ISSN: 2584-0355
DOI: doi.org/10.51219/MCCRJ/Kaoutar-Zirhirhi/484

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Medical & Clinical Case Reports Journal

https://urfpublishers.com/journal/case-reports

Vol: 4 & Iss: 2

Research Article

Perioperative Complications in Thoracic Surgery: Risk Factors, Prevention and Management

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Citation: Lamghari S, Zirhirhi K, Joutey OT, Chabbar S, Mounir A, Bouhouri MZ. Perioperative Complications in Thoracic Surgery: Risk Factors, Prevention and Management. *Medi Clin Case Rep J* 2026;4(2):1800-1806. DOI: doi.org/10.51219/MCCRJ/Kaoutar-Zirhirhi/484

Received: 05 June, 2026; **Accepted:** 08 June, 2026; **Published:** 10 June, 2026

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A B S T R A C T

Background: Thoracic surgery remains associated with substantial perioperative morbidity and mortality, yet contemporary data from North African tertiary centers - where the case-mix combines hydatid disease, post-tuberculous sequelae and thoracic malignancies - are scarce. We aimed to determine the incidence, spectrum and risk factors of perioperative complications in this setting.

Methods: We conducted a single-center retrospective cohort study at the Ibn Rochd University Hospital, Casablanca, including all consecutive patients aged ≥ 16 years who underwent thoracic surgery under general anesthesia with selective intubation and were admitted to the surgical ICU between May 2022 and May 2025. Perioperative complications were defined a priori (Berlin definition for ARDS; ATS/IDSA criteria for pneumonia; MAP < 65 mmHg ≥ 5 min for hemodynamic instability). Crude odds ratios with 95% confidence intervals were computed for each candidate predictor using 2×2 cross-tabulations, with Fisher's exact tests and Haldane–Anscombe continuity correction for zero cells. No multivariable model was fitted; associations are reported as univariable.

Results: Of 200 patients (mean age 47.0 ± 13.6 years; male-to-female ratio 1.38), 55 (27.5%) experienced at least one perioperative complication. The dominant intraoperative events were hemodynamic instability (17.5%) — chiefly surgical bleeding (10.5%) — and intraoperative hypoxia (3%). The most frequent postoperative respiratory events were ARDS (1.5%) and subcutaneous emphysema (1%); in-hospital mortality was 2%. On univariable analysis, seven variables were significantly associated with an increased risk of complications: abnormal preoperative echocardiography (OR 40.2, 95% CI 5.1–317.9), substernal goiter (OR 19.4, 95% CI 0.99–381.9, n = 3 — to be interpreted with caution), ASA ≥ II (OR 9.3, 95% CI 4.6–18.8), age > 50 years (OR 8.2, 95% CI 4.1–16.5), operative time > 6 hours (OR 7.4, 95% CI 2.8–19.4), prior pulmonary tuberculosis (OR 6.2, 95% CI 3.0–13.1) and aspergilloma (OR 3.4, 95% CI 1.1–10.6). One association was observed in the protective direction: surgery for pulmonary hydatid cyst (OR 0.21, 95% CI 0.08–0.51, p = 0.0002), most plausibly reflecting confounding by indication (younger, ASA I patients undergoing conservative resection).

Conclusions: In a thoracic-surgery population shaped by endemic granulomatous disease, more than one in four patients

developed a perioperative complication. Seven readily available variables were associated with increased risk on univariable analysis and one protective association was identified. These exploratory findings define a profile that may benefit from intensified preoperative evaluation and perioperative monitoring; a prospective multicenter cohort with adjusted multivariable analysis is required before causal inference can be drawn.

Keywords: Thoracic Surgical Procedures; Postoperative Complications; Intraoperative Complications; Risk Factors; Anesthesia, General; Tuberculosis, Pulmonary; Echinococcosis, Pulmonary; Morocco

Introduction

Thoracic surgery has been transformed over the past two decades by the diffusion of video-assisted techniques, lung-protective one-lung ventilation and enhanced recovery (ERAS) protocols. Despite these advances, perioperative morbidity remains high - reported between 15% and 30% in contemporary cohorts - and continues to drive prolonged hospital stays, ICU readmissions and a non-negligible mortality of 2–6%, predominantly attributable to respiratory and cardiovascular events[1-3].

