Original Article

The association between patient preoperative disposition and outcomes after diagnostic lung biopsy

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Background: Surgical diagnostic lung biopsy (DLB) is performed to guide the management of pulmonary disease with unclear etiology. However, the utilization of surgical DLB in critically ill patients remains unclear. The purpose of this study was to determine if patient preoperative disposition impacts complication rates after DLB.

Methods: This was retrospective cohort study using electronic health record (EHR) data at one academic institution [2013–2021]. Patients who underwent DLB were identified using current procedural terminology (CPT) codes and cohorted based on preoperative disposition. The primary outcome was 30-day mortality; secondary outcomes were overall morbidity, individual complications, and changes to medical therapy. Complication rates were compared using chi-squared tests, Fisher's exact tests, or analysis of variance (ANOVA). Multivariable logistic regression was performed to generate risk-adjusted odds ratios (ORs) for each complication.

Results: Of 285 patients, 238 (83.5%) presented from home, 26 (9.1%) from inpatient floor units, and 21 (7.4%) from intensive care units (ICUs). Patients requiring ICU had the highest 30-day rates of mortality, overall morbidity, and all individual complications (all $P<0.05$). After risk adjustment, non-ICU inpatients had higher odds of postoperative ventilator use, prolonged ventilation, and ICU need than outpatients (all $P<0.05$). Preoperative ICU disposition was associated with increased OR of 30-day mortality [OR, 70.92; 95% confidence interval (CI): 5.55–906.32] and overall morbidity (OR, 7.27; 95% CI: 1.93–27.42) compared to patients with other preoperative dispositions. There were no differences in changes to medical therapy between the cohorts.

Conclusions: Patients requiring ICU before DLB had significantly higher risk-adjusted rates of mortality and postoperative complications than outpatients and other inpatients. A clear benefit from tissue diagnosis should be defined prior to performing DLB on critically ill patients.

Keywords: Diagnostic lung biopsy (DLB); intensive care; risk assessment; postoperative outcomes; critical care

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Introduction

Surgical diagnostic lung biopsies (DLBs) are commonly performed to provide histologic or pathologic tissue evaluation for patients with unspecified interstitial lung disease or pulmonary disease of unclear etiology. DLBs are thought to be particularly useful when a confirmatory tissue diagnosis may guide subsequent changes in therapeutic medical interventions. While other modalities like transbronchial biopsy exist, recent literature has shown that surgical DLB has increased in popularity throughout the years. Unfortunately, this has been associated with increased rates of postoperative complications, such as iatrogenic pneumothorax, bleeding, or infections (1). There are several reports that describe the safety and efficacy of elective DLBs (2-5), and significant evidence exists that patients who are already hospitalized and undergo DLB have worse outcomes and higher hospital costs than elective outpatients (1,6,7). Specifically, non-elective DLB mortality rates have been reported at over 15%, which is roughly eight-fold higher than elective operations (8), with interstitial lung diseases like idiopathic pulmonary fibrosis having been identified as risk factors for poor outcomes (5,8). However, postoperative outcomes among inpatients who undergo DLB have not previously been stratified by level of care (e.g., routine floor, intensive care). This is particularly notable as some series show mortality rates higher than 50% after DLB in certain patient cohorts, including mechanically ventilated patients (9).

In addition to the risk of procedural complications, it is unclear how often the tissue diagnosis obtained by surgical pathology benefits admitted or critically ill, patients. Most of the literature surrounding changes to medical therapy after DLB rely on data collected during the late 1990s and early 2000s (9). These might represent outdated data as imaging and laboratory bloodwork have advanced significantly since then (10), and evolving literature suggests that a multidisciplinary approach towards diagnosing interstitial lung disease is more effective than any single modality alone (11). Additionally, definitions used to characterize changes in medical therapy were not standardized amongst studies. With advances in non-surgical diagnosis of lung failure, we suspect that inpatients whom surgical services are consulted for surgical lung biopsy have become sicker over time. Thus, patients requiring pre-procedural intensive care who undergo DLB may have an even greater surgical risk compared to other inpatients and outpatients undergoing surgical biopsy, without significant benefit from change in therapy associated with obtaining a tissue diagnosis.

