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Dysphagia incidence in intensive care unit patients with coronavirus disease 2019: retrospective analysis following systematic dysphagia screening

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Main Article

Dr P Zuercher takes responsibility for the integrity of the content of the paper

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Abstract

Objective. Post-extubation dysphagia in critically ill patients is known to affect about 18 per cent of mixed medical-surgical intensive care unit patients. This study investigated the incidence of post-extubation dysphagia in adult intensive care unit patients with coronavirus disease 2019.

Method. This study was a retrospective analysis of consecutive intensive care unit patients prospectively screened for dysphagia. Systematic screening of all extubated intensive care unit patients at our tertiary centre was performed using the Bernese intensive care unit dysphagia algorithm. The primary outcome measure was the incidence of post-extubation dysphagia.

Results. A total of 231 critically ill adult coronavirus disease 2019 positive patients were included, and 81 patients remained in the final analysis after exclusion criteria were applied (e.g. patients transferred). Dysphagia screening positivity was 25 of 81 (30.9 per cent), with 28.2 per cent (22 of 78) having confirmed dysphagia by specialist examination within 24 hours ($n = 3$ lost to follow up).

Conclusion. In this observational study, it was observed that the incidence of dysphagia in adult critically ill coronavirus disease 2019 patients was about 31 per cent (i.e. increased when compared with a historical pre-pandemic non-coronavirus disease 2019 intensive care unit cohort).

Introduction

The severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) pandemic has caused a large number of confirmed cases of coronavirus disease 2019 (Covid-19) including 4 498 451 deaths worldwide.[1] Severe Covid-19 may lead to Covid-19 induced acute respiratory distress syndrome.[2] It was previously suggested[3] that SARS-CoV-2 may enter the nervous system and that this may impact the complex swallowing network[4] on multiple levels, either peripherally or centrally, leading to or augmenting (subsequent) dysphagia.[5] The Dysphagia in Mechanically Ventilated Intensive Care Unit Patients study, a large prospective observational study on dysphagia in the intensive care unit (performed in the pre-Covid-19 era) with systematic dysphagia screening, showed that about 18 per cent of intensive care unit patients admitted for emergency reasons were affected by post-extubation dysphagia.[6]

Furthermore, dysphagia post-extubation was identified as an independent risk factor for mortality, with roughly an additional 9 per cent increase in all-cause 90-day mortality.[6] Recently, several key risk factors could be identified after adjustment for confounders with baseline neurological disease, emergency admission and days on mechanical ventilation as the most prominent factors that remained independent risk factors for dysphagia post-extubation.[7] Given the fact that dysphagia is commonly observed in the intensive care unit and increasingly recognised regarding its relevance in the intensive care environment[8–10] and follow up, we embarked on a study to assess the incidence of dysphagia in critically ill adult patients with Covid-19.

Materials and methods

The present retrospective single-centre analysis was performed in a tertiary care academic centre with a mixed medical-surgical intensive care unit. This centre is the sole provider for the care of critically ill adults in our institution.

Study patients

All consecutive adult intensive care unit patients (aged 18 years or older) admitted to our intensive care unit between 1 February 2020 and 31 January 2021 who tested positive for SARS-CoV-2 (polymerase chain reaction, nasopharyngeal swab) and did not withdraw

