities in at least one of the preoperative test results did not adversely affect intra-hospital outcomes in this population ($p = 0.426$). Even when assessed individually, ECG ($p > 0.999$), X-ray ($p = 0.259$), and laboratory tests abnormalities ($p = 0.441$) were also not associated with adverse intra-hospital outcomes (four events).

Regarding the second surgery, 820 (84.5%) were considered as short duration, 118 (12.2%) as intermediate duration, and 32 (3.3%) as long duration. There were four deaths (0.4%) and 29 intra-hospital complications (3%). The second procedure duration was equally distributed ($p = 0.112$) among patients with and without changes in preoperative tests.

Discussion

This retrospective study assessed a large cohort of patients undergoing two elective non-cardiac surgical procedures with a minimum interval of six months regarding changes in preoperative tests and the impact of those changes on intra-hospital morbidity and mortality. At our institution, we perform ECG, chest X-rays, and laboratory tests for all patients undergoing a surgical procedure under general anesthesia, given that current guideline recommendations are based on levels of evidence B and C and few studies have included cancer patients.[2,14,15]

According to this study main hypothesis that preoperative exams are routinely and excessively performed, we found that 58% of our cohort presented with no comorbidity and yet they were submitted to the same preoperative testing for a second intervention. Our finding was similar to that of Guerra et al.[16] who showed in a retrospective review of 500 patients that although 56% of patients did not present comorbidities, they were submitted to preoperative laboratory tests. In another study that evaluated 1044 patients undergoing surgical procedures, Narr et al.[17] demonstrated that in 97% of subjects considered healthy, there was no increase in morbidity or mortality, although they had not preoperative tests.

Table 2 Estimated odds of change in preoperative tests according to characteristics of interest over time and results of comparative tests.

	Months							p[a]
	12	24	36	48	60	72	84	
All	1.9 (0.9–2.9)	6 (4.2–7.8)	9.4 (7–11.8)	15.4 (12.1–18.7)	22.4 (18.1–26.7)	34.5 (27.6–41.4)	62.4 (46.7–78.1)	
Age								0.009
<50 years	1.7 (0.5–2.9)	3.6 (1.8–5.4)	6.4 (3.9–8.9)	13.6 (9.3–17.9)	20.2 (14.5–25.9)	30.1 (21.5–38.7)	44 (29.1–58.9)	
≥50 years	2.1 (0.7–3.5)	9.2 (5.9–12.5)	13.4 (9.3–17.5)	17.8 (12.7–22.9)	25.3 (18.4–32.2)	39.9 (29.1–50.7)	87.6 (66.8–100)	
ASA								<0.001
I	2 (0.8–3.2)	5 (2.8–7.2)	7.4 (4.7–10.1)	13.6 (9.1–18.1)	18.7 (13–24.4)	26.8 (18.2–35.4)	38.6 (23.3–53.9)	
II	1.4 (0.2–2.6)	5.4 (2.9–7.9)	10.1 (6.4–13.8)	16.1 (11.2–21)	22.1 (15.6–28.6)	37.3 (26.9–47.7)	73.8 (55–92.6)	
III	5.5 (012.9)	22 (7.5–36.5)	25.4 (10.1–40.7)	29.5 (13–46)	56.9 (33.4–80.4)	71.3 (43.5–99.1)	71.3 (43.5–99.1)	
Comorbidities								<0.001
No	2.1 (0.9–3.3)	4.1 (2.3–5.9)	6.3 (3.8–8.8)	12.1 (8–16.2)	16.3 (11.2–21.4)	23.1 (15.7–30.5)	33 (20.5–45.5)	
Yes	1.6 (0.4–2.8)	8.3 (5.2–11.4)	13.2 (9.1–17.3)	19.5 (14.2–24.8)	29.7 (22.4–37)	48.2 (36.8–59.6)	83.6 (68.1–99.1)	
Chemotherapy								0.001
No	1.6 (0.4–2.8)	3.5 (1.5–5.5)	6.5 (3.6–9.4)	12.8 (8.5–17.1)	17.2 (11.5–22.9)	30.7 (20.7–40.7)	41 (27.3–54.7)	
Yes	2.2 (0.8–3.6)	8.4 (5.7–11.1)	12.3 (8.8–15.8)	17.8 (13.1–22.5)	27.6 (20.9–34.3)	38.4 (29–47.8)	80.1 (59.5–100)	
Radiotherapy								0.012
No	1.7 (0.5–2.9)	3.8 (1.8–5.8)	6 (3.3–8.7)	11.3 (7.2–15.4)	17.3 (11.4–23.2)	29 (18.8–39.2)	76.7 (51.8–101.6)	
Yes	2.1 (0.7–3.5)	8.1 (5.4–10.8)	12.8 (9.116.5)	19.4 (14.5–24.3)	27.1 (20.6–33.6)	39.4 (30.2–48.6)	50.4 (37.7–63.1)	

Values presented as % (95% confidence interval).