The aim of this study was to determine if patient preoperative disposition was associated with postoperative complications after DLB. Specifically, we sought to determine whether preoperative disposition is significantly associated with rates of postoperative complications and whether patients requiring preoperative intensive care are more or less likely to undergo changes in their medical treatment regimen after lung tissue diagnosis when compared to other inpatients or outpatients undergoing DLB. We hypothesized that patients requiring intensive care have higher rates of postoperative complications than other inpatients or outpatients, but that these patients would also have their medical therapy changed more often when compared to other patients undergoing DLB. Understanding these associations may help guide surgical decision making in these patient populations. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1724/rc).

Highlight box

Key findings

- Surgical diagnostic lung biopsy (DLB) confers significant morbidity and mortality in critically ill patients.

What is known and what is new?

- Surgical DLB is generally considered safe in outpatients with pulmonary disease of unclear etiology.
- This study shows the marginal increase in morbidity and mortality after surgical lung biopsy in inpatients and critically ill inpatients.

What is the implication, and what should change now?

- Further randomized studies should evaluate the benefit of performing surgical lung biopsy in critically ill patients.

Methods

Ethical oversight

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The Colorado Multiple Institutional Review Board determined this study exempt from review as it used deidentified patient data. Informed consent was not required because the study used deidentified retrospective patient data.

Patient population and data

This was a retrospective cohort study of patients who underwent DLB at the University of Colorado Hospital (UCH) from January 1, 2013, to December 31, 2021. UCH is a quaternary referral academic medical center partnered with the University of Colorado School of Medicine. The general thoracic surgery group performs over 500 lung resections annually. Surgeons accrue patients locally, regionally, and nationally with significant referrals for lung biopsy through one of their affiliated outpatient clinics at National Jewish Health (Denver, CO, USA). All patients who underwent DLB were targeted for inclusion and were identified using electronic health record (EHR) current procedural terminology (CPT) codes corresponding to DLB (32607: thoracoscopy; with diagnostic biopsy(ies) of lung infiltrate(s) (e.g., wedge, incisional), unilateral; 32096; thoracotomy, with diagnostic biopsy(ies) of lung infiltrate(s) (e.g., wedge, incisional, unilateral). Patients undergoing wedge resection to diagnose a lung nodule, for therapeutic resection, or for other indications were excluded. Patients who were <18 years old or who had missing key data elements were also excluded.

Study design and statistical analysis

Chart review of the EHR was performed to generate a *de novo* database. Patients were sorted into cohorts based on their preoperative disposition: home, inpatient floor [admitted but not in an intensive care unit (ICU)], and inpatient ICU. The primary outcome was 30-day mortality; secondary outcomes were 30-day overall morbidity, individual complications, and changes to medical therapy. We defined changes to medical therapy as a preoperative to postoperative difference in the prescription of systemic steroids, disease-modifying antirheumatic drugs (DMARDs), or immunologic agents, including differences in specific agents within these drug classes for treatment of pulmonary disease. Patient medical comorbidities, perioperative characteristics, and postoperative outcomes were compared using chi-square tests, Fisher's exact tests, and analysis of variance (ANOVA). Multivariable logistic regression controlling for preoperative American Society of Anesthesiologists physical status classification (ASA class) and functional health status was performed to generate risk-adjusted odds of postoperative outcomes. Two-sided P values ≤0.05 were considered statistically significant. Statistical analyses were performed using SAS version 9.4 (SAS Inc., Cary, NC, USA).

