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Early View

Review

Personalising airway clearance in chronic suppurative lung diseases: a scoping review

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Personalising airway clearance in chronic suppurative lung diseases: a scoping review.

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Summary

Personalising airway clearance in chronic suppurative lung diseases is complex. This review identifies a range of factors that should be considered by physiotherapists, presenting them as an evidence-guided airway clearance personalisation model.

Keywords

Airway clearance, personalisation, chronic suppurative lung disease,

Abstract

Background

Personalised airway clearance techniques are commonly recommended to augment mucus clearance in chronic suppurative lung diseases. It is unclear what current literature tells us about how airway clearance regimens should be personalised. This scoping review explores current research on airway clearance technique in chronic suppurative lung diseases, to establish the extent and type of guidance in this area, identify knowledge gaps and determine the factors which physiotherapists should consider when personalising airway clearance regimens.

Methods

Systematic searching of online databases (MEDLINE, EMBASE, CINAHL, PEDro, Cochrane, Web of Science) was used to identify full-text publications in the last 25 years that described methods of personalising airway clearance techniques in chronic suppurative lung diseases. Items from the TIDieR framework provided *a priori* categories which were modified based on the initial data to develop a “Best-fit” framework for data charting. The findings were subsequently transformed into a personalisation model.

Results

A broad range of publications were identified, most commonly general review papers (44%). The items identified were grouped into seven personalisation factors: physical, psychosocial, ACT type, procedures, dosage, response, and provider. As only two divergent models of airway clearance technique personalisation were found, the personalisation factors identified were then used to develop a model for physiotherapists.

Conclusions

The personalisation of airway clearance regimens is widely discussed amongst current literature which provides a range of factors that should be considered. This review summarises the current literature, organising findings into a proposed airway clearance personalisation model, to provide clarity in this field.

Introduction

Rationale

Chronic suppurative lung disease (CSLD) is a clinical syndrome, with respiratory signs or symptoms of a persistent productive cough, dyspnoea, airway reactivity and recurrent chest infections (1). The reported incidence of CSLD in the UK varies between 2/100,0000 in children and 352/100,0000 in adult females (2, 3). CSLD is a heterogenous condition with a wide a range of causes including Primary Ciliary Dyskinesia (PCD), Cystic Fibrosis (CF) and can also be of unknown cause (4). This heterogenous group have a common feature; impaired mucociliary clearance fuelling a complex vortex of impaired mucociliary clearance, secretion retention, infection and inflammation (5). CSLD is burdensome for individuals and their families, with recurrent exacerbations, poor nutritional status, reduced quality of life (6, 7) and reduced life expectancy (8, 9).

Broadly, CSLD management endeavours to stabilise lung function, improve quality of life, manage symptoms and reduce exacerbations (1). A core component of CSLD management are airway clearance techniques (ACTs) (1, 10), a range of interventions which aim to facilitate secretion clearance. Whilst current guidance recommends individualised ACT regimens (10-13), with an array of interventions, methods of application and a heterogenous population, there is ambiguity about how regimens should be personalised.

As a complex and broad area in which a comprehensive review had not been previously undertaken, this inquiry lacked the clarity required for a systematic review and as such, a scoping review was undertaken (14). Scoping reviews aim to comprehensively capture the research in the field, (15) including all types of study design, with iterative and methodical

processes to analytically describe and interpret the literature without critically appraising the quality of the individual pieces found (15).

Objectives

This scoping review seeks to answer the question "*What information is currently available on the personalisation of ACT regimens in CSLDs?",* with two specific objectives:

I. To examine the extent and range of research on personalisation of ACT regimens in CSLDs

II. To summarise key findings of the literature and identify research gaps.

This review does not seek to appraise the quality of individual publications.

Methods

Protocol and registration

This scoping review is part of a larger body of work for which the protocol is published on Figshare (Study protocol: ASPECT- PCD).

Eligibility criteria

As a scoping review, publications were eligible for inclusion if published in the period 1996-July 2022, written in English with a full-text version available. They were required to pertain to the area of inquiry (15);

- Participants: CSLDs (CF, PCD, Bronchiectasis),
- Context: ACTs
- Concept: Personalisation/individualisation.

Publications were excluded if they involved animals, neonates, individuals with COPD, direct comparison of ACT modalities without any aspect of personalisation, exercise or physiotherapeutic interventions not aiming to facilitate lower airway clearance.

Information sources & Search

A highly relevant article (16) was used as the primary manuscript for a “pearl growing exercise” (17). Citation searching and reference list checking were used to identify further key articles of known interest. An extensive search strategy (see Appendix 1) based on key articles index terms was developed and run through relevant health databases (MEDLINE and Embase via Ovid, CINAHL via EBSCO, PEDro, Cochrane, Web of Science). Citations and hand searching of known highly relevant journals identified further items.

Selection of sources of evidence

Duplicates were removed using appropriate software (EndNote™20) and uploaded to Rayyan (http://rayyan.qcri.org)(18) for blind screening. Screening criteria were developed and refined by the lead reviewer and supervisory team. Screening was completed by two expert reviewers; a highly specialist clinician in the field (LMS) and, a patient and public involvement group member (ZY) who received bespoke training. Conflict of decisions was managed initially by discussion between the two reviewers with a final decision made by a third reviewer (SJS).

Data charting process and items

Two publications, the European “Blue booklet” (19) and the CF Trust standards of care (20) were large, highly relevant multi-section multi-author publications. As such, a one-to-many approach was used to unpack these publications into relevant sections included as individual items for data extraction. As such, the unit of analysis changes from “publications” to “documents” within the analysis.

The following items from the Template for Intervention Description and Replication (TIDieR) checklist (21) were used as *a priori* categories for initial data charting: “what (materials, procedures)?”, “when?” and “how much?”, “who?”, “tailoring”, “modification”, and, “how well?”. The rationale for personalising ACT regimens is embedded within the overarching fundamental principles of evidence-based medicine (22) and individualised health care (23); as such the “why?” field was not maintained.

As the object of the enquiry was the personalisation of interventions in clinical practice, TIDieR (21), as a checklist for reporting research interventions, was a close fit for initial charting, but had limited translation to the context of this complex enquiry. As such, following the initial data sweep, the data categories were modified using a “Best-fit” approach to ensure all relevant data was captured (24). As a dense volume of highly relevant data fell into the “Tailoring” category, sub-categories were introduced based on themes arising from initial interpretation of the literature and subsequent constant comparison (24). The new sub-categories permitted the fidelity component “how well” to be explored in the contexts of adherence and mid-ACT response, and “where” to be understood in the context of the provider and resources required. Multiple data extraction sweeps were completed to ensure that all items were extracted and charted appropriately.