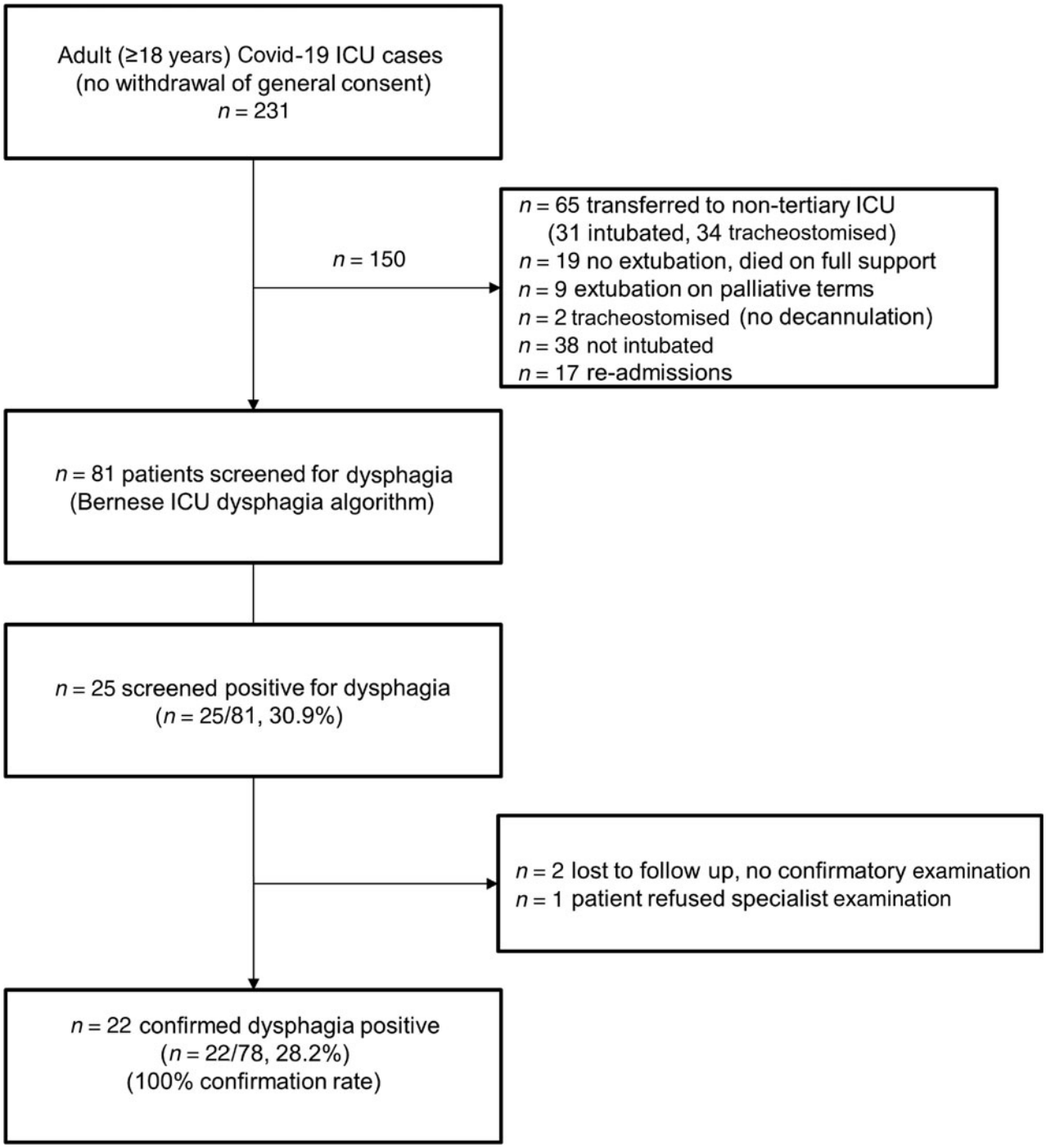

Fig. 1. Strengthening the Reporting of Observational Studies in Epidemiology study flow chart. Covid-19 = coronavirus disease 2019; ICU = intensive care unit.

from our institutional general consent were initially included. Of this group, patients who were not mechanically ventilated, not extubated on our intensive care unit (e.g. dying on full support, transferred to another institution), extubated on palliative terms or re-admissions were excluded (Figure 1).

The primary outcome measure was the incidence of (screening) positivity for dysphagia following mechanical ventilation. This was assessed according to our institutional systematic screening protocol (Bernese intensive care unit dysphagia algorithm), published elsewhere,[11] with an initial bedside screening performed within three hours of extubation by a trained intensive care unit nurse using a water swallow test unless any exclusion criteria were met such as: (1) patients dying or on comfort therapy or (2) patients with recent oesophageal injury or surgery. If necessary, a reassessment was performed after another three hours. If the patient failed in two screenings, a subsequent specialist examination complemented this pragmatic diagnostic approach.