Results

A total of 323 patients underwent DLB at the UCH during the study period, 2013–2021. Of these, 28 patients (8.7%) were excluded due to inability to accurately map the patient's operation to an EHR encounter, and 10 patients (3.1%) were excluded for being <18 years old at the time of operation, leaving 285 patients (88.2%) in the analytic cohort. In this cohort, mean age was 55 years, mean body mass index was 29.5 kg/m^2; most patients were male (56.5%), Caucasian (74.7%), and non-Hispanic (89.8%). The most common pathologic tissue diagnoses were usual interstitial pneumonia (56 patients, 19.6%), nonspecific interstitial pneumonia (38 patients, 13.3%), and hypersensitivity pneumonitis (20 patients, 7.0%). Of the 285 patients, 238 (83.5%) presented from home, 26 (9.1%) from an inpatient hospital floor unit, and 21 (7.4%) from an ICU.

Table 1 shows the patient preoperative characteristics and intraoperative variables stratified by preoperative disposition. Inpatients regardless of level of care were more frequently ASA class III or IV (P<0.0001) and underwent more left-sided operations (P=0.04) than outpatients. Patients admitted to an ICU preoperatively had higher rates of preoperative congestive heart failure (P=0.04), were more frequently functionally dependent (P<0.0001), and were intubated using a single-lumen endotracheal tube rather than a double-lumen endotracheal tube more commonly (P<0.0001) than other inpatients or outpatients. There were no other statistically significant differences in patient demographics, the seventeen other preoperative medical comorbidities, or operative characteristics between the patients stratified by preoperative disposition (all P>0.05).

Table 2 shows the unadjusted rates and risk-adjusted odds of postoperative outcomes stratified by patient preoperative disposition. Inpatients regardless of level of care had higher rates of all 30-day complications than outpatients.

Table 1 Patient preoperative characteristics by preoperative disposition prior to DLB (n=285)

Patient characteristics	Preoperative disposition			P value
	Home (n=238)	Floor (n=26)	ICU (n=21)	
Age (years)	55.4 (14.8)	52.0 (12.7)	56.9 (13.1)	0.44
Body mass index (kg/m^2)	29.5 (6.1)	29.2 (6.9)	29.8 (6.8)	0.94
Sex				0.87
Male	131 (55.0)	17 (65.4)	13 (61.9)	
Female	107 (45.0)	9 (34.6)	8 (38.1)	
Race				0.87
Asian or API	5 (2.1)	0 (0.0)	0 (0.0)	
Black	14 (5.9)	1 (3.8)	1 (4.8)	
Multiple	13 (5.5)	2 (7.7)	2 (9.5)	
Other	13 (5.5)	2 (7.7)	2 (9.5)	
White	178 (74.8)	21 (80.8)	14 (66.7)	
Unknown	15 (6.3)	0 (0.0)	2 (9.5)	
Ethnicity				0.08
Hispanic	20 (8.4)	5 (19.2)	4 (19.0)	
Non-Hispanic	218 (91.6)	21 (80.8)	17 (81.0)	
Preoperative medical team				<0.0001
Thoracic surgery	238 (100.0)	3 (11.5)	0 (0.0)	
Medicine hospitalist	0 (0.0)	19 (73.1)	18 (85.7)	
Pulmonary transplant	0 (0.0)	2 (7.7)	1 (4.8)	
Other surgical team	0 (0.0)	0 (0.0)	2 (9.5)	
Other medical team	0 (0.0)	2 (7.7)	0 (0.0)	
Hypertension requiring medication				0.16
Yes	77 (32.4)	12 (46.2)	10 (47.6)	
No	161 (67.6)	14 (53.8)	11 (52.4)	
Hyperlipidemia				0.81
Yes	40 (16.8)	3 (11.5)	4 (19.0)	
No	198 (83.2)	23 (88.5)	17 (81.0)	
Gastroesophageal reflux disease				0.14
Yes	76 (31.9)	4 (15.4)	4 (19.0)	
No	162 (68.1)	22 (84.6)	17 (81.0)	
Diabetes mellitus				0.23
Yes	23 (9.7)	5 (19.2)	3 (14.3)	
No	215 (90.3)	21 (80.8)	18 (85.7)	