The published evidence base is, however, dominated by Western and East Asian cohorts in which oncological resections (lobectomy and pneumonectomy for lung cancer) are the majority indication. In North Africa and the Mediterranean basin, the case-mix is markedly different: pulmonary hydatid cyst, post-tuberculous sequelae and chronic aspergilloma still account for a substantial share of thoracic procedures, alongside increasing volumes of oncological surgery[4-6]. The spectrum of complications, the relative weight of risk factors and the consequences for resource planning in this setting are poorly characterized.

We therefore conducted a 3-year retrospective cohort study at the Ibn Rochd University Hospital, Casablanca, with three objectives: (i) to quantify the incidence and clinical spectrum of perioperative complications across the full thoracic-surgery case-mix of a North African tertiary center; (ii) to identify the patient-, etiology-, anesthesia- and procedure-related variables associated with complications, with crude odds ratios and confidence intervals; and (iii) to derive practical implications for preoperative risk stratification and perioperative management in similar settings.

Methods

Study design and setting

We conducted a single-center, retrospective observational cohort study at the Department of Thoracic Surgery (Aile 2) and the surgical intensive-care units 7 and 17 of the Ibn Rochd University Hospital, Casablanca. The study period extended from 1 May 2022 to 1 May 2025 (36 months).

Population

All consecutive patients aged ≥ 16 years (the institutional threshold for management in adult surgical units) who underwent thoracic surgery under general anesthesia with endobronchial (selective) intubation and were subsequently admitted to the surgical ICU during the study period were eligible. Patients with incomplete medical records that precluded ascertainment of the primary or secondary outcomes were excluded.

Outcomes

The primary outcome was the occurrence of at least one perioperative complication, defined as any clinical, radiological, biological or therapeutic event deviating from the expected postoperative course and requiring specific intervention, occurring between anaesthetic induction and the 30th postoperative day (or hospital discharge, whichever came first). Secondary outcomes were the individual complication categories, the duration of ICU stay, the duration of postoperative mechanical ventilation, in-hospital mortality and the rate of surgical revision[7].

Operational definitions

Hemodynamic instability was defined as a mean arterial pressure < 65 mmHg for ≥ 5 minutes or requiring vasopressor support. Intraoperative hypoxia was defined as SpO_2 < 90% for > 1 minute. Prolonged air leak was defined as a persistent leak at the chest drain beyond the 7th postoperative day. Acute respiratory distress syndrome (ARDS) was defined according to the Berlin criteria[7]. Postoperative pneumonia was defined by a new radiographic infiltrate associated with fever > 38 °C, leucocytosis > 12 000/mm³ or purulent secretions[8]. Cardiac complications included new-onset supraventricular or ventricular arrhythmias, myocardial ischemia and acute heart failure documented by electrocardiography, troponin and/or echocardiography.

Data collection

The two primary outcomes were (i) accurate knowledge of laparoscopic surgery, defined as correct identification of the technique as minimally invasive using trocars and pneumoperitoneum and (ii) stated preference for the laparoscopic approach. Candidate explanatory variables included age group, sex, area of residence (urban/rural), education level, prior personal or familial surgical experience and the main source of information about laparoscopy.

Data were extracted from the institutional medical records by two trained investigators using a structured case-report form. Variables included demographics, comorbidities, toxic exposures, preoperative imaging and functional workup, ASA physical-status score, etiology and surgical procedure, surgical approach, type of anesthesia and intubation, mode of analgesia, operative time, intraoperative events, postoperative course, ICU and ventilator data and final outcome.

Statistical analysis

Categorical variables are reported as count (percentage) and continuous variables as mean ± standard deviation (range). Between-group comparisons used the χ^2 test or Fisher's exact test for categorical variables and Student's t-test or the Mann–Whitney U test for continuous variables, as appropriate. For

each candidate predictor, the crude (unadjusted) odds ratio (OR) and its 95% confidence interval (CI) were derived from the corresponding 2×2 table using the log-odds standard-error approximation; the Haldane–Anscombe 0.5 continuity correction was applied to tables containing a zero cell. A two-tailed Fisher's-exact p-value < 0.05 was considered statistically significant. A multivariable logistic-regression model was not fitted because, with only 55 outcome events available in this single-center cohort, the events-per-variable ratio precluded a stable model accommodating the eight candidate predictors that reached significance on univariable analysis; the present analysis is therefore reported as exploratory and hypothesis-generating and a prospective multicenter cohort with Firth-penalized multivariable modeling is planned to confirm independent effects. Analyses were performed with Python 3.12 (SciPy 1.15).

