The Association Between Timing of Routine Preoperative Blood Testing and a Composite of 30-Day Postoperative Morbidity and Mortality

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BACKGROUND: Laboratory testing is a common component of preanesthesia evaluation and is designed to identify medical abnormalities that might otherwise remain undetected. While blood testing might optimally be performed shortly before surgery, it is often done earlier for practical reasons. We tested the hypothesis that longer periods between preoperative laboratory testing and surgery are associated with increased odds of having a composite of 30-day morbidity and mortality.
METHODS: We obtained preoperative data from 2,320,920 patients in the American College of Surgeons National Surgical Quality Improvement Program who were treated between 2005 and 2012. Our analysis was restricted to relatively healthy patients with American Society of Anesthesiology physical status I–II who had elective surgery and normal blood test results (n = 235,010). The primary relationship of interest was the odds of 30-day morbidity and mortality as a function of delay between preoperative testing and surgery. A multivariable logistic regression model was used for the 10 pairwise comparisons among the 5 laboratory timing groups (laboratory blood tests within 1 week of surgery; 1–2 weeks; 2–4 weeks; 1–2 months; and 2–3 months) on 30-day morbidity, adjusting for any imbalanced baseline covariables and type of surgery.
RESULTS: A total of 4082 patients (1.74%) had at least one of the component morbidities or died within 30-days after surgery. The observed incidence (unadjusted) was 1.7% when the most recent laboratory blood tests measured within 1 week of surgery, 1.7% when it was within 1–2 weeks, 1.8% when it was within 2–4 weeks, 1.7% when it was between 1 and 2 months, and 2.0% for patients with most recent laboratory blood tests measured 2–3 months before surgery. None of the values within 2 months differed significantly: estimated odds ratios for patients within blood tested within 1 week were 1.00 (99.5% confidence interval, 0.89–1.12) as compared to 1–2 weeks, 0.88 (0.77–1.00) for 2–4 weeks, and 0.95 (0.79–1.14) for 1–2 months, respectively. The estimated odds ratio comparing 1–2 weeks to each of 2–4 weeks and 1–2 months were 0.88 (0.76–1.03) and 0.95 (0.78–1.16), respectively. Blood testing 2–3 months before surgery was associated with increased odds of outcome compared to patients whose most recent test was within 1 week (P = .002) and 1–2 weeks of the date of surgery.
CONCLUSIONS: In American Society of Anesthesiologists physical status I and II patients, risk of 30-day morbidity and mortality was not different with blood testing up to 2 months before surgery, suggesting that it is unnecessary to retest patients shortly before surgery. (Anesth Analg 2018;127:897–903)

KEY POINTS

- **Question:** How reliable is preoperative laboratory testing up to 3 months before surgery in relatively healthy patients having elective surgery?
- **Findings:** Preoperative laboratory testing more than 2 months before surgery is associated with increased odds of a composite of 30-day postoperative morbidity and mortality.
- **Meaning:** This study provides evidence that in healthy patients having elective surgeries, existing laboratory tests performed up to 2 months before surgery can be accepted for preoperative evaluation.

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Reprints will not be available from the authors.

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Laboratory blood testing is a common component of preanesthesia evaluation and can help identify medical abnormalities that are not otherwise apparent from the medical history or physical examination.[1–3] While ideally preoperative tests would be conducted shortly before surgery, optimal and acceptable periods remain unclear. For example, preoperative evaluations are often done weeks before surgery and it would be inconvenient to separately schedule laboratory testing just to shorten the interval between testing and surgery—especially in relatively healthy patients in whom values are unlikely to change substantively. There are also patients in whom blood tests are obtained for other reasons, including routine screening, in the weeks or months before surgery. It is similarly unknown what preoperative interval should provoke repeat testing, assuming normal initial values.

A survey of American Society of Anesthesiologists (ASA) members regarding acceptable timing of preoperative laboratory blood testing showed that most providers believe that electrocardiogram, chest X-ray, and hemoglobin/hematocrit testing within 1–6 months is acceptable, but that serum chemistry should be tested within a month and that coagulation should be tested within a week.[1] On the basis of these responses, an ASA practice advisory suggests that "test results obtained from the medical record within 6 months of surgery generally are acceptable if the patient's medical history has not changed substantially."[1] However, the same advisory specifies that "the current literature is not sufficiently rigorous to permit an unambiguous assessment of the clinical benefits or harms of the timing for preoperative tests."