Table 1 (*continued*)

Table 1 (*continued*)

Patient characteristics	Preoperative disposition			P value
	Home (n=238)	Floor (n=26)	ICU (n=21)	
Hypothyroidism				0.31
Yes	25 (10.5)	5 (19.2)	1 (4.8)	
No	213 (89.5)	21 (80.8)	20 (95.2)	
Chronic kidney disease				0.26
Yes	4 (1.7)	1 (3.8)	1 (4.8)	
No	234 (98.3)	25 (96.2)	20 (95.2)	
Congestive heart failure				0.04
Yes	3 (1.3)	1 (3.8)	2 (9.5)	
No	235 (98.7)	25 (96.2)	19 (90.5)	
Major depression or anxiety disorder				>0.99
Yes	17 (7.1)	2 (7.7)	1 (4.8)	
No	221 (92.9)	24 (92.3)	20 (95.2)	
Blood or clotting disorder				>0.99
Yes	6 (2.5)	0 (0.0)	0 (0.0)	
No	232 (97.5)	26 (100.0)	21 (100.0)	
Stroke or transient ischemic attack				0.51
Yes	9 (3.8)	0 (0.0)	1 (4.8)	
No	229 (96.2)	26 (100.0)	20 (95.2)	
Connective tissue disease				0.61
Yes	8 (3.4)	0 (0.0)	1 (4.8)	
No	230 (96.6)	26 (100.0)	20 (95.2)	
Cardiac arrythmias				0.08
Yes	11 (4.6)	4 (15.4)	1 (4.8)	
No	227 (95.4)	22 (84.6)	20 (95.2)	
Coronary artery disease				0.87
Yes	14 (5.9)	2 (7.7)	1 (4.8)	
No	224 (94.1)	24 (92.3)	20 (95.2)	
Deep vein thrombosis/pulmonary embolism				0.27
Yes	7 (2.9)	2 (7.7)	1 (4.8)	
No	231 (97.1)	24 (92.3)	20 (95.2)	
Obstructive sleep apnea				0.11
Yes	32 (13.4)	5 (19.2)	0 (0.0)	
No	206 (86.6)	21 (80.8)	21 (100.0)	

Table 1 (*continued*)

Table 1 (*continued*)

Patient characteristics	Preoperative disposition			P value
	Home (n=238)	Floor (n=26)	ICU (n=21)	
Osteoarthritis				0.71
Yes	12 (5.0)	0 (0.0)	1 (4.8)	
No	226 (95.0)	26 (100.0)	20 (95.2)	
Autoimmune disorder				0.19
Yes	16 (6.7)	4 (15.4)	2 (9.5)	
No	222 (93.3)	22 (84.6)	19 (90.5)	
Malignancy				0.11
Yes	18 (7.6)	3 (11.5)	4 (19.0)	
No	220 (92.4)	23 (88.5)	17 (81.0)	
Functional health status				<0.0001
Independent	235 (98.7)	25 (96.2)	8 (38.1)	
Partially dependent	3 (1.3)	1 (3.8)	1 (4.8)	
Totally dependent	0 (0.0)	0 (0.0)	12 (57.1)	
ASA physical status classification				<0.0001
I	2 (0.8)	0 (0.0)	0 (0.0)	
II	57 (23.9)	3 (11.5)	1 (4.8)	
III	173 (72.7)	22 (84.6)	5 (23.8)	
IV	6 (2.5)	1 (3.8)	15 (71.4)	
Operative approach				<0.0001
MIS	237 (99.6)	25 (96.2)	15 (71.4)	
Open	1 (0.4)	1 (3.8)	6 (28.6)	
Operative side				0.04
Right	224 (94.1)	23 (88.5)	17 (81.0)	
Left	14 (5.9)	3 (11.5)	4 (19.0)	
Endotracheal tube				<0.0001
Double lumen	236 (99.2)	23 (88.5)	13 (61.9)	
Single lumen	2 (0.8)	3 (11.5)	8 (38.1)	

Data are presented as mean (SD) or n (%). DLB, diagnostic lung biopsy; ICU, intensive care unit; API, Asian Pacific Islander; ASA, American Society of Anesthesiology; MIS, minimally invasive surgery; SD, standard deviation.