Ethics

This retrospective observational study was conducted in accordance with the Declaration of Helsinki and with the institutional research policies of the Ibn Rochd University Hospital, Casablanca. Given the strictly retrospective design and the use of fully anonymized data extracted from routine medical records, formal ethics committee review was not required by institutional policy and the requirement for individual written informed consent was waived.

Results

Cohort description

Two hundred patients met the inclusion criteria. The mean age was 47.0 ± 13.6 years (range 16–85) and the male-to-female ratio was 1.38. Patients who later developed a perioperative complication were on average 15 years older than those who did not (54.8 ± 13.1 vs. 39.7 ± 10.2 years; $p < 0.001$). The most prevalent respiratory history items were active smoking (31.5%) and prior pulmonary tuberculosis (20%); a previous thoracic procedure was reported in 8% and known chronic obstructive pulmonary disease (COPD) in only 2%. Non-respiratory comorbidities were uncommon, dominated by previous chemo- or radiotherapy (10.5%), diabetes (6.5%) and hypertension (6%). The full baseline distribution is shown in **(Table 1)**.

Table 1: Baseline characteristics of the 200 patients undergoing thoracic surgery.

Variable	Overall (n = 200)	Complicated (n = 55)	Non-complicated (n = 145)
Age (years), mean ± SD	47.0 ± 13.6	54.8 ± 13.1	39.7 ± 10.2
Age > 50 years, n (%)	69 (34.5)	38 (19.0)	31 (15.5)
Male sex, n (%)	116 (58.0)	33 (16.5)	83 (41.5)
Active smoking, n (%)	63 (31.5)	21 (10.5)	42 (21.0)
Prior pulmonary tuberculosis, n (%)	40 (20.0)	24 (12.0)	16 (8.0)
COPD, n (%)	4 (2.0)	1 (0.5)	3 (1.5)
Prior thoracic surgery, n (%)	16 (8.0)	2 (1.0)	14 (7.0)
Diabetes mellitus, n (%)	13 (6.5)	4 (2.0)	9 (4.5)
Hypertension, n (%)	12 (6.0)	1 (0.5)	11 (5.5)
Cardiac disease, n (%)	7 (3.5)	4 (2.0)	3 (1.5)
Prior chemo- or radiotherapy, n (%)	21 (10.5)	2 (1.0)	19 (9.5)
Pulmonary hydatid cyst, n (%)	60 (30.0)	6 (3.0)	54 (27.0)
Malignant lung tumor, n (%)	32 (16.0)	10 (5.0)	22 (11.0)
Thymoma, n (%)	14 (7.0)	5 (2.5)	9 (4.5)
Aspergilloma, n (%)	13 (6.5)	7 (3.5)	6 (3.0)

COPD = chronic obstructive pulmonary disease; SD = standard deviation.

Etiology, surgical approach and perioperative management

Pulmonary hydatid cyst (30%) and malignant lung tumors (16%) were the leading indications, followed by thymoma (7%), aspergilloma (6.5%) and thoracic trauma (5%) - a case-mix typical of a North African tertiary center where granulomatous and parasitic diseases remain prevalent. Video-assisted thoracoscopic surgery (VATS) was used in 56.5% of cases and open thoracotomy in 39%; the most frequent procedures were lobectomy (19.5%), wedge resection (17.5%), pericystectomy (16%) and decortication (14%), with pneumonectomy and thymectomy each accounting for 7%. All patients received general anesthesia, 94% with selective endobronchial intubation and most (71%) were ASA I; ASA ≥ III patients represented 6% of the cohort. Median operative time was 3.5 hours, with 42.5% of procedures lasting > 4 hours. Multimodal analgesia was used in 20.5% of patients and locoregional techniques (epidural, paravertebral, erector-spinae plane block) in 53%. Perioperative-management data are summarized in **(Table 2)**.

Spectrum of perioperative complications (primary outcome)

Fifty-five patients (27.5%) experienced at least one perioperative complication. Intraoperative events were dominant: hemodynamic instability (17.5%) - driven mainly by surgical bleeding (10.5%), anesthetic-related hypotension (3.5%) and acute decompensation of pre-existing heart disease (2%) - and intraoperative hypoxia (3%). Adjacent-organ injury was reported in 1% (two cases, one of the dorsal scapular artery and one of an intercostal artery, both controlled within 15 minutes). A single intraoperative cardiac arrest (0.5%) occurred in a patient with known ischemic heart disease undergoing thoracotomy for sternal chondrosarcoma; the patient was successfully resuscitated. The most frequent postoperative respiratory events were ARDS (1.5%, n = 3) and subcutaneous emphysema (1%, n = 2); pyothorax, prolonged air leak, infectious pneumonia, acute respiratory failure and an incidentally detected right bundle branch block were each recorded in a single patient (0.5%). The complete distribution is shown in **(Table 3)**.