Synthesis of results

The elements which should be considered by clinicians when personalising ACTs regimens that were identified within the data were grouped into personalisation factors (Table 3), based on contextual use within the literature and the authors, for example, Daniels[25] description of patient preference within ACT personalisation:

"Preference for specific techniques has been suggested in the literature; however individuals will respond differently to each technique. Preference may be associated with issues raised about matching technique to lifestyle but may also be about less identifiable issues, such as patient beliefs about the technique, other patients' experiences and appearance of the device" (25, p.207)

To assess face validity of the findings, the personalisation factors were reviewed at a virtual patient and public involvement (PPI) meeting and by physiotherapists. The UK based PPI group comprised of five young people with PCD aged 9 to 20 years, and four of their parents. As the PPI members identified an additional consideration for inclusion, "Time to follow up" a final sweep through the documents was undertaken to ensure data pertaining to this had not been overlooked.

Finally, following the PPI meeting, a diagrammatic representation or model was developed to provide insight into the findings (14), specifically, relationships between the categories of personalisation factors. Where necessary, we referred to the wider physiotherapy literature to support inferences in model making that were not directly supported by the CSLD literature. The model was reviewed by respiratory physiotherapists to assess face validity.

Results

Selection of sources of evidence

One thousand and eighty-five abstracts were identified, of which 823 were reviewed after the removal of duplicates. Seventy publications were reviewed in full, of which 62 met the inclusion criteria and were included in the analysis (see Figure 1 and table 1).

Figure 1: PRISMA flowchart with literature identification and screening details.

Table 1: Publication details

Author (year)	Location (first author)	Publication type	Population
ACPCF[20]	UK	Standards of care	CF, paediatric and adult
Acton and Stark[26]	USA	Review	CF
Bishop, Erskine[27]	Australia	RCT	CF, adults
Butler and Sutherland[28]	New Zealand	Review	CF
Button, Heine[29]	Australia	Cohort study	CF, paediatric
Button[30]	Australia	Guideline	CF, paediatric and adult
Chang, Fortescue[31]	Australia	Task Force Report	Bronchiectasis, paediatric and adult
Currie, Tai[32]	Australia	Survey	CF
Daniels[25]	UK	Review	CF, adults
Davidson[33]	USA	Review	CF, paediatrics
Dentice, Elkins[34]	Australia	RCT	CF, adults
Dentice and Elkins[35]	Australia	Cochrane review	CF, paediatric and adult
Dwyer, Robbins[36]	Australia	RCT	CF, adults
Egan, Clain[37]	USA	Review	Bronchiectasis

Author (year)	Location (first author)	Publication type	Population
Elkins and Dentice[38]	Australia	Cochrane review	CF, paediatric and adult
Fitzgerald, Hilton[39]	Australia	RCT	CF, paediatric
Flume, Robinson[12]	USA	Guideline	CF
Flume[40]	USA	Review	CF
Franks, Walsh[41]	Australia	Qualitative interviews	Bronchiectasis
Hill, Sullivan[10]	UK	Guideline	Bronchiectasis, adults
Hill, Barker[42]	UK	Expert panel	CF, Bronchiectasis, paediatric and adult
Hill, Prasad[43]	UK	Review	CF, paediatric
Homnick[44]	USA	Review	CF, paediatric
Hoo, Daniels[45]	UK	Survey	CF, paediatric and adult
Hristara-Papadopoulou, Tsanakas[46]	Greece	Review	Various
IPGCF[19]	Switzerland	Booklet	CF, paediatric and adult
Lannefors, Button[47]	Sweden	Review	CF, paediatric
Lee, Button[48]	Australia	Review	CSLD, Bronchiectasis, paediatric, adult
Lee, Baenziger[49]	Australia	Letter- audit	Bronchiectasis, adults
Lester and Flume[50]	USA	Review	CF
Main, Prasad[51]	UK	Cochrane review	CF, paediatric, adult
Main, Grillo[52]	UK	Review	CF, Bronchiectasis, paediatric, adult
Marks[53]	USA	Review	CF
McCool and Rosen[54]	USA	Guideline	Various
McIlwaine, Button[55]	Canada	Cochrane	CF, paediatric, adult
McIlwaine, Bradley[16]	Canada	Review	CLD, paediatric, adult

Author (year)	Location (first author)	Publication type	Population
McIlwaine, Lee Son[56]	Canada	Review	CF
Milla, Hansen[57]	USA	RCT	CF, paediatric, adult
Myers[58]	USA	Review	Various
Oberwaldner[59]	Austria	Review	Various, paediatric
Olsen, Lannefors[60]	Sweden	Review	unspecified
O'Neill, Bradley[61]	UK	Survey	Bronchiectasis
O'Neill, Moran[62]	UK	RCT	CF, adults
O'Neill, Bradley[63]	USA	Review	Bronchiectasis, paediatric, adult
Palma, Spadarella[64]	Italy	Case report	CF+SMA, paediatric
Pasteur, Bilton[13]	UK	Guideline	Bronchiectasis, paediatric, adult
Pembridge and Chalmers[65]	UK	Review	Bronchiectasis
Phillips, Lee[66]	Australia	Survey	Bronchiectasis, paediatric, adult
Prasad and Main[67]	UK	Review	CF, paediatric, adult
Rowbotham and Daniels[68]	UK	Review	CF
Schechter[69]	USA	Review	Various, paediatric
Schofield, Lloyd[70]	UK	Standards of care	PCD, paediatric
Southern, Clancy[71],	UK	Review	CF, paediatric, adult
Spinelli, Timpano[72]	Italy	Case Report	CF, paediatric
Spinou[73]	UK	Review	CF
Terlizzi, Masi[74]	Italy	Review	CF
Treacy[75]	UK	Case Report	CF, adult
van der Giessen[76]	Netherlands	RCT	CF, paediatric
Van Der Schans[77]	Netherlands	Review	Various
Volsko[78]	USA	Review	Various, paediatric, adult

Author (year)	Location (first author)	Publication type	Population
Walicka-Serzysko, Orlik[79]	Poland	Consensus	CF
Wilson, Robbins[80]	Australia	RCT	CF, paediatric, adult

Characteristics of sources of evidence

The publications included; general reviews (n=29), randomised controlled trials (RCTs) (n=8), guidelines (n=5), Cochrane reviews (discussion and author conclusion sections) (n=4), case reports (n=3), surveys (n=4), expert panel or consensus reports (n=3), standards of care (n=2), qualitative interview (n=1), audit (n=1), a self-classified “booklet” (n=1) and a cohort study (n=1). Articles related specifically to CF (n=38), Bronchiectasis (n=10), PCD (n=1), or more than one condition (n=7). In terms of age, the publications pertained to both paediatrics and adults (n=14), paediatrics (n=14), adults (n=8), or did not specify this (n=15).

Results of individual sources of evidence

From this point onwards, the 62 publications will be represented as 94 documents. Details of the ACTs featuring in each paper are provided in Table 2 for context, and the factors identified in each of the individual documents can be found in Table 3.