Table 2 Unadjusted rates and risk-adjusted ORs of postoperative complications by preoperative patient disposition (n=285)

Postoperative outcomes	Home (n=238), n (%)	Floor (n=26), n (%)	ICU (n=21), n (%)	Unadjusted P value	Floor *vs.* home		ICU *vs.* home	
					Adjusted OR (95% CI)	Adjusted P value	Adjusted OR (95% CI)	Adjusted P value
30-day mortality	1 (0.4)	0 (0.0)	4 (19.0)	0.0002	<0.01 (<0.01–>999.99)	0.98	70.92 (5.55–906.32)	0.001
Overall morbidity	23 (9.7)	5 (19.2)	10 (47.6)	<0.0001	2.11 (0.72–6.18)	0.17	7.27 (1.93–27.42)	0.003
Persistent air leak	0 (0.0)	1 (3.8)	2 (9.5)	0.003	>999.99 (<0.01–>999.99)	0.94	>999.99 (<0.01–>999.99)	0.93
Postoperative ventilator use	1 (0.4)	2 (7.7)	15 (71.4)	<0.0001	16.28 (1.41–188.30)	0.03	286.41 (25.92–>999.99)	<0.0001
Prolonged ventilation >48 hours	1 (0.4)	2 (7.7)	13 (61.9)	<0.0001	16.21 (1.40–187.68)	0.03	163.15 (15.10–>999.99)	<0.0001
Unplanned reintubation	0 (0.0)	1 (3.8)	2 (9.5)	0.003	>999.99 (<0.01–>999.99)	0.94	>999.99 (<0.01–>999.99)	0.93
Other complication	23 (9.7)	5 (19.2)	7 (33.3)	0.005	2.09 (0.71–6.13)	0.18	2.81 (0.67–11.83)	0.16
Postoperative ICU use	5 (2.1)	7 (26.9)	21 (100.0)	<0.0001	14.90 (4.20–52.93)	<0.0001	>999.99 (<0.01–>999.99)	0.95

OR, odds ratio; ICU, intensive care unit; CI, confidence interval.

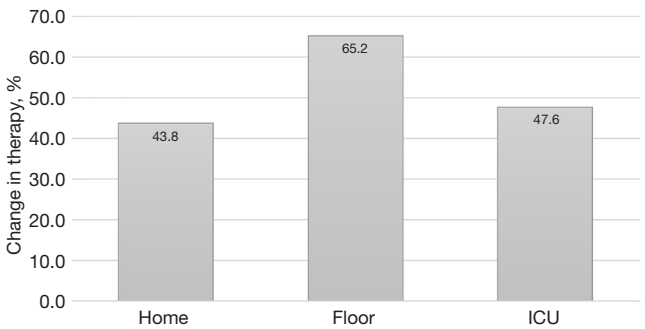

Figure 1 Change in medical therapy (Y-axis) after DLB stratified by preoperative patient disposition (P=0.15). ICU, intensive care unit; DLB, diagnostic lung biopsy.