Table 2: Perioperative management of the 200 patients

Variable	n	%
ASA physical-status score		
ASA I	142	71.0
ASA II	46	23.0
ASA III	10	5.0
ASA IV	2	1.0
Endobronchial (selective) intubation	188	94.0
Surgical approach		
VATS	113	56.5
Open thoracotomy	78	39.0
Mediastinoscopy	2	1.0
Procedure type (principal)		
Lobectomy	39	19.5
Wedge resection	35	17.5
Pericystectomy	32	16.0
Decortication	28	14.0
Pneumonectomy	14	7.0
Thymectomy	14	7.0
Operative time		
< 2 hours	37	18.5
2–4 hours	78	39.0
4–6 hours	63	31.5
> 6 hours	22	11.0

ASA = American Society of Anesthesiologists; VATS = video-assisted thoracoscopic surgery.

Table 3: Spectrum and frequency of perioperative complications (n = 200).

Complication	**n**	**%**
At least one complication	55	27.5
Intraoperative — hemodynamic instability (total)	35	17.5
Surgical bleeding	21	10.5
Anesthetic-related hypotension	7	3.5
Decompensation of pre-existing heart disease	4	2.0
Cardiac rhythm disturbance	2	1.0
Tension pneumothorax	1	0.5
Intraoperative — hypoxia (total)	6	3.0
Contralateral pneumothorax	3	1.5
Bronchospasm	2	1.0
Bilateral pneumothorax (two-lung ventilation)	1	0.5
Post-extubation desaturation	1	0.5
Intraoperative cardiac arrest	1	0.5
Injury to adjacent organs (vascular)	2	1.0
Postoperative respiratory complications		
Acute respiratory distress syndrome (ARDS)	3	1.5
Subcutaneous emphysema	2	1.0
Infectious pneumonia	1	0.5
Prolonged air leak (> 7 days)	1	0.5
Acute respiratory failure	1	0.5
Pyothorax	1	0.5
Postoperative cardiac complications		
Right bundle branch block	1	0.5
In-hospital mortality	4	2.0

ARDS = acute respiratory distress syndrome. Several patients had more than one complication.

ICU course, ventilation and final outcome

All patients were managed postoperatively in the surgical ICU (an institutional pathway rather than clinical necessity). Length of ICU stay was < 3 days in 82.5% of patients and > 7 days in 2.5%. Twenty patients (10%) required postoperative mechanical ventilation (mean duration 1.6 days, range 1 hour - 20 days), delivered as invasive ventilation in 35%, non-invasive in 45% and a combination of both in 20%. Overall, in-hospital mortality was 2% (4 patients). The remaining 196 patients (98%) were transferred to the ward and subsequently discharged.

Variables associated with the primary outcome

Univariable analysis identified seven variables significantly associated with an increased risk of perioperative complications and one variable associated with a lower risk **(Table 4)**. The seven risk-associated variables were: abnormal preoperative transthoracic echocardiography (OR 40.2, 95% CI 5.1–317.9), substernal goiter (OR 19.4, 95% CI 0.99–381.9 after Haldane–Anscombe correction; the lower bound included unity and the very small subgroup (n = 3) precludes precise estimation, so this association is reported with caution), ASA ≥ II (OR 9.3, 95% CI 4.6–18.8), age > 50 years (OR 8.2, 95% CI 4.1-16.5), operative time > 6 hours (OR 7.4, 95% CI 2.8–19.4), prior pulmonary tuberculosis (OR 6.2, 95% CI 3.0-13.1) and aspergilloma (OR 3.4, 95% CI 1.1–10.6). The single protective association was pulmonary hydatid-cyst surgery (10% vs. 35% of other indications; OR 0.21, 95% CI 0.08–0.51, p = 0.0002), most plausibly reflecting confounding by indication - pericystectomy was performed in 53% of these patients, who were younger and predominantly ASA I. Sex, active smoking, COPD, prior thoracic surgery, diabetes, hypertension, prior chemo- or radiotherapy and abnormal preoperative electrocardiography or pulmonary function tests were not significantly associated with complications. Pneumonectomy and cardiac disease showed clinically relevant but non-significant trends (OR 2.9 and 3.7 respectively, p = 0.064 and 0.092), likely under-powered for these subgroups (n = 14 and n = 7).