Secondary outcome parameters included: the incidence of confirmed dysphagia (clinical dysphagia specialist examination performed in the consecutive 24 hours following positive screening), adherence to our institutional screening algorithm, all-cause mortality at intensive care unit discharge, at 28 days, 90 days, 180 days and 365 days, dysphagia incidence per Acute Physiology and Chronic Health Evaluation admission diagnostic group (Acute Physiology and Chronic Health Evaluation-IV admission category), risk profiles possibly influencing dysphagia development such as body mass index (BMI), gender, age, disease severity scores (Acute Physiology and Chronic Health Evaluation-II admission diagnostic group and Simplified

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Table 1. Baseline demographic data of extubated Covid-19 intensive care unit patients

Variable	All patients*	Dysphagia screening negative†	Dysphagia screening positive‡	*P*-value
Age (median (IQR); years)	69.00 (55.00, 76.00)	68.00 (54.75, 74.25)	71.00 (62.00, 80.00)	0.2
Body mass index (median (IQR); kg/m^2)	28.30 (25.95, 31.48)	29.38 (25.95, 31.74)	26.73 (25.25, 28.95)	0.044**
Height (median (IQR); cm)	172.00 (165.00, 178.00)	172.00 (165.00, 178.00)	170.00 (165.00, 180.00)	0.8
Weight (median (IQR); kg)	85.00 (75.00, 97.00)	86.50 (77.25, 97.50)	77.00 (70.00, 90.00)	0.060
Gender, male (*n* (%))	59 (73)	41 (73)	18 (72)	>0.9
APACHE-II (median (IQR); score)	28.00 (23.00, 33.00)	27.00 (20.75, 31.25)	30.00 (26.00, 35.00)	0.049**
SAPS-II (median (IQR); score)	68.00 (55.00, 75.00)	64.50 (49.00, 71.25)	69.00 (64.00, 81.00)	0.019**
APACHE-IV admission diagnostic group (*n* (%))				
– Miscellaneous	1 (1.2)	1 (1.8)	0 (0)	1
– Trauma	1 (1.2)	1 (1.8)	0 (0)	1
– Respiratory	60 (74)	44 (79)	16 (64)	0.181
– Cardiovascular	10 (12)	7 (12)	3 (12)	1
– Neurological	8 (9.9)	3 (5.4)	5 (20)	0.093
– Urological	0 (0)	0 (0)	0 (0)	–
– Metabolic	0 (0)	0 (0)	0 (0)	–
– Gastrointestinal	1 (1.2)	0 (0)	1 (4.0)	0.309
Post-operative patients (*n* (%))	6 (7.4)	5 (8.9)	1 (4.0)	0.7
Admission status (emergency) (*n* (%))	74 (91)	50 (89)	24 (96)	0.4

*$n = 81$; †$n = 56$; ‡$n = 25$; **Statistically significant value. Covid-19 = coronavirus disease 2019; IQR = interquartile range; APACHE = Acute Physiology and Chronic Health Evaluation; SAPS = Simplified Acute Physiology Score

Acute Physiology Score-II), intensive care unit resource use assessed by the Therapeutic Intervention Scoring System-28, need for enteral feeding using a nasogastric tube, length of mechanical ventilation, need for renal replacement therapy (including continuous veno-venous haemodiafiltration or intermittent haemodialysis).

Whenever resources were available, an additional endoscopic swallowing examination was performed (i.e. flexible endoscopic evaluation of swallowing) to complement the confirmatory specialist examination. Given this is an aerosol generating procedure, flexible endoscopic evaluation of swallowing implementation followed current guidelines.[12]

Data of Covid-19 positive intensive care unit patients were compared with non-Covid-19 critically ill patients assessed between April 2015 and October 2015.[6] The study was performed in adherence with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines and the Declaration of Helsinki and approved by the local ethics committee on human research (Kantonale Ethikkommission, Bern, Switzerland; number 2021-00426).

Data assessment

Database enquiry, extraction and delivery was performed in an automated fashion by data scientists from the hospital data laboratory (Insel data coordination laboratory) according to the approved study protocol.

Statistical analysis

Statistical analyses were performed using R programming language (version 4.1.2). Data are given as median and 25–75th interquartile ranges or mean ± standard deviation (SD) as indicated. For categorical data, Fisher's exact test was used. For between-group comparisons, the Mann–Whitney U rank sum test was used. Univariate logistic regressions were used to assess performance in this patient cohort of previously identified predisposing risk factors leading to dysphagia.[7] For mortality prediction, Cox proportional hazard regression models were calculated with patient censoring for time of loss to follow up or at days 28, 90, 180 or 365. Survival estimates and hazard ratios are provided. Significance was assigned when the *p*-value was less than 0.05.

Results

A total of 231 adult intensive care unit admissions with Covid-19 were recorded during the observational interval. A total of 81 patients remained in the final analysis set after removing re-admissions ($n = 17$), non-survivors ($n = 19$), patients transferred while being mechanically ventilated (i.e. before extubation or decannulation; $n = 67$), those who underwent terminal extubation on palliative terms ($n = 9$) or those who were not invasively mechanically ventilated ($n = 38$) (Figure 1).