Inpatients requiring an ICU had higher unadjusted rates of mortality (P=0.0002), overall morbidity (P<0.0001), prolonged air leak (P=0.003), unplanned reintubation (P=0.003), and other complications (P=0.005), as well as ventilator related complications. After risk adjustment, when compared to outpatients, non-ICU inpatients had higher odds of postoperative ventilator use [odds ratio (OR), 16.28; 95% confidence interval (CI): 1.41–188.30], prolonged ventilation (OR, 16.21; 95% CI: 1.40–187.68), and postoperative ICU need (OR, 14.90; 95% CI: 4.20–52.93). Inpatients requiring preoperative ICU had higher risk-adjusted odds of mortality (OR, 70.92; 95% CI: 5.55–906.32) and any morbidity (OR, 7.27; 95% CI: 1.93–27.42) than both outpatients and non-ICU inpatients. Notably, all 30-day mortalities in the cohort were related to progression of pulmonary disease rather than complications related to surgery.

Figure 1 shows the changes in medical therapy after DLB stratified by patient preoperative disposition. In total, 46.3% of patients had postoperative changes to their medication regimen based off the results of pathologic tissue diagnosis. While non-ICU inpatients had the highest rate of changes to medical therapy (65%) amongst the three cohorts, this did not reach statistical significance (P=0.15). Outpatients and inpatients requiring ICU preoperatively had changes in therapy less than half of the time after DLB (43.8% and 47.6%, respectively). There was not a statistically significant difference in 30-day mortality rates amongst patients who had a change in medical therapy after lung biopsy *vs.* those who did not (10.0% *vs.* 27.3%, P=0.59).

Discussion

Results from our study of 285 consecutive patients

undergoing DLB describe the differences in postoperative complications after DLB and subsequent changes to medical therapy based on patient preoperative disposition. Overall, inpatients had significantly higher risk-adjusted rates of complications than outpatients, and this effect was even more profound amongst patients requiring preoperative intensive care. Mortality rates for outpatients and non-ICU inpatients were acceptably low, approaching 0%, but reached almost 20% in patients requiring ICU preoperatively. Notably, all mortalities across the study were related to progression of pulmonary disease rather than a direct surgical complication. Less than half of patients had a change in their medical therapy based on their tissue pathologic results after DLB, and while the rate of change was highest among non-ICU inpatients, this did not reach statistical significance. There was no statistically significant difference in mortality between patients who did *vs.* who did not have a change in medical therapy. These findings highlight the importance in balancing the risks and benefits of surgery when surgeons are consulted to obtain a tissue diagnosis for pulmonary disease of unclear etiology, including appropriate risk stratification and the likelihood of change in therapy.

This study builds on the existing literature that characterizes patient morbidity, mortality, and changes in treatment strategies after DLB. Mortality after DLB is associated with progression of disease rather than operative complications (9,12,13), which we also found in this study. However, mortality rates particularly among ICU patients are significant, merit consideration in these high-risk patients, and may even suggest futility of obtaining definitive diagnosis to guide therapy. Clinical predictors associated with increased risk of mortality after DLB include severe smoking history (14), presence of pulmonary hypertension (2), baseline oxygen requirement (14,15), and low baseline diffusion capacity of lung (2), among others. An overall assessment of a patient's baseline medical comorbidities, acute illness severity, and potential benefit of surgical tissue diagnosis on a patient's prognosis and treatment strategy should be contextualized when determining the utility of DLB. Although the high mortality rate associated with ICU patients in this study population should give clinicians pause, the results of this study fall short of being able to provide a definitive recommendation. Future studies directly comparing patient outcomes after empiric treatment without surgical biopsy *vs.* outcomes with early surgical tissue diagnosis and subsequent guided therapy could definitively determine the utility of DLB in critically ill patients.

