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Early View

Original article

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Lung ultrasound findings in patients with novel SARS-CoV-2

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Conflicts of interest:

All authors declare to have no conflicts of interest.

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Prior Abstract presentation

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Abbreviations list

BLUE:	Bedside Lung Ultrasound in Emergency
CI:	Confidence Interval
CoV:	Corona Virus
COVID:	Corona Virus Disease
CRP:	C Reactive Protein
CT:	(chest) Computed Tomography
CXR:	Chest X-ray
FiO2:	Fraction of Inspired Oxygen
IQR:	Inter Quartile Range
LUS:	Lung Ultrasound Score
METC:	Medisch Ethische Toetsings Commissie (Medical Ethics Board)
PaO2:	Partial Oxygen Pressure
PEEP:	Positive End Expiratory Pressure
PLAPS	Postero Lateral Alveolar and Pleural Syndrome
PC:	Pressure Control
PS:	Pressure Support
P/F ratio:	Ratio between Partial Oxygen Pressure and Fraction of Inspired Oxygen
SARS:	Severe Acute Respiratory Distress Syndrome
SD:	Standard Deviation
SOFA:	Sequential Organ Failure Assessment
WBC:	White Blood cell Count

Abstract:

Background:

Over 2 million people worldwide have been infected with Severe Acute Respiratory Distress Syndrome Corona Virus 2 (SARS CoV-2). Lung ultrasound has been proposed to diagnose and monitor it, despite the fact that little is known about the ultrasound appearance due to the novelty of the illness. The aim of this manuscript is to characterize the lung ultrasonographic appearance of critically ill patients with SARS CoV-2 pneumonia with particular emphasis on its relationship with the time course of the illness and clinical parameters.

Methods:

On the Intensive Care Unit of two academic hospitals, adult patients who tested positive for SARS-CoV-2 were included. Images were analyzed using internationally recognized techniques which included assessment of the pleural line, number of B-lines, pathology in the PLAPS (Postero Lateral Alveolar and Pleural Syndrome) point, BLUE-profiles (Bedside Lung Ultrasound in Emergency), and the lung ultrasound score (LUS). The primary outcomes were frequencies, percentages and differences in lung ultrasound findings overall and between short (≤14 days) and long (>14 days) duration of symptoms and their correlation with clinical parameters.

Results:

In this pilot observational study, 61 patients were included with 76 examinations for analysis. 26% of patients had no anterior lung abnormalities, while the most prevalent pathological ultrasound findings present but subtle lung sliding (35%), thickening of the pleura (42%), ≥ B-lines per view (38%) and present PLAPS (74%). Patients with "long" duration of symptoms presented more frequently with a thickened and irregular pleura (21% (32) vs 9% (11)), C-profile (47% (18) vs. 25% (8)) and pleural effusion (19% (14) vs 5% (3)), compared to patients with short duration of symptoms. Lung ultrasound findings did not correlate with P/F ratio, fluid balance or dynamic compliance.

Conclusion:

SARS CoV-2 results in significant, but not specific, ultrasound changes, with decreased lung sliding, thickening of the pleura and a B-profile being the most observed. With time, a thickened and irregular pleura, C-profile and pleural effusion become more common findings. When screening patients, a comprehensive ultrasound protocol might be necessary.

Introduction

At the time of writing, close to 2,5 million people worldwide have been infected with Severe Acute Respiratory Distress Syndrome Corona Virus 2 (SARS CoV-2), of whom approximately 150.000 have died. The rapid spread of the illness in the pandemic necessitates constant adjustments of clinical and management protocols in keeping with our evolving knowledge of the illness. As part of this, there has been ongoing debate as to the optimal approach for imaging these patients as the normal gold standard for thoracic imaging, chest computed tomography (CT), poses the risk of spread of infection since it necessitates transportation of patients. Furthermore, given the novelty of the illness, the sensitivity and specificity of CT when diagnosing SARS CoV-2 is untested.

Bedside lung ultrasound has significant advantages as the imaging modality of choice in both diagnosis and monitoring; it has high sensitivity for detecting pathology at the lung surface, such as pleural thickening, consolidation and ground glass like patterns as seen on CT.(1,2) Recent literature also demonstrates that ultrasound outperforms chest X ray (CXR) in detecting these pathologic entities.(3) Furthermore, lung ultrasound has additional advantages in that it offers no radiation exposure, does not require transport and therefore also saves direly needed personal protective material.