[a] Log-rank test.

ASA, American Society of Anesthesiologists Physical Status Classification.

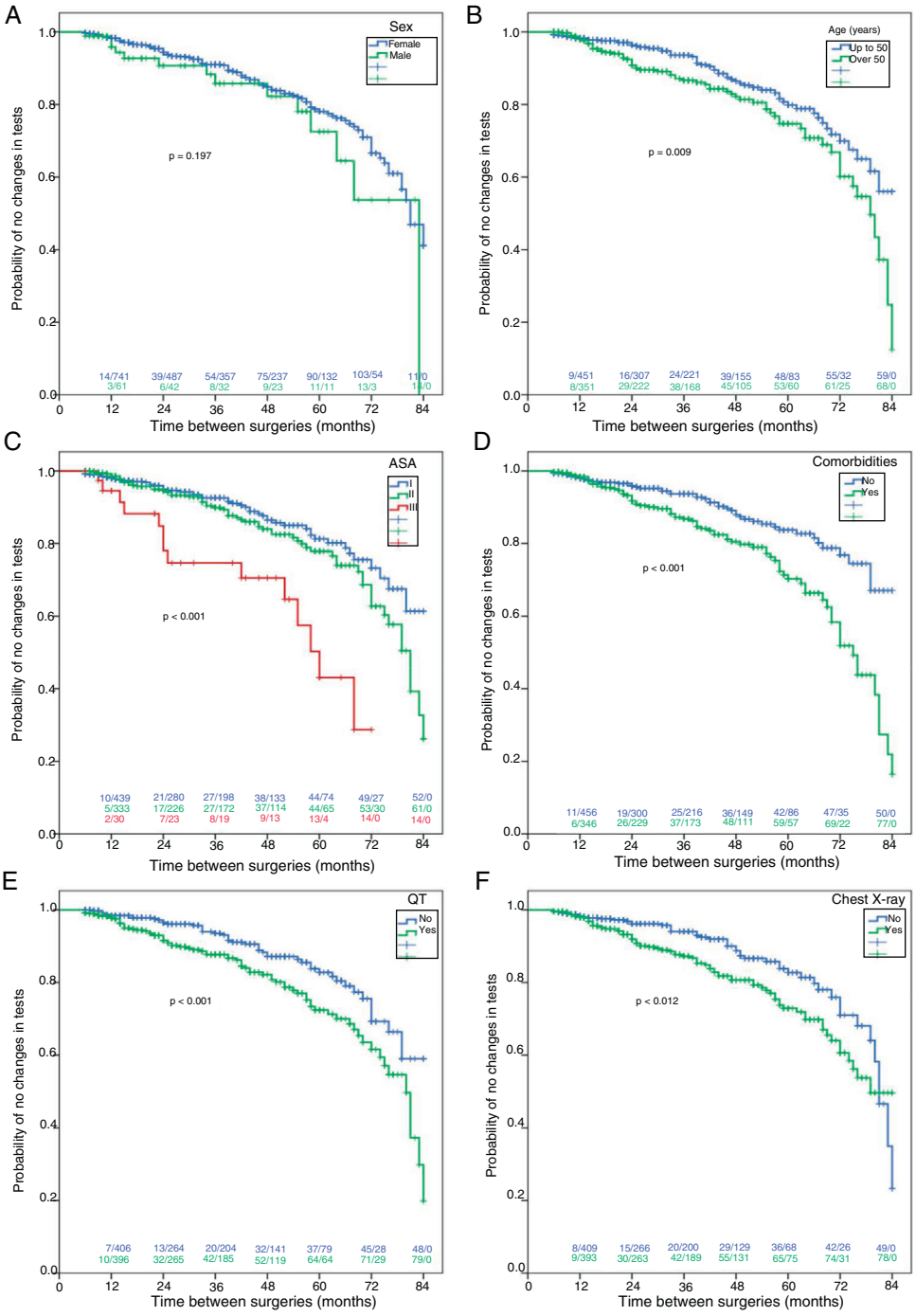

Figure 1 Kaplan–Meier curves that establish the relationship between the probability of change in at least one of the normal preoperative tests at the first surgical intervention and the assessed variables. Sex (A); age (B); American Society of Anesthesiologists Physical status – ASA (C); presence of comorbidities (D); prior chemotherapy (E); prior radiotherapy (F).