Discussion

In this 3-year retrospective cohort of 200 consecutive patients undergoing thoracic surgery at a North African tertiary center, more than one in four developed a perioperative complication and intraoperative hemodynamic instability - driven mainly by surgical bleeding - emerged as the single most frequent event. On univariable analysis, seven readily available preoperative or intraoperative variables were associated with an increased risk and one with a lower risk and the case-mix - dominated by pulmonary hydatid cyst, post-tuberculous sequelae and aspergilloma - shaped both the spectrum and the candidate predictors of complications in a way that diverges from the predominantly oncological cohorts of high-income settings.

Our 27.5% complication rate sits within the upper range of contemporary reports (10-30% in pooled reviews[3,5], 20.3% in the German Thorax Registry[9], 18% in a recent West-African series[10]) but should be interpreted in light of three contextual factors. First, the inclusion criterion required postoperative ICU admission, which selects for higher-risk procedures. Second, our definition of complication was deliberately inclusive, capturing transient intraoperative events that some series omit. Third, the high prevalence of granulomatous and parasitic disease in our case-mix - particularly aspergilloma, a condition associated with

pleural adhesions and friable parenchyma - plausibly increases intraoperative bleeding, the dominant complication observed here[11,12].

Table 4: Univariable analysis of candidate predictors of perioperative complications (n = 200): crude odds ratios with 95% confidence intervals.

Variable	Crude OR	95% CI	p (Fisher)
Patient-related factors			
Age > 50 years	8.22	4.10 – 16.49	< 0.0001
Male sex	1.12	0.60 – 2.11	0.751
Active smoking	1.51	0.79 – 2.91	0.235
Prior pulmonary tuberculosis	6.24	2.97 – 13.14	< 0.0001
COPD	0.88	0.09 – 8.61	1.000
Prior thoracic surgery	0.35	0.08 – 1.61	0.244
Diabetes mellitus	1.19	0.35 – 4.02	0.755
Hypertension	0.23	0.03 – 1.79	0.185
Cardiac disease	3.71	0.80 – 17.16	0.092
Prior chemo- or radiotherapy	0.25	0.06 – 1.11	0.069
Preoperative workup			
Abnormal echocardiography	40.19	5.08 – 317.91	< 0.0001
Abnormal electrocardiography	2.03	0.44 – 9.40	0.396
Etiology			
Pulmonary hydatid cyst (protective)	0.21	0.08 – 0.51	0.0002
Aspergilloma	3.38	1.08 – 10.55	0.048
Substernal goiter (Haldane-corrected)	19.40	0.99 – 381.92	0.020
Anesthesia and surgery			
ASA score ≥ II	9.28	4.58 – 18.83	< 0.0001
Pneumonectomy	2.88	0.96 – 8.62	0.064
Operative time > 4 hours	3.71	1.93 – 7.14	< 0.0001
Operative time > 6 hours	7.39	2.82 – 19.38	< 0.0001

OR = odds ratio; CI = confidence interval; COPD = chronic obstructive pulmonary disease; ASA = American Society of Anesthesiologists. Crude odds ratios computed from 2×2 cross-tabulations; the Haldane–Anscombe 0.5 continuity correction was applied to tables containing a zero cell (substernal goiter). Significant associations ($p < 0.05$) are highlighted in bold. Multivariable adjustment was not performed because of the limited number of events (n = 55); residual confounding cannot be excluded.

The strongest univariable association, although based on a small absolute number of events, was abnormal preoperative transthoracic echocardiography (OR 40.2). The very wide confidence interval reflects the small subgroup size and precludes precise estimation; nonetheless, the magnitude of the effect - far exceeding that of routine ECG or pulmonary function tests in our cohort - supports a low threshold for preoperative echocardiography in selected high-risk thoracic-surgery candidates, particularly those aged > 50 or with cardiovascular comorbidity, consistent with ESTS/ERS recommendations[17,23]. The univariable associations of age, ASA score and operative time are consistent with the broader literature[13,14,18] and are biologically plausible in the context of declining physiologic reserve and increasing surgical complexity. Parenchymal and pleural remodeling - captured here by prior tuberculosis and aspergilloma - represents an under-appreciated risk dimension that is particularly relevant in endemic regions[11,16] and that deserves explicit acknowledgment in preoperative counseling and theater planning.