However, due to the novelty of the disease, there is a scarcity of data related to the typical lung ultrasound findings which may be observed in patients infected with SARS CoV-2. In addition, we do not know if lung ultrasound can be used for monitoring of disease progression, as it is unknown how findings may change

throughout the course of the disease and if they correlate to clinically relevant disease related parameters.

We therefore aim to present an outline of lung ultrasound findings in critically ill SARS CoV-2 patients overall, in relation to duration of symptoms, and to determine if there is a correlation between ultrasound findings and physiological parameters such as the P/F-ratio (ratio between partial oxygen pressure and fraction of inspired oxygen).

Methods

Study design and population

This study was conducted in two academic intensive care units (ICU's) (Amsterdam University Medical Centers (UMC), location VUmc (Vrije Universiteit Medical Center), Amsterdam, the Netherlands and Leiden University Medical Center (LUMC), Leiden, the Netherlands). The protocol to utilize data gathered during routine ultrasound was approved by the local ethics board (Registration ID: 2020.011). The necessity for informed consent was waived. The trial was registered in the Dutch trial registry (Netherlands Trial Register (registration ID: NL8540). Patients were followed up until discharge, death or when still admitted on the ICU until submission of the manuscript to this journal.

The study population consisted of adult (>18 years) ICU patients, who tested positive for SARS-CoV-2 at least once before admission. In addition to baseline demographics, days from hospital and ICU admission, time spent on the ventilator before ultrasound examination, SOFA score (Sequential Organ Failure Assessment) on the day of examination, ventilator settings, inflammatory markers, and serum

creatinine were recorded. Data were derived form a dedicated patient data management system and data closest to the time of examination were used.

Two groups were defined based on symptom duration from their onset, where ≤ 14 days was defined as “short group” and >14 days as “long group”, which were arbitrarily chosen based on the clinical observation that the disease often worsens after 10-14 days.

Ultrasound Measurements:

All images were acquired by lung ultrasound certified clinicians, using a Sonosite-EDGE II or Philips Lumify ultrasound system. Certification entailed a two-day course and thereafter supervision by a physician with extensive ultrasound experience (> 5 years) until sufficient expertise was reached (a minimum of 30 exams).(4) Researchers (MEH, MLH and JLM) performing offline ultrasound analysis were blinded to the patient’s baseline characteristics.

The examination in both centers were performed with the patient in the supine position, utilizing the BLUE-protocol (two ventral- (Upper BLUE-point and Lower BLUE-point) and one dorso-lateral point (PLAPS-point, postero lateral alveolar and pleural syndrome) point of measurement(s), on either side of the thorax).(5)

Ventral measurements were performed using a 10-5 MHz linear transducer (VUmc) or a 12-4 MHz linear transducer (LUMC), both in lung setting (suppression of artefact filtering software) and with image depth set at >6 centimeters. This depth was chosen based on the hospital’s local guideline on ultrasound acquisition to ensure standardization of imaging. (6) The PLAPS measurements were made with a 5-1 MHz cardiac transducer (VUmc) or a 4-1 MHz broadband phased array

transducer (LUMC), with settings freely adjustable by the operators in both centers to obtain an ideal image. In one center (LUMC), in addition to the aforementioned protocol, the Lung Ultrasound Score (LUS), a 12-region protocol was performed as well.(7) In this center the number of B-lines are not routinely measured due to presumed low reproducibility.(8)

In each image the following analyses were made: 1) Movement of pleura classified as present (easily and directly visible), present but subtle (visible, but closer examination needed) or absent 2) the pleura was described as either normal, thickened (by eyeballing if the pleura appears as a sharp, thin line or wider with diffuse border) , irregular (by eyeballing if one continuous line or small echogenic bands/septa/gaps in between) or thickened and irregular 3) the total number of B-lines 4) the appearance of B-lines as either separated- or confluent 5) appearance of the lung parenchyma per view as normal, ≥ 3 B-lines and consolidated and 6) the BLUE-profile as A, A/B, B or C profile (A' and B' were not present) 7) in case of a C-profile, as small or large consolidation (small in case of shred-sign and large if a tissue like pattern was visible) 8) PLAPS as either absent or present with consolidation and/or pleural effusion. (7,9) Due to the hierarchical nature of the BLUE-protocol, where a C-profile overrules a B-profile, which overrules an A-profile, data are presented per view and per exam, with the aim of better capturing the heterogeneity of the disease.

