Swallow patterns associated with aspiration in COPD: a prospective analysis

To the Editor:

Aspiration during swallow may have devastating consequences in COPD. It is known that COPD can impair swallow efficiency and safety [1–3] and a better understanding of how patients with COPD swallow is essential to inform preventative strategies. To date, no studies have examined swallow of large liquid volumes representative of everyday fast-paced drinking in an ample number of patients with COPD. In this letter we detail swallow patterns evaluated by videofluoroscopy in patients with COPD, with and without evidence of aspiration.

Normal sequential swallow involves the hypopharynx [4] and evidence indicates that breathing during sequential liquid cup swallows can increase the risk of aspiration [5]. Shorter breaths with active cessation of respiration may be one important airway protection feature during swallow that is compromised in COPD when patients may be unable to breath-hold for long. Conversely, shorter swallow duration during drinking of larger volumes of liquid may interfere with bolus movement through the oesophagus and contribute to increased risk of retrograde flow and post-swallow aspiration. In that context our previous studies in COPD suggested that patients may use adaptive airway protective strategies to prevent aspiration [6].

Detecting aspiration in COPD is best achieved using videofluoroscopy [3]. Swallow testing using ∼100 mL water is common practice in clinical settings, but sequential drinking has not been considered standard practice in videofluoroscopic examinations. However, recent studies have indicated that poorer swallow performance during 100 mL water testing could indicate potential swallowing difficulty [7] and revealed that sequential thin liquid drinking has the highest probability to detect impaired airway protection [8]. We used this improved methodology in recent studies [6].

Our observational study of swallow in COPD [6] provided data to evaluate swallow patterns linked to aspiration in COPD. The study protocol was approved by the Human Research Ethics Committee of Monash Health, Melbourne, Australia. Patient characteristics and methods were as published [6]. Briefly, patients swallowed 100 mL of ultra-thin liquid barium solution during videofluoroscopy using two methods (self-paced cup-drinking allowing single discrete swallows and fast-paced cup-drinking with sequential swallows). Penetration–aspiration scale (PAS) [9] and pharyngo-oesophageal measurements were made by two speech pathologists and a radiologist. Number of swallows was the number of total liquid swallows used to consume 100 mL volume. Total swallow duration was time from swallow onset until the last liquid contrast passed through the upper oesophageal sphincter (adapted from [7]) using media player frame-by-frame analysis. Swallow speed (mL·s^{-1}) was calculated as volume (100 mL) divided by total swallow duration and was evaluated for fast-paced drinking. Swallow frequency was calculated as number of swallows divided by total swallowing duration. Swallow patterns were defined as sequential (closure of laryngeal vestibule for duration of swallows), discrete (laryngeal vestibule opened in between swallows) or mixed [5]. Pharyngeal retention was defined as presence of residual liquid volume greater than coating of contrast material within the pharynx and oesophageal retention was defined as inefficiency in bolus flow through the oesophagus [10]. Statistical analysis was undertaken using IBM SPSS Statistics software version 24+ (IBM Corp., Armonk, NY, USA). Appropriate univariate and multivariate regression analyses were conducted to identify variables that may confound associations between swallow patterns and aspiration. Factors evaluated were age, sex, body mass index, forced expiratory volume in 1 s (FEV$_1$), FEV$_1$/forced vital capacity ratio, previous exacerbation history,

Shareable abstract (@ERSpublications)
Few studies have examined swallow of large liquid volumes representative of everyday drinking in COPD. Swallow by cup-drinking was evaluated in COPD using videofluoroscopy. Slower swallow was linked to aspiration indicating altered swallow habits in COPD. https://bit.ly/3wpdnO3
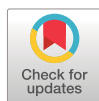
comorbidities and medications. Number of patients with sequential, mixed and discrete swallow were evaluated using Chi-squared and Fisher's exact test analyses. Significance was set at p⩽0.05.

Overall, 151 patients (mean±SD age 70.6±5.0 years) with verified and stable COPD across all severities underwent videofluoroscopy. Patients had no history of neurological or neuromuscular disorder, head and neck surgery or cancer impacting swallow. Other patient demographic data have been reported [6]. Patients with aspiration were marginally older compared with patients without aspiration (72.4±4.3 versus 70.2±5.1, p=0.02) [6], but no other significant differences were noted between the groups.