The impact of various delays between laboratory testing and surgery remains unclear and previous reports are contradictory. Laboratory test results reflect a patient's status at the time of the test. However, underlying physiological conditions can change over time, even in relatively healthy patients. To the extent that substantive changes in baseline condition are undetected, they may increase perioperative mortality. Prognostically important changes in baseline status are increasingly likely as the period between testing and surgery lengthens. Prolonged delays between laboratory testing and surgery may thus increase mortality. We therefore tested the hypothesis that longer periods between preoperative laboratory testing and surgery are associated with increased odds of having a composite of 30-day morbidity and mortality. We restricted our analysis to a cohort of relatively healthy surgical patients (ASA physical status I and II) because sicker patients often require more routine blood testing and because their medical status may well change over a period of several weeks or months. We restricted analysis to 3 months because few patients in the National Surgical Quality Improvement Program (NSQIP) registry had older laboratory tests reported. We similarly excluded patients with abnormal blood test values under the assumption that abnormal values would usually provoke repeat testing.

METHODS

The American College of Surgeons (ACS)–NSQIP (ACS-NSQIP) is an externally validated, prospective quality improvement program. Participating institutions use full-time clinical nurse reviewers to ensure the integrity of patient, surgical, and 30-day outcomes data.[4] We obtained perioperative data from the ACS-NSQIP registry for 2,320,920 patients treated between 2005 and 2012. These data are fully deidentified; therefore, institutional review board approval was not sought.

The primary relationship of interest was the timing of preoperative blood testing and the odds of 30-day all-cause mortality and morbidity among ASA physical status I and II patients. To characterize morbidities, we utilized a previously published composite-score of major postoperative complications recorded in the NSQIP database.[5,6] These morbidities include superficial surgical infection, urinary infection, deep incisional infection, deep vein thrombosis, organ space infection, wound disruption, sepsis, bleeding, pulmonary embolism, pneumonia, unplanned intubation, graft, peripheral nerve injury, myocardial infarction, stroke, septic shock, progressive renal insufficiency, cardiac arrest, ventilator dependence >48 hours, acute renal failure, and coma >24 hours. Specific definitions for each outcome variable are described in more detail in the ACS-NSQIP Participant Use Data File User Guide.[7] We restricted analysis to ASA physical status I and II patients having elective outpatient surgery who had laboratory blood testing before surgery and had normal results for each test (Supplemental Digital Content 1, Appendix 1, http://links.lww.com/AA/C267, for definitions of normal lab ranges). In patients having several normal laboratory blood test results, the most recent test was used for our analysis, due to availability of only the most recent laboratory testing in the registry. We excluded ASA physical status III and IV patients under the assumption that patients with complex morbidity or illness are inherently unstable and that laboratory values therefore cannot be assumed to remain constant over time. We further excluded patients who were not admitted directly from home, who had any abnormal laboratory blood testing results at any time, and those who had missing lab dates or missing covariables. A total of 235,010 patients who met our inclusion/exclusion criteria were included in the analysis (Figure 1). Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines were followed for the reporting of our study.

Statistical Methods

The primary relationship of interest was the timing of preoperative blood testing and the odds of 30-day morbidity and all-cause mortality among ASA physical status I and II patients. Because the relationship may have been nonlinear (on a log scale), we first visually assessed it by plotting the estimated probability of the outcome as a function of preoperative laboratory blood testing time, using a univariable logistic regression incorporating a smooth (thin-plate regression spline) term for preoperative laboratory blood time (smoothing parameter obtained through cross-validation). On the basis of the result of the smooth relationship, we planned to enter either a linear or nonlinear term for laboratory blood testing time into an additive logistic regression model which adjusted for all available baseline covariables (variables included in Table 1).