Table 2: ACT modalities discussed

Author **(and subchapter no. when applicable)**		FET	Directed cough	ACBT	AD	PEP	OPEP	Percussions/ Vibrations	Postural drainage	Positioning	HFCWO	Physical activity	NIV	IPPB	MIE	IPV	Simeox	Inhaled medication
ACPCF[20]	5.1	-		✓		-	-	-	-	-	-	-	-	-	-	-	-	-
	5.2	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
	5.3	-	-	-	-	✓		-	-	✓		-	-	-	-	-	-	-
	5.4	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
	5.5	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
	5.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-
	5.7	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-
	5.8	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
	9.1	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	
	11.2	-	-	-	-	-	-	-	-	✓		-	-	-	-	-	-	✓
	11.3	-	-	-	-	✓		-	-	✓		-	-	-	-	-	-	
	11.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ap1	-	-	-	✓	✓	✓	✓	✓	-	-	✓	-	-	-	-	-	-
Acton and Stark[26]		-	-	✓	✓	✓	✓	✓	✓	-	-	✓	-	-	-	✓	-	✓
Bishop, Erskine[27]		-	-	✓	-	✓	-	✓	-	-	-	-	-	-	-	-	-	✓
Butler and Sutherland[28]		-	-	✓	-	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-
Button, Heine[29]		-	-	✓	-	-	-	-	✓	-	-	✓	-	-	-	-	-	-
Button[30]		-	-	✓	✓	✓	✓	✓	✓	✓		✓	✓	-	-	-	-	✓

Author **(and subchapter no. when applicable)**	FET	Directed cough	ACBT	AD	PEP	OPEP	Percussions/ Vibrations	Postural drainage	Positioning	HFCWO	Physical activity	NIV	IPPB	MIE	IPV	Simeox	Inhaled medication
Chang, Fortescue[31]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
Currie, Tai[32]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
Daniels[25]	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-	-
Davidson[33]	✓	-	✓	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	-
Dentice, Elkins[34]	-	-	-	-	✓	-	✓	-	-	-	-	-	-	-	-	-	✓
Dentice and Elkins[35]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
Dwyer, Robbins[36]	-	-	-	✓	✓	✓	✓	-	-	-	-	✓	-	-	-	-	-
Egan, Clain[37]	-	-	✓	✓			✓	✓	-	✓	✓		-	-	-	-	✓
Elkins and Dentice[38]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
Fitzgerald, Hilton[39]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
Flume, Robinson[12]	-	-	✓	-	✓	✓	✓	✓	-	✓	✓	-	-	-	-	-	-
Flume[40]	-	-	-	✓	✓	-	✓	-	-	✓	-	-	-	-	✓	-	✓
Franks, Walsh[41]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hill, Sullivan[10]	-	-	✓	✓	✓	✓	✓	✓	-	✓	✓	-	✓	-	✓	-	✓
Hill, Barker[42]	✓	✓	✓		✓	✓		✓	-	✓	✓	-	-	✓	✓	-	-
Hill, Prasad[43]	✓	-	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	-	✓	-	✓
Homnick[44]	✓	-	✓	✓	✓	✓	✓	✓	-	✓	✓	-	-	-	✓	-	-
Hoo, Daniels[45]	✓	-	✓	✓	✓	✓	-	✓	-	✓	✓	-	-	-	-	-	✓
Hristara-Papadopoulou, Tsanakas[46]	-	-	-	-	✓	✓	-	-	-	✓	-	-	-	-	✓	-	-
IPGCF[19] 2.1	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Author **(and subchapter no. when applicable)**		FET	Directed cough	ACBT	AD	PEP	OPEP	Percussions/ Vibrations	Postural drainage	Positioning	HFCWO	Physical activity	NIV	IPPB	MIE	IPV	Simeox	Inhaled medication
	2.2	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
	2.3	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
	2.4	✓	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
	2.5	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
	2.6	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
	2.7	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
	2.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-
	2.9	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2.10	✓	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-
	2.11	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
	4	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-
	6	-	-	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
Lannefors, Button[47]		-	-	-	✓	✓	-	-	✓	-	-	✓	-	-	-	-	-	✓
Lee, Button[48]		-	-	✓	-	✓	✓	-	-	-	-	✓	-	-	-	-	-	✓
Lee, Baenziger[49]		-	-	✓	✓	✓	-	✓	✓	-	✓	✓	-	-	-	-	-	✓
Lester and Flume[50]		-	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-	-	-	✓	-	-
Main, Prasad[51]		✓	✓	✓	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	-
Main, Grillo[52]		-	-	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	-	✓	-	-	✓
Marks[53]		-	-	-	-	✓	✓	-	-	-	-	-	-	-	-	✓	-	-

Author **(and subchapter no. when applicable)**	FET	Directed cough	ACBT	AD	PEP	OPEP	Percussions/ Vibrations	Postural drainage	Positioning	HFCWO	Physical activity	NIV	IPPB	MIE	IPV	Simeox	Inhaled medication
McCool and Rosen[54]	✓	-	-	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-
McIlwaine, Button[55]	-	-	-	-	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	-
McIlwaine, Bradley[16]	-	-	-	-	✓	✓	✓	✓	-	✓	✓	-	-	-	-	-	-
McIlwaine, Lee Son[56]	✓	✓	✓	✓	✓	✓	✓		-	✓	✓	-	-	-	-	-	-
Milla, Hansen[57]	-	-	-	-	-	-	-	-	-	✓		-	-	-	-	-	-
Myers[58]	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-	-	-
Oberwaldner[59]	-	-	-	-	✓	-	✓	✓	-	-	-	-	-	-	-	-	-
Olsen, Lannefors[60]	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
O'Neill, Bradley[61]	-	-	✓	✓	✓	✓	-	✓	-	-	✓	-	✓	-	-	-	✓
O'Neill, Moran[62]	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	✓
O'Neill, Bradley[63]	-	-	✓	✓	✓	✓	-	-	-	✓	-	-	-	-	-	-	✓
Palma, Spadarella[64]	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	✓	-	--
Pasteur, Bilton[13]	-	-	✓	✓	✓	✓	✓	✓	-	✓		✓	✓	-	-	-	✓
Pembridge and Chalmers[65]	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	✓
Phillips, Lee[66]	✓	-	✓	-	-	✓	-	-	✓	-	✓	-	-	-	-	-	-
Prasad and Main[67]	-	-	-	✓	✓	✓	✓	✓	-	✓	✓	-	-	-	✓	-	-
Rowbotham and Daniels[68]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Schechter[69]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Author **(and subchapter no. when applicable)**	FET	Directed cough	ACBT	AD	PEP	OPEP	Percussions/ Vibrations	Postural drainage	Positioning	HFCWO	Physical activity	NIV	IPPB	MIE	IPV	Simeox	Inhaled medication
Schofield, Lloyd[70]	✓	-	✓	✓	✓	✓	✓	-	-	✓	✓	-	-	-	-	-	-
Southern, Clancy[71],	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
Spinelli, Timpano[72]	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
Spinou[73]	-	-	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	-	-	-	-
Terlizzi, Masi[74]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
Treacy[75]	-	-	-	-	-	-	✓	✓	-	✓	-	✓	-	-	-	-	-
van der Giessen[76]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
Van Der Schans[77]	✓	-	-	✓	✓	-	✓	✓	-	✓	✓	-	-		-	-	-
Volsko[78]	-	-	✓	✓	✓	✓	✓	✓	-	✓	✓	-	-	✓	✓	-	-
Walicka-Serzysko, Orlik[79]	-	-	-	-	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓
Wilson, Robbins[80]	-	-	✓	✓	✓	✓	✓	-	✓	-	✓	-	-	-	-	-	✓