An important finding of this study was that the previously normal test results remained unchanged for several months. The fact that only 1.7% of patients aged <50 years and 2.1% of those aged 50 years or older have shown change in at least one of the tests at 12 months is clinically relevant, since most anesthesiologists accept pre-operative tests performed less than six months, according to the orientation of some publications.[12,13] Although some studies[18–20] have shown a relationship between age and change in preoperative tests, this was not observed in our analysis. When analyzed individually, age was significant, but with the association of other variables in the analysis, this significance disappeared. We believe this has occurred because of the higher prevalence of comorbidities with aging.

MacPherson et al.[21] evaluated patients with or without normal test results and observed that in 47% of 1109 patients evaluated there was no change in test results performed within 12 months. Consistently with these data, in

Table 3 Results for change in any of the preoperative tests according to assessed variables.

Variable	Odds ratio (IC 95%)	Statistics of Wald	p[a]
ASA			
I	1.00		
II	0.99 (0.65–1.52)	0.001	0.969
III	2.23 (1.16–4.29)	5.806	0.016
Chemotherapy	1.76 (1.23–2.52)	9.405	0.002
Comorbidities	1.91 (1.25–2.93)	8.996	0.003

ASA, American Society of Anesthesiologists physical Status Classification.
[a] Multiple Cox proportional hazards model.

our sample, in which we assessed only patients with normal test results, approximately 80% remained with all tests unchanged not only in the first year, but over five years. These findings were similar for all clinical variables assessed. Among these variables, ASA physical status was more closely related to a greater probability of change in tests results, however the majority of our sample consisted of patients ASA I and II and between these two groups there was no statistically significant difference. A significant difference was found when patients ASA III were included, but this type of patient becomes rare in a cohort study in which the major inclusion criterion was the results of all preoperative tests being normal. For this reason there was also no patient classified as ASA IV (Table 4).

Patients with preexisting comorbidities or some new clinical condition diagnosed between procedures were more likely to show changes in test results compared to healthy patients. This may be explained by the fact that the presence of comorbidities is related to a group of patients with a more deteriorated clinical condition and, therefore, with more chance of presenting changes in test results.

Chemotherapy may have a large effect on a variety of tests, particularly laboratory tests; however, these changes are usually limited or occur within a few months after chemotherapy.[22] Due to the minimum of six months between surgical procedures adopted in the study protocol, and with an observed median of 27 months, it can be concluded that we could expect few changes in preoperative tests for a second intervention even in those patients who underwent chemotherapy.

Our study has immediate practical implications. Regardless of the presence of variables with potential to induce changes in preoperative tests, 80% of the study population showed no change in these tests up to five years of follow-up. And in those who showed some change over time, no adverse impact on intra-hospital outcome was observed. As shown in Fig. 1, the curve of the different variables can almost be overlapped up to 12 months, indicating the low probability of change in test results in this period. Thus, the probability of these variables inducing changes in previously normal preoperative tests is virtually zero during the first year. If we take these results into account, the requirement to repeat preoperative tests (if recommended) for a second intervention seems unnecessary; and the acceptance of tests after six months of the first intervention by anesthesiologists and surgeons seems reasonable.

Table 4 Impact of changes in preoperative tests on intra-hospital outcomes.

Abnormalities	Adverse outcome		p
	No ($n = 937$)	Yes ($n = 33$)	
Change in ECG	47 (5)	1 (3)	>0.999
Change in X-ray	27 (2.9)	2 (6.1)	0.259
Change in blood tests	55 (5.9)	3 (9.1)	0.441
Change in any test	121 (12.9)	6 (18.2)	0.426

ECG, electrocardiogram.
Values presented as *n* (%).

This study has some limitations. First, it was a retrospective study and data were collected from electronic medical records. Thus, there is the possibility of inadequate and/or incomplete data. In addition, the study was carried out in a single center and all surgical procedures were performed on patients with malignant tumors. The vast majority of surgeries were considered as having a short operative period and consequently there were few intra-hospital complications.

The probability of change in at least one of the previously normal preoperative tests repeated during the first few years after the first surgical intervention is low. If changes occur, they are not associated with adverse outcomes during hospitalization. These results suggest a deep reflection about the real need to repeat preoperative tests previously normal for a second intervention occurring in the first years after the initial procedure.

Conflicts of interest

The authors declare no conflicts of interest.

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