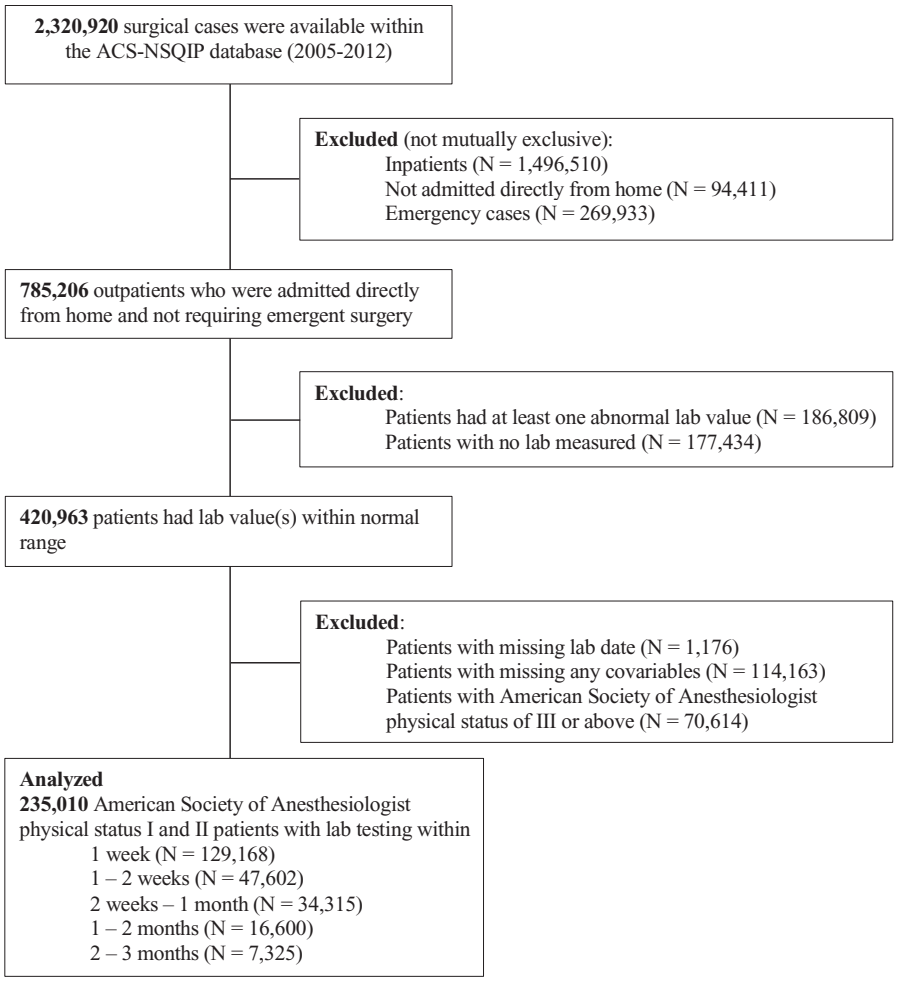

Figure 1. Flow chart of the patient inclusion and exclusion. ACS-NSQIP indicates American College of Surgeons–National Surgical Quality Improvement Program.

In the presence of a significant association between laboratory blood testing time (as a continuous measurement) and the incidence of any 30-day morbidity and mortality, we further explored the relationship by first grouping laboratory blood testing time into 5 clinically relevant groups and then performing pairwise comparisons among the 5 groups (for a total of 10 comparisons). These groups were specified a priori and were defined as follows: most recent laboratory blood tests within 1 week of surgery; 1–2 weeks; 2–4 weeks; 1–2 months; and 2–3 months.

A multivariable logistic regression model was used for the multiple comparisons, adjusting for any baseline covariables showing imbalance among the aforementioned groups (as characterized by a significant univariable test of association at the 0.05 significance level) and type of surgery (type of surgery characterized using the Agency for Healthcare Research and Quality's Clinical Classifications Software for Services and Procedures). To avoid an inflated type I error from multiple comparisons, we used a Bonferroni correction; thus, the significance criterion was $P < .005$ (ie, 0.05/10) for each of these 10 hypothesis tests.

As a sensitivity analysis to our main multivariable analysis, we conducted the same 10 pairwise comparisons using propensity score matching method to control for potential confounders. First, 10 1-to-2 propensity-matched datasets were obtained as follows: we estimated the probability (ie, the propensity score) of having the most recent preoperative laboratory blood tested within 1 week before surgery (versus 2–4 weeks) using logistic regression based on all the available covariables except for type of surgery, for which exact matching was used. A greedy distance matching algorithm (using a maximum allowable propensity score difference of 0.01 units) was used. Similarly, we obtained the other 9 propensity-matched sets of patients. Then, logistic regression models were used for comparing the matched groups. The significance criterion was $P < .005$ for each comparison.

