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Contents

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Introduction

Amit Kulkarni
RCSLT research and development manager

With the amount of speech and language therapy research out there growing by the day, the RCSLT often gets requests from members for evidence summaries. Our 'Ask the Experts' pieces, where we hear from leading experts within a clinical field, are one way we try to provide such summaries. Normally, these are published as individual articles in *Bulletin*, answering a specific clinical question. However, it is with great pleasure that this time around, I am able to introduce not one, but six fantastic pieces addressing aspects of assessment and intervention for developmental speech sound disorder (SSD).

Written by the Child Speech Disorder Research Network (CSDRN), a group of expert clinicians and researchers specialising in this area, the articles introduce the CSDRN group, then go on to provide up-to-date, evidence-based commentaries about key issues when working with children with SSD, such as risk factors for persistent SSD, transcription, analysis, and much more.

Together, these pieces provide a wealth of expertise on various aspects of SSD and I would very much like to thank the CSDRN for writing them for us. I hope those of you reading this special issue will agree it is an invaluable, go-to resource, informing key components of our evidence-based approach to assessing and supporting children with SSD.

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With thanks to all the members of the CSDRN:

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What is the Child Speech Disorder Research Network?

Victoria Joffe and Jan Broomfield introduce the Child Speech Disorder Research Network and present an overview of its work

The Child Speech Disorder Research Network (CSDRN) was established in 2011. Its aim was to provide a forum for specialist clinicians to develop a collaborative approach in addressing issues relating to this client group and to drive the research agenda, while working closely with the RCSLT and other stakeholders. The network also acts as a reference group for clinicians and researchers working in the field, in particular through speech clinical excellence networks (CENs).

The CSDRN meets twice yearly to discuss key issues, and while the objectives of the network have developed over time to meet the needs and priorities of the profession, its current terms of reference are as follows:

- To raise the profile of child speech disorder within the profession.
- To promote and facilitate the implementation of evidence-based practice with this population.
- To drive the research agenda through building research links and identifying opportunities, both within and beyond the network.
- To provide expert research and clinical knowledge.

The network consists of 15 SLTs who have a depth of knowledge, experience, understanding and skill within this specialism, and also a track record in research, clinical work and/or teaching in the field of child speech disorder. There is representation in the network from across the UK, from universities offering speech and language therapy courses, and from specialist clinicians and clinical services, including those who work with children with cleft palate and children with hearing impairment.

Research priorities

As part of our work, we surveyed the research priorities for the profession at the 2014 RCSLT conference, where members of the network led a workshop, using nominal group technique, to identify, explore and prioritise clinical research priorities. During the workshop, delegates were invited to respond to a range of questions on service delivery in the area of child speech disorder, and the information generated is helping to inform the research agenda for this clinical group, with its foundations firmly embedded at grassroots level.

Although children with speech sound disorder (SSD) form nearly half a typical paediatric caseload (Mullen and Schooling, 2010), few are seen by SLTs specialising in child speech disorder (Pring et al., 2012). Child speech disorder is a complex field, comprising a range of clinical subtypes with different presenting characteristics and underlying aetiology, including those with a known cause such as cleft palate or hearing impairment, as well as those with delayed or disordered phonological or motor development. There is a range of underlying theoretical models, leading to varying terminology, and each clinical presentation has different prevalence rates. For example, of those children presenting to clinicians, research based on the Dodd classification showed that 40% will have a disordered developmental clinical profile. Of these, 25% will have an articulation disorder, 25% inconsistent phonological disorder, 50% consistent phonological disorder, and fewer than 1% developmental verbal dyspraxia (DVD) (Broomfield and Dodd, 2004).

McLeod et al. (2012, p.1) define SSD as: 'Any combination of difficulties with perception, articulation/motor production, and/or phonological representation of speech segments (consonants and vowels), phonotactics (syllable and word shapes), and prosody (lexical and grammatical tones, rhythm, stress and intonation), which may impact on speech intelligibility and acceptability'.

There is evidence that different profiles require different intervention targets and approaches. It is essential therefore that appropriate transcription and analysis is undertaken to identify the particular clinical profile, and plan optimum evidence-based intervention.

Guidelines

The CSDRN has developed two sets of guidelines to support clinicians and students working with children with SSD.

- The *Good Practice Guidelines for Transcription of Children's Speech Samples in Clinical Practice and Research* includes a decision-making flowchart that can be used to determine when screening data is sufficient to identify speech difficulties, versus when further sampling of single words and connected speech is required. It also explores why accurate transcription is essential to understanding a child's speech profile; explains and describes best practice in transcription; and advises clinicians as to how and when to transcribe child speech.
- The *Good Practice Guidelines for the Analysis of Child Speech* outlines a systematic approach to the phonetic/phonological analysis of a child's SSD, supported by an evidence-based rationale for why such areas require investigation. Guidance is provided for when a more in-depth phonetic/phonological analysis is preferential to a more basic analysis such as identification of a phonological error pattern.

Both sets of guidelines are based on current evidence and consider the individual needs of the client, as well as the realities of speech and language therapy practice. They were both deemed essential pieces of work, since phonetic transcription and analysis skills are core aspects of SLT training and practice (Health and Care Professions Council, 2013), informing choice of intervention and target selection, as well as providing critical baseline and outcome data (McLeod and Baker, 2014). However, NHS systems preclude storage of audio/video recordings and transcriptions, and large caseloads constrain the time available for detailed transcription and analysis. The guidelines have been developed to support SLTs in clinical decision-making, and to justify the time and skills required when undertaking in-depth transcription and analysis for specific, severe cases.

Implementation should help inform accurate differential diagnosis, appropriate target selection and choice of intervention, leading to therapy that is both efficient and effective, saving time in the longer term.

Feedback

The network is currently exploring how best to conceptualise and frame speech disorder within the new developmental language disorder category, and how to categorise children with speech disorders without concomitant language disorder. The CSDRN disseminates information online through its website (see **bit.ly/CSDRNonline**) and on Twitter (**@CSDRNetwork**). We encourage RCSLT members to visit both to see the breadth of areas we cover.

We maintain a profile at relevant conferences at a national and international level, including posters, verbal presentations and workshops (including at the RCSLT's 2017 conference, for example). We also welcome feedback and encourage SLTs to get in touch with us for further information or to explore any areas of concern or interest about child speech.