Statistical Analysis

No sample size calculation was performed as this study was meant to be a pilot exploratory study to give insights into baseline findings in patients with SARS CoV-2. Statistical analyses were performed using SPSS IBM version 22 (SPSS Inc., Chicago, IL, USA) and R statistical software. Variables were tested for normality with the Shapiro-Wilk test, evaluation of histograms and Q-Q plots. Descriptive statistics are presented as means ± standard deviations (±SD), medians and interquartile range [IQR] or numbers (percent %) when appropriate. Differences in characteristics between duration of symptoms/ventilation, the ≤ 14 and >14 days of symptoms groups, were tested with an independent-samples t-test, Mann-Whitney U test or Pearson's chi-squared test, using Yates' continuity correction (R function chisq.test) when appropriate. The latter was used to test a global association between the categories of the variable (e.g. A, B, C) and the binarized duration. To complement this global p-value, we also provide confidence intervals (CI) for difference in proportions (long vs. short duration), specifically per category. These were based on continuity corrected Z-statistics (R function prop.test). Correlations for dichotomous and categorical variables were tested with generalized linear models and with linear regression for continuous variables.

Analyses were made per patient and view, equaling 6 views per patient. The LUS was calculated based on 6 views per hemithorax but analyzed as one data-point per patient.

In one center (LUMC) the total amount of B-lines per view was not counted and perceived as missing data, while in the other center (VUmc) the LUS was not calculated and perceived as missing data. Statistical analyses were performed

using two-sided hypothesis tests; a p-value of < 0.05 was regarded statistically significant.

Results

This study was performed from March 27th 2020 until April 20th 2020. Patient enrolment is summarized in figure 1. A total of 93 patients were screened of which 61 patients were included, with a total of 76 lung ultrasound examinations ((50 x 1 exam) + (9 x 2 exams) + (1 x 3 exams) + (1 x 5 exams)) and 456 images/views to be analyzed. Of these, 2.9% (13) were missing. When divided into short and long duration of symptoms, 5 patients (30 views = 6.7% of all views) were not included due to missing information on the start date of the symptoms.

Baseline characteristics

Baseline characteristics are presented in Table 1. An overall BMI of 28.5 (±4.9) was found and 90% of the included patients were male. No differences were found in baseline characteristics between the missed and included patients (BMI 28.6 (±3.5), p=.15; Gender, male 81%, p=.22 and Age 62 [54-70], p=.15). Patients in the long duration group had a longer hospital admission-, ICU admission- and mechanical ventilation time before ultrasound examination and a higher white blood cell count (8.7 [5.2-12.3] vs. 13.8 [7.8-17.7], p=.01).

Ultrasound Analysis

Ultrasound variables are presented in Table 2 (per view) and Table 3 (per patient). Lung sliding was present in 99% of patients but only subtle in 35% of views and did not differ between groups. An unaffected pleura was seen in 36% of views, with a

thickened pleural line being seen in 42% of them. A thickened and irregular pleural line was more frequently seen in in the long vs. short symptom duration group, 21% (32) vs. 9% (11), respectively (p=.024).

According to the BLUE-protocol, an A-, A/B, B- and C-profile was seen in, 26%, 21%, 15% and 38% of patients respectively. The C-profile was seen more frequently in the long symptom duration group and consolidation per view, 25% (8) vs. 47% (18) (difference -12, 95% CI -48 to 2) and 9% (11) vs. 20% (31) (difference -11, 95% CI -21 to 3). Overall, the PLAPS point did not show pathology in 39% of views. When present, consolidation (46%) was the most frequent finding. Pleural effusions were seen more frequently in the long symptom group (5% (3) vs. 19% (14), difference -14 95% CI -23 to 20). Out of all exams, only one exam (1.3%) did not show any detectable ultrasonographic changes. A "typical" ultrasound exam is presented in Figure 2.

The LUS was calculated in 24 patients, with a mean of 19 (± 1). The score did not differ between symptom duration groups. There was no correlation between BLUE-profile or LUS with P/F-ratio (p=.29), fluid balance (p=.84) or dynamic compliance (p=.19). For the LUS, a correlation was observed with compliance (R^2=0.27, p=.02), a trend for fluid balance (p=.09) but not correlation with P/F-ratio (p=.98).