All of the critically ill 81 Covid-19 patients were extubated on our intensive care unit and systematically screened for dysphagia using the Bernese intensive care unit dysphagia algorithm including a water swallow test within three hours post-extubation (details are given in the study by Zuercher *et al.*[11]).

Patient demographic data

Patient demographic data indicated a predominantly male, overweight and older aged patient cohort (Table 1). Significantly higher disease severity scores were noted in dysphagia screening positive patients (Acute Physiology and

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Table 2. Resource use and clinical outcomes of dysphagia screening positive versus negative Covid-19 intensive care unit patients

Variable	All patients*	Dysphagia screening negative†	Dysphagia screening positive‡	*P*-value
Invasive mechanical ventilation (median (IQR); days)	3.9 (0.9, 7.8)	2.4 (0.6, 7.1)	5.7 (4.2, 9.8)	0.002**
Days on feeding tube (median (IQR); days)	4.4 (1.6, 9.2)	3.2 (0.6, 8.7)	7.7 (4.3, 10.3)	<0.001**
Patients on renal replacement therapy (*n* (%))	17 (21)	8 (14)	9 (36)	0.027**
Days on renal replacement therapy (median (IQR); days)	9 (6, 16)	11 (6, 16)	9 (6, 16)	>0.9
Days on intensive care unit (median (IQR); days)	7 (4, 13)	5 (2, 10)	11 (7, 16)	<0.001**
All-cause intensive care unit mortality (*n* (%))	5 (6.2)	3 (5.4)	2 (8.0)	0.6
All-cause 28-day mortality (*n* (%))	16 (20)	11 (20)	5 (20)	>0.9
All-cause 90-day mortality (*n* (%))	20 (25)	13 (23)	7 (28)	0.6
All-cause 180-day mortality (*n* (%))	20 (25)	13 (23)	7 (28)	0.6
All-cause 365-day mortality (*n* (%))	21 (26)	13 (23)	8 (32)	0.4

*$n = 81$; †$n = 56$; ‡$n = 25$; **Statistically significant value. Covid-19 = coronavirus disease 2019; IQR = interquartile range

Chronic Health Evaluation-II score, 30 (26–35) *vs* 27 (20.75–31.25, $p = 0.049$; Simplified Acute Physiology Score-II, 69 (64–81) *vs* 64.5 (49–71.25), $p = 0.019$)). The vast majority of cases (91 per cent) were emergency admissions, most often because of an acute respiratory (74 per cent) or neurological (9.9 per cent) problem without significantly different distribution between patients who screened positive or negative (respiratory, 64 per cent positive *vs* 79 per cent negative, $p = 0.181$; neurological, 20 per cent positive *vs* 5.4 per cent negative, $p = 0.093$).

Primary outcome data

Dysphagia screening returned positive in 25 of 81 Covid-19 patients post-mechanical ventilation (dysphagia screening incidence 30.9 per cent). In the subgroup of patients with emergency admission, screening positivity increased to 32.4 per cent (24 of 74; Table 1).

Secondary outcome data

Following the Bernese intensive care unit dysphagia algorithm, the incidence of confirmed dysphagia (by clinical specialist examination) was 28.2 per cent ($n = 22$ of 78) with a 100 per cent confirmation rate in these clinical dysphagia specialist examinations ($n = 22$ of 22, missing data, $n = 3$: 2 patients were lost to follow up and 1 refused the specialist examination). Complementary flexible endoscopic evaluation of swallowing was only used in addition whenever the indication for an endoscopic examination was considered to be strong by the multidisciplinary dysphagia management team (e.g. in case of a high suspicion of silent aspiration; 10 per cent, 3 of 30).

Dysphagia screening positive Covid-19 intensive care unit patients were significantly less obese (BMI, 26.73 *vs* 29.38 kg/m^2; $p = 0.044$) with higher disease severity scores (Acute Physiology and Chronic Health Evaluation-II, 30 *vs* 27, $p = 0.049$; Simplified Acute Physiology Score-II, 69.0 *vs* 64.5, $p = 0.019$; Table 1), spent longer on mechanical ventilation in comparison with patients who screened negative (5.7 *vs* 2.4 days; $p = 0.002$), spent longer on a feeding tube regime (7.7 *vs* 3.2 days; $p < 0.001$), needed more frequent renal replacement therapy (36 *vs* 14 per cent; $p = 0.027$) and were hospitalised for significantly longer in our intensive care unit (11 *vs* 5 days; $p < 0.001$). However, regarding all-cause mortality, no significant differences could be observed for intensive care unit, 28-day, 90-day, 180-day or 365-day all-cause mortality (Table 2).