As children with SSD form a large proportion of paediatric caseloads, and given the relatively strong evidence base for the effectiveness of speech and language therapy with this group, we hope this special publication helps to support and guide you further in the assessment and evidence-based management of this client group.

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"Although children with SSD form nearly half a typical paediatric caseload, few are seen by SLTs specialising in child speech disorder"

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For further information about the network, visit bit.ly/CSDRNonline

To view the CSDRN's *Good Practice Guidelines*, visit bit.ly/CSDRNguidelines

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How do we identify children whose speech problems are unlikely to resolve?

Yvonne Wren explores the evidence base for predicting persistent speech sound disorder in children

Children with speech sound disorder (SSD) make up a large percentage of many paediatric SLTs' caseloads (Mullen and Schooling, 2010). We know that prevalence estimates vary, but there is consensus that referrals decrease with age, with approximately 75% of children with speech difficulties in preschool having typical speech by age 6 (Shriberg, Tomblin and McSweeny, 1999). Our challenge in clinical practice then is to reliably identify which children are likely to have persistent speech sound disorder (PSSD) from those whose difficulties will resolve spontaneously.

Recent evidence by Dodd and colleagues shows that children presenting with disordered rather than delayed patterns are more likely to have PSSD. However, although disordered speech patterns at 4 years were twice as likely to be associated with persistent problems at 7 years, a third of children with speech delay still had difficulties three years later (Dodd et al., 2017; Morgan et al., 2017). So while these findings have clear clinical implications, they suggest that type of speech error alone is not sufficient to identify risk for PSSD. Moreover, as many children are referred to speech and language therapy in the UK before age 4, there is a need to identify markers that can be observed in younger children so that services can prioritise early intervention for those who are at higher risk.

Risk factors

A number of reported studies have considered a wide range of potential risk factors for PSSD using a variety of research designs. These have produced conflicting findings, explained at least in part by differences in definitions of PSSD, sample size and age range under observation. There are some common findings relating to demographic factors and family/environmental factors, but none consistent across all studies. Similarly, factors relating to early development including the use of dummies, delays in language development, difficulties with feeding and dribbling, and co-morbidities with medical conditions, were identified as risk factors by some and not by others. (For a review of these papers, see Wren et al., 2016.)

Many of these findings were based on case control or patient cohort studies, limiting the sample to children who had been referred to speech and language therapy. Population studies solve this problem by including all children within a given geographical area. One such study was the Avon Longitudinal Study of Parents and Children (ALSPAC). Expectant mothers were recruited to the study and they, their partners and offspring have been followed up over the subsequent 25 years. Speech data collected from participants in this study facilitated identification of a subgroup of children with PSSD at age eight (Wren et al., 2016). Utilising data available in the wider ALSPAC study, it was possible to look at associations between variables and outcomes to identify risk factors for PSSD.

A number of variables were identified as important for predicting risk for PSSD in the ALSPAC sample; however, a subset showed greater relevance. For example, low socio-economic status was associated with a 50% increased likelihood of PSSD at age 8. Similarly, children in the study were twice as likely to have PSSD if they had ever had

grommets fitted or had a history of hearing impairment. These findings are generally unsurprising, having been previously reported, and are likely to align with SLTs' own clinical experience.

While these findings are of interest, they are unlikely to change what we do in clinical practice. However, the findings from the analyses do have a direct clinical relevance and can be used in evidence-based care pathways for clinical decision-making. Specifically, the study found an increased risk of PSSD was observed in children who were not combining words at 24 months, and in children who demonstrated poor use of word morphology at 35 months (Wren et al., 2016).

PSSD predictors

One of the strongest predictors of PSSD in the dataset was intelligibility. In particular, children whose mothers reported that they were unintelligible to strangers at age 3 were 140% more likely to have PSSD at age 8. Routine assessment of intelligibility at age 3 of individual children presenting to SLTs, using a tool such as the Intelligibility in Context Scale (McLeod, Harrison and McCormack, 2012), now available in 60 languages, could aid identification of PSSD risk.

Some results of the analyses were surprising and throw up some interesting points to consider with regards to our understanding of the nature of PSSD. A pattern of weak sucking in infants at age 4 weeks was associated with PSSD, as was a history of reports of poor coordination.

To summarise, a number of markers relating to speech presentation and to other non-speech factors have been identified in the literature as risk factors for PSSD. In order to fully understand the predictive value of these factors, a longitudinal study of children referred in the early years with concerns about their speech is necessary. In the meantime, the findings summarised in this article can be used to provide an evidence-based approach to clinical decision-making regarding prioritisation for early intervention for speech disorders.

Who is at risk of PSSD?

The figures in brackets indicate the degree of increased risk of PSSD—100% is equivalent to doubling the risk. A combination of factors is likely to increase the total risk compared with the presence of just one or two factors.

- Low socioeconomic status (50%)
- Unintelligible to strangers at age 3 (140%)
- Not combining words at age 2 (80%)
- History of weak sucking at 4 weeks (40%)
- Poor with word morphology at age 3 (unquantified)
- Patterns of speech disorder rather than delay at age 4 (100%)
- More likely to be reported as having had coordination problems before age 8 (100%)
- More likely to have had grommets or hearing impairment before age 8 (100%)
- More likely to struggle with nonword repetition (unquantified)

(Dodd et al., 2017; Morgan et al., 2017; Wren et al., 2016)

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"Children who were unintelligible to strangers at age 3 were 140% more likely to have PSSD at age 8"

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Transcription of children's speech in clinical practice and research: Why and how?

Jane Speake and Jocelynne Watson outline the importance of phonetic transcription in the assessment and management of children with speech sound disorders

The *Good Practice Guidelines for Transcription of Children's Speech Samples in Clinical Practice and Research* was the first set of guidelines produced by the CSDRN. As a group, we strongly advocate the need for principled and careful phonetic transcription. The information provided in these guidelines can contribute to the care of many client groups (Knight, 2018) and is critical for clinical decision-making for children with speech sound disorders (SSDs).

These children form a significant part of the caseload for most paediatric SLTs (Dodd, 2014) and arguably remain a touchstone group for the profession. Assessment and management require knowledge and skills that are unique to the SLT. These children differ widely in presentation, from being essentially unintelligible to those whose speech is almost typical—but even within these extremes the underpinning difficulties and speech patterns can vary widely. One child who cannot be understood may be functioning with a very small inventory of sounds, relying on a few vowels, intonation and gesture. Another can have a large inventory which is compromised by non-system sounds or multiple phonological processes that can operate consistently, inconsistently (i.e. different productions of the same item) and/or variably (i.e. conditioned by word position or phonetic context). A child with seemingly few sound difficulties can still be at risk of problems with social inclusion on account of unusual or indistinct pronunciation. For these reasons, clinical decisions remain challenging.