We also assessed whether the relationships described earlier depended on patients' age by testing the age-by-blood test timing interaction. The imbalance of baseline covariables among the 5 clinically relevant groups of preoperative laboratory blood testing time (ie, statistically significant univariably at $P < .05$ criterion) was adjusted for when assessing the interaction.

Finally, we compared our composite of 30-day morbidity and mortality in the study population with patients who met our inclusion and exclusion criteria but had no recorded preoperative laboratory blood values using standardized difference, which is the difference in means or proportions divided by the pooled standard deviation.

SAS software version 9.4 for UNIX (SAS Institute, Cary, NC) and R software version 3.1.2 for Windows (The R Foundation for Statistical Computing, Vienna, Austria) were used for all statistical analyses.

Given around 130,000 patients with fresh preoperative labs (within 1 week) and around 7000 patients with labs

Table 1. Demographic and Baseline Characteristics (N = 235,010)

Variables[a]	Preoperative Lab Testing Time <1 wk (N = 129,168)	1–2 wk (N = 47,602)	2 wk–1 mo (N = 34,315)	1–2 mo (N = 16,600)	2–3 mo (N = 7325)	*P*[b]
Gender (male) (%)	64.7	64.1	65.0	65.0	63.6	.02
Race (%)						
Caucasian	75.3	77.3	76.9	75.0	74.2	<.001
African American	8.7	8.1	7.5	7.1	6.7	
Others	16.0	14.6	15.6	17.9	19.1	
Patient age (y)	50 ± 15	52 ± 14	52 ± 15	51 ± 15	50 ± 15	<.001[c]
Body mass index (kg/m^2)	29 [25, 33]	29 [25, 33]	29 [25, 33]	29 [25, 33]	29 [25, 33]	.08[d]
Smoking[e] (%)	17.4	15.2	15.7	16.7	16.2	<.001
Alcohol use[f] (%)	1.9	2.0	1.9	1.9	1.8	.54
Diabetes mellitus (%)	5.3	5.2	4.9	4.6	4.3	<.001
Dyspnea (%)	3.1	3.1	3.4	3.0	3.0	.050
Health status[g] (dependent) (%)	0.3	0.2	0.2	0.1	0.2	.002
Hypertension[h] (%)	28.6	30.0	29.2	26.3	24.5	<.001
Hemiplegia (%)	0.1	0.1	0.1	0.1	0.1	.42
Paraplegia (%)	0.1	0.1	0.1	0.0	0.0	.39
Steroid use[i] (%)	0.7	0.6	0.8	0.9	0.8	<.001
>10% loss body weight[j] (%)	0.3	0.3	0.3	0.4	0.3	.20
American Society of Anesthesiologists physical status (II vs I) (%)	80.9	82.8	83.1	81.3	81.1	<.001
General anesthesia (versus other) (%)	87.9	86.7	85.8	83.2	82.0	<.001
Surgical specialty (%)						
General surgery	70.4	73.2	78.3	80.5	76.8	<.001
Orthopedics	7.9	7.5	6.2	5.3	7.1	
Gynecology	7.4	4.9	3.0	2.2	2.1	
Cardiovascular/thoracic	4.2	4.6	3.7	3.2	3.7	
Plastics	3.0	3.2	3.2	2.9	3.9	
Urology	3.0	2.8	2.4	2.3	2.3	
Otolaryngology	2.8	2.8	2.6	3.3	4.0	
Neurosurgery	1.2	1.1	0.7	0.3	0.1	
Others	0.0	0.0	0.0	0.0	0.0	
Medical history (%)						
Transient ischemic attacks	0.6	0.7	0.6	0.6	0.6	.61
Angina[k]	0.1	0.1	0.1	0.1	0.1	.28
Revascularization/amputation[l]	0.2	0.2	0.2	0.1	0.1	.02
Cardiac surgery	0.6	0.5	0.5	0.5	0.5	.11
Percutaneous coronary intervention	0.8	0.7	0.8	0.8	0.7	.06
Severe chronic obstructive pulmonary disease	0.8	0.8	0.8	0.8	0.8	.87
Cerebral vascular accident/stroke with neurological deficit	0.2	0.2	0.2	0.2	0.2	.82
Cerebral vascular acciden/stroke without neurological deficit	0.4	0.4	0.5	0.3	0.4	.09

Summary statistics are percentage of patients, mean ± standard deviation, or median [Q1, Q3], as appropriate.