This study has several other notable findings. For example, changes to medical therapy after DLB were similar across all three patient cohorts. The reasons for this are likely multifactorial. The development of disease-modifying anti-fibrotic medications like nintedanib and pirfenidone has possibly led to an increased rate of therapy initiation and/or tailoring in recent years (16), especially in the outpatient setting. Advancements in high-resolution computed tomography imaging have also been substantial in the last several decades, which have led to improvement in interpretation, interobserver agreement, and prediction of response to therapy in interstitial lung disease (17). This advancement may have decreased the relative efficacy of tissue diagnosis in severe cases of pulmonary disease with unclear etiology by limiting the patients who receive biopsy to only those with complex or elusive pathology. Changes in medical therapy amongst critically ill patients ranges from 64–81% in the literature (9,12,13,18,19), which is notably higher than our observed rate. Some of this difference could be attributed to the fact that we did not consider antibiotics classes as changes in medical therapy while many of these studies did. Our reasons for excluding antibiotics are severalfold. Locally, most critically ill patients with unknown pulmonary pathology are empirically started on broad-spectrum antibiotics long before tissue diagnosis is requested and obtained. Thus, the cost and potential risks of a surgical lung biopsy, often performed via mini-thoracotomy in critically ill patients, seems far greater than the potential relative benefit of possibly removing or narrowing antibiotics. Also, at our institution, a trial of empiric steroids is often performed prior to receiving pathologic confirmation as steroid-sensitive pathologies are associated with lower mortality than steroid-resistant pathologies causing respiratory distress (20). Compared to prior published series, this study uses more recent data and may reflect advances in care outlined above. These factors combined may have lowered our rates of therapy changes compared to historical norms without significantly impacting patient outcomes.

This study has some important limitations to consider. First, this study was a single institution retrospective study, which may limit its generalizability to other patient populations and healthcare systems. The study only compared patients who underwent operations and did not consider patients for whom thoracic surgery was consulted for but did not undergo a surgical biopsy. Thus, it reflects some selection bias by our thoracic surgeons. The non-

surgical cohort of patients requiring intensive care for pulmonary disease of unclear etiology was not evaluated, so these patients may have undergone a change in medical therapy more or less frequently than the group who had tissue diagnosis and may have had different rates of inpatient or short-term mortality. We did not evaluate the ICU indication for patients at the time of surgery, so it is possible that some patients did not require intensive care but were boarding in the ICU for other reasons. Changes to medical therapy may not be the only benefit observed in patients who receive tissue diagnosis, as other therapies like removal of allergenic agents or diagnosis of unknown aspiration, for example, may also be of benefit to guide management in these patients. Because of these limitations, we cannot definitively recommend that DLB be performed or deferred in the critically ill population. However, we do recommend appropriate risk stratification and informed multidisciplinary discussion on the need for lung biopsy on ICU patients.

Conclusions

Inpatients who require preoperative intensive care have significant risk of postoperative morbidity, mortality, and undergo changes in medical therapy less than half of the time following surgical DLB. Other non-ICU inpatients also have a higher risk of complications when compared to outpatients, but these effects were less pronounced. There was no difference in whether patients had changes in medical therapy or not based on preoperative disposition. Careful consideration of the risk and benefits of surgery and patient goals of care should be performed prior to performing DLB on critically ill patients. A study comparing the outcomes of critically ill patients with pulmonary disease of unclear etiology undergoing surgical *vs.* non-surgical diagnosis and subsequent treatment is warranted to further determine the pros and cons of surgical DLB in this population.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1724/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1724/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1724/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The Colorado Multiple Institutional Review Board determined this study exempt from review as it used deidentified patient data. Informed consent was not required because the study used deidentified retrospective patient data.

References

1. von Itzstein MS, Gupta A, Mara KC, et al. Increasing Numbers and Reported Adverse Events in Patients with Lung Cancer Undergoing Inpatient Lung Biopsies: A Population-Based Analysis. Lung 2019;197:593-9.
2. Durheim MT, Kim S, Gulack BC, et al. Mortality and Respiratory Failure After Thoracoscopic Lung