The association of pulmonary hydatid cyst with a lower complication rate (OR 0.21) is at first glance counter-intuitive but readily explained: in our cohort, hydatid surgery was performed predominantly through conservative techniques (pericystectomy) in younger, ASA I patients with otherwise unscarred lungs. The protective signal therefore reflects confounding by indication rather than a true biological effect of the disease itself and should be interpreted as a marker of a globally favorable surgical profile. This pattern is consistent with published Moroccan series in which conservative hydatid surgery carries a mortality of 1% and a morbidity of 3-10%[6,11].

The absence of association between complications and conventional risk factors such as active smoking, COPD and diabetes deserves cautious interpretation. The very low prevalence of formally diagnosed COPD in our cohort (2%) almost certainly reflects under-diagnosis rather than true rarity, given the 31.5% rate of active smoking and the regional burden of post-tuberculous lung disease[19,20]. Diabetes prevalence (6.5%) was also lower than national estimates[21], suggesting selection or documentation effects. An intra-institutional comparison with the 2007 Ibn Rochd cohort, in which a complication rate of 16.5% was reported in 200 patients[22], suggests an apparent rise to 27.5% in the present series. This difference is unlikely to reflect deterioration of care - case-mix evolution, expanded use of selective intubation and a more granular ascertainment of intraoperative events are far more plausible explanations. The temporal comparison illustrates the sensitivity of complication rates to operational definitions and reinforces the need for standardized reporting tools such as the ESTS and STS composite scores[23,24] in resource-limited contexts.

Several practical implications can be cautiously drawn from these exploratory associations. Patients > 50 years, ASA ≥ II, with prior tuberculosis or aspergilloma may warrant flagging at the preoperative consultation as higher-risk, with a low threshold for preoperative transthoracic echocardiography, optimization of nutritional and respiratory status and informed counselling on perioperative risk. For procedures expected to exceed 4 hours - particularly through scarred or adherent pleura - early planning for blood-product availability, protective one-lung ventilation[25,26] and goal-directed hemodynamic management appear reasonable. Pneumonectomy in this population carried a complication rate that appeared comparable to international benchmarks but in a context of limited intraoperative monitoring; further effort to centralize pneumonectomies and to standardize fluid and ventilatory strategies seems warranted[27]. The systematic ICU admission of all thoracic-surgery patients, although safe, may not be cost-effective; risk-stratified pathways could reserve ICU beds for higher-risk profiles[28].

Strengths and Limitations

The strengths of this study include the contemporary 3-year window, the consecutive inclusion of all thoracic-surgery patients regardless of indication, the diversity of the case-mix and the granular ascertainment of intraoperative events with quantitative odds ratios and confidence intervals. The limitations are inherent

to the design: single-center retrospective data with reliance on chart review; the small number of events (n = 55) precluded a stable multivariable logistic model - only univariable crude ORs are therefore reported, leaving residual confounding (notably between age, ASA and tuberculosis-related lung remodeling) unaddressed; the inclusion criterion of ICU admission introduces a selection bias toward higher-risk patients; COPD and diabetes were likely under-ascertained; and long-term outcomes beyond hospital discharge were not collected. A prospective multicenter Moroccan cohort with Firth-penalized multivariable modeling, ideally aligned on the ESTS Database definitions, should be the next step.

Conclusion

In this 3-year North African cohort of 200 thoracic-surgery patients, perioperative complications occurred in 27.5%, were dominated by intraoperative hemodynamic events and were associated on univariable analysis with seven readily available variables (abnormal preoperative echocardiography, substernal goiter, ASA ≥ II, age > 50 years, operative time > 6 hours, prior pulmonary tuberculosis and aspergilloma) and with one protective association (pulmonary hydatid cyst, most likely reflecting confounding by indication). In-hospital mortality (2%) appeared comparable to figures reported in larger international series. These exploratory findings support a low threshold for preoperative echocardiography in selected high-risk patients, careful preoperative risk-stratification at the consultation, protective one-lung ventilation and prospective standardized reporting aligned on international definitions. A prospective multicenter Moroccan cohort with adjusted multivariable analysis is required to confirm these predictors and to build a context-specific risk score for thoracic surgery in endemic regions.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Faculty of Medicine and Pharmacy of Casablanca (15 December 2022) and conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants.

Funding

The authors received no specific funding for this work.

Conflicts of interest

The authors declare no conflicts of interest.

Data availability statement

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

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