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Original Article

Diagnostic accuracy and distress associated with oropharyngeal suction in cystic fibrosis☆

Michael Doumit [a,b,*], Yvonne Belessis [a,b], Sacha Stelzer-Braid [b,c], Kylie-Ann Mallitt [b], William Rawlinson [b,c], Adam Jaffe [a,b]

[a] Sydney Children's Hospital, High St, Randwick, NSW2031, Australia
[b] University of NSW, High St, Randwick, NSW2031, Australia
[c] Virology Division, Prince of Wales Hospital, Barker St, Randwick, NSW2031, Australia

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Abstract

Background: Early detection of bacterial pathogens in the lower airway is an important part of managing CF. This study aimed to assess the diagnostic accuracy of oropharyngeal suction (OPS) samples in obtaining airway bacterial cultures in young children with cystic fibrosis (CF), and the level of child distress caused by obtaining OPS samples.
Methods: Young children with CF undergoing broncho-alveolar lavage (BAL) as part of concurrent research or routine annual surveillance were studied. OPS was performed by stimulating a cough and suctioning the back of the oropharynx in the awake child to replicate clinical practice. BAL of the right upper, middle and lingula lobes was then performed. Samples were sent for standard bacterial culture. The child's distress during OPS was rated using the Groningen Distress Scale (1 = calm, 2 = timid/nervous, 3 = serious distress but still under control, 4 = serious distress with loss of control, 5 = panic).
Results: There were 65 paired samples obtained from 39 children (21 boys, mean age on day of first sampling was 34.1 months, SD 19.1 months). For *Pseudomonas aeruginosa*, specificity, sensitivity, NPV and PPV with 95% CI were 98% (87–99), 75% (20–96), 98% (91–98) and 60% (15–93%) respectively. In all age groups combined, median level of distress was 3 (IQR 2–4), with distress highest in 2 and 3 year olds, with a median of 4 (IQR 3–4).
Conclusion: OPS has diagnostic utility in determining the absence of organisms in the lower airway, with specificity for *P.aeruginosa* detection of 98%. However, a positive OPS result is not necessarily a good indicator of lower airway infection. Distress levels were high during OPS, mostly in 2 and 3 year olds.

Keywords: Diagnostic accuracy; Sputum; Bacteria; Suction; Bronchoalveolar lavage; Cystic fibrosis

1. Introduction

Recurrent bacterial lower respiratory tract infections are the leading cause of morbidity and mortality in cystic fibrosis (CF), being responsible for at least 80% of deaths [1]. Therefore, early and accurate detection of bacterial pathogens from the lower airway is an important part of management. International guidelines recommend that airway samples be obtained at each visit to a CF clinic [2]. In children who are able to expectorate, sputum samples accurately reflect lower airway organisms[3,4]. However, obtaining lower airway samples in children who are too young to expectorate is particularly difficult. The gold standard

Abbreviations: BAL, broncho-alveolar lavage; BALF, broncho-alveolar lavage fluid; CF, cystic fibrosis; GA, general anaesthesia; NPV, negative predictive value; OPS, oropharyngeal suction; PPV, positive predictive value.

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* Corresponding author at: Physiotherapy Department, Sydney Children's Hospital, High St, Randwick, NSW, Australia, 2031. Tel.: +61 2 9382 1050.
E-mail address: Michael.Doumit@sesiahs.health.nsw.gov.au (M. Doumit).

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method for identification of lower airway organisms is bronchoalveolar lavage (BAL). However, this method is not commonly performed for a number of reasons including: potential risk of adverse events of general anaesthesia (GA); limited evidence that regular BAL improves clinical management [5]; and limited availability of operating theatre space and cost.

Upper airway samples such as oropharyngeal swabs, cough swabs and cough plates are often obtained as practical and easily repeatable alternatives to BAL. However, these methods have been shown to have variable diagnostic accuracy when compared to BAL [6–8] or expectorated sputum [9–11]. Furthermore, common CF pathogens are present in the upper airways of healthy children [12,13], further complicating meaningful interpretations of positive upper airway bacterial cultures. Therefore, there is a need for a method as an alternative to BAL that accurately reflects the presence of organisms in the lower airway. One method of obtaining airway samples is oropharyngeal suction (OPS), which involves obtaining a suction sample from the posterior pharynx. Although previous investigators have examined the utility of OPS [14,15], these studies have only compared BAL to OPS in samples 10 children or less with CF, and diagnostic accuracy results for OPS in these studies were not thoroughly reported. Therefore, a definitive study into the diagnostic accuracy of OPS is warranted.