Table 3:Personalisation aspects identified

Author (and subchapter no. when applicable)		Patient factors		Intervention factors			Response	Provider
		Physical	**Psychosocial**	**ACT type**	**Procedure**	**Dosage**		
ACPCF[20]	5.1	Age Disease severity Resp. signs	Preference Engagement Lifestyle Burden	Difficulty Contraindication/ precaution	Unit repetition Technique Multi-intervention	Duration	-	-
	5.2	Age Resp. signs	Engagement Burden	Physiology Device features	Unit repetition Technique Sequencing Settings Multi-intervention	Duration	Mid-ACT session Adverse effects	-
	5.3	Age Resp. signs	Preference	Physiology Device features	Technique Settings Multi-intervention	Duration	Mid-ACT session	-
	5.4	Age Resp. signs	Preference Adherence	Physiology Device features	-	-	-	-
	5.5	Disease severity	Preference Adherence Engagement	Resources	Multi-intervention	-	Adverse effects	-
	5.6	Disease severity Resp. signs	-	Resources Device features	Settings Multi-intervention	-	Mid-ACT session	-
	5.7	Age Disease severity Resp. signs Non-resp. signs	Engagement Burden	Contraindication/ precaution	Multi-intervention	-	Mid-ACT session	-

Author (and subchapter no. when applicable)		Patient factors		Intervention factors			Response	Provider
		Physical	**Psychosocial**	**ACT type**	**Procedure**	**Dosage**		
	5.8	Disease severity Resp. signs	-	Resources	Multi-intervention	-	-	-
	7	Age Disease severity Resp. signs	Preference Engagement Burden	Resources Environment Device features	Sequencing Multi-intervention	-	Mid-ACT session Post-ACT session(s) Adverse effects	Individual clinician Institution
	9.1	Disease severity Resp. signs	Preference	Device features	-	-	Post-ACT session(s)	-
	11.2	Disease severity Resp. signs Non-resp. signs	Burden Lifestyle	Physiology	Multi-intervention	-	-	-
	11.3	Resp. signs Non-resp. signs	-	Contraindication/ precaution	Technique	-	Adverse effects	-
	11.4	Resp. signs	-	Contraindication/ precaution	-	-	Post-ACT session(s)	-
	11.5	Resp. signs	-	Physiology Contraindication/ precaution	-	-	-	Institution
	11.9	Disease severity Resp. signs	Burden	-	-	Duration Frequency	-	-
	Ap1	Age	Preference Adherence	-	-	Duration Frequency	-	Individual clinician

Author (and subchapter no. when applicable)	Patient factors		Intervention factors			Response	Provider
	Physical	**Psychosocial**	**ACT type**	**Procedure**	**Dosage**		
	Disease severity Resp. signs Non-resp. signs	Lifestyle					Institution
Acton and Stark[26]	Age Disease severity Resp. signs	Adherence Engagement Burden	Resources Difficulty Device feature Environment	Unit repetition Multi-intervention	Duration Frequency	Mid-ACT session Post-ACT session(s)	-
Bishop, Erskine[27]	Medication	Preference Burden	-	Sequencing	-	Post-ACT session(s)	-
Butler and Sutherland[28]	Age Resp. signs. Non-resp. signs	Preference Adherence Engagement Burden	Resources Difficulty Physiology	Technique	Duration Frequency	Mid-ACT session Post-ACT session(s) Adverse events	Individual clinician Institution
Button, Heine[29]	Disease severity Resp. signs Non-resp. signs	-	Contraindication/ precaution	Unit repetition Settings	Duration Frequency	Mid-ACT session	-
Button[30]	Age Disease severity Resp. signs Non-resp. signs	Preference Engagement Burden	Resources Device features	Sequencing	Frequency	-	-
Chang, Fortescue[31]	Age	-	Resources	-	Frequency	Adverse effects	-

Author (and subchapter no. when applicable)	Patient factors		Intervention factors			Response	Provider
	Physical	Psychosocial	ACT type	Procedure	Dosage		
	Disease severity Resp. signs						
Currie, Tai[32]	Resp. signs	-	-	-	Frequency	-	Individual clinician
Daniels[25]	Disease severity	Preference Adherence Lifestyle Burden	Resources Environment Contraindication/ precaution Device features	Settings Unit repetition Sequencing Multi-intervention	-	Mid-ACT session Post-ACT session(s)	-
Davidson[33]	Age Disease severity Non-resp. signs	Preference Adherence Engagement Lifestyle Burden	Resources Difficulty Environment Device features	Multi-intervention	-	Mid-ACT session Post-ACT session(s) Adverse events	Institution
Dentice, Elkins[34]	-	Preference Burden	Device features	Sequencing	-	Mid-ACT session	-
Dentice and Elkins[35]	-	Preference	-	Sequencing Multi-intervention	-	-	-
Dwyer, Robbins[36]	Disease severity Resp. signs	Burden	-	Settings	Duration Frequency	Mid-ACT session Post-ACT session(s)	-
Egan, Clain[37]	Age Disease severity Resp. signs	Adherence Engagement Burden	Resources	-	Frequency	-	-

Author (and subchapter no. when applicable)	Patient factors		Intervention factors			Response	Provider
	Physical	Psychosocial	ACT type	Procedure	Dosage		
	Non-resp. signs Diagnosis						
Elkins and Dentice[38]	Resp. signs	Preference Adherence Burden	-	Sequencing	-	Mid-ACT session	-
Fitzgerald, Hilton[39]	Resp. signs	-	-	Sequencing	-	Post-ACT session(s) Adverse effects	-
Flume, Robinson[12]	Age Disease severity Resp. signs Non-resp. signs	Preference Engagement Burden	Resources Environment Contraindication/ precaution Device features	Settings Multi-intervention	Duration Frequency	Mid-ACT session Post-ACT session(s) Adverse effects	-
Flume[40]	Disease severity Resp. signs	Preference	Resources Contraindication/ precaution	-	-	-	-
Franks, Walsh[41]	Disease severity Resp. signs	Preference Adherence Engagement Lifestyle	Resources	Multi-intervention Sequencing	-	Post-ACT session(s)	Individual clinician Institution
Hill, Sullivan[10]	Disease severity Resp. signs Non-resp. signs	Preference Adherence Burden	-	Multi-intervention	Duration Frequency	Mid-ACT session	-
Hill, Barker[42]	Disease severity	-	Resources	-	Frequency	-	Institution