Discussion:

The main findings of this exploratory study are that 1) SARS CoV-2 results in significant changes in the lung in most patients, detectable on ultrasound with subtle lung sliding, pleural thickening and a C-profile being the most frequently observed, though with a large proportion of cases still showing an A-profile. 2) In patients with long duration of symptoms (>14 days) compared to those with a short duration (≤ 14 days), a thickened and irregular pleura, C-profile and pleural effusion are more common. 3) The BLUE-profiles and LUS did not show a strong correlation with P/F-ratio, fluid balance or dynamic compliance.

In recent weeks, several case-reports have already described changes of the pulmonary parenchyma due to SARS CoV-2. However, these were only presented in a very small number of patients without baseline characteristics or a standardized ultrasound approach.(2,10) To our knowledge, this is the first study to accurately present a comprehensive overview of ultrasound findings in a large cohort.

In line with the published data, we noticed a high prevalence of pleural changes, with more than half of the patients presenting with either thickening and/or irregularities. Additionally, a relatively high frequency of anterior interstitial syndrome and lung consolidation was noted, which was also described in the other studies. However, while pleural effusion was uncommon in the short symptom duration group, it became more prevalent in the long symptom duration group. The latter finding is not entirely in line with the previous literature, however in

those studies no time course was described which makes direct comparison difficult.

In comparison to other pathological entities, these findings resemble those seen in ARDS, with varying patterns of interstitial syndrome and consolidation, though with a lower rate of pleural effusion.(11,12) In line with this, it should be noted that while the described findings are typically seen in patient with SARS CoV-2, they are not specific for the condition. This is especially relevant in a first-line setting, where different etiologies could present with similar findings.

Comparison of our data with regards to the temporal component with other ultrasound studies is not possible, as this data is not yet available. What was observed in our data set was a change in the occurrence of the described findings over time, with increasing frequency of pleural thickening and irregularity, C-profile and pleural effusion. Interestingly, these changes overlap with previous articles that demonstrated comparable changes on CT.(13–15) With this in mind, we believe lung ultrasound presents a valuable alternative for monitoring disease progression in the context of this pandemic.(16) Especially considering that it does not require transport and therefore not only saves direly needed personal protective equipment but also limits the necessity to take patients out of isolation. However, it is crucial to realize that 26% of all cases were found to have an A-profile, indicating a non-pathological state of the lungs when assessing the anterior BLUE-points. This is not completely unexpected, given that on CT the lung parenchyma is very heterogeneously affected and pathological regions might be missed. At this point, we wish to mention, that in all but one case with A-profile,

either thickening of the pleura, present PLAPS or one BLUE-point showing a B-line pattern was seen. It is therefore an important consideration, when utilizing lung ultrasound examinations as a diagnostic modality in patients with suspected SARS CoV-2 infection, to select a more comprehensive approach such as the 12-region protocol or to also interpret pleural thickening or a local B-line pattern as indicative of disease.(7) We hypothesize that this becomes especially relevant in patients presenting to the emergency ward, as in this population, abnormalities in the PLAPS point or pleural thickening might be less frequently encountered, thus leaving an important part of patients with a negative lung ultrasound examination.

We also set out to determine whether the BLUE-profiles or LUS was correlated to currently relevant parameters such as the P/F-ratio, fluid balance or dynamic lung compliance. This was not the case, except for LUS and compliance, where there was a very weak correlation and therefore not regarded as relevant. We hypothesize that this might be attributed to several factors. While the 12-region protocol covers a larger area of the lung than the BLUE-protocol, a large part of the most dorsal regions is not visualized and therefore not accounted for. In addition, even if extensive, lung ultrasound only examines the outermost parts of the pulmonary parenchyma, while studies show that on CT also deeper lung parts are affected.(13–15) This issue is also relevant when considering the radiographic differences between the proposed “H” -and “L”-type lungs, as the former can present with deep- and subpleural abnormalities, while the latter mostly with subpleural abnormalities .(17) Therefore, one might under- or overestimate disease severity in the “H”- and “L”-type respectively, solely based on ultrasound examination, as it cannot visualize deeper structures. It is important to note that

as no sample size calculation was performed, these conclusions should be read with caution and analyses in a larger dataset is necessary.

Strengths:

The strength of this study is its size with an overview of lung ultrasound findings in SARS-CoV-2 positive patients and reporting both on the use of the BLUE-protocol and LUS. This contributes greatly to the currently available body of evidence. In addition, the study was carried out in two different hospitals, by multiple operators and using two different ultrasound approaches, thereby increasing its external validity. It is also the first study to highlight ultrasonographic differences according to symptom duration.