Given the prevalence of the difficulty, there is a particular imperative to ensure that children presenting with SSD are appropriately triaged, and assessment and management is efficient. On the one hand, SLTs have the professional skills, underpinned by a comparatively rich research literature to support assessment and treatment, and strong historic evidence that intervention is effective (McLeod and Baker, 2017). We can also distinguish clinically useful sub-groups (Waring and Knight, 2013) and can provide a detailed longitudinal profile of the strengths and weaknesses of any individual system. On the other hand, there are reports from some areas that assessment beyond a minimal screen and intervention for SSD beyond a generic group or consultancy approach is no longer available. The CSDRN is concerned about the evidence base for this radically different approach.

Why transcribe?

Learning phonetic transcription is a mandatory part of pre-registration speech and language therapy programmes (RCSLT, 2018). The purpose is to ensure that clinicians have objective and analytical listening skills and can systematically describe and document the articulatory and acoustic characteristics of any individual's speech system. The analysis also serves to highlight any explicit links between the speaker's perceptual and expressive ability.

While transcription can be criticised on the basis of transcriber subjectivity and thus reliability (Howard and Heselwood, 2002), it is also acknowledged to be the gold standard in clinical practice (Howard and Heselwood, 2011). It provides the best accessible means of identifying individual patterns affecting both intelligibility and acceptability of children's speech, and thus appropriate evidence on which to base principled clinical decision-making in the following areas (*Transcription Guidelines*, RCSLT, 2017):

- Differential diagnosis
- Establishing the nature and extent of difficulties
- Taking on a duty of care
- Selecting intervention approach
- Measuring change/effectiveness

Transcription also aids the efficient transfer of information between therapists and, importantly, it contributes unique information within the multidisciplinary team.

Referring professionals, carers, or the speakers themselves can often identify the presence of a few obvious structural or segmental speech issues (e.g. cluster reduction or velar fronting). The SLT is charged with adding professional value. If transcription data and analysis is not available, it is hard to demonstrate the basis on which the SLT is able to provide direct speech work or offer appropriate advice for indirect intervention.

Assessment without transcription arguably leaves us equipped only for very general consultancy advice, or work on listening and attention. There is a risk that the speaker's profile is not adequately described and recorded. This includes clinically important features such as inconsistency; variability influenced by phonetic context; and changes over time. Without a confident understanding of these factors and their influence in the developing speech system, there is a danger of misdiagnosis, less efficient target selection and inefficient or even ineffective intervention (*Transcription Guidelines*, RCSLT, 2017).

Transcription data are appropriately part of any initial assessment process and are then useful to measure points of change, to establish outcome, or to more regularly monitor when progress is limited and target-setting needs adjustment.

Where concerns about SSD are identified, a minimum sampling might be:

- Single word screening and further targeted probing to examine presenting patterns. Standardised tests typically do not capture enough examples of patterns relevant to individual children (McCrae, 2017). Supplementary data may be required to examine vowel production; variability conditioned by word position and phonetic context; inconsistency; and production of multi-syllable words (Bernhardt and Holdgrafer, 2001).
- Small connected speech sample. This allows assessment of intelligibility and suprasegmental/prosodic features such as rate rhythm and intonation. Simultaneous audio recordings are desirable for all children but essential for those with severe or complex SSD (Bates and Watson, 2012).

We know that all SLTs are trained to a high level in phonetic transcription, but regular practice is needed to maintain and enhance both skills and confidence. More experienced clinicians will have worked with a wider range of children (and may have more specialist responsibilities), but often the child's first contact will be with a clinical generalist, so competence at team level is important. Team skills can be enhanced with in-service training, allowing discussion and calibration of transcription for children with unusual speech characteristics. Routine use of the International Phonetic Alphabet (and extensions) and phonetic/phonological charts, and checklists for connected speech processes, aid both training and information sharing within and across services.

Recommendations

Transcription takes time to complete. Including time for analysis and planning should be seen as part of the child's allocated therapy time not only at initial assessment but at all appropriate points during intervention. It should be transparent to families and providers that this is integral to the package of care.

Data collected form part of the child's health record and should be stored accordingly, and consent to this should be discussed and agreed with parents/carers and documented in the notes. Issues relating to electronic collection of transcription data (both written phonetic fonts and audio/video recordings) may need resolution at a national level.

Both the RCSLT and Health and Care Professions Council rightly recognise the importance of transcription as a core skill for SLTs. It contributes uniquely to the provision of effective and efficient care of children with SSD, and requires our professional commitment to ensure that sufficient time and attention are allowed for both the maintenance and ongoing development of this aspect of clinical practice.

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"Assessment without transcription arguably leaves us equipped only for very general consultancy advice"

References & resources

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How should SLTs analyse child speech?

Sally Bates and Jill Titterington

As discussed in the previous article, a phonetically transcribed representative sample of a child's speech is the fundamental first step to support effective clinical decision-making for children with speech sound disorder (SSD). It underpins subsequent systematic and principled analysis of the child's speech, which is also an integral part of an SLT's assessment for children with SSD (McLeod and Baker, 2017; 2014; Howard and Heselwood, 2002). Phonetic and phonological analysis of a transcribed speech sample provides the SLT with in-depth understanding of the child's phonetic capabilities, phonological skills and productive phonological knowledge (PPK); i.e. how he or she is using sounds in words. The findings from this analysis are the foundation stone on which accurate differential diagnosis, and selection and sequencing of appropriate intervention approaches, rest. Knowledge of a child's PPK and the sounds for which they have most or least PPK also inform prioritisation of therapy targets. Regular repeated transcription and analysis (i.e. through the use of probes and baseline measures) also allows the SLT to monitor progress in therapy and change the intervention approach or targets as appropriate. Importantly, it also provides the SLT with evidence that can be used to demonstrate the effectiveness of intervention and hence the value of SLT services.

The CSDRN's guidelines

The CSDRN's *Good Practice Guidelines for the Analysis of Child Speech* start by considering terminology and the importance of distinguishing a child's phonetic and phonological skills. The SLT can then review key analysis approaches and measures, including the following:

- Phonetic and phonemic inventory: singleton consonants, clusters, vowels and word structures.
- Process analysis: natural phonological processes and atypical/non-developmental patterns.
- Variability in production: progressive and non-progressive variability and inconsistent production of the same lexical item.
- Systemic (or contrastive) analysis and detailed measures of PPK.
- Connected speech processes and analysis of prosodic features.