While it is generally acknowledged that airway sampling in young children with CF is distressing [14] and this distress has been the target of behavioural therapy [16], the level of distress experienced by young children with cystic fibrosis during airway sampling has not previously been measured. The current study aimed to determine the diagnostic accuracy of OPS and assess the distress experienced during collection of oropharyngeal suction samples in children with cystic fibrosis.

2. Patients and methods

All young children with CF who underwent BAL either as part of another study [17] or as part of an annual surveillance programme at Sydney Children's Hospital, Randwick, Australia, between February 2011 and March 2013 were invited to participate in the study. Children were diagnosed through newborn screening and CF was confirmed by sweat test and/or genetic mutation analysis. Parental report of whether or not the child had a current cough and the duration of that cough were recorded prior to the procedures. Children were excluded if they had an acute respiratory illness within three weeks of the investigation. As BAL is performed at Sydney Children's Hospital on an annual basis and the study recruitment period was greater than one year, some children were invited to participate on more than one occasion. The project received ethical approval from the South Eastern Sydney and Illawarra Area Health Service—Northern Hospital Network Human Research Ethics Committee (Approval No. 10/183) and written, informed consent was obtained for all participants.

2.1. Sample collection

2.1.1. OPS

OPS was performed a maximum of two hours prior to general anaesthetic for BAL. The procedure was performed with the child awake in order to replicate clinical practice. In children who were old enough to cough effectively on command, but unable to expectorate before they swallowed any secretions, the child was asked to cough strongly and a size 10 suction catheter was advanced to the back of the oropharynx and suction was applied at negative 100–150 mm Hg to obtain a sample. In children who could not cough effectively on command, the suction catheter was advanced to the back of the oropharynx and contact was made with the posterior oropharyngeal wall to stimulate a cough. After a cough was stimulated, suction was then applied at negative 100–150 mm Hg to collect a sample. The length of catheter insertion was pre-measured as the distance between the child's nose and ear. The child's parent was asked to assist by holding the child if necessary. All samples were collected by a single, experienced physiotherapist.

2.1.2. BAL

Flexible bronchoscopy and BAL were performed under GA using Olympus models BF-3C40, BF-3C160, and BF-XP16F; Olympus Medical Systems Corporation, Tokyo, Japan. Suctioning of airway secretions through the bronchoscope was avoided until the tip had passed beyond the carina to avoid possible contamination by upper airway flora. The bronchoscope was sequentially wedged into the right upper lobe, right middle lobe, and lingula to maximise microbiological yield and a single aliquot (1 ml/kg; minimum,10 ml; maximum, 20 ml) of warmed non-bacteriostatic, sterile saline was instilled into each lobe. Bronchoalveolar lavage fluid (BALF) was gently but immediately aspirated avoiding airway collapse and maximising return volumes. Retrieved BALF was pooled into a single sterile container. Topical anaesthesia (1% lignocaine), if required, was applied only after all 3 BAL samples had been collected to avoid inhibition of bacterial growth.

2.2. Microbiology

OPS samples were cultured according to standard microbiological techniques. Briefly, a cotton swab was used to extract purulent material from the sample and the inoculum was spread out onto selective and non-selective media. All plates were incubated for 48 h with the exception of *Pseudomonas cepacia* medium, which was maintained for 7 days and sealed with Parafilm to prevent dehydration. All plates were examined for growth every morning until the incubation time had expired. BAL samples were processed as previously described [17]. BAL samples were processed using quantitative methods and OPS samples were processed using semi-quantitative culture methods. Positive cultures were identified as organism growth at any density as well as growth $>10^3$ cfu/ml to enable comparison of diagnostic accuracy at different detection levels.

2.3. Measurement of distress

Distress level was measured using the Groningen Distress scale, a scale shown to be valid and reliable in the measurement of distress in young children undergoing medical procedures [18,19]. The Groningen Distress Scale is a five point observational scale where 1 = calm, 2 = timid/nervous, 3 = serious distress, but still