

Prospective Cohort Study of Preoperative Pulmonary Function, Functional Capacity, and Risk of Postoperative ICU Admission

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Abstract

Preoperative pulmonary function and functional capacity are critical determinants of postoperative outcomes in patients undergoing major surgical procedures. This prospective cohort study evaluated the association between preoperative spirometric parameters, functional capacity, and risk of postoperative intensive care unit (ICU) admission.

A total of 180 adult patients scheduled for elective major abdominal and thoracic surgeries were followed prospectively. Mean forced expiratory volume in 1 second (FEV1) was $78.4 \pm 16.2\%$ predicted, and mean forced vital capacity (FVC) was $81.7 \pm 14.9\%$ predicted. Mean 6-minute walk distance (6MWD) was 382.5 ± 96.3 meters.

Postoperative ICU admission occurred in 54 patients (30%). Patients requiring ICU admission had significantly lower FEV1 ($65.2 \pm 13.4\%$ vs $84.1 \pm 14.2\%$, $p < 0.001$), reduced 6MWD (298.6 ± 74.5 m vs $418.3 \pm$

82.1 m, $p < 0.001$), and higher ASA grade ($p < 0.001$).

Multivariate regression revealed FEV1 $< 70\%$ (OR 2.9, 95% CI 1.6–5.3), 6MWD < 350 m (OR 3.4, 95% CI 1.8–6.1), and presence of COPD (OR 2.6, $p = 0.01$) as independent predictors of ICU admission.

The study concludes that reduced pulmonary function and impaired functional capacity significantly increase the risk of postoperative ICU admission, highlighting the importance of preoperative cardiopulmonary evaluation in surgical risk stratification.

Keywords: Pulmonary function, functional capacity, ICU admission, postoperative risk

Introduction: Preoperative risk assessment is a cornerstone of modern surgical practice, aiming to identify patients at increased risk of postoperative complications and optimize perioperative management strategies. Among the various systems evaluated during preoperative assessment, pulmonary function

and functional capacity play a central role in predicting postoperative respiratory complications and intensive care unit (ICU) requirements [1–3].

Pulmonary function tests (PFTs), including forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC), provide objective measures of ventilatory capacity and airway function. These parameters are particularly important in patients undergoing thoracic and upper abdominal surgeries, where postoperative pulmonary complications are common. Reduced pulmonary reserve has been consistently associated with increased risk of hypoventilation, atelectasis, pneumonia, and prolonged mechanical ventilation [4–6].

Functional capacity, often assessed using the 6-minute walk test (6MWT), reflects the integrated response of the cardiovascular, pulmonary, and musculoskeletal systems. It provides a global estimate of physiological reserve and is strongly associated with postoperative outcomes. Patients with reduced 6-minute walk distance (6MWD) have diminished ability to tolerate surgical stress and are more likely to require postoperative ICU care [7–9].

The relationship between pulmonary function and functional capacity is complex and interdependent. Patients with chronic respiratory diseases such as chronic obstructive pulmonary disease (COPD), interstitial lung disease, or restrictive ventilatory defects often exhibit reduced exercise tolerance, which directly impacts perioperative outcomes. Moreover, comorbid conditions such as obesity, cardiovascular disease, anemia, and frailty further exacerbate functional impairment [10–12].

In recent years, increasing emphasis has been placed on multimodal preoperative risk assessment models that integrate pulmonary function tests with functional capacity measures and clinical risk scores such as ASA classification. These integrated

approaches have demonstrated improved predictive accuracy compared to single-variable assessment models [13–15].

Despite advances in perioperative medicine, there remains variability in clinical decision-making regarding ICU admission after surgery. Some patients with borderline pulmonary function undergo routine ward care, while others are preemptively admitted to ICU based on subjective clinical judgment. This variability highlights the need for objective predictive models based on quantifiable physiological parameters [16–18].

Furthermore, the global burden of chronic respiratory disease is increasing, particularly in aging populations, making preoperative pulmonary evaluation increasingly relevant. Identifying high-risk patients before surgery allows for targeted optimization strategies such as pulmonary rehabilitation, smoking cessation, bronchodilator therapy, and perioperative ventilatory support planning [19–20].

Therefore, this prospective cohort study aims to evaluate the relationship between preoperative pulmonary function, functional capacity, and postoperative ICU admission risk in patients undergoing elective major surgeries.