Limitations:

This study has several important limitations. Firstly, no sample size calculation was performed, for which reason caution is warranted when interpreting results due to significant results by chance. The included sample was based on availability of an ultrasound examination and in the first days of the outbreak with a large number of admissions, restructuring of the wards and medical support by other specialties untrained in lung ultrasound, some patients did not receive an ultrasound examination. With the introduction of better logistics and dedicated proning-teams this changed and we were able to examine every admitted patient. Secondly, the length of symptom duration for subgroup analysis was arbitrarily chosen, based on our experience of clinical worsening after 10-14 days. Thirdly, some patients were examined more than once, which could introduce bias. However, the images acquired showed great heterogeneity within patients over time, limiting this effect

to some extent. In addition, due to grouping by symptom duration, these cases were distributed between groups, also mitigating this effect. Fourthly, we were not able to correlate our findings to endpoints such as mortality or extubation outcome, as the majority of the patients was still admitted and ventilated at the time of writing. Lastly, 90% of the included patients were male, which limits the overall generalizability. Still, this number roughly reflects the percentage of male gender in patients admitted to our ICU during this pandemic.

Conclusion:

SARS CoV-2 pneumonia results in significant changes in the lung, detectable on ultrasound with decreased lung sliding, pleural thickening and a B-profile being the most frequently observed. With time, a thickened and irregular pleura, C-profile and pleural effusion become more prevalent. Lung ultrasound might be a valuable alternative to CT in diagnosing and monitoring SARS CoV-2 pneumonia. When screening patients, a comprehensive ultrasound protocol should be used.

Acknowledgements

Guarantor statement:

Mark Evert Haaksma takes responsibility for the content of the manuscript, including the data and analysis.

Authors' contributions

MHa, MHe, AG, LH, CK, JM, DW and PT were responsible for the conception and design of the work. MHa, MHe, JN, JT, JM, PT were responsible for acquisition and or analysis of the data. MHa, MHe, JM were responsible for building the database. MHa and PT were responsible for drafting the manuscript and all authors provided critical revisions for it. All authors read and approved the final manuscript and ensured that questions related to the accuracy or integrity of any part of the work were investigated and resolved.

Ethics approval and consent to participate

Approval was given by the local ethics committee (METc (Medisch Ethische Toetsings Commissie) VUmc) with the study number 2020.11. Consent for participation was not applicable as ultrasound measurements were carried out as part of routine clinical examination.

Consent for publication

Consent for publication was waived by the local ethics board.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of interest:

All authors declare to have no conflicts of interest.

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Tables and Figures

Table 1. Baseline characteristics of patients included

Variable	OVERALL	SYMPTOMS ≤ 14	SYMPTOMS >14	P-VALUE
Number of patients	61	23	33	(5 patients missing)
Number of studies	76	32	38	(6 studies missing)
Age, years	66 [59-73]	69 [60-76]	65 [59-73]	.18
Gender, male	55 (90%)	21 (91%)	30 (91%)	1
BMI, m/kg^2	28.5 (±4.9)	28.1 (±4.9)	28.6 (±5.2)	.75
Mechanically ventilated	58 (95%)	21 (98%)	32 (97%)	.29
Ventilator mode, controlled	35 (58%)	15 (65%)	15 (45%)	.11
NMBA use, yes	18 (30%)	7 (30%)	8 (24%)	.84
Days until LUS				
Symptoms	15 [11-21]	11 [9-13]	20 [17-25]	n.a.
Hospital admission	7 [4-13]	5 [3-6]	13 [7-17]	.00
ICU admission	3 [1-12]	2 [1-3]	10 [3-19]	.00
Mechanical ventilation	4 [2-11]	3 [1-4]	10 [3-15]	.00
Ventilator settings				
FiO2 (%)	50 [40-60]	55 [47-60]	50 [40-60]	.49
Pressure above PEEP (cmH_2O)	12 [10-15]	13 [10-15]	11 [5-17]	.17
PEEP (cmH_2O)	12 (±3)	12 (±4)	11 (±3)	.05
Arterial blood gas				
pH	7.38 [7.33-7.45]	7.37 [7.31-7.44]	7.41 [7.34-7.45]	.19