Throughout the guidelines, red flags are used to highlight points of interest and support clinical thinking and decision-making in relation to specific aspects of analysis (see Figure 1 below for an example).

Figure 1

Identifying patterns of multiple phoneme collapse assists selection of therapy targets and approach; e.g. multiple oppositions <dare, share, care, tear, chair>, maximal oppositions <lip vs. dip>, empty-set <lip vs. ship>.

Areas for potential further assessment are also discussed. A checklist tool has been developed which aims to support SLTs to pull together all their analysis on one child, summarising all their findings in one place. This checklist tool can be used to support auditing of current practice and/or to perform more in-depth analyses (see Figure 2 below). A list of useful resources is also included in the guidelines' appendices.

Figure 2: Initial sheet of the Checklist for Speech Analysis (find the complete checklist in the CSDRN Guidelines)

CHECKLIST FOR SPEECH ANALYSIS								
NAME:	DOB:	DATE:						
CONSONANTS								
PHONETIC INVENTORY (PI) AND PRODUCTIVE PHONOLOGICAL KNOWLEDGE (PPK): Circle any sounds the child uses (whether correctly or incorrectly) (PI). Underline any sounds never used correctly by the child (providing more information on the child's PPK) NB. Sounds remaining will obviously not have been tested AND sounds that are both circled and underlined are those which are in the child's PI but never used correctly in words								
Singletons: p b t d k θ m n ŋ f v θ ð s z ʃ ʒ h tʃ dʒ w ɹ l j other: (i.e.,/?/) **Clusters:** Word initial: pl pɹ bl bɹ tw tɹ dw dɹ kw kl kɹ gl gɹ fl fɹ θɹ sp sm sw st sn sl sk spl spɹ stɹ skw skɹ Word final: mp nt nd ŋk ft sp st sk lp lt ps bz ts dz ks gz pt bd kt ɹp ɹb ɹd ɹts ɹn other: Word medial – consonant sequences that may or may not cross a syllable boundary (specify):								
SUPPLEMENTARY STIMULABILITY ASSESSMENT FOR PHONES WITH LIMITED TO NO PRODUCTIVE PHONOLOGICAL KNOWLEDGE (list those that are stimulable and not stimulable):					STIMULABLE		NOT STIMULABLE	
Optional: PCC (correct singletons/total singletons x 100 = %) =	% onset clusters correct =				% final clusters corrects =			
List phonetic level errors, i.e. dentalisation:								
PATTERNS AND PROCESSES (with age of suppression if known, in parentheses (Grunwell, 1987))								
Typical/atypical phonological processes/ patterns	Redup (2;0)	WSD (4;0)	FCD (3;3)	H-del	V.Insert	Cl.Red (4;0)	CH (4;0)	Seq.err

Case by case

A comprehensive analysis is not always possible, or indeed warranted, for every child, so guidance is provided with respect to the clinical value of individual analysis measures, and where more detailed profiling of a child's speech presentation is necessary. In particular, the guidelines recommend a more in-depth systemic (or contrastive) analysis in the case of: children presenting with persisting speech difficulties at school-age, or in moderate, severe or complex cases where there is evidence of atypical patterns; widespread variability in production; and/or multiple phoneme collapse (i.e. one phoneme is used to substitute many) (see also Skahan et al., 2007).

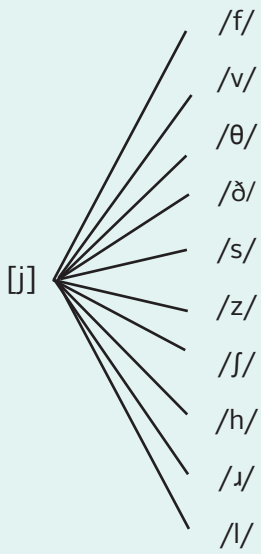
Let's consider the case of Stanley, aged 5 years and 6 months, whose transcribed speech from the *Diagnostic Evaluation of Articulation and Phonology* (Dodd et al., 2006) has been analysed using the Phonetic and Phonological Systems Analysis (PPSA) (Bates and Watson, 2012)—one of several tools that may be used for this purpose as outlined in the guidelines (see Figure 3 overleaf).

"There are clear ethical and economic reasons... to support the time required for SLTs to complete systematic and appropriately detailed analysis"

→

Figure 3: System-wide (contrastive) analysis using the PPSA providing a detailed measure of PPK and clearly highlighting the pattern of phoneme collapse

Name: Stanley		Date/age:/5;6			Data used: DEAP screen + phonology assessment						Place	Manner
PI	Target	Correct realisation			Errored realisation			Deletion				
		WI	WM	WF	WI	WM	WF	WI	WM	WF		
✔	p		−		b	b					Front-back	Oral stops/plosives
✔	b	III	II	II		b						
✔	t	≡		−	dbd					I		
✔	d	I	≡			bbb				I		
✔	k	−	=	II −	d	???	?					
✔	g		−	=		d				III		
✔	m	I		I							Front-back	Nasals
✔	n	I		IIII								
	ŋ			≡			nnnn					
	f	≠	≡	=	jjjjj	jjj				III	Front-back	Fricatives
	v	−			j							
	θ	≡		−	jj					I		
	ð	−	−		j	j						
✔	s	≡	−	I −	jjjj	j				II		
	z	−	≡	≡	j	jjj	jj			I		
	ʃ	−	≡	=	j	jjj				II		
	ʒ											
	h	≡			jjj							
	ʧ		−	≡		?				III	Affricates	
	ʤ	−		=	d					II		
✔	w	III −			b						Front-back	Appointments
	ɹ	−	=		w	jj						
✔	l		≠ ≡	II	j	jjjjjjjj						
✔	j	I										
	ɹ										Rhotic	



Other errors (e.g. sequencing errors, consonant harmony)

THESE ARE ANALYSED ON THE SINGLETON AND CLUSTER TABLES IN BLUE:

[ˈbaɪbə] x3 (ch), [bab] (ch), [ˈbɔbi] (ch and weak syllable deletion), [bɛb] (ch) [ˈbubʌ] (redup); [jʌmˈbɛjə] x3, [ˈjɛjɪˈʔɒbə] x 3, [ˈjɛjɪˈjənt] x3, [ˈjɒjɪn], [jɛ], [ˈjabəl], [jiə] (consonant insertion); [ˈmadəʊ] (weak syllable deletion (not analysed above))

To support interpretation of the PPSA for those unfamiliar with it, the consonant singleton chart shown in Figure 4 (right) has three main sections: correct realisation, errored realisation and deletion. These main sections are further divided into three columns to represent the different positions in the word possible for the target phoneme: WI (word-initial), WM (word-medial) and WF (word-final). A worked example is provided in Figure 4, in which a child realises /bai/ ‹bye› and /bip/ ‹beep› as [bai] and [ib] respectively.