All patients were able to consume the 100 mL volume using the two methods of drinking with aspiration (PAS scores 6–8) identified in 30 out of 151 patients (19.9%). Patients with aspiration took longer to swallow compared with patients without aspiration (self-paced drinking: time per swallow 2.92±1.68 s for aspiration versus 2.17±0.99 s without aspiration; p=0.002 and fast-paced drinking: 1.90±0.73 s for aspiration versus 1.51±0.41 s without aspiration; p<0.001; table 1). Total swallow duration was also longer for both swallow methods with self-paced drinking: 19.80±10.97 s versus 15.97±9.11 s (p=0.050) and fast-paced drinking: 11.07±7.81 versus 8.83±4.17 (p=0.033; table 1). Finally, patients with aspiration had a lower swallow frequency for both self-paced drinking (0.44±0.19 versus 0.53±0.17; p=0.011) and fast-paced drinking (0.59±0.18 versus 0.70±0.16; p=0.001; table 1).

Swallow speed $<10 \text{ mL} \cdot \text{s}^{-1}$ has been proposed as a marker for reduced swallow capacity for 100 mL volumes using fast-paced drinking [7], but was not predictive of aspiration ($<10 \text{ mL} \cdot \text{s}^{-1}$ in 11 out of 30 patients with aspiration compared to 26 out of 121 patients without aspiration; OR 2.12 (95% CI 0.9–5); p=0.09). Pattern of swallow (sequential or discrete) was different between self-paced and fast-paced drinking; however, there was no association with aspiration. For example, as expected single discrete swallows occurred less often during fast-paced drinking (15 out of 151 patients, 9.9%) compared to self-paced drinking (47 out of 151 patients, 31.1%; p<0.001), but there was no difference in other swallow metrics (not shown).

Rates of pharyngeal retention (13.2%), oesophageal retention (20.5%), and more frequent thoracic location observed in up to half of patients were similar to findings in studies of asymptomatic older adults [11]. Oesophageal clearance was not linked to the mode of drinking (p=0.79), there was no significant obstruction that impacted bolus flow and cricopharyngeal indentation was not associated with aspiration (p=0.078). Our findings are consistent with previous comparable studies in healthy older individuals [12].

Surprisingly, our findings indicate that aspiration is not linked to fast-paced swallowing suggesting that patients may have the ability to respond to aspiration by amending individual swallow modes. One key adaptation may be a slower swallow time, but disappointingly this factor alone cannot be used to identify individuals who aspirate. In a clinical context videofluoroscopy, with both self-paced and fast-paced swallow, is likely to provide the most sensitive detection of aspiration in COPD.

The current study has some caveats. The sample size is relatively small, which may cause bias in results and conclusions. We did not have an aged-matched healthy control group due to restrictions on radiation

TABLE 1 Swallow characteristics for fast-paced drinking in 151 patients with COPD based on presence/absence of aspiration			
	Aspiration not detected	Aspiration[#] detected	Mean difference (95% CI)
Subjects n	121	30	
Timed swallow metrics			
Total swallow duration (s)	8.83±4.17	11.07±7.81*	2.24 (0.19–4.29)
Number of swallows to complete task	5.92±2.28	5.60±2.06	0.32 (-0.58–1.22)
Time per swallow (s per swallow)	1.51±0.41	1.90±0.73***	0.39 (0.19–0.59)
Swallow frequency (swallows per s)	0.70±0.16	0.59±0.18***	0.11 (0.04–0.18)
Swallow pattern			
Sequential	74 (61)	16 (53)	
Mixed	36 (30)	10 (33)	
Discrete	11 (9)	4 (13)	

Data are presented as mean±SD or n (%), unless otherwise stated. [#]: aspiration score of 6–8 on the penetration–aspiration scale [9]. *: p⩽0.05; ***: p⩽0.001.

exposure and swallow of solids was not examined. Other measurements such as high-resolution manometry with impedance may have provided detailed information on oesophageal function.

In summary, swallow patterns are altered in patients with COPD who aspirate. Individual swallows take longer in patients who aspirate, both with self-paced and fast-paced drinking. Whether this pattern is the cause or result of aspiration is unclear, but it is feasible that it is a reflex physiological response to preceding aspiration and that respiratory–swallow-modulated task adaptation is used in an attempt to prevent aspiration. Current treatment practices that aim to prevent aspiration emphasise a similar strategy [3] and our findings provide support for strategies to prevent aspiration such as swallow at a slower pace and pauses between swallows to optimise respiratory–swallow coordination. This approach may also permit patients to use clearing swallows. Given the potentially calamitous impacts of aspiration, prospective studies are needed to examine how this occurs and to ascertain whether altering swallow patterns through retraining can prevent aspiration in COPD.

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