Biopsy for Interstitial Lung Disease. Ann Thorac Surg 2017;104:465-70.
3. Ferson PF, Landreneau RJ. Thoracoscopic lung biopsy or open lung biopsy for interstitial lung disease. Chest Surg Clin N Am 1998;8:749-62.
4. Millaire É, Ouellet É, Fortin M, et al. Outcomes Following Surgical Lung Biopsy for Interstitial Lung Diseases: A Monocenter Experience. Thorac Cardiovasc Surg 2022;70:583-8.
5. Samhouri BF, Kanj AN, Chehab O, et al. Outcomes for Elective Open and Thoracoscopic Surgical Lung Biopsies in the United States and Temporal Trends. Mayo Clin Proc Innov Qual Outcomes 2022;6:87-97.
6. Pastre J, Khandhar S, Barnett S, et al. Surgical Lung Biopsy for Interstitial Lung Disease. Safety and Feasibility at a Tertiary Referral Center. Ann Am Thorac Soc 2021;18:460-7.
7. Chiu YW, Kao YH, Simoff MJ, et al. Costs of Biopsy and Complications in Patients with Lung Cancer. Clinicoecon Outcomes Res 2021;13:191-200.
8. Hutchinson JP, Fogarty AW, McKeever TM, et al. In-Hospital Mortality after Surgical Lung Biopsy for Interstitial Lung Disease in the United States. 2000 to 2011. Am J Respir Crit Care Med 2016;193:1161-7.
9. Wong AK, Walkey AJ. Open Lung Biopsy Among Critically Ill, Mechanically Ventilated Patients. A Metaanalysis. Ann Am Thorac Soc 2015;12:1226-30.
10. Baratella E, Ruaro B, Giudici F, et al. Evaluation of Correlations between Genetic Variants and High-Resolution Computed Tomography Patterns in Idiopathic Pulmonary Fibrosis. Diagnostics (Basel) 2021;11:762.
11. Sanduzzi Zamparelli S, Sanduzzi Zamparelli A, Bocchino M. The Evolving Concept of the Multidisciplinary Approach in the Diagnosis and Management of Interstitial Lung Diseases. Diagnostics (Basel) 2023;13:2437.
12. Baumann HJ, Kluge S, Balke L, et al. Yield and safety of bedside open lung biopsy in mechanically ventilated patients with acute lung injury or acute respiratory distress syndrome. Surgery 2008;143:426-33.
13. Arabi Y, Ahmed R, Ahmed Q, et al. Risks and benefits of open-lung biopsy in the mechanically ventilated critically ill population: a cohort study and literature review. Med Sci Monit 2007;13:CR365-71.
14. Yun JK, Lee GD, Kim HR, et al. Parsimonious risk model for predicting mortality after surgical lung biopsy for interstitial lung disease. Eur J Cardiothorac Surg 2022;62:ezac291.
15. Rotolo N, Imperatori A, Dominioni L, et al. Efficacy and safety of surgical lung biopsy for interstitial disease. Experience of 161 consecutive patients from a single institution in Italy. Sarcoidosis Vasc Diffuse Lung Dis 2015;32:251-8.
16. Mudawi D, Heyes K, Hastings R, et al. An update on interstitial lung disease. Br J Hosp Med (Lond) 2021;82:1-14.
17. Jeny F, Brillet PY, Kim YW, et al. The place of high-resolution computed tomography imaging in the investigation of interstitial lung disease. Expert Rev Respir Med 2019;13:79-94.
18. Donaldson LH, Gill AJ, Hibbert M. Utility of surgical lung biopsy in critically ill patients with diffuse pulmonary infiltrates: a retrospective review. Intern Med J 2016;46:1306-10.
19. Depuydt OE, Daeze C, Benoit D, et al. Diagnostic potential of open lung biopsy in mechanically ventilated patients with diffuse pulmonary infiltrates of unclear aetiology. Anaesth Intensive Care 2013;41:610-7.
20. Gerard L, Bidoul T, Castanares-Zapatero D, et al. Open Lung Biopsy in Nonresolving Acute Respiratory Distress Syndrome Commonly Identifies Corticosteroid-Sensitive Pathologies, Associated With Better Outcome. Crit Care Med 2018;46:907-14.

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