[a]Some balanced covariables were not listed here due to rare occurrences: myocardial infarction in 6 mo before surgery, congestive heart failure in 30 d before surgery, pneumonia, ascites, esophageal varices, acute renal failure, dialysis, and quadriplegia.

[b]Pearson χ^2 test, unless specified.

[c]1-way analysis of variance.

[d]Kruskal-Wallis 1-way analysis of variance by ranks.

[e]Smoking in 1 y before admission.

[f]>2 drinks/d in 2 wk before admission.

[g]Health status before surgery.

[h]Hypertension requiring medication.

[i]Steroid use for chronic condition.

[j]>10% loss body weight in last 6 mo.

[k]Angina in 1 mo before surgery.

[l]Revascularization/amputation for peripheral vascular disease.

older than 2 months, and 1.7% of fresh lab patients experiencing 30-day morbidity or mortality, we had just about 4% power at the 0.005 (ie, 0.05/10 = 0.005 after Bonferroni adjustments) significance level to detect an odds ratio of 0.91 or greater (1/0.91 = 1.10, ie, 10% increase in odds of morbidity or mortality) comparing fresh preoperative lab patients to patients who had their labs done between 2 and 3 months before surgery. The 10% increase in the odds of outcome was identified as clinically important before the study in our relatively healthy patient population.

RESULTS

Among the 2,320,920 surgical cases within the NSQIP database, 235,010 patients were ASA physical status I and II and

Table 2. Primary Analysis

Pairwise Comparisons[a]	Odds Ratio[b] (99.5% CI)[c]	P
Within 1 wk (vs)		
1–2 wk	1.00 (0.89–1.12)	.99
2 wk–1 mo	0.88 (0.77–1.00)	.01
1–2 mo	0.95 (0.79–1.14)	.40
2–3 mo	0.77 (0.60–0.98)	.002[d]
1–2 wk (vs)		
2 wk–1 mo	0.88 (0.76–1.03)	.02
1–2 mo	0.95 (0.78–1.16)	.44
2–3 mo	0.77 (0.59–0.99)	.004[d]
2 wk–1 mo (vs)		
1–2 mo	1.08 (0.88–1.32)	.32
2–3 mo	0.87 (0.67–1.13)	.15
1–2 mo (vs)		
2–3 mo	0.81 (0.61–1.09)	.04

Pairwise comparisons on 30-d morbidity among the 5 lab timing groups for American Society of Anesthesiologists physical status I and II patients using multivariable logistic regression models (N = 235,010).

Abbreviation: CI, confidence interval.

[a]Number of patients (%) having the outcome were 2250 (1.74% of 129,168), 788 (1.66% of 47,602), 623 (1.82% of 34,315), 275 (1.66% of 16,600), and 146 (2.0% of 7325) for patients with lab testing within 1 wk, 1–2 wk, 2 wk–1 mo, 1–2 mo, and 2–3 mo, respectively.

[b]We adjusted for all the available demographics and baseline characteristics listed in Table 1 and type of surgery.

[c]CIs are adjusted for multiple comparisons (a total of 10) using the Bonferroni correction, thus the significance criterion for each comparison was 0.005 (ie, 0.05/10).

[d]Statistically significant.

had laboratory blood value(s) within normal range and were thus included in the primary analysis (Figure 1). Of these patients, 55% (129,168) had their most recent preoperative laboratory blood testing time within 1 week of surgery, 20% (47,602) between 1 and 2 weeks, 15% (34,315) between 2 weeks and 1 month, 7% (16,600) between 1 and 2 months, and 3% (7325) between 2 and 3 months. Table 1 shows the summary statistics of baseline characteristics by the 5 lab testing time groups. The 20 most frequent types of surgery are listed in Supplemental Digital Content 2, Appendix 2, http://links.lww.com/AA/C268.

Four thousand eight-two patients (1.74%) had at least one of the morbidities or died within 30-days after surgery (Supplemental Digital Content 3, Appendix 3, http://links.lww.com/AA/C269). The observed incidence (unadjusted) was 1.74% when the most recent laboratory blood tests measured within 1 week of surgery, 1.66% when it was within 1–2 weeks, 1.82% when it was within 2–4 weeks, 1.66% when it was between 1 and 2 months, and 2.0% for patients with most recent laboratory blood tests measured 2–3 months before surgery (Table 2). The estimated probability of 30-day morbidity and mortality, as a smooth function of preoperative laboratory blood time (unadjusted for confounders), is given in Figure 2. The figure suggests that the risk of having any 30-day morbidity and mortality is largely unchanged until 2 months, but then increases slightly (although not significantly so).