PaCO2 (kPa)	6.6 [5.7-7.5]	6.2 [5.6-7.2]	6.7 [5.9-7.6]	.31
PaO2 (kPa)	9.7 (±1.3)	9.8 (±1.4)	9.6 (±1.2)	.55
P/F ratio (mmHg)	147 (±42)	145 (±42)	148 (±40)	.95
Other				
SOFA	8 [7-10]	8 [7-10]	9 [7-11]	.16
Respiratory rate	24 (±5)	23 (±4)	25 (±5)	.13
Blood pressure systolic (mmHg)	119 [132]	117 [106-129]	119 [107-138]	.71
Blood pressure diastolic (mmHg)	56 [51-63]	55 [51-62]	55 [50-64]	.85
WBC ($x10^9$/L)	10.4 [6.6-15.2]	8.7 [5.2-12.3]	13.8 [7.8-17.7]	.01
CRP (mg/L)	204 (±109)	216 (±100)	187 (±102)	.20
CREATININE (umol/L)	96 [70-164]	96 [70-150]	99 [70-168]	.80
Fluid balance (ml) (SINCE ADMISSION)	245 [-492-1027]	344 [-442-835]	215 [-904-1224]	.80

NUMBERS ARE GIVEN AS: MEAN (± SD**); MEDIAN [IQR]; NUMBER (%),**
BMI= BODY MASS INDEX, NMBA = NEURO MUSCULAR BLOCAKDE, SOFA = SEQUENTIAL ORGAN FAILURE ASSESSEMENT, PS = PRESSURE SUPPORT, PC = PRESSURE CONTROL, PEEP = POSITIVE END EXPIRATORY PRESSURE, FIO2 = FRACTION OF INSPIRED OXYGEN, TV = TIDAL VOLUME, CRP = C REACTIVE PROTEIN, WBC = WHITE BLOOD CELL COUNT

Table 2. Lung ultrasound findings in critically ill patients with SARS CoV-2 pneumonia per view

VARIABLE	OVERALL	MISSING	SYMPTOMS ≤ 14	SYMPTOMS >14	DIFFERENCE [95%CI]	P-VALUE	MISSING
LUNGSLIDING	303	1	127	152		.609	25
PRESENT	64% (195)		66% (84)	61% (92)	5 [-6 to 18]		
PRESENT BUT SUBTLE	35% (105)		33% (42)	39% (59)	-6 [-17 to 6]		
ABSENT	1% (3)		1% (1)	1% (1)	n.a.		
PLEURA	303	1	127	152		.024	25
NORMAL	36% (110)		44% (56)	32% (49)	12 [0 to 24]		
THICKENED	42% (129)		43% (54)	42% (64)	1 [-12 to 12]		
IRREGULAR	5% (16)		5% (6)	5% (7)	0 [-5 to 5]		
THICKENED AND IRREGULAR	16% (48)		9% (11)	21% (32)	-12 [-21 to 4]		
LUNG	303	1	127	152		.004	25
NORMAL	46% (139)		56% (71)	39% (59)	17 [5 to 29]		
≥ 3 B-LINES	38% (117)		35% (45)	41% (62)	-6 [-17 to 7]		
CONSOLIDATION	15% (47)		9% (11)	20% (31)	-11 [-21 to 3]		
B-LINE APPEARANCE (IN AVAILABLE VIEWS)	117	0	46	62		.449	9
≥ 3 AND SEPARATED	68% (79)		72% (33)	63% (39)	9 [-11 to 28]		
≥ 3 AND CONFLUENT	32% (38)		18% (13)	37% (23)	-19 [-28 to 11]		

C-PROFILE SIZE (IN AVAILABLE VIEWS)	48	0	11	22		1.0	15
SMALL	92% (44)		91% (10)	95% (21)	-4 [-28 to 19]		
LARGE	8% (4)		9% (1)	5% (1)	n.a.		
PLAPS TYPE	139	13	56	73		.051	23
NO PATHOLOGY	39% (54)		45% (25)	32% (23)	7 [5 to 50]		
PLEURAL EFFUSION	12% (17)		5% (3)	19% (14)	-14 [-23 to 20]		
CONSOLIDATION	46% (64)		45% (25)	48% (35)	-3 [-22 to 16]		
PLEURAL EFFUSION AND CONSOLIDATION	3% (4)		5% (3)	1% (1)	n.a.		