Author (and subchapter no. when applicable)		Patient factors		Intervention factors			Response	Provider
		Physical	**Psychosocial**	**ACT type**	**Procedure**	**Dosage**		
		Resp. signs						
Hill, Prasad[43]		Age Disease severity Resp. signs Non-resp. signs	Preference Adherence Engagement Lifestyle Burden	Resources Difficulty Environment Device features	Setting Multi-intervention Sequencing	-	Mid-ACT session	Institution
Homnick[44]		Age Disease severity Resp. signs Non-resp. signs	Preference Adherence Engagement Lifestyle Burden	Resources Environment	Multi-intervention	-	Post-ACT session(s)	Individual clinician
Hoo, Daniels[45]		Disease severity Non-resp. signs	Preference	Resources	-	-	-	Institution
Hristara-Papadopoulou, Tsanakas[46]		Age Disease severity	Adherence Burden	Resources Environment Device features	Setting	Duration Frequency	Mid-ACT session	-
IPGCF[19]	2.1	Age Resp. signs	Burden Preference	Resources Physiology	Unit repetition Technique Multi-intervention	Duration Frequency	Mid-ACT session	-
	2.2	-	Engagement	-	Technique	Duration	Mid-ACT session	-
	2.3	Age Resp. signs	Engagement	Physiology Contraindication/ precaution	Technique Multi-intervention	-	Mid-ACT session	-

Author (and subchapter no. when applicable)		Patient factors		Intervention factors			Response	Provider
		Physical	**Psychosocial**	**ACT type**	**Procedure**	**Dosage**		
	2.4	Age Resp. signs Non-resp. signs	Preference Engagement	Device features	Unit repetition Technique Setting Multi-intervention	Duration Frequency	Mid-ACT session	-
	2.5	Resp. signs	Preference Adherence Burden	Resources Difficulty Physiology	Setting Multi-intervention	Frequency Duration	Mid-ACT session	-
	2.6	Age Resp. signs Non-resp. signs Diagnosis	-	-	Unit repetition Technique Multi-intervention	-	-	-
	2.7	Age Resp. signs Disease severity Non-resp. signs	Engagement	Physiology	Setting Technique	Duration	Mid-ACT session	Individual clinician
	2.8	Resp. signs Non-resp. signs	-	Device features	Setting Physiology	-	-	-
	2.9	Age	-	-	Unit repetition Technique Multi-intervention Sequencing	Duration	Mid-ACT session	-
	2.10	Age Resp. signs	Adherence Burden	Resources Physiology Device features	Multi-intervention	Frequency	-	Institution

Author (and subchapter no. when applicable)		Patient factors		Intervention factors			Response	Provider
		Physical	Psychosocial	ACT type	Procedure	Dosage		
	2.11	Age Resp. signs	-	Physiology	Multi-intervention	-	-	-
	3	Age Disease severity Resp. signs	Adherence Engagement	Device features Combination	Technique Sequencing Multi-intervention	-	Mid-ACT session	-
	4	Age Resp. signs Non-resp. signs	Burden	Physiology	Multi-intervention	-	-	-
	6	Disease severity Resp. signs	Burden	Device features Physiology	Setting Multi-intervention	-	-	-
	9	Resp. signs	-	Contraindication/ precaution	-	Duration	-	-
	10	Disease severity Resp. signs	-	Contraindication/ precaution	Technique	-	-	-
	11	Non-resp. signs	-	Contraindication/ precaution	-	-	-	-
	13	Resp. signs Non-resp. signs	-	-	-	-	-	-
Lannefors, Button[47]		Age Disease severity Resp. signs Non-resp. signs Diagnosis	Preference Adherence Engagement Lifestyle Burden	Contraindication/ precaution Device features Physiology	Settings Multi-intervention Technique	Duration Frequency	Mid-ACT session Post-ACT sessions	Institution

Author (and subchapter no. when applicable)	Patient factors		Intervention factors			Response	Provider
	Physical	Psychosocial	ACT type	Procedure	Dosage		
Lee, Button[48]	Age Resp. signs Non-resp. signs	Preference Adherence Engagement Burden	Resources Difficulty Environment Contraindication/ precaution Device features Physiology	Settings Unit repetition Technique Multi-intervention	-	Mid-ACT session	-
Lee, Baenziger[49]	Resp. signs Non-resp. signs	Preference	-	Multi-intervention	-	-	-
Lester and Flume[50]	Age Disease severity Resp. signs Non-resp. signs	Preference Engagement Lifestyle Burden	Resources Difficulty Environment	Settings Unit repetition Technique Multi-intervention	Duration	Mid-ACT session	Individual clinician Institution
Main, Prasad[51]	Age	Preference Burden	Resources	-	-	Post-ACT session(s)	-
Main, Grillo[52]	Age Disease severity Resp. signs Non-resp. signs Diagnosis	Preference Engagement Adherence Lifestyle Burden	Resources Difficulty Environment Contraindication/ precaution Device features Physiology	Unit repetition Sequencing Multi-intervention	Duration Frequency	Mid-ACT session Post-ACT session(s) Adverse effects	Individual clinician Institution
Marks[53]	-	Preference Burden Lifestyle	Resources Device features Physiology	Setting Unit repetition Multi-intervention	Duration	Mid-ACT session	-

Author (and subchapter no. when applicable)	Patient factors		Intervention factors			Response	Provider
	Physical	Psychosocial	ACT type	Procedure	Dosage		
McCool and Rosen[54]	Diagnosis	Burden	Resources Difficulty	Multi-intervention	-	-	-
McIlwaine, Button[55]	Age Disease severity Resp. signs	Preference	-	-	-	-	-
McIlwaine, Bradley[16]	Age Disease severity Resp. signs Diagnosis	Preference Engagement Lifestyle	Resources Physiology Device features Difficulty Contraindication/ precaution	Technique Multi-intervention	-	-	-
McIlwaine, Lee Son[56]	-	Preference Burden	-	-	-	-	-
Milla, Hansen[57]	-	-	Device features	Setting	-	Mid-ACT session	-
Myers[58]	Resp. signs Diagnosis	Preference	Resources	Setting Technique Multi-intervention	Duration Frequency	Mid-ACT session Post-ACT session (s)	-
Oberwaldner[59]	Age Resp. signs Diagnosis	Engagement Adherence	Resources Contraindication/ precaution	Multi-intervention	-	-	-
Olsen, Lannefors[60]	Disease severity Resp. signs Diagnosis	Preference Adherence	Resources Contraindication/ precaution Physiology	Setting Unit repetition Technique Multi-intervention	Duration Frequency	Mid-ACT session	-
O'Neill, Bradley[61]	Resp. signs	-	-	-	-	-	Individual clinician