Having blood tests taken 2–3 months before surgery was associated with higher odds of experiencing 30-day morbidity and mortality compared to patients whose most recent test was within 1 week ($P = .002$) and 1–2 weeks of the date of surgery ($P = .004$), after adjusting for potential confounding (ie, all the variables included in Table 1). The corresponding estimated odds ratio were 0.77 (99.5% confidence interval [CI], 0.60–0.98) for within 1 week vs 2–3 months and

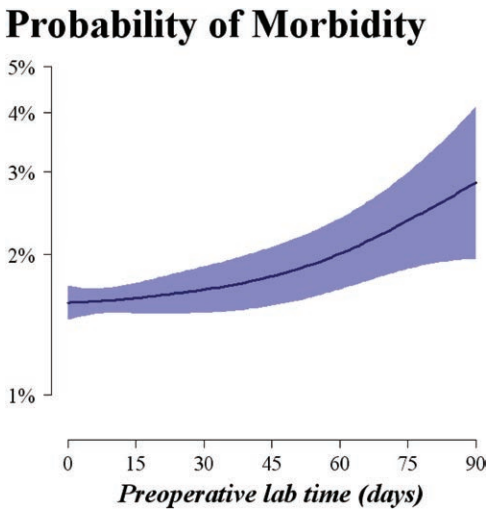

Figure 2. Probability of postoperative 30-day composite morbidity (unadjusted) versus preoperative lab testing time for US surgical patients treated between 2005 and 2012. Probabilities were estimated using logistic regression with a smoothing term.

0.77 (0.59–0.99) for 1–2 weeks vs 2–3 months, respectively (Table 2). However, no difference was found between the 2–3 months' group and 2 weeks–1 month or 1–2 months group (Table 2). No difference was found between any pair of the 4 laboratory blood timing groups within 2 months (Table 2). In summary, we found that among ASA physical status I and II patients, the adjusted risk of experiencing a composite of 30-day postoperative morbidity and mortality was not different when routine blood tests were normal up to 2 months before surgery. Patients who had normal blood tests between 60 and 90 days preoperatively had a slightly increased risk.

Similar pairwise comparison results were obtained from our sensitivity analysis using propensity score matching (Table 3). Furthermore, the relationship between the laboratory blood testing time and the composite of 30-day morbidity and mortality did not depend on patient age (interaction: $P = .82$). Patients without laboratory blood were, in general, younger and healthier as compared to patients with normal laboratory blood values (Supplemental Digital Content 4, Appendix 4, http://links.lww.com/AA/C270).

DISCUSSION

This large cohort study investigated the association between postoperative 30-day morbidity and mortality and the time elapsed between the most recent normal preoperative laboratory testing and the day of surgery in ASA physical status I and II patients. Our primary finding is that adjusted 30-day morbidity and mortality did not differ significantly or by clinically important amounts when laboratory blood testing tests were conducted up to 2 months before surgery. Patients who had normal blood tests between 60 and 90 days preoperatively had a slightly increased risk. The association was not age-independent. These findings somewhat contrast with the ASA expert panel recommendation that clinicians accept laboratory blood testing within 6 months before surgery in healthy patients. That recommendation was largely based on expert assumption that healthy patients are at low risk for changing from normal to abnormal blood test results within 6 months.

Table 3. Sensitivity Analysis

Propensity Score–Matched Groups (Number of Matched Patients)	Odds Ratio (99.5% CI)[a]	*P*
Within 1 wk (N = 93,509) vs 1–2 wk (N = 47,550)	1.01 (0.90–1.15)	.78
Within 1 wk (N = 68,287) vs 2 wk–1 mo (N = 34,285)	0.90 (0.78–1.04)	.04
Within 1 wk (N = 33,155) vs 1–2 mo (N = 16,585)	0.92 (0.74–1.14)	.26
Within 1 wk (N = 14,639) vs 2–3 mo (N = 7322)	0.75 (0.56–1.02)	.01
1–2 wk (N = 34,019) vs 2 wk–1 mo (N = 34,019)[b]	0.94 (0.79–1.10)	.26
1–2 wk (N = 32,073) vs 1–2 mo (N = 16,477)	0.92 (0.74–1.14)	.25
1–2 wk (N = 14,495) vs 2–3 mo (N = 7289)	0.72 (0.53–0.98)	.003[c]
2 wk–1 mo (N = 30,292) vs 1–2 mo (N = 16,432)	1.05 (0.85–1.30)	.49
2 wk–1 mo (N = 14,420) vs 2–3 mo (N = 7281)	0.85 (0.63–1.15)	.13
1–2 mo (N = 13,727) vs 2–3 mo (N = 7228)	0.82 (0.61–1.11)	.07