NUMBERS ARE GIVEN AS PERCENTAGE OF AVAILABLE IMAGES AND AS ABSOLUTE NUMBER (). NUMBERS IN THE ROW WITH TEXT IN BOLD INDICATE THE TOTAL NUMBER OF IMAGES AS ABSOLUTE NUMBER
PLAPS: POSTERO LATERAL AND/OR ALVEOLAR SYNDROME

Table 3. Lung ultrasound findings in critically ill patients with SARS CoV-2 pneumonia per patient*

VARIABLE	OVERALL	MISSING	SYMPTOMS ≤ 14	SYMPTOMS >14	DIFFERENCE [95%CI]	P-VALUE	MISSING
BLUE PER CASE	76	0	32	38		.055	6
A	26% (20)		41% (13)	13% (5)	28 [4 to 51]		
A/B	21% (16)		22% (7)	24% (9)	- 2 [-23 to 20]		
B	15% (11)		13% (4)	16% (6)	-3 [-22 to 16]		
C	38% (29)		25% (8)	47% (18)	-12 [-48 to 2]		
NUMBER OF B-LINES	51	25	21	24		.89	31
TOTAL	7 (±5)		7 (±5)	7 (±4)			
PLAPS	68	8	27	37		.661	12
PRESENT	74% (50)		70% (19)	78% (29)	-8 [-33 to 17]		
ABSENT	26% (18)		30% (8)	22% (8)	8 [-17 to 33]		
LUNG SCORES CALCULATED	24	52	10	14		.244	52
LUS	19 (±1)		18 (±3)	20 (±6)			

NUMBERS ARE GIVEN AS PERCENTAGE OF AVAILABLE IMAGES AND AS ABSOLUTE NUMBER (). NUMBERS IN THE ROW WITH TEXT IN BOLD INDICATE THE TOTAL NUMBER OF IMAGES AS ABSOLUTE NUMBER, PLAPS: POSTERO LATERAL AND/OR ALVEOLAR SYNDROME, LUS: LUNG ULTRASOUND SCORE
***DATA ARE PRESENTED AS 76 EXAMINATIONS IN 61 PATIENTS**

Figure 1. Flowchart of patient inclusion
See supplementary image PDF

Figure 2. Lung ultrasound findings in patients with SARS CoV-2 pneumonia
See supplementary image PDF