Author (and subchapter no. when applicable)	Patient factors		Intervention factors			Response	Provider
	Physical	Psychosocial	ACT type	Procedure	Dosage		
							Institution
O'Neill, Moran[62]	-	Burden	-	Sequencing	-	-	-
O'Neill, Bradley[63]	Age Disease severity Resp. signs	Preference Adherence Engagement Burden	Environment Physiology Device features	Multi-intervention	-	Post-ACT session(s)	-
Palma, Spadarella[64]	Non-resp. signs Diagnosis	-	-	Setting Multi-intervention	Duration Frequency	-	-
Pasteur, Bilton[13]	Resp. signs Diagnosis	Preference Adherence Lifestyle Burden	Resources Contraindication/ precaution	Sequencing Multi-intervention	Duration Frequency	Mid-ACT session Post-ACT session(s)	Individual clinician
Pembridge and Chalmers[65]	Diagnosis Resp. signs	-	-	-	-	-	-
Phillips, Lee[66]	Age Resp. signs Non-resp. signs	Preference Adherence Burden	Resources Contraindication/ precaution	-	Duration Frequency	-	Individual clinician Institution
Prasad and Main[67]	Age Disease severity Resp. signs Non-resp. signs	Adherence Lifestyle Burden	Resources Contraindication/ precaution Physiology	Setting Unit repetition Technique Multi-intervention	Duration Frequency	Mid-ACT session	Institution
Rowbotham and Daniels[68]	Age Resp. signs Non-resp. signs	Preference Adherence Engagement Burden	Resources	-	Duration Frequency	Post-ACT session(s)	Institution

Author (and subchapter no. when applicable)	Patient factors		Intervention factors			Response	Provider
	Physical	Psychosocial	ACT type	Procedure	Dosage		
	Diagnosis						
Schechter[69]	Age Resp. signs Non-resp. signs Diagnosis	Preference Adherence Engagement Lifestyle	Resources Contraindication/ precaution	-	-	-	-
Schofield, Lloyd[70]	Age Resp. signs Non-resp. signs Diagnosis	Preference Engagement Burden	Resources Contraindication/ precaution Device features	Sequencing	Frequency	Post-ACT session(s)	Institution
Southern, Clancy[71]	Age Disease severity	Preference Adherence Burden Lifestyle	-	-	Frequency	Mid-ACT session Post-ACT session(s)	-
Spinelli, Timpano[72]	Age Non-resp. signs Diagnosis	Engagement	-	-	-	Post-ACT session(s) Adverse events	-
Spinou[73]	Age Disease severity Resp. signs Non-resp. signs	Preference Adherence Engagement	Resources Contraindication/ precaution	Multi-intervention	Duration Frequency	Post-ACT session(s)	-
Terlizzi, Masi[74]	Age Resp. signs Medication	Preference Lifestyle Burden	Resources	Sequencing	Frequency	Post-ACT session(s)	-
Treacy[75]	Resp. signs	Preference Burden	Resources	Setting Sequencing	Duration Frequency	Mid-ACT session	-

Author (and subchapter no. when applicable)	Patient factors		Intervention factors			Response	Provider
	Physical	Psychosocial	ACT type	Procedure	Dosage		
						Post-ACT session(s) Adverse effects	
van der Giessen[76]	-	Preference Burden	-	Sequencing	-	-	-
Van Der Schans[77]	Resp. signs Non-resp. signs	Preference	Contraindication/ precaution Physiology	-	-	Post-ACT session(s)	-
Volsko[78]	Age Disease severity Resp. signs Non-resp. signs	Preference Adherence Engagement Burden	Difficulty Contraindication/ precaution	Setting Multi-intervention	-	Mid-ACT session Post-ACT session(s) Adverse effects	-
Walicka-Serzysko, Orlik[79]	Age Disease severity Resp. signs Medication	Preference Adherence Engagement Burden	Resources Device features Contraindication/ precaution Environment	Sequencing Multi-intervention Technique	Drug dosage	-	-
Wilson, Robbins[80]	-	Preference	-	Sequencing	-	-	-

Synthesis of results

Twenty-nine considerations for personalisation were grouped into seven broad categories: the patient's physical and psychosocial factors, the ACT type (Table 2), procedure and duration, the individual patient's response to the intervention, and the provider.

Patient factors

The consideration of patient's physical factors was discussed in a total of 87 documents: age (n=47), disease type (n=16), disease stage or severity (n=42), clinical respiratory signs, for example radiological appearances and lung function (n=72), clinical non-respiratory signs, for example gastroesophageal reflux (n=36), and other medications such as nebulised antibiotics (n=4).

Psychosocial factors were discussed in 72 documents; patient preference (n=52), treatment burden (n=47), the individual's ability to engage with treatments (n=33), adherence (n=32), lifestyle (n=18).

Intervention factors

Personalisation of aspects of the ACT regimen featured in all documents. Most commonly, consideration was given to the type of ACT intervention used (n=91). Factors that may influence the type of ACT intervention chosen featured in 70 documents; the physical resources required for the intervention such device cost (n=42), difficulty to perform (n=12), physiological properties of the intervention (n=24), specific device features for example the patient interface (n=28), environmental aspects relating to the appearance of the device such as the noise it

produces (n=13), recognised contraindications or precautions of certain interventions (n=28).

Adapting elements of the procedure, or how the patient performs the ACT was also commonly advised (n=69); combining multiple ACT interventions within the same session (n=49); sequencing or timing of interventions (n=22); device settings, such as the resistance (n=25), number of repetitions of regimen components (n=15), and “patient technique” (n=24).

Titrating the frequency or duration of ACT regimens each featured in 32 documents. With some overlap between these elements, this “dosage” component of personalisation was identified in a total 41 documents. Additionally, one paper reported varying the dose of ACT adjunctive inhaled medications.

Other

The use of individual response to personalise ACT regimens, featured in 53 documents; modifying the regimen during the initial set up or during a session (n=38), modification based on response after multiple treatment sessions (n=27), assessing for adverse effects (n=13).

The influence of the provider on the ACT regimen was discussed in 23 documents, either in terms of the experience of the individual clinician (n=12); or the characteristics of the institution (n=18).

The factors influencing clinician treatment choice were reported in 2 survey-based documents. Clinical decision processes to guide ACT personalisation featured in 2 documents, presented as algorithms.

Recommendations for future research specifically pertaining to personalisation of ACTs were expressed in 18 publications, as summarised in Table 4.

Table 4: Summary of recommendations for future research.(RCT= Randomised controlled trial)

Personalisation factor	Recommendation
Provider	Studies to understand international variation in the use of different ACTs (45).
Patient, Physical	RCT subgroup analysis and cross-sectional studies to identify physical factors or situations which may indicate efficacy of different ACT regimens (47, 51, 55, 67, 77). Studies with recruitment targeting people who the interventions are intended for (63). RCTs to evaluate the effects of ACTs during exacerbations (10). Trials to explore the efficacy of NIV as an ACT in people with CF with more severe disease or those who have recently been discharged from hospital (36). Studies to evaluate the safety and efficacy of ACTs in children and young people (47). Trials to identify biomarkers for subgroups of children with bronchiectasis who may benefit from mucoactives (31).
Patient, Psychosocial	RCT subgroup analysis and cross-sectional studies to identify psychosocial factors which may indicate efficacy of different ACT regimens (47). Trials to assess the variation in adherence to different ACTs (20). Studies should report validated measures of patient preference, cost-effectiveness and adverse reactions to assist consumer decision making (55).
Intervention	Multicentre studies to determine subgroup of children with bronchiectasis who may benefit from mucoactives (31). Trials to understand the impact of timing of DNase on adherence, clearance and lung function (34).