An inverse association between BMI and mortality was noted (i.e. for each 1-step increase (i.e. class) in BMI, 28-day or 365-day mortality is reduced by 18 per cent (odds ratio, 0.82 (95 per cent confidence interval (CI) = 0.70–0.94); $p = 0.011$) and 13 per cent (odds ratio, 0.87 (95 per cent CI = 0.76–0.98); $p = 0.027$), respectively (Table 3).

When comparing data with the pre-pandemic historical dataset,[6] the entire patient cohort in the Dysphagia in Mechanically Ventilated Intensive Care Unit Patients study was less severely ill (Acute Physiology and Chronic Health Evaluation-II score, 21 *vs* 17, $p < 0.001$; Simplified Acute Physiology Score-II, 42.5 *vs* 35, $p < 0.001$). The patient cohort of the present study in its entirety spent longer on mechanical ventilation (3.9 *vs* 0.7 days), longer on a feeding tube (4.4 *vs* 0.6 days), was more often on renal replacement therapy (21 *vs* 5 per cent) with an overall longer intensive care unit length of stay (7 *vs* 1 days) and an increased all-cause intensive care unit mortality (6.2 *vs* 0.9 per cent), 28-day mortality (20 *vs* 3.8 per cent) and 90-day mortality (25 *vs* 4.8 per cent).

Discussion

Our data showed that about 30.9 per cent of critically ill adult Covid-19 intensive care unit patients screened positive for dysphagia (32.4 per cent in emergency admissions). The incidence was confirmed within 24 hours (100 per cent of cases) by dysphagia specialist examinations (performed using the Bernese intensive care unit dysphagia algorithm), resulting in a total confirmed dysphagia incidence of 28.2 per cent.

The present study observed that dysphagia incidence in critically ill Covid-19 intensive care unit patients is considerably higher when compared with pre-pandemic (historical) data from the same institution using the same systematic screening protocol.[6] Other findings (e.g. disease severity scores) were similar. In the historical cohort, a dysphagia screening positivity of 12.4 per cent (18.3 per cent of emergency admissions) was observed. Although the reasons for this increased incidence rate cannot be elucidated in this observational study, it appears tempting to speculate that

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Table 3. Univariate logistic regression for 28- and 365-day all-cause mortality for patients with and without post-extubation dysphagia

	28-day all-cause mortality following intensive care unit admission			365-day all-cause mortality following intensive care unit admission		
Variable	Patients (*n*)	Odds ratio (95% CI)	*P*-value	Patients (*n*)	Odds ratio (95% CI)	*P*-value
Dysphagia screening positive: yes	81	1.02 (0.29, 3.22)	>0.9	81	1.56 (0.53, 4.40)	0.4
Age (per 1 year increase)	81	1.10 (1.04, 1.19)	0.003	81	1.15 (1.08, 1.26)	<0.001
Gender, male	81	1.15 (0.35, 4.53)	0.8	81	1.27 (0.42, 4.35)	0.7
Weight (per 1 kg increase)	81	0.95 (0.90, 0.99)	0.013	81	0.96 (0.93, 0.99)	0.030
BMI (per 1 step increase in class)	81	0.82 (0.70, 0.94)	0.011	81	0.87 (0.76, 0.98)	0.027
APACHE-II (per 1 increase in score)	81	1.07 (1.00, 1.16)	0.066	81	1.08 (1.01, 1.17)	0.025
SAPS-II (per 1 increase in score)	81	1.03 (1.00, 1.07)	0.11	81	1.04 (1.01, 1.09)	0.024
Admission status (emergency)	81	1.53 (0.24, 30.0)	0.7	81	0.86 (0.17, 6.38)	0.9
Days on invasive mechanical ventilation (per 1 day increase)	81	0.97 (0.85, 1.09)	0.6	81	1.05 (0.95, 1.16)	0.4
Need for renal replacement therapy	81	2.01 (0.55, 6.71)	0.3	81	2.50 (0.78, 7.78)	0.11
Days on renal replacement therapy (per 1 day increase)	17	0.88 (0.69, 1.04)	0.2	17	0.93 (0.78, 1.08)	0.4
Days on feeding tube (per 1 day increase)	78	0.96 (0.85, 1.07)	0.5	78	1.04 (0.94, 1.14)	0.4