Figure 4: Worked example to aid interpretation of Stanley's PPSA

PI	Target	Correct realisation			Errored realisation			Deletion			Place	Manner
		WI	WM	WF	WI	WM	WF	WI	WM	WF		
	p			—			b				Fr	Oral s
✔	b	| —						|				

For the child's correct realisation of [bai], a vertical tally mark is placed in the WI column within the correct realisation section for the target /b/ to show that it is produced correctly in this instance. The PI column is also ticked to indicate that [b] is part of the child's phonetic inventory. For the child's realisation of /bip/ > [ib] the initial /b/ has been deleted and the final /p/ has been voiced. In this instance, a horizontal tally or dash is placed in the WI column for the target /b/ to show that the phoneme has not been realised correctly within the correct realisation section, and a vertical tally mark is also placed in the WI deletion column to illustrate that it has been deleted in this position. Voicing of word final /p/ to [b] is captured by firstly placing a horizontal tally or dash in the WF correct realisation column to indicate that it is not realised correctly in this position in this instance, and the substitution used ([b]) is placed in the errored realisation WF column. If the child had not used [b] for [bai], we would still be able to tick the PI column against the target /b/ to show that the child has this phone in their phonetic inventory in their incorrect realisation of /bip/ > [ib].

Considering Stanley's completed singleton chart using the PPSA then (see Figure 3), the analysis clearly shows that he presents with a system-wide phoneme collapse to the glide [j]. It can be seen that this thorough analysis of Stanley's SSD easily and clearly supports a differential diagnosis of pattern-based phonological errors, and in particular his system-wide phoneme collapse, allowing clinically informed reflection to support the choice of both an optimal intervention approach and possible targets to select for this child.

Support for clinicians

The evidence-based use of SLT resources requires that intervention is not only effective but also efficient, helping children with SSD realise their potential as soon as possible. We hope that the CSDRN's analysis guidelines will support clinicians in their analysis and interpretation of phonetic transcription data and, consequently, their differential diagnosis, prioritisation of therapy targets and choice of optimal intervention approach (see McLeod and Baker, 2017 for some useful further direction on evidence-based selection of targets and therapy approaches). SSDs are one of the most prevalent presenting conditions for paediatric SLTs (McLeod and Baker, 2017). There are thus clear ethical and economic reasons for commissioners to support the time required for SLTs to complete systematic and appropriately detailed analysis. Despite this, it is clear from research into the current practice of SLTs that services tend to provide a more cursory surface analysis of speech data than outlined in the CSDRN's guidelines (Skahan et al., 2007). There may be a range of reasons for this, including time pressures, but also factors related to confidence, skill-level and so forth (Skahan et al., 2007). The current guidelines aim to synthesise and distil the evidence base around the analysis of disordered speech, providing step-by-step support to best inform clinical decision-making. We therefore hope that these guidelines can also be used by services to justify the level of resource required to enable SLTs to utilise, maintain and develop their unique skills in transcription and analysis and deliver high-quality, evidence-based provision.

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The CSDRN guidelines can be downloaded from: bit.ly/CSDRNguidelines

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Intervention for children with phonological speech sound disorders

Helen Stringer and Jane Speake consider the evidence for interventions for children with the most commonly seen group of speech sound disorders

As we have seen in Yvonne Wren's article on p6, knowledge of the risk factors for persistent speech sound disorders (PSSDs) potentially enables us to more accurately identify children who would benefit from intervention from as young as 3–4 years old. Appropriate data collection and analysis will guide us to diagnostic labels and the choice of intervention. This article will consider the evidence for interventions for the most commonly seen group of children with SSD: those with a differential diagnosis of phonological delay or disorder (Broomfield and Dodd, 2004) and age-appropriate phonological awareness skills. However, it is important to stress that other children may require different interventions, which is why good data analysis and diagnosis are so important.

Therapeutic content

There is a growing evidence base for interventions for phonological delay or disorder, with a number of high-quality studies. Interventions found to be effective in increasing intelligibility are: minimal pairs, maximal oppositions, empty set, multiple oppositions and cycles (Baker and McLeod, 2011; Law et al., 2017; Law et al., 2012). These are all types of phonological contrast intervention (further information on some of these approaches can be found in the *What Works?* database and in the numerous published evidence reviews).

There is mixed evidence about the effectiveness of SLTs delivering interventions for SSD compared with delivery by non-SLTs (parents, teaching assistants, etc.). In their 2003 systematic review, Law et al. found that intervention for SSD had the greatest effect when delivered by an SLT. However, interventions were also effective when additional work was carried out by a trained parent. The level of training is important, as is provision of sufficient resources and continued monitoring and support from an SLT (Lancaster et al., 2010).

How much therapy a child receives is a crucial aspect of intervention planning. Too little (under-learning) can render the best intervention ineffective, so we need to be careful that we do not spread our interventions too thinly or cease intervention too early. The research that relates to over-learning (Kaipa and Peterson, 2016; Zourou et al., 2010) indicates that it can support the transfer of skills to new contexts. Over-learning happens when the child is supported to develop skills at a level above a typically developing peer, giving them a higher level of competence in that particular area. Overlearning may also address the capacity versus competence issue discussed in the context of grammatical learning by Bishop (1994), i.e. when children demonstrated competence early in an utterance or in sentences with low process demand, but as the context became more complex and process demand increased, their capacity was challenged and they made more errors.