	Studies to ascertain the efficacy of combining nebulisers and ACT devices (38). Studies on of the effects of different ACTs on different aspects of the pathophysiology of CF (55). Studies exploring ACT personalisation (63). Trials should provide sufficient detail of ACTs undertaken (12, 60).
Response	RCTs using appropriate outcomes; QoL , exacerbations, symptoms, hospitalisations, days of school/work lost, lung function indices and adverse events (31). Studies with outcomes appropriate for the population (47). Development of outcomes which will be sensitive to differentiate the effects of different ACTs in children (51). RCTs to understand appropriate outcome measures for assessing the effects of ACTs in patients with more severe disease (10).
Time to follow up	Studies assessing the shorter-term effects of ACTs during exacerbations, or longer term effects in stable patients (55).

ACT personalisation model

The model developed from the findings is shown in Figure 2.

X . Ongoing clinical encounters

Everything in the rounded rectangle is a clinical encounter or a set of linked encounters concerning an individual patient. Klein's theory of naturalistic decision-making predicts that the expert perceives this as a *gestalt,* a complex whole which explores different types of relationships and interactions, using cues, actions, goals and expectancies as components of recognition (81).

Figure 2: ACT personalisation model

A. Evidence

Evidence based practice involves *"integrating individual clinical expertise with the best available external clinical evidence"* (22 p.71) (Relationship B>A). The clinician uses their expertise to assess the applicability of the evidence to the individual patient (22), linking evidence with known physiological properties of ACTs to meet individual patient needs (16) (Figure 2, Relationship A>B>X).

B. Provider

The provider encompasses the individual clinician working with the individual to devise a personalised ACT regimen, and the institution in which they are based (Table 3).

This category incorporates the previous experience of the individual clinician and the institution which can influence ACT recommendations (66, 67). A provider may learn experientially from healthcare encounters (Figure 2, X>B) and carry forward that knowledge, as well as knowledge based on published research and guidelines (A>B) into future healthcare encounters (B>X). Working by analogy with studies on physiotherapist reasoning from outside of CSLDs, we can posit that clinician experience may influence the cues they distinguish as relevant when assessing a patient (X>B), either during the initial assessment or when reviewing their treatment response (82). Clinician experience and their institution may also influence the choice and method of application of ACT intervention (45, 66).

C. Patient

Patient has two key areas: physical and psychosocial factors.

1. Physical factors are a range of physical attributes of the patient, including their age, diagnosis, disease severity or stage, signs, and symptoms from both the respiratory system and other key multi-systems and medications (Table 3).

Physical factors provide the overall warrant for ACTs (78), and for selection of the components of ACT regimens (Figure 2, C1>D1 and D2) (16). A patients age can be an indicator of their ability to engage with treatments (C1>D) (83) and the physiological development of their lungs ((16). Age along with comorbidities, such as pneumothorax or gastroesophageal reflux (GOR), may restrict the types of ACT interventions appropriate for use (C1>D1) (20), or the ways in which the interventions are completed (C1>D2), for example, the presence of GOR may affect the positions in which ACTs are completed (29). Physical factors may also moderate the frequency or duration of ACT required (C1>D3) (10) and ultimately, guide time to follow up (20). Medications which are not a component of the ACT regimen, for example as inhaled antibiotics, can influence the timing of the ACT regimen (27).

2. Psychosocial factors

Psychosocial factors are a broad range of non-physical factors specific to the individual; patient preference, adherence, engagement, lifestyle (home environment, support structure, daily routine) and treatment burden (Table 3).

These can prove to be facilitators or barriers to completion of ACTs, with patient preference and adherence being key components, potentially guiding ACT choice, procedures and timing (Figure 2, C2>D1 and D2), (25). An individual's ability to engage with treatment can also influence the ACT type, materials and procedures chosen (84) and the frequency or duration advised (20) (C2>D1 and D3).

Treatment burden, preference and adherence can all be impacted by components of the intervention (D>C2) such as the required duration (28) or the noise a device makes (25).

D. Intervention

Intervention has three key areas: ACT type, Procedure, Dosage.

1. ACT type

This encompasses the type of ACT intervention and any resources required to complete the regimen. It comprises the intervention's physiological properties, features, the resources it requires, difficulty to complete, how it affects the immediate environment, and potential contraindications/precautions (Table 3).

The ACT type may be selected for the underlying physiological properties it theorises to target, guided by physical factors (16) (Figure 2, C1>D1). Some ACT types can be more difficult to complete effectively and as such, elements of this may be influenced by cognitive or physical ability (20, 48) (C2>D1). Different ACT types have different equipment requirements, not limited to, cost, availability, cleaning and maintenance, electricity. ACTs may influence the environment around them as they may vary in size, appearance or make noise, this can affect patients preference and the choice of intervention may be influenced by how the ACT fits into a patient's lifestyle (25) (D1>C2). Physical factors may also flag a contraindication or precaution to a certain intervention (66) (C1>D1).

2. Procedures

Procedures are the way in which the intervention is completed.

Personalisation here can involve; number of repetitions of certain components, the technique used, device settings, combining multiple ACT types within one session and the sequence of interventions (Table 3).

The way in which a technique is employed can be varied; informed by physiological reasoning (60) (Figure 2, D1>D2), enabled by physical or cognitive ability (C>D2) and guided by response (85) (E>C >D2). Unit-repetition including number of breaths or FETs per cycle may be influenced by physical or psychosocial cues or response (19) (B/C>D2). Adjunct settings may be manipulated to target underlying physiological properties or a

desired response. Different ACT types may be combined with the aim of incorporating their physiological strengths and the sequencing of these interventions may be based on known properties of the interventions, response, or patient preference (16, 84).

3. Dosage

Dosage relates to the frequency and duration of ACT completion (Table 3). This may be influenced by physical or psychosocial factors/cues, such as disease severity (86) (Figure 2, C1>D3) or burden (20) (C2>D3), and could be modified based on treatment response (29) (E>C>D3). Different interventions may require different durations to achieve the goal of effective airway clearance which may affect patient preference and treatment burden (D3>C2). Prior knowledge of this may in turn influence ACT choice and procedures (48) (D3>D1/D2).

E. Response

Response is the outcome of trialling the intervention (Figure 2, D>E). This can be; immediate allowing for modifications to be made whilst the ACT session is in progress, at the end of a single intervention, or after the intervention has been completed numerous times (47) (Table 3). Response also includes assessing for adverse effects (86)

F. Time to follow up

The timing of the next review may be influenced by the context in which the review is taking place, for example, more frequent reviews usually occur during an inpatient admission compared to routine outpatient follow up. Knowledge of the time to the next review directly affects the time until the response is reassessed which in turn may influence the extent of changes made.

Discussion

This scoping review provides an overview of published approaches to personalisation of ACTs in CSLDs. Twenty-nine considerations for personalisation, grouped into seven broad areas, were extracted from 62 publications, mostly review papers, from 12 countries and presented in narrative, graphical and tabular form. These factors include: the individual's physical and psychosocial presentation; the intervention type, procedures completed with the intervention, frequency and duration of the intervention, the individuals' response, and the provider. The diversity of considerations involved in personalising ACT regimens illustrates the complexity of this field. As such, this review has provided an ACT personalisation model grounded in the published literature and feedback from people with CSLDs.