CI = confidence interval; BMI = body mass index; APACHE = Acute Physiology and Chronic Health Evaluation; SAPS = Simplified Acute Physiology Score

SARS-CoV-2 affects the incidence of dysphagia, potentially via central or peripheral involvement in the complex swallowing network. In summary, we did observe an increased dysphagia incidence in adult Covid-19 intensive care unit patients, but we cannot deduce that any further. SARS-CoV-2 inevitably leads to an accumulation of reported key risk factors for dysphagia via Covid-19 induced acute respiratory distress syndrome[7] (e.g. to an increased duration of mechanical ventilation).

Another interesting, somewhat counterintuitive, association was noted between lower BMI and higher dysphagia incidence. Comparison with the pre-pandemic dataset[6] did not show a similar association, although the post-hoc risk factor analysis[7] identified BMI as a potential risk factor for dysphagia in the final multiple regression model (odds ratio, 0.94 (0.9–0.99), $p = 0.01$, Wald test, 6.6). After exclusion of probable collider stratification,[13,14] this might seem to be an obesity paradox. However, this is speculative and should be investigated in future studies.

- Post-extubation dysphagia in critically ill patients is common
- In a mixed medical-surgical intensive care unit setting, more than 18 per cent of all emergency admissions are dysphagia positive
- Post-extubation dysphagia persists at intensive care unit and hospital discharge with more than 60 per cent still affected
- Post-extubation dysphagia is an independent mortality risk factor with an excess all-cause 90-day mortality of about 9 per cent
- Dysphagia incidence in coronavirus disease 2019 intensive care unit patients is higher (about 32 per cent in emergency admissions)
- The pragmatic Bernese intensive care unit dysphagia algorithm seemed feasible and safe to perform in the severe acute respiratory syndrome coronavirus-2 pandemic

A number of strengths of our analysis apply. First, all consecutive patients were systematically screened for dysphagia using the same standards and protocols (Bernese intensive care unit dysphagia algorithm), and this was possible despite the ongoing pandemic. Second, data derived from the same institution and setting including a large-scale pre-pandemic dataset. Third, a high adherence to the dysphagia algorithm was noted with particularly high adherence to specialist examination (100 per cent assessed, missing data in $n = 3$, 11 per cent). Fourth, it appears that the incidence is likely underestimated because some intensive care unit patients were transferred to other hospitals with tracheostomy (no decannulation or extubation).

Several limitations deserve discussion. First, the present study is a single-centre and retrospective design, limiting external validity. Nevertheless, as mentioned, the same systematic screening procedures and the same dysphagia assessments were applied as before the pandemic. Second, dysphagia screening is ideally complemented by a flexible endoscopic evaluation of swallowing examination (as supported by current guidelines),[12] which was only occasionally used. Third, as stated,[6] we cannot identify the number of patients who would be false negative because only patients who screened positive received further testing and follow up. Fourth, some intensive care unit patients were lost to follow up because of transfer to a non-tertiary intensive care unit with no systematic dysphagia screening. This may underline that the exact incidence is likely to be higher (e.g. in tracheostomised patients). Fifth, because of the observational design of the study, we present associations rather than causal relationships here. Sixth, regarding the comparison of the study groups, selection bias (driven by the study design) may theoretically apply to the Covid-19 intensive care unit patients.

Conclusion

In this observational study, we observed that the incidence of dysphagia in adult critically ill Covid-19 patients was about 31 per cent. When compared with the historical group of non-Covid-19 adult intensive care unit patients, the incidence of dysphagia was increased by about 13 per cent. Our data further indicate that systematic screening for dysphagia can feasibly be performed in the SARS-CoV-2 pandemic, and this may be of particular interest in Covid-19 positive critically ill adult patients.

Competing interests. The Department of Intensive Care Medicine has received research and development or consulting contracts with: Orion Corporation, Abbott Nutrition International, B. Braun Medical, CSEM, Edwards Lifesciences Services, Kenta Biotech, Maquet Critical Care, Omnicare Clinical Research, Nestlé, Cytel and Phagenesis. No personal financial gain resulted from respective development or consulting contracts or grants.

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