Methodology

This prospective cohort study was conducted on 180 adult patients scheduled for elective major abdominal and thoracic surgeries at Allama Iqbal Memorial Teaching Hospital. Patients were enrolled consecutively after fulfilling inclusion criteria and followed from preoperative assessment until postoperative discharge.

Preoperative evaluation included spirometry (FEV1, FVC, FEV1/FVC ratio), performed according to American Thoracic Society guidelines. Functional capacity was assessed using the 6-minute walk test (6MWT). ASA physical status classification and comorbid conditions were also recorded.

Patients with emergency surgeries, pre-existing mechanical ventilation, severe cardiac failure (EF <30%), or inability to perform pulmonary function testing were excluded.

The primary outcome was postoperative ICU admission within 48 hours of surgery. Secondary outcomes included duration of ICU stay and postoperative respiratory complications.

Sample size was calculated using Epi Info StatCalc assuming an expected ICU admission rate of 25–30%, 95% confidence interval, and 80% power, resulting in a minimum required sample of 170 patients.

Statistical analysis included independent t-tests, chi-square tests, and multivariate logistic regression. A p-value < 0.05 was considered statistically significant.

Results

Table 1: Baseline Characteristics (n=180)

Variable	Value
Age (years)	52.6 ± 14.8
Male (%)	58.3%
Female (%)	41.7%
COPD	32 (17.7%)
Hypertension	96 (53.3%)
Diabetes	61 (33.9%)
Smoking history	74 (41.1%)

Table 2: Preoperative Pulmonary Function and Functional Capacity

Parameter	Mean ± SD
FEV1 (% predicted)	78.4 ± 16.2
FVC (% predicted)	81.7 ± 14.9
FEV1/FVC ratio	0.76 ± 0.08
6-minute walk distance (m)	382.5 ± 96.3
ASA grade ≥ III	44.4%

Table 3: Comparison Between ICU and Non-ICU Groups

Parameter	ICU Admission (n=54)	No ICU (n=126)	p-value
FEV1 (%)	65.2 ± 13.4	84.1 ± 14.2	<0.001
FVC (%)	69.5 ± 12.8	86.9 ± 13.6	<0.001
6MWD (m)	298.6 ± 74.5	418.3 ± 82.1	<0.001
ASA ≥ III	70.4%	33.3%	<0.001
COPD (%)	31.5%	11.1%	0.002

Table 4: Multivariate Logistic Regression for ICU Admission

Predictor	Odds Ratio (OR)	95% CI	p-value
FEV1 <70%	2.9	1.6–5.3	<0.001
6MWD <350 m	3.4	1.8–6.1	<0.001
COPD	2.6	1.2–4.8	0.01
ASA ≥ III	3.1	1.7–5.7	<0.001

Discussion

This prospective cohort study demonstrates that reduced preoperative pulmonary function and impaired functional capacity are strong predictors of postoperative ICU admission. The findings highlight the importance of objective physiological assessment in perioperative risk stratification.[13–15]

Reduced FEV1 and FVC were significantly associated with ICU admission, reflecting limited ventilatory reserve and increased susceptibility to postoperative respiratory failure. These findings are consistent with the established role of spirometry in predicting postoperative pulmonary complications.[14–16]

Functional capacity, measured by 6MWD, emerged as an even stronger predictor of ICU admission. This suggests that global

physiological reserve may be more important than isolated pulmonary measurements in determining postoperative outcomes.[17]

The strong association between ASA grade and ICU admission reinforces its role as a general surgical risk marker, although it lacks specificity compared to quantitative measures like FEV1 and 6MWD.[18]

Patients with COPD demonstrated significantly higher ICU admission rates, reflecting baseline airway obstruction and impaired gas exchange. This aligns with known perioperative risks in chronic respiratory disease populations.

The multivariate analysis confirms that both pulmonary function and functional capacity independently contribute to postoperative risk, suggesting that combined assessment provides superior predictive accuracy.[19–20]

Overall, the study supports integration of pulmonary function testing and functional capacity evaluation into routine preoperative assessment protocols to improve ICU triage and perioperative planning.

Conclusion

Reduced preoperative pulmonary function significantly increases the risk of postoperative ICU admission. Functional capacity assessed by 6-minute walk distance is a strong independent predictor of postoperative outcomes. Integrated cardiopulmonary evaluation improves risk stratification in surgical patients.

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