As a scoping review, formal assessment of the evidence quality was beyond the scope of this review (87). This review did not attempt to explore the relative importance of individual factors, instead presenting them as inter-related components of a healthcare encounter or encounters. The organisation of factors into a model may be controversial as the current guidance provided within CSLD literature on which factors should be prioritised is divergent: clinical presentation and contraindications (66); adherence in relation to the timing of inhaled medications (25); establishment of an effective regimen then address adherence (77); or, progression through previous response, physical factors, current response, then adherence (78). This review presents a model with ACT personalisation as a cyclical process, which holistically incorporates all factors which may be relevant for an individual at the time, permitting the prioritisation of factors to be done by physiotherapists at a case-by-case level. This provides a key difference to previously published literature and facilitates the application of the model to all age groups.

In his definition of evidence-based medicine as *"The conscientious, explicit and judicious use of current best-evidence in making decisions about the care of individual patients"* (p.71) Sackett, Rosenberg[22] implied that we should personalise care in the expectation of better outcomes. However, it is unlikely that routinely used lung function is sensitive to the changes brought about by personalisation (88). FEV_1 is commonly not responsive to a single ACT session (89, 90) and when a response is seen, it may be statistically, but not clinically significant (91). Patient reported outcome measures such as the St George's Respiratory Questionnaire or Leicester Cough Questionnaire, may provide insight into the longer term outcomes of ACT regimens(90). Biomarkers, such as the percentage of ventilation defects within the lungs identified by hyperpolarised gas ventilation MRI (92, 93) have the potential to detect changes in lung health (90, 94). As a more sensitive quantitative outcome measures, biomarkers could be used along with patient-important outcomes, such as exacerbation frequency, quality of life, and patient preference, in evaluating the effectiveness of care personalisation.

The clinical presentation of people with CSLDs is changing in terms of the timing and specificity of diagnosis, exacerbation frequency, lung function (95) and survival rates (96). As the needs of people with CSLD change, it is vital that physiotherapists can effectively navigate the personalisation of ACT regimens to allow them to be responsive clinical decision makers.

A number of recommendations for future research pertaining to ACT personalisation were found within the literature. There is a warrant for research to provide a better understanding of how to identify individuals who may respond well to certain ACTs regimen components (28, 47). ACT regimens are complex and there is a call for more transparent reporting of the regimens completed by study participants (12, 60),

which the TIDieR checklist (21) would be well placed for. With known limitations of randomised controlled trials in airway clearance research (97), consideration should be given to trial designs which permit adaptation of interventions (98, 99) to facilitate exploration of personalised ACTs and research which is more reflective of physiotherapists' practice.

Conclusion

This scoping review has synthesised the current literature on personalising ACT regimens in CSLD. There was variance in the frequency and distribution of factors in the literature. There is uncertainty if equal consideration is given to all the components of ACT personalisation and if decision making in this field varies between individual clinicians. The findings suggest the personalisation of ACT regimens is a complex area with multiple factors considered by physiotherapists in an iterative process.

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Figure 1: PRISMA flowchart with literature identification and screening details.

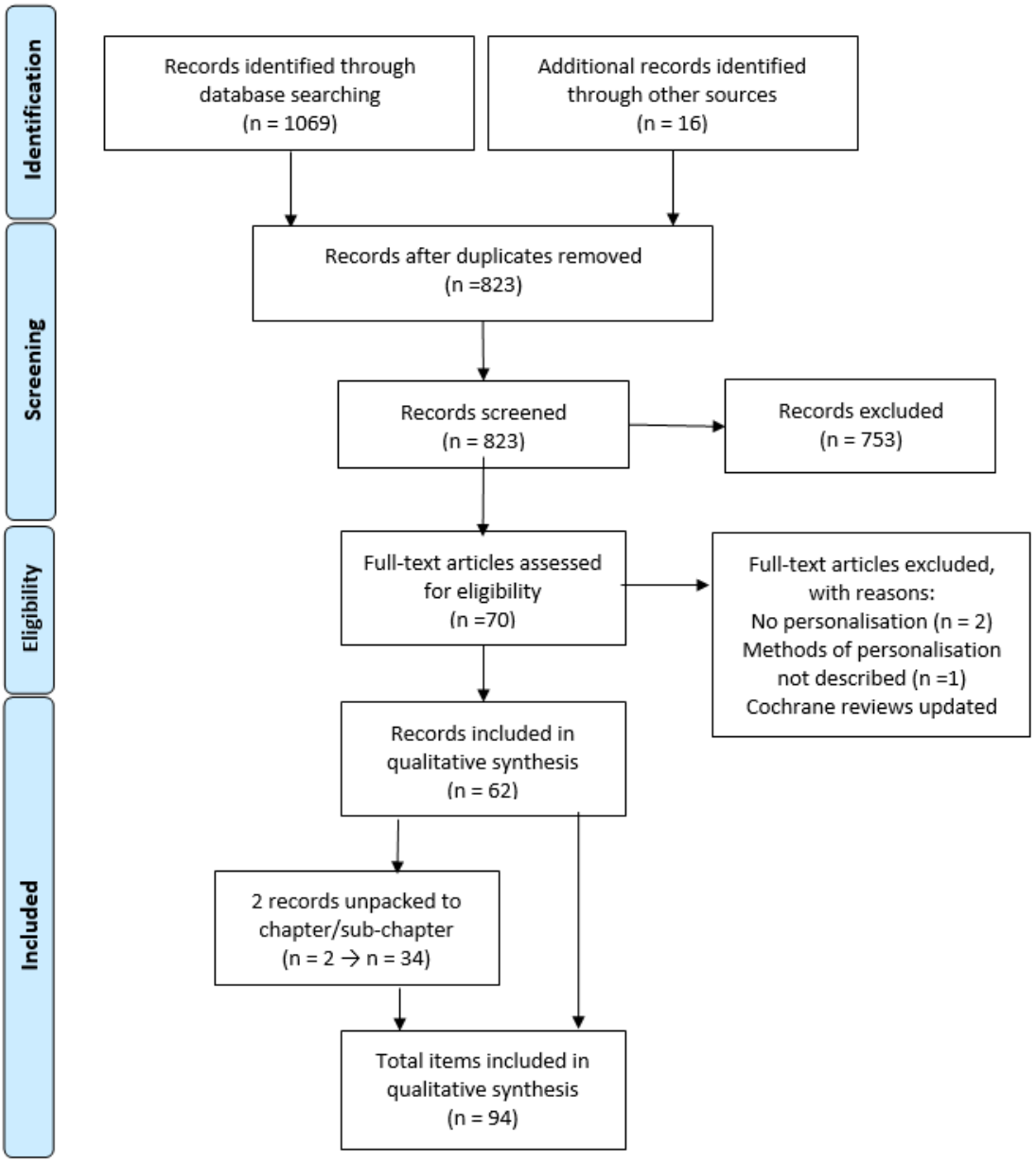

Figure 2: ACT personalisation model