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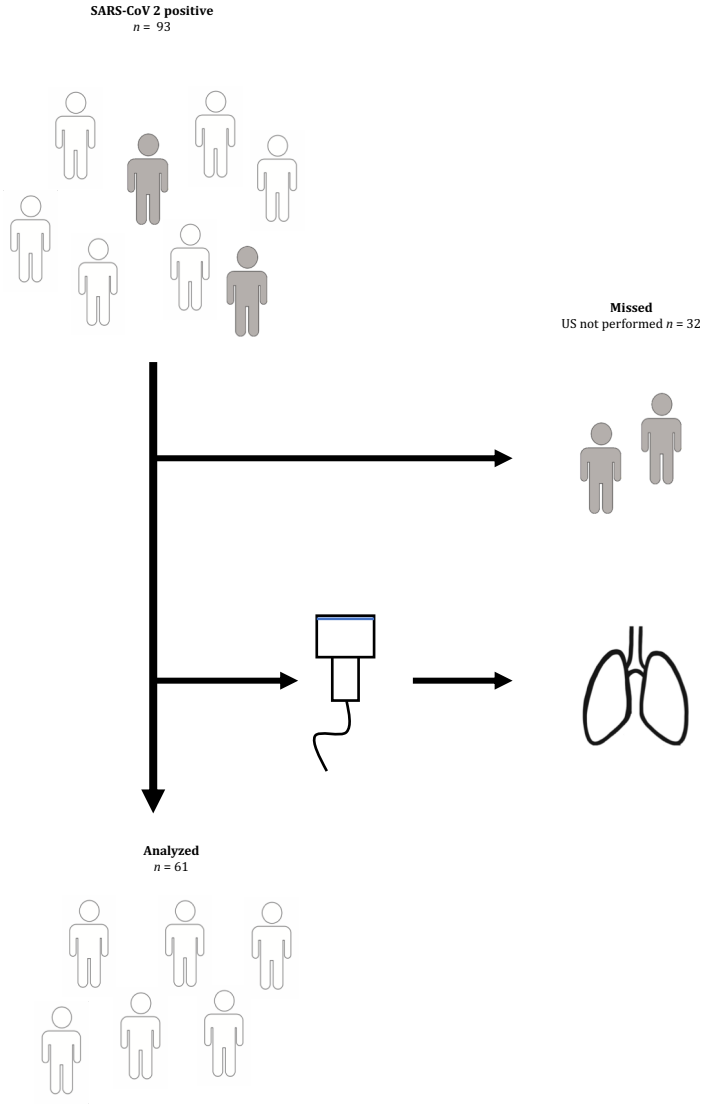
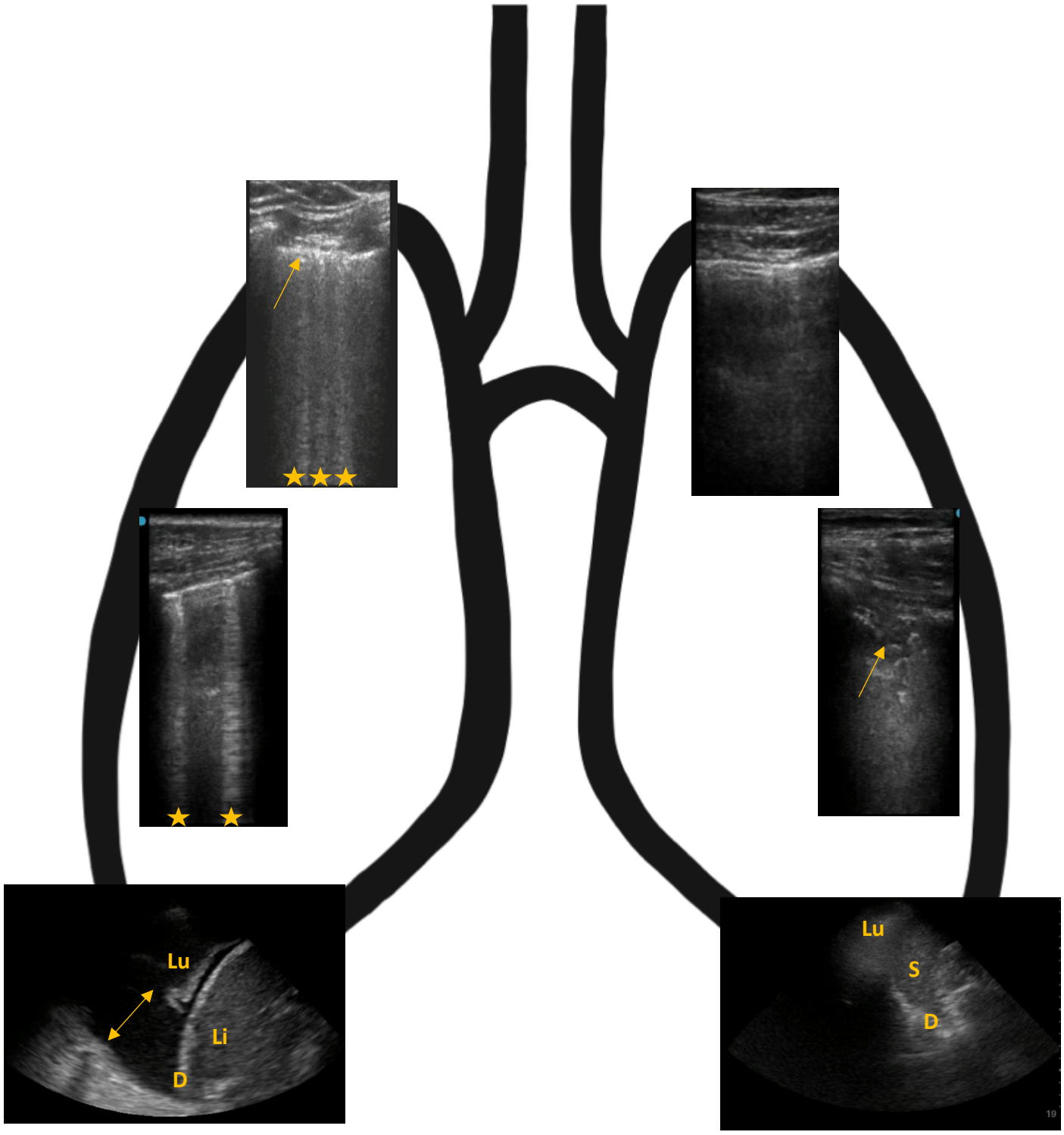

SARS-CoV 2 positive
n = 93
Missed
US not performed n = 32
Analyzed
n = 61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