Pairwise comparisons on 30-d morbidity among the 5 lab timing groups for American Society of Anesthesiologists physical status I and II patients using propensity score matching method.
Abbreviation: CI, confidence interval.
[a]CIs are adjusted for multiple comparisons (a total of 10) using the Bonferroni correction, thus the significance criterion for each comparison was 0.005 (ie, 0.05/10).
[b]One-to-one matched.
[c]Statistically significant.

Why a prolonged gap between laboratory testing and surgery was associated with increased estimated risk remains mostly unclear. A potential explanation is that truly healthy surgical patients will have normal laboratory values over prolonged periods. Sicker patients will at times have abnormal test results as their underlying conditions vary over time. Consistent with this theory, laboratory values obtained more than 2 months before surgery apparently poorly reflected health status at the time of surgery, at least in a fraction of patients. This is the primary reason that analysis was restricted to ASA physical status I and II patients. Sicker patients would also be prone to develop postoperative morbidity and mortality—a classic case of confounding.

When we compared our study population with patients meeting our inclusion and exclusion criteria but having no preoperative laboratory blood values on the outcome of interest, we found that patients with no laboratory blood testing were, in general younger and less likely to have diabetes or hypertension (Supplemental Digital Content 4, Appendix 4, http://links.lww.com/AA/C270). After adjustment for potential confounding factors, the odds of experiencing postoperative 30-day morbidity and mortality was similar in patients who did and did not meet our inclusion and exclusion criteria.

Narr et al[8] reported that patients who have been evaluated by history and physical examination and determined to have no preoperative indication for laboratory tests can safely undergo anesthesia and surgery without preoperative laboratory blood testing. Another study also demonstrated that there was no increase in the perioperative adverse outcomes resulting from no preoperative testing in ambulatory surgical patients.[9] Available evidence thus suggests that routine preoperative testing should not be ordered in younger healthy patients who are scheduled for low-risk surgeries.[10] But in those for whom blood testing is indicated, our results suggest that the tests might best be done within 2 months before surgery, as results of our study indicate, that odds of morbidity and mortality was significantly higher in patients having most recent blood testing longer than 2 months before surgery, compared to within 1 and 1–2 weeks before surgery.

Specific preoperative laboratory blood tests have been studied in the past,[11–14] we intended to study the generalized preoperative testing. A consequent limitation of our analysis is that we did not consider specific blood tests for specific surgical procedures or medical conditions. For example, preoperative coagulation studies would have been especially relevant in patients having spine surgery or receiving long-acting anticoagulation therapy. Hemoglobin and hematocrit is indicated for patients with history of anemia and bleeding disorders, and is essential for patients undergoing surgery with potential for large blood loss.

The results of our study are limited to laboratory blood testing, as we did not use any further preoperative testing including electrocardiography and chest X-ray. Laboratory test timing was not random, but was ordered by the primary service probably taking into consideration the patients' condition, anticipated surgery and blood loss, previous comorbidities, and results of previous laboratory blood testing, including those outside of the study window. The findings of this study are limited to outpatient with ASA physical status I and II, and likely do not apply to sicker patients.

The NSQIP is a nationally validated, outcomes-based program that uses a prospective, peer-controlled, validated database to quantify 30-day surgical outcomes in the 240 participating hospitals. However, we had no ability to confirm accuracy of data in the registry. As in any registry, there are surely some errors. For example, some patients coded as being ASA physical status I and II may have had comorbidities that many would normally earn them an ASA physical status III designation. As in all retrospective analyses, we were able to adjust only for confounding variables that were measured and recorded in the ACS-NSQIP.

As a conclusion, our results provide evidence that in healthy patients having elective procedures, existing laboratory tests performed up to 2 months before surgery can be accepted for preoperative evaluation. ■

DISCLOSURES

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