Treatment intensity

We need to aim for the right amount of intervention for each child with SSD. Treatment intensity is a complex issue not completely addressed in the majority of current research. Warren et al. (2007) suggest five aspects that we should consider:

- **Dose (number of practice items):** the number of times an item is practised in a therapy session; e.g. the target phoneme in 20 target words repeated in three activities (=60 times) in a 30-minute session.
- **Dose form:** the activity that provides the practice; e.g. picture naming.
- **Dose frequency (or intensity):** the number of therapy sessions delivered in a period of time; e.g. daily, weekly.
- **Total intervention duration (episode of care):** the period of time over which intervention is delivered; e.g. half a term, eight weeks.
- **Cumulative intervention intensity:** derived from a calculation of *dose* × *dose frequency* × *total intervention duration*. This can be expressed in number of items, sessions or hours; e.g. 2,400 practice items, 40 sessions or 20 hours.

To determine optimum treatment intensity for SSD we have to combine this knowledge with our ongoing monitoring of the child and with information from research. Law et al. (2003) found that interventions were significantly more effective when they lasted longer than eight weeks (duration). Greater intensity of intervention is also more effective. For example, the same number of sessions delivered over eight weeks are significantly more effective than when delivered over 24 weeks, with the latter being equivalent to the non-treatment control group (frequency) (Allen, 2013). Within a 30-minute session it is essential to have between 50-100 practice items to effect change (dose) (Williams, 2012). To be effective, we should aim to have high-level intensity and frequency of delivery (Sugden et al., 2018, p725).

There is little research comparing group with individual intervention in SSD. However, data from practice (therefore treat with caution) indicate that the majority of speech interventions are delivered on an individual basis with limited use of groups (McLeod and Baker, 2014) and suggest that individual interventions for SSD are more effective than groups (ASHA, 2011).

Desired outcomes

To optimise our input, we need to deliver interventions that facilitate generalisation, since this is our desired outcome. This takes two forms:

1. Response generalisation is the process whereby taught responses carry over to behaviours that have not been included in the intervention; e.g. transfer from treated to non-treated words or across word positions, accelerating phonological change.

2. Stimulus generalisation occurs when a treated behaviour is evoked by different stimuli. This is typically evidenced by the child performing a behaviour with the SLT, then again in the classroom, then to a parent, and again to different stimuli (Bernthal et al., 2009). This type of generalisation is usually very easily built into service delivery; e.g. through targeted school and homework tasks.

In summary, the current best evidence indicates that the most effective intervention for phonological delay or disorder for children from 3-4 years of age is:

- a type of phonological contrast intervention;
- delivered by an SLT in a 1:1 session;
- supported by additional practice with a trained adult, monitored by the SLT;
- at least eight weeks in duration;
- at least three times per week with 50-100 practice items in each session; and
- designed to facilitate generalisation.

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How to differentiate and manage children with developmental verbal dyspraxia from those with inconsistent phonological disorder

Pam Williams and Jan Broomfield on supporting clinicians to make a differential diagnosis between the two conditions and plan appropriate evidence-based intervention

It is eight years since the RCSLT published a policy statement on developmental verbal dyspraxia (DVD) (RCSLT, 2011). Since then, a vast amount of evidence has been generated about the condition. Known as childhood apraxia of speech (CAS) throughout the rest of the world, DVD/CAS is rare, comprising only 0.1 to 0.2% of children with speech disorder (Shriberg et al., 1997). It continues to be over-identified, especially in very young children, and is often confused with inconsistent phonological disorder (IPD), which in contrast has a prevalence of around 10% of the speech-disordered population (Broomfield and Dodd, 2004). Both conditions are characterised by inconsistent production and poor intelligibility; however, they respond to different interventions and have different long-term outcomes and consequences.

Diagnosis

Theoretically, different levels of deficit are proposed for DVD/CAS and IPD in terms of speech processing models, with DVD/CAS being identified as a multi-level deficit, whereas IPD is identified as a single-level deficit. DVD/CAS sits primarily at the levels of motor programming and planning (ASHA, 2007; McCabe et al., 2018), whereas IPD sits at the level of the phonological plan (Ozanne, in Dodd 1995 and Dodd 2005). These different components of speech processing breakdown for DVD and IPD can be readily identified in Stackhouse and Wells' speech processing model (Stackhouse and Wells, 1997 p350). In DVD/CAS the primary breakdowns occurs on the output side of the model at the levels of motor programming and motor planning of speech, whereas in IPD the breakdown occurs in the creation and storage of phonological representations. Within the model proposed by Ozanne in Dodd (1995, 2005), DVD/CAS is also recognised as a motor-speech disorder involving multi-deficit breakdowns in phonological planning, phonetic (motor) programming and motor programme implementation. Again, IPD is identified as resulting from a single deficit at the level of phonological planning.

Inconsistent production of consonants, vowels and phonotactic structures on repeated trials of the same word is central to IPD. It is also a key feature in the diagnosis of DVD/CAS (ASHA, 2007), alongside lengthened and disrupted co-articulatory transitions between sounds and syllables, and inappropriate prosody (particularly stress). Other features of DVD/CAS include: poor diadochokinetic (DDK) rate and sequencing (e.g. of /p/, /t/, /k/); consonant and vowel errors; limited phonotactic structures (word and syllable shapes); increased difficulty with polysyllabic words; syllable segregation (noticeable gaps between syllables); imitation often poorer than spontaneous production; and poor intelligibility. Finally, DVD/CAS changes with age and stage of development.

In comparison, the phonological nature of IPD means that, unless the child has additional articulatory difficulties, there are no challenges in imitating age-appropriate consonants, vowels, phonotactic structures and words; their difficulty is in maintaining consistent production during spontaneous speech, being inconsistent in at least half the words produced. Further, they produce many atypical errors, with few systematic error patterns (phonological rules or processes) being apparent. This leads to extremely poor intelligibility, even to family members.

In-depth assessment

Initial in-depth assessment is key in differentiating DVD/CAS and IPD. It is essential to identify atypical errors and any apparent error patterns, but these must be evaluated in the context of performance on single sound inventory, oral examination, spontaneous naming versus imitation, as well as prosody. Performance on three repeated productions of the same word is an essential component of the assessment, if IPD is to be considered. Other papers in this series detail guidelines for clinicians that have been developed by the CSDRN in transcription and analysis, and readers are referred to these.

Detailed assessment of all relevant features, accurate transcription and in-depth analysis should lead to appropriate differential diagnosis of DVD/CAS and IPD. These conditions respond to very different intervention approaches, owing to the different underlying levels of deficit.

Core vocabulary (CV) therapy has been proven effective for IPD (Dodd and Poole, 2017).

Notably, there is also clear evidence that it is not the best approach for other speech difficulties e.g. consistent phonological disorder (CPD) or DVD/CAS. The hypothesis of CV is that inconsistent children do not apply phonological processing rules after they learn their first 50-100 words, so are unable to build phonological plans. This leads to inconsistent production of new words. A therapy bank of 50-70 new, highly functional words is identified, and 12 to 16 sessions of intervention focus on helping the child to formulate phonological plans, leading to consistent production. The child is then generally intelligible, presenting with age-appropriate speech or with consistent error patterns and ready to participate in conventional treatment.

In contrast, there is no single identified intervention approach for DVD/CAS, but evidence is growing for a number of therapies. Each follows several key principles:

- To create movement plans for speech sounds through motor learning principles
- To sequence and blend sounds together smoothly into syllables, words, phrases and sentences of varying complexity
- To address prosodic aspects of speech
- To mainly focus on addressing motor programming and motor planning

A high intensity of treatment is recommended (Baker 2012a; Baker 2012b), involving frequent therapy sessions delivered directly by an SLT, with a high number (100+ in a 45-60 minute session) of productions of target sounds and/or words. This should be supported by frequent opportunities to practise therapy exercises in between treatment sessions.

Good evidence currently exists for the following four approaches:

- Dynamic temporal and tactile cueing (DTTC) (Strand, 2009)
- Integrated phonological awareness (McNeill et al., 2009)
- Rapid syllable transition treatment (ReST) (sydney.edu.au/health-sciences/rest/)
- Nuffield Dyspraxia Programme (NDP3) (Williams and Stephens, 2012)

NDP3 and ReST currently have the best evidence, having been evaluated in randomised controlled trials (Murray et al., 2015; www.thecommunicationtrust.org/whatworks; McCabe et al., 2018).

It is clear that DVD and IPD have different presentations, different underlying deficits, and respond to very different intervention approaches. SLTs therefore need to carefully differentiate between the two, in order to maximise clinical effectiveness.

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"Initial in-depth assessment is key in differentiating DVD/CAS and IPD"

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The Miracle Factory.

Glossary

Acceptability: a subjective assessment of a listener's response to the question "How would you rate this person's speaking ability?" (Dagenais, Brown and Moore, 2006).

Atypical or non-developmental error patterns: error patterns that are not found in the speech acquisition of typically developing children; e.g. backing of alveolars: /tɒfi/ > [kɒfi] (<toffee> goes to <coffee>). Alongside delayed suppression of natural phonological processes, the presence of atypical or non-developmental error patterns is considered to be indicative of phonological disorder, or potentially developmental verbal dyspraxia/childhood apraxia of speech.

Childhood apraxia of speech (CAS): a neurological childhood SSD in which the precision and consistency of movements underlying speech are impaired in the absence of neuromuscular deficits; e.g., abnormal reflexes, abnormal tone (ASHA, 2007) (see also DVD).

Connected speech processes: common processes that are typically used when producing words in the context of utterances; e.g. <she wasn't careful> is often realised as [ʃi wɒzŋ kɛəful] where you can see the /t/ in the contracted negative is elided and the nasal has been produced in velar position because of the influence of the following /k/. These processes usually happen at word junctures and make speech sound 'acceptable' (as opposed to over-precise), rarely impacting on intelligibility. Children with SSD can have difficulties with these types of effects (both over- and under-using them), increasing their unintelligibility within the context of connected speech as opposed to when producing single words.

Consistent phonological disorder (CPD): an SSD where the child makes consistent use of one or more unusual (non-developmental) error patterns, such as initial consonant deletion or affrication of fricatives, in the absence of articulatory constraints (Dodd, 2017).

Child Speech Disorder Research Network (CSDRN) a forum for specialist clinicians who have developed a collaborative approach in addressing issues relating to SSD.

Developmental verbal dyspraxia (DVD): a condition in which the child has difficulty making and co-ordinating the precise movements that are used in the production of spoken language, although there is no damage to muscles or nerves (Ripley, Daines and Barrett, 1997; RCSLT, 2011). Outside of the UK, DVD is referred to as childhood apraxia of speech (CAS).

Inconsistent phonological disorder (IPD): an SSD where the child makes inconsistent productions of the same target word, in the absence of any phonetic constraints. It is determined by production of 25 target words in three separate trials, with a criterion of 40% inconsistent productions for a diagnosis, based on normative data (Dodd, 2017).

Intelligibility: the degree to which a listener understands a person's speech (McLeod and Baker, 2017).

Natural phonological processes: a set of speech patterns which typically developing children progress through developmentally as they mature, such as fronting of velars; e.g. /kɑ/ > [tɑ] (<car> goes to <tar>). Children with phonological impairment exhibit persistent use of natural phonological processes beyond the age where they would have been expected to have been suppressed. Natural phonological processes provide SLTs with a tool to describe these delayed phonological patterns.

Persistent speech sound disorder (PSSD): speech difficulties continuing beyond the period of typical speech development (Wren, Roulstone and Miller, 2012).

Phonemic inventory: lists the speech sounds that the child uses correctly when targeted. Capturing a child's phonemic inventory allows the SLT to calculate their PPK (see below) for different speech sounds, which can be useful to support target selection, as noted below.

Phonetic inventory: lists any speech sounds articulated by the child, regardless of whether they are used correctly, as substitutions, or whether or not they are found within the child's ambient language. Let's consider the case of a child who shows a pervasive pattern supported by the example here where /ʃi/ > [si] (<she> goes to <sea>) and /sop/ > [dop] (<soap> goes to <dope>). The voiceless alveolar fricative [s] is in this child's phonetic inventor; i.e. they can articulate it, but it is not used appropriately when targeted as yet. On the other hand, the final /p/ in <soap> is used appropriately when targeted and is therefore in both the child's phonetic inventory and their phonemic inventory (see above).

Phonetics: how speech sounds are articulated. SLTs are interested in whether speech sounds are produced accurately or not; e.g. /s/ > [s̻]. We capture the phonetic level of speech production using narrow phonetic transcription in square brackets (supported by the use of diacritics).

Phonology: how sounds are used contrastively within a language to signal meaning. At this level, we talk about phonemes as the meaningful sound units in the language; e.g. /t/ vs /d/ - /tɒfi/ vs /kɒfi/ (<coffee> vs <toffee>). We capture this using slanted brackets with broad transcription. All children attending SLTs with SSD may present with both phonetic and phonological difficulties, which means that SLTs should always allow for narrow transcription in their assessment.

Productive phonological knowledge (PPK): this measure captures how often a phoneme is realised correctly when it is targeted within the child's phonological system (Gierut et al., 1987). Valuable information can be obtained by considering the degree of PPK a child may have. For example, a phoneme that is never realised correctly or only realised correctly inconsistently in one syllable position in a child's sound system has limited to no PPK compared to a phoneme realised correctly 50% or 90% of the time it is targeted. The degree of PPK can indicate which phonemes may spontaneously emerge without intervention (those with more PPK) compared with those with limited to no PPK, which may require intervention to support their development (e.g. Gierut 1989, 2005; Gierut and Champion, 2001).

Speech sound disorders (SSD): an overarching term to describe difficulties with speech production and perception (includes phonological and articulation impairment, inconsistent speech disorder, childhood apraxia of speech (CAS) and childhood dysarthria (McLeod & Baker, 2017).

Systemic analysis: considers how effectively the child contrasts one speech sound with another in their speech system, and how this maps to the target phonology. It involves a system-wide analysis of a child's speech within the context of the target phonology and is dependent on collection and transcription of a representative speech sample in the first instance.

Variability: the nature of variability in a child's speech system needs to be carefully considered. Progressive variability tends to be apparent when a child's speech system is showing signs of development (Stoel-Gammon & Dunn, 1985); for example the child is starting to use /k/ in word final position following a back vowel, as in /bʊk/ (<book>), but not yet at the start of words before a high front vowel, as when /kip/ (<keep>) is realised as [tip] (<teep>). As shown in these examples, progressive variability is often influenced by context (context conditioning). However, widespread and inexplicable variability (Grunwell, 1987) and/or inconsistent production of the same lexical item (token-to-token variability); e.g. /ʌmbɹɛlə/ produced as [bɛlə], [ʌbɛjə], [bɛjə] indicate the presence of disorder and warrant further investigation and analysis to support an appropriate diagnosis of the nature of the child's difficulty.

References

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Conclusions and future directions

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Speech Sound Disorders (SSDs) are ubiquitous yet complex. Several of the articles in this series highlight the fact that SSD is a large proportion of the paediatric caseload (article 1, 2), yet there are still challenges in identifying which of these children are most likely to continue to have problems producing speech in line with their peers (article 2). It remains both a challenge and a necessity to transcribe and analyse the speech of these children accurately (articles 3 and 4), and to provide effective intervention of adequate dosage (article 5). We conclude our series of articles with an illustration of the complexity of differential diagnosis, and the impact this has on intervention choice, by highlighting the similarities and differences between inconsistent phonological disorder and developmental verbal dyspraxia (article 6).

We are sure that readers will agree that clinical management of SSD is not a 'one size fits all' approach. While some children with a straightforward pattern of phonological delay may require minimal transcription and analysis, other children with highly unintelligible speech require more of our resources, both to prevent misdiagnosis due to insufficient transcription and analysis, and to mitigate the risk of persistent SSD by providing effective intervention. By providing transcription (article 3) and analysis (article 4) guidelines we hope that we have provided clinicians with the tools they need to navigate the initial part of a client's journey from assessment through to accurate diagnosis. We hope that future guidelines might help clinicians to determine the best management plan for a client.

The CSDRN is confident that it is SLTs who have the unique skills required to help children with SSD to achieve intelligible speech and to prevent future social, emotional and academic difficulties (article 2). The network remains committed to raising the profile of this client group and contributing to the evidence base (article 1) and we welcome both feedback on our current guidelines (articles 3 and 4) and ideas for future guidelines that would be helpful for clinical practice with children with SSD.

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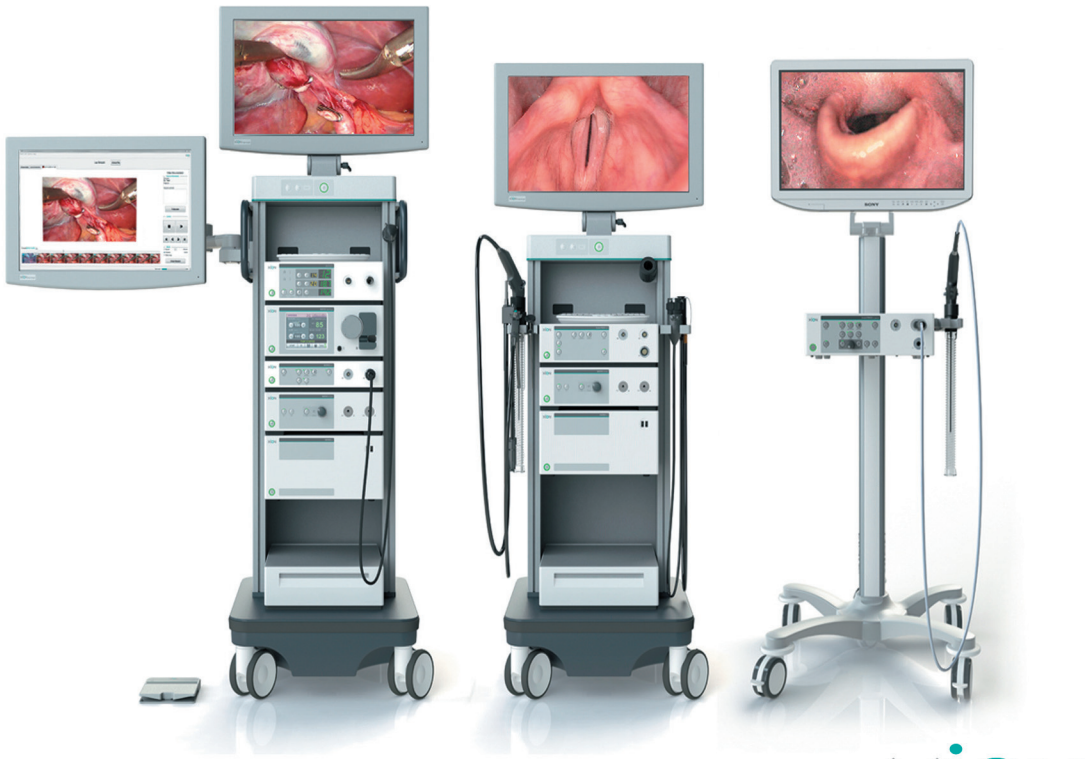

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Edited by Victoria Briggs and Amelia Dale

Clinical editor: Amit Kulkarni

Cover illustration: Paul Garland

Design: Yvey Bailey

Printing: